THIRTIETH ANNUAL REPORT

OF THE

Maine Agricultural Experiment Station

ORONO, MAINE

1914

STATE OF MAINE

1915.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

Organization January to June, 1914.

THE STATION COUNCIL.

PRESIDENT ROBERT J. ALEY,	*President*
DIRECTOR CHARLES D. WOODS,	*Secretary*
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LEONARD C. HOLSTON, Cornish,	*Maine Livestock Breeders' Association*
WILLIAM G. HUNTON, Readfield,	*Maine Seed Improvement Association*

AND THE HEADS AND ASSOCIATES OF STATION DEPARTMENTS, AND THE DEAN OF THE COLLEGE OF AGRICULTURE.

THE STATION STAFF.

ADMINISTRATION	CHARLES D. WOODS, Sc. D.	*Director*
	BLANCHE F. POOLER,	*Clerk*
	GEM M. COOMBS,	*Stenographer*
	JANIE L. FAYLE,	*Stenographer*
BIOLOGY	RAYMOND PEARL, PH. D.,	*Biologist*
	FRANK M. SURFACE, PH. D.,	*Biologist*
	MAYNIE R. CURTIS, PH. D.,	*Assistant*
	CLARENCE W. BARBER, B. S.,	*Assistant*
	JOHN RICE MINER, B. A.,	*Computer*
	HAZEL F. MARINER, B. A.,	*Clerk*
	FRANK TENNEY,	*Poultryman*
CHEMISTRY	JAMES M. BARTLETT, M. S.,	*Chemist*
	HERMAN H. HANSON, M. S.,	*Associate*
	EDWARD E. SAWYER, B. S.,	*Assistant*
	ELMER R. TOBEY, B. S.,	*Assistant*
	HAROLD P. VANNAH, B. A.,	*Assistant*
	HARRY C. ALEXANDER,	*Laboratory Assistant*
ENTOMOLOGY	ALICE W. AVERILL,	*Laboratory Assistant*
	EDITH M. PATCH, PH. D.,	*Entomologist*
PLANT PATHOLOGY	WARNER J. MORSE, PH. D.,	*Pathologist*
	MICHAEL SHAPOVALOV, M. S.,	*Assistant*
	VERNON FOLSOM,	*Laboratory Assistant*
HIGHMOOR FARM	WELLINGTON SINCLAIR,	*Superintendent*
	HAROLD G. GULLIVER, B. A.,	*Scientific Aid*
ROYDEN L. HAMMOND,		*Seed Analyst and Photographer*
CHARLES S. INMAN,		*Assistant*

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, Maine.

Organization July to December, 1914

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	JACOB ZINN, D. AGR.,	*Assistant*
	JOHN W. GOWEN, B. S.,	*Assistant*
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	ELMER R. TOBEY, B. S.,	*Assistant*
	HOYT D. LUCAS, B. S.,	*Assistant*
	HARRY C. ALEXANDER,	*Laboratory Assistant*
ENTOMOLOGY	EDITH M. PATCH, PH. D.,	*Entomologist*
	ALICE W. AVERILL,	*Laboratory Assistant*
PLANT PATHOLOGY	WARNER J. MORSE, PH. D.,	*Pathologist*
	MICHAEL SHAPOVALOV, M. S.,	*Assistant*
	VERNON FOLSOM,	*Laboratory Assistant*
AROOSTOOK FARM	GUY A. BAKER,	*Superintendent*
HIGHMOOR FARM	WELLINGTON SINCLAIR,	*Superintendent*
ROYDEN L. HAMMOND,		*Seed Analyst and Photographer*
CHARLES S. INMAN,		*Assistant*

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*Died November 13, 1914

The publications of this Station will be sent free to any address in Maine. All requests should be sent to

Agricultural Experiment Station,

Orono, Maine.

CONTENTS.

ANNOUNCEMENTS.

Establishment of the Station.

The Maine Fertilizer Control and Agricultural Experiment Station, established by Act of the Legislature approved March 3, 1885, began its work in April of that year in quarters furnished by the College. After the Station had existed for two years, Congress passed what is known as the Hatch Act, establishing agricultural experiment stations in every state. This grant was accepted by the Maine Legislature by an Act approved March 16, 1887, which established the Maine Agricultural Experiment Station as a department of the University. The reorganization was effected in June, 1887, but work was not begun until February 16, 1888. In 1906 Congress passed the Adams Act for the further endowment of the stations established under the Hatch Aact.

The purpose of the experiment stations is defined in the Act of Congress establishing them as follows:

"It shall be the object and duty of said experiment stations to conduct original researches or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies for the same; the chemical composition of useful plants at their different stages of growth; the comparative advantage of rotative cropping as pursued under a varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and water; the chemical composition of manure, natural and artificial, with experiments designed to test their comparative effects on crops of different kinds; the adaptation and value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and cheese; and such other researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective states or territories."

The work that the Experiment Station can undertake from the Adams Act fund is more restricted and can "be applied only to paying the necessary expenses for conducting original researches or experiments bearing directly on the agricultural industry of the United States, having due regard to the varying conditions and needs of the respective states and territories."

Investigations.

The Station continues to restrict its work to a few important lines, believing that it is better for the agriculture of the State to study thoroughly a few problems than to spread over the whole field of agricultural science. It has continued to improve its facilities and segregate its work in such a way as to make it an effective agency for research in agriculture. Prominent among the lines of investigation are studies upon the food of man and animals, the diseases of plants and animals, breeding of plants and animals, orchard and field experiments, poultry investigations, and entomological research.

The Legislature of 1913 provided for investigations by the Station in animal husbandry which make Chapter 141 of the Public Laws for 1913. The following quoted from the act outlines the purpose of the act: "The Maine Agricultural Experiment Station in addition to the investigations now conducted by it, shall conduct scientific investigations in animal husbandry, including experiments and observations on dairy cattle and other domestic animals. Said investigations shall be carried out under control of the director of the Maine Agricultural Experiment Station. There shall be appropriated annually from the State Treasury the sum of five thousand dollars to be paid to the Maine Agricultural Experiment Station and the same shall be expended by the director of said Station in executing the provisions of this act."

Inspections.

Up to the close of the year 1913 it had been the duty of the Director of the Station to execute the laws regulating the sale of agricultural seeds, apples, commercial feeding stuffs, commercial fertilizers, drugs, foods, fungicides and insecticides, and the testing of the graduated glassware used by creameries Beginning with January 1914 the purely executive part of these laws are handled by the Commissioner of Agriculture. The analytical examination of the samples and the publishing the results of the analyses will still be done by the Station. The cost of the inspections is borne by fees and by a state appropriation.

Offices and Laboratories.

The offices, laboratories and poultry plant of the Maine Agricultural Experiment Station are at the University of Maine, Orono. Orono is the freight, express, post, telegraph and telephone address for the offices and laboratories.

Visitors to the Station will find it convenient to leave the steam cars at Bangor or Old Town, as the railway station at Orono is a mile from the University. Bangor and Old Town trolley cars pass through the campus. They pass the railway station in Bangor 5 minutes after the hour and half hour, and the railway station in Old Town, 20 minutes after and 10 minutes before the hour.

Aroostook Farm.

The Legislature of 1913 (Chapter 190 of the Private Laws of 1913) named a committee and appropriated ten thousand dollars for the purpose of purchasing land for a farm for conducting scientific investigations in agriculture in Aroostook County. The law provides that: "The Maine Agricultural Experiment Station shall have the general supervision, management and control of said farm and of all experiments and investigations conducted thereon, and may if it sees fit or deems it best authorize any agent or agents of the United States Department of Agriculture to conduct experiments upon such farm under such terms as it deems best."

The committee on location decided that it would be impracticable to purchase a farm in Aroostook County for the amount named in the act. After several meetings and proposals made from several towns in the county it was decided to purchase a farm at Presque Isle which, with the buildings to be erected upon it will cost $23,000. The farm that was purchased contains about 275 acres, has upon it a large barn with concrete potato house in the basement, a small dwelling house for the farmer. The erection of a suitable dwelling house for the farm superintendent is provided for by money raised by the citizens of Presque Isle.

The Station came into possession of the farm late in December 1913, and work was begun in the season of 1914.

Highmoor Farm.

Highmoor Farm, purchased by the State for the use of the Station, is located in the town of Monmouth, 2 1-2 miles from the Monmouth station and the same distance from the Leeds Junction station. It is on the Farmington branch of the Maine Central Railroad. A flag station, called Highmoor, is on the farm. Monmouth is the post, telegraph and telephone address for Highmoor Farm. Both Leeds Junction and Monmouth are freight and express addresses.

The Aim of the Station.

Every citizen of Maine concerned in agriculture has the right to apply to the Station for any assistance that comes within its province. It is the wish of the Trustees and Station Council that the Station be as widely useful as its resources will permit.

In addition to its work of investigation, the Station is prepared to make chemical analyses of fertilizers, feeding stuffs, dairy products and other agricultural materials; to test seeds and creamery glassware; to identify grasses, weeds, injurious fungi and insects, etc.; and to give information on agricultural matters of interest and advantage to the citizens of the State.

All work proper to the Experiment Station and of public benefit will be done without charge. Work for the private use of individuals is charged for at the actual cost to the Station. The Station offers to do this work only as a matter of accommodation. Under no condition will the Station undertake analyses, the results of which cannot be published, if they prove of general interest.

Correspondence.

As far as practicable, letters are answered the day they are received. Letters sent to individual officers are liable to remain unanswered, in case the officer addressed is absent. All communications should, therefore, be addressed to the Director or to the

Agricultural Experiment Station,
Orono, Maine.

Publications.

The Station is organized so that the work of investigation is distinct from the work of inspection. The results of investigation are published in the bulletins of the Station. These make up the annual report for the year. The results of the work of inspection are printed in publications known as Official Inspections. These are paged independently of the bulletins and are bound in with the annual report as an appendix thereto. Miscellaneous publications consisting of newspaper notices of bulletins, newspaper bulletins and circulars which are not paged consecutively and for the most part are not included in the annual report are issued during the year.

All the bulletins issued by the Station are sent to the names upon the official mailing list prepared by the Office of Experiment Stations, to all newspapers in Maine and to libraries and to agricultural exchanges. Bulletins which have to do with general agriculture and the Official Inspections which bear upon the feeding stuffs, fertilizer and seed inspections are sent to a general mailing list composed chiefly of farmers within the State. The publications having to do with the food and drug inspection are sent to a special list including all dealers in Maine and other citizens who request them. The annual report is sent to directors of experiment stations and to libraries. Copies of all publications are sent to the newspapers within the State and to the press on the exchange list outside of the State.

BULLETINS ISSUED IN 1914.

No. 223. Spraying Experiments and Apple Diseases in 1913. 24 pages.
No. 224. Field Experiments. 24 pages.
No. 225. Currant and Gooseberry Aphids in Maine. 12 pages, 41 illustrations.
No. 226. Notes on the Accuracy of Bushel Weight Determinations. Note on the Influence of Shape and Size of Plots in Tests of Varieties of Grain. Table for Estimating the Probable Significance of Statistical Constants. 20 pages.
No. 227. Powdery Scab of Potatoes. 16 pages, 9 illustrations.
No. 228. Factors influencing the Size, Shape and Physical Constitution of the Egg of the Domestic Fowl. 32 pages.
No. 229. Studies on Oat Breeding. I. Variety Tests 1910-1913. 56 pages, 8 illustrations.
No. 230. The Rhizoctonia Disease of Potatoes. 24 pages, 13 illustrations.

No. 231. Improving Egg Production by Breeding. 20 pages, 3 illustrations.
No. 232. Histological Basis of Shank Colors in Domestic Fowl. 16 pages, 12 illustrations.
No. 233. Maine Aphids of the Rose Family. 30 pages, 11 illustrations.
No. 234. Meteorology, Finances and Index. 40 pages.

OFFICIAL INSPECTIONS ISSUED IN 1914.

No. 56. Carbonated and Other Beverages. 12 pages.
No. 57. Ice Cream. 8 pages.
No. 58. Butter. 12 pages.
No. 59. Molasses. 8 pages.
No. 60. Feed Inspection. 48 pages.
No. 61. Drugs. 16 pages.
No. 62. Fertilizer Inspection. 36 pages.
No. 63. Ice Cream. 12 pages.
No. 64. Seed Inspection. 12 pages.
No. 65. Miscellaneous Food Materials. 12 pages.

MISCELLANEOUS PUBLICATIONS ISSUED IN 1914.

No. 492. Special Report to Commissioner of Agriculture for 1913. 48 pages.
No. 493. Experiments at Highmoor Farm, 1914. 8 pages.
No. 494. Newspaper Notice Bulletin 227. 1 page.
No. 495. Abstract Bulletin 228. 5 pages.
No. 496. Abstract Bulletin 229. 6 pages.
No. 497. Plant Lice of Currant and Gooseberry Bushes. 6 pages, 4 illustrations.
No. 498. Abstract Bulletin 230. 4 pages.
No. 499. Abstract Bulletin 232. 4 pages.
No. 500. Record blank for dairy cattle. 2 pages.
No. 501. Plum and Cherry Aphids. 4 pages.
No. 502. Practical Suggestions Regarding the Growing of Sweet Corn. 8 pages.
No. 503. Report of Progress in Animal Husbandry Investigations in 1914. 11 pages.

BIOLOGY PUBLICATIONS 1914.

In the numbered series of "Papers from the Biological Laboratory:"

60. Some Physiological Observations Regarding Plumage Patterns. By Raymond Pearl and Alice M. Boring, Science, N. S., Vol. 39, pp. 143-144, 1914.
61. Note on the Accuracy of Bushel Weight Determinations. By Clarence W. Barber, Maine Agricultural Experiment Station Annual Report for 1914, pp. 69-75.

62. Note on the Influence of Shape and Size of Plots in Tests of Varieties of Grain. By Clarence W. Barber. Maine Agricultural Experiment Station Report for 1914, pp. 76-84.

63. A Table for Estimating the Probable Significance of Statistical Constants. By Raymond Pearl and John Rice Miner. Maine Agricultural Experiment Station Annual Report for 1914, pp. 85-88.

64. Growth and Variation in Maize. By Raymond Pearl and Frank M. Surface. Zeitschrift f. ind. Abstammungs-u. Vererbungslehre. (In press).

65. Studies on the Physiology of Reproduction in the Domestic Fowl. VII. Data regarding the brooding instinct in its relation to egg production. By Raymond Pearl. Journal Animal Behavior, Vol. 4 No. 4, pp. 266-268.

66. Studies on Inbreeding. IV. On a general formula for the constitution of the nth generation of a Mendelian population in which all matings are of brother x sister. By Raymond Pearl. American Naturalist Vol. XLVIII, pp. 491-494.

67. Studies on Oat Breeding. I. Variety tests 1910-1913. By Frank M. Surface and Clarence W. Barber. Maine Agricultural Experiment Station Annual Report for 1914, pp. 137-192.

68. Studies on the Physiology of Reproduction in the Domestic Fowl. VIII. On some physiological effects of ligation, section or removal of the oviduct. By Raymond Pearl and Maynie R. Curtis. Jour. Exp. Zoöl., Vol. 17, No. 3, pp. 395-424.

69. Studies on Inbreeding. V. Inbreeding and relationship coefficients. By Raymond Pearl. American Naturalist, Vol. XLVIII, No. 573, pp. 513-523.

70. The Measurement of Changes in the Rate of Fecundity of the Individual Fowl. By Raymond Pearl. Science, N. S., Vol. XL, No. 1028, pp. 383-384.

71. Studies on the Physiology of Reproduction in the Domestic Fowl. IX. On the effect of corpus luteum substance upon ovulation in the fowl. By Raymond Pearl. Journal Biological Chemistry, Vol. XIX, No. 2, pp. 263-278.

72. The Histological Basis of the Different Shank Colors in the Domestic Fowl. By H. R. Barrows. Maine Agricultural Experiment Station Annual Report for 1914, pp. 237-252.

73. Studies on the Physiology of Reproduction in the Domestic Fowl. X. Further Data on somatic and genetic sterility. By Raymond Pearl and Maynie R. Curtis. Journal Experimental Zoölogy. (In press).

74. On the Law Relating Milk Flow to Age in Dairy Cattle. By Raymond Pearl. Proc. Soc. Exper. Biol. and Med. Vol. XXI, pp. 18-19.

Papers published but not in the numbered series.

a. The Service and Importance of Statistics to Biology. By Raymond Pearl. Quarterly Publication of American Statistical Society, March 1914, pp. 40-48.

b. Factors Influencing the Size, Shape and Physical Constitution of the Egg of the Domestic Fowl. By Maynie R. Curtis. Maine Agricultural Experiment Station Annual Report for 1914, pp. 105-136.

c. An Important Contribution to Statistical Theory. By Raymond Pearl. American Naturalist, Vol. XLVIII, pp. 505-507.

d. A Jersey Landmark Gone. By Raymond Pearl. Hoard's Dairyman. Vol. XLVIII, p. 144.

e. Improving Egg Production by Breeding. By Raymond Pearl. Maine Agricultural Experiment Station Bulletin 231, pp. 218-236.

ENTOMOLOGICAL PAPERS FROM THE MAINE AGRICULTURAL EXPERIMENT STATION, 1914.

Ent. 70. The Immature Stages of the Tenthredinoidea. By Prof. Alex. D. MacGillivray. Extract from the Forty-Fourth Annual Report of the Entomological Society of Ontario, 1913 (1914).

Ent. 71. Currant & Gooseberry Aphids in Maine.

Ent. 72. Food Plant Catalogue of the Aphidae of the World. Part IV. By Edith M. Patch. Bul. 225, Mr. Agr. Exp. Station.

Ent. 73. A Note on Rhagoletis pomonella in Blueberries. By William C. Woods. Journal of Economic Entomology, Vol. 7, No. 5.

Ent. 74. List of the Hemiptera-Heteraptera of Maine. By H. M. Parshley. Psyche, Vol. XXI No. 5.

Ent. 75. A Note on a Parasite of Rhagoletis pomonella. By William C. Woods. In press with The Canadian Entomologist.

Ent. 76. Two Clover Aphids. By Edith M. Patch. In press with Journal of Agricultural Research.

Ent. 77. Maine Aphids of the Rose Family. By Edith M. Patch. Bul. 233. Me. Agr. Exp. Station.

Ent. 78. Food Plant Catalogue of the Aphidae of the World, Part V. By Edith M. Patch. Submitted to the Journal of Agricultural Research for a supplement.

Changes in Members of Council.

At the November, 1913 meeting of the State Pomological Society Mr. Howard L. Keyser of Greene was elected a member of the Council in place of Mr. Robert H. Gardiner of Gardiner.

At its annual meeting the Maine Livestock Breeders Association elected Mr. Leonard C. Holston of Cornish as their representative on the Council in place of Mr. William H. Davis of Augusta.

Hon. Rutillus Alden who was a Trustee member of the Station Council for the years 1888-1894 and who represented the Maine State Dairymen's Association on the Council since 1902 died at his home in Winthrop, November 13, 1914. With his long service, his very active interest in agriculture, his genuine sympathy with and keen appreciation of the value of science as applied to agricultural problems his death is a great loss to the Station as well as to the agriculture of the State as a whole. At its annual meeting in December 1914 Mr. Frank S. Adams of Bowdoinham was elected by the State Dairymen's Association a member of the Council in Mr. Alden's stead.

CHANGES IN STATION STAFF.

July 1, Mr. Clarence W. Barber resigned from the Station Staff but is still connected with the University as Farm Demonstrator for Cumberland County.

July 1, Mr. Harold Gulliver resigned as Scientific Aid at Highmoor Farm.

July 1, Mr. Harold P. Vannah resigned his position of Assistant Chemist to take a commercial position.

September 1, Mr. Frank Tenney resigned as poultryman.

April 1, Mr. Guy A. Baker of Presque Isle was appointed Superintendent of Aroostook Farm.

July 15, Jacob Zinn, D. Agr., (Hochschule für Bodenkultur, Vienna, Austria 1914) and August 1, Mr. John W. Gowen, B. S. (University of Maine 1914) were appointed Assistant Biologists.

September 1, Mr. Hoyt D. Lucas, B. S. (Massachusetts Agricultural College 1914) was appointed Assistant Chemist.

Buildings and Equipment.

A new eight room house costing about $3500 was erected on Aroostook Farm during the summer of 1914.

The small farm house of little value at Aroostook Farm burned in July, 1914.

Repairs at the cost of about $250 were made on the barn and potato storage at Aroostook Farm. Large platform scales were placed in the barn and farm machinery and implements to the value of about $3000 were installed. The house and barn were wired for electric lighting, and electric power for threshing, etc., was introduced into the barn.

At a cost of nearly a thousand dollars all of the pastures at Highmoor Farm have been enclosed with a very heavy 58 inch dog and man proof wire fence. Two summer shelters for sheep have been built in the pastures and the old barn and part of the former manure shed have been fitted for winter quarters for sheep. At the April meeting the Council authorized the Director to purchase about 100 sheep with the object of finding out whether sheep without any fancy breeding, kept merely for meat and wool, can be profitably carried under present conditions on Maine farms. It is proposed to continue this test for at least five years.

The inventory July 1, 1914, showed an increase over that of July 1, 1913, in land and buildings of $10,000 and equipment of $10,500.

BULLETIN No. 223.

SPRAYING EXPERIMENTS AND STUDIES ON CERTAIN APPLE DISEASES IN 1913.

W. J. Morse.

In spite of the fact that a large amount of work has been done both in this and in other countries, in studying the effects of different insecticides and fungicides upon the trees themselves and their efficiency in controlling the various insect and fungous pests, the ideal spray or combination of sprays for use on apple orchards has not yet been discovered. It is true that with the introduction of lime-sulphur some of the previous difficulties have been eliminated, but at the same time there are others of equal importance which have arisen or which have not been overcome. This is particularly the case under the climatic conditions which exist in the apple growing regions of the northeastern portion of the United States and the adjacent parts of the Dominion of Canada where apple scab frequently appears in its most virulent form.

While it is granted that lime-sulphur, as ordinarily used, has been found to be less likely to produce spray injury many orchardists maintain that in practical work it is less efficient with them than bordeaux mixture in controlling apple scab. In fact a prominent apple grower from the famous Annapolis valley of Nova Scotia recently told the writer that even with the most careful and thorough spraying with lime-sulphur their fruit the past season was badly attacked by scab and that many orchardists were seriously considering going back to bordeaux mixture again next year. On the other hand it has been the writer's experience that with varieties susceptible to spray injury lime-sulphur is, on the whole, by far the most satisfactory material.

As a rule we have found that with the Ben Davis spray injury from bordeaux mixture was so severe that it equalled or more than offset the beneficial effects derived from the control of apple scab. While a much better grade of fruit from the standpoint of keeping quality and freedom from disease has been the invariable result from trees sprayed with this material the russeted appearance of the skin materially reduced its market value. In other words, while the injurious effects of bordeaux mixture and certain other sprays upon the fruit of susceptible varieties like the Ben Davis are concerned almost wholly with the appearance of the fruit and not with its keeping quality or value as an article of food, the price it will bring on the market is just as effectually reduced as though the latter were the case. If the selling price of apples depended more on the quality of the fruit and less on the appearance of the skin certain of the difficulties now experienced in spraying would disappear.

The difficulties encountered in spraying apple orchards are not restricted to spray injury of the fruit however. It is a well known fact that the leaves of certain varieties are frequently injured by sprays and that the occurrence and severity of this injury is markedly influenced by seasonal climatic conditions in the case of bordeaux mixture. During the 5 seasons that this Station has experimented with this spray on Baldwin and Ben Davis trees at Highmoor Farm leaf injury has been experienced in some degree each year, and some years it has been so severe as to result in a decided leaf drop in mid-summer. For the main orchards, consisting of some 2300 trees it became necessary to abandon its use altogether.

The question of the proper fungicide to use is by no means the only important matter involved in efficient orchard spraying. Insecticides are necessary and it is both necessary and convenient to use them in combination with fungicides. New forms of both of these are constantly being recommended and the orchardist is urged by manufacturers of various proprietary compounds to substitute these for the materials already in use, on the ground of their greater efficiency, economy, or ease of use. Often these are placed on the market without being sufficiently tested by their makers, under a variety of conditions, to determine their effects on the foliage and fruit in combinations with materials which must be used with them and disastrous results are secured in the hands of the purchasers.

While a fairly settled policy has been reached as to the proper time to apply the various sprays or combinations of sprays to secure the greatest efficiency there is still insufficient data with regard to some of these points, particularly as applied to local conditions.

The present publication constitutes the fourth report of the results of a series of orchard spraying experiments designed to secure additional data upon some of the points mentioned above.* It has also seemed desirable to include in the same bulletin certain observations which have been made during the year upon apple scab and apple cankers.

Spraying Experiments in 1913.

During the past season the spraying experiments were conducted in the same portion of one of the orchards as in previous years but included 238 instead of 139 trees used in 1912, or 40 rows of 6 trees to the row, with one tree missing in each of two rows. The plots were changed somewhat to avoid a supposed difficulty of the previous year. While, as will be seen later, the results of the present year indicate that this idea was incorrect it was thought that the relatively small amount of scab appearing in 1912 on the plot sprayed only with 4 pounds of arsenate of lead paste in 50 gallons of water might be partially due to its location at the corner of the orchard and thus better exposed to sunlight and drying winds.

The trees were of the Ben Davis variety and are between 25 and 30 years old. They are now in a very healthy, vigorous condition. For the last 4 years they have been well cultivated, fertilized and pruned. In 1909 some renovation work was done on them but previous to this they had been badly neglected for several years.

The 1913 experiments comprised 10 different plots. All plots used for making important comparisons between fungicides, except that sprayed with bordeaux mixture, consisted of

* The previous reports are given in Bulletins 189, 198 and 212 of this Station. The first two are now out of print and are no longer available for distribution.

6 rows each, or 36 trees. The unsprayed check, the bordeaux plot, the arsenite of zinc plot and those upon which insecticides were used alone consisted of 3 rows each, or 18 trees.

All plots received the same number of sprayings on the same dates with the exception of plot 4. On this the first application of lime-sulphur was omitted for comparison with plot 3 to test the efficiency in control of apple scab of the application usually made when the blossom buds are showing pink. All spray materials were applied with a gasoline power spraying outfit at a pressure of from 125 to 150 pounds. The tank, pump and hose were thoroughly washed out with water after each separate spray material was used. The original plan was to spray all plots with the exception of number 4 when the blossom buds were showing pink, repeat the application for all, number 4 included, just after the petals fell and again about 2 weeks later. This program was adhered to except that between the second and third sprayings a period of 21 days elapsed.

Weather conditions during the early part of the season materially influenced the date of application of the different sprays. The latter part of April and the first week of May were abnormally warm and very little rain fell. As a result the blossom buds came along very rapidly so that they were in condition such that it was necessary to make the first application on May 8. This was immediately followed by a month of unseasonably cold weather with frosts and cold, northwest winds associated with continued cloudy weather and heavy rainfall. The flower buds opened very slowly and the petals did not drop so that the second application could be made till June 3. This allowed an interval of 26 days between the first and second applications as compared with only 12 in 1912. The third and last application was made on June 24.

In 1913 dry, powdered arsenate of lead, using half the quantity by weight as compared with the paste form previously employed, was adopted for use on all the orchards on the farm. On all the experimental plots sprayed with a fungicide, (not counting plot 10 where arsenite of zinc was used) one pound of this dry arsenate of lead was added as an insecticide to each 50 gallons of spray. With this exception the treatment of each plot is given below.

Plot 1 18 trees, bordeaux mixture, 3-3-50 formula.
Plot 2 35 trees, lime-sulphur, 20 per cent stronger than standard dilution.
Plot 3 36 trees, lime-sulphur, standard dilution (1.5 gals. 29° Baumé, home-cooked concentrate diluted to 50 gals.)
Plot 4 35 trees, lime-sluphur, standard dilution, first application omitted.
Plot 5 36 trees, "Soluble sulphur," 2 pounds to 50 gallons of water.*
Plot 6 36 trees, "Atomic sulphur," 7 pounds to 50 gallons of water.*
Plot 7 18 trees, unsprayed check.
Plot 8 18 trees, 1 pound of dry arsenate of lead in 50 gallons of water.
Plot 9 18 trees, 2 pounds of dry arsenate of lead in 50 gallons of water.
Plot 10 18 trees, standard dilution lime-sulphur plus 1 pound of arsenite of zinc to 50 gallons.

The orchards bloomed profusely and at the time of the first spraying there was promise of a full crop of fruit. Mention has been made of the weather conditions which prevailed during the first part of the season. Between May 8 and the close of the month somewhat over 4 inches of rain fell, many of the days were cloudy and cold with prevailing northwest winds. Freezing temperatures were recorded on May 14, 15 and 21. This resulted in very imperfect pollination and apparently many

* The Soluble sulphur and Atomic sulphur are proprietary spray materials and were supplied by the manufacturers, the Niagara Sprayer Company Middleport, New York, and the Thomsen Chemical Company, Baltimore, Maryland. The former in the literature sent out last spring recommended that their soluble sulphur compound be used for spraying trees in foliage at the rate of 1½ to 2 pounds to each 50 gallons of water. Mr. W. M. Scott, pathologist for the Thomsen Chemical Company in correspondence stated that Atomic sulphur should be used at the rate of 7 pounds to 50 gallons of water but that a greater quantity would do no harm. His letter and supply of material did not arrive till after the date of the first application. Hence it was necessary to purchase a supply from their State agency which recommended that Atomic sulphur be used at the rate of 14 pounds to 50 gallons. This was done at the first spraying but 7 pounds were used in the last two.

of the partially opened buds were killed by frost. On June 2 considerable frost injury was noted on the young leaves throughout the orchards. By June 10 it was evident that a large proportion of the flowers had failed to set fruit and were falling off. As a result the crop obtained was only about 10 per cent of that harvested in 1912.

EFFECT OF DIFFERENT SPRAYS ON THE FOLIAGE.

On June 2 there was some evidence of spray injury on plot 1, sprayed with bordeaux mixture, but the leaves on the other plots were entirely healthy with the exception of the frost injury mentioned above. A small amount of spray injury developed on plot 1 during the season but at no time was it sufficient to do any appreciable damage or to cause any material amount of leaf drop—a marked contrast with the results obtained in some of the previous experiments where bordeaux mixture was applied. The control of scab on the leaves was almost perfect and better on this plot than on any of the others.

Plot 2, sprayed with lime-sulphur 20 per cent stronger than standard dilution, showed some leaf injury from the spray but this was very slight and somewhat less than was observed on plot 1. In this case, however, the injury did not appear until after the second application of the spray. Scab control on the leaves while not equalling that where bordeaux mixture was used, was better than that on all of the remaining plots.

Plot 3, where standard dilution lime-sulphur was applied, was practically free from leaf injury throughout the season, although a little was noted. Scab on the leaves was fairly well controlled, but more in amount than on plot 2. This began to appear about June 10 or later.

Plot 4, treated the same as plot 3 except that the first application of lime-sulphur when the flower buds were showing pink was omitted, agreed in appearance with plot 3 throughout the season as far as the condition of the foliage was concerned. The control of scab seemed to be as good in one case as in the other.

Plot 5, where "Soluble sulphur" was applied, presented a marked contrast with the other plots where fungicides were used. Up to June 3 no difference could be observed between the foliage on the trees on this plot and that on those which had been sprayed with lime-sulphur, but shortly after the second application of the spray very evident injury began to appear.

This injury was in the form of spotting and more or less browning of the margins of the leaves and continued to develop slowly till the time of the third application on June 24. After the third application this spray injury developed very rapidly and became quite severe. On July 7, 75 to 90 per cent of the leaves on all of the trees on this plot were spotted or burned at the margins, or both, many of them being badly injured. Much yellowing and leaf drop showed at this time. The specimens shown in Fig. 1 were collected on this date. The yellowing and falling of the leaves continued for over a month afterwards and conditions on July 15 were recorded as worse than on July 7, the ground being nearly covered with fallen leaves at this time. As a result of this leaf fall the "Soluble sulphur" plot presented a marked contrast to the other fungicide plots when viewed at a distance. It could be located readily on account of the sparse condition of the foliage.

"Soluble sulphur" appeared to be fully equal to standard dilution lime-sulphur in controlling scab on the leaves.

Plot 6, sprayed with "Atomic sulphur" showed nothing on the foliage throughout the season which could be definitely classed as spray injury, although an occasional brown spot was observed on the leaves. With regard to scab control it equalled or exceeded all others except the bordeaux plot.

Plot 7, unsprayed check. Scab on this, like the sprayed plots, did not appear on the leaves till about June 10, or midway between the dates of the second and third applications, but from then on it developed very rapidly on both foliage and fruit. It was recorded as very common and severe, especially on some trees, on July 7 and 15, and nearly every leaf was reported as affected on August 4. Nothing like what has been classed as spray injury on the other plots was observed on the check, but frost injury was noted on this as well as on the others early in the season.

Plot 8, sprayed with one pound of dry arsenate of lead in 50 gallons of water. Throughout the season it was plainly evident that the amount of scab on the leaves of the trees on this plot was considerably less than on the unsprayed check but it was also equally apparent that it was more than on the adjoining plot, sprayed with the larger amount of arsenate of lead, and more than on the plots sprayed with fungicides plus the same amount of arsenate as was used on it.

The only evidence of spray injury observed was a slight spotting of the leaves and this in all cases appeared to be associated with areas of leaf surface where the epidermis had first been attacked by the scab fungus, allowing the poison to come in contact with the interior tissues.

On plot 9, sprayed with 2 pounds of dry arsenate of lead in 50 gallons of water, the control of scab on the leaves throughout the season appeared to be fully equal to that where standard dilution lime-sulphur and the smaller quantity of arsenate had been used together.

Some spotting of the leaves was observed similar to that described on plot 8, but up to the middle of August this was of no consequence. After this date the farm was visited less frequently and less detailed records were kept as to the condition of the foliage. At harvest time it was discovered that more or less spotting of the leaves had developed late in the season and that there had been a slight amount of premature leaf fall. However it may be said that the general health of the foliage on the trees on this plot throughout the season as a whole compared favorably with that on the lime-sulphur plots.

Plot 10, standard dilution lime-sulphur plus one pound of arsenite of zinc to 50 gallons. This plot was introduced simply to secure additional data as to the combined effect of arsenite of zinc and lime-sulphur on apple foliage. In 1912 this combination gave no appreciable spray injury but in 1913, used in exactly the same manner, in the same proportions, and from the same stock of arsenite of zinc a decidedly opposite result was obtained. This year severe leaf injury resulted. The character, amount and time of appearance of this was almost identical with that produced by "Soluble sulphur" already described. The specimens shown in Fig. 2 were collected on July 7.

EFFECT OF DIFFERENT SPRAYS ON THE FRUIT.

Detailed records were kept throughout the season of the appearance of the fruit with reference to scab and russeting but they tell little which is not also given in the tabulated results of the condition of the fruit at harvest time. The first record of the beginning of russeting of the fruit was on July 7 but the experiment was not visited by the writer between June 24 and this date. It is interesting to note that at this time russeting was recorded on all of the plots, including the unsprayed check.

The crop was harvested on October 5 and sorted immediately thereafter. In 1912 about 20 barrels of apples from the rows near the center of each plot were set aside for careful sorting and record as to the condition of the fruit. In 1913, on account of the short and irregular crop on the trees, all of the apples on each plot were saved for sorting and counting except those borne on the half of each outside row which adjoined another plot having a different treatment. While this may not have entirely eliminated the effects of the spray drifting from one plot to another it was felt that it did so in a large measure.

The following is a tabulated summary of the results obtained from sorting and counting the number of fruits on each of the different plots. The percentages of smooth, scabby and russeted fruit do not always total 100 for in some instances apples were found which were both scabby and russeted and were counted twice. All apples which showed any traces of scab were classed as scabby. None were classed as russeted unless this was plainly evident. That is, apples which showed minor scars or imperfections of the skin were classed as smooth.

Summary of Results Obtained from Sorting Fruits.

Plot No.	Treatment.	Total number of apples.	Number smooth.	Number scabby.	Number russeted.	Per cent of perfect apples.	Per cent of scabby apples.	Per cent of russeted apples.	Difference in per cent of russeting as compared with check.
1	Bórdeaux mixture 3-3-50	1,400	416	11	973	29.7	0.8	69.5	37.9
2	Lime-suplhur 20% stronger than standard	4,102	2,449	46	1,625	59.7	1.12	39.6	8
3	Lime-sulphur standard dilution (1.5 gals. 29° Baumé, diluted to 50 gals)	3,421	1,886	108	1,446	55.1	3.15	42.2	10.6
4	Lime-sulphur standard dilution, first application omitted	2,056	1,054	131	871	51.2	6.32	42.3	10.7
5	"Soluble sulphur" 2 pounds to 50 gals. of water	1,885	974	68	843	52.7	3.6	44.7	13.1
6	"Atomic sulphur" 7 pounds to 50 gals. of water	3,032	1,674	95	1,263	55.2	3.13	41.6	10
7	Unsprayed check	1,693	501	657	535	29.5	38.8	31.6	-
8	One pound of dry arsenate of lead in 50 gals. of water	2,311	1,183	362	766	51.1	15.6	33.1	1.5
9	Two pounds of dry arsenate of lead in 50 gals. of water	1,416	954	39	423	67.3	2.75	29.8	-1.8
10	Standard dilution lime-sulphur plus 1 pound arsenite of zinc to 50 gals.	1,961	1,067	217	677	54.4	11	34.5	2.9

DISCUSSION OF RESULTS.

The experiments of the present year were designed, in a measure, to supplement the data obtained in 1912, hence in the discussion of the results obtained this year it is necessary to take into consideration certain of those obtained last year and reported in Bulletin 212.

Efficiency of the first spray application. It is claimed by some that the spray application made when the buds are showing pink is the most effective one in controlling apple scab. That this may be the case was shown in a most striking manner in 1912. Where this spray (lime-sulphur) was omitted only about 50 per cent of perfect apples were obtained and over 47 per cent were scabby. Where it was applied nearly 90 per cent of the fruit was sound and perfect and less than 1.5 per cent were scabby. The general conclusion was that, under the climatic conditions which prevailed that season, the two later sprayings paid little more than the cost of application. Attention was called to the fact that while this is important as showing the value of the first spraying it should not be taken as implying that the two later sprayings should be omitted.

The results secured in this part of the 1913 experiment would seem quite contradictory to those obtained the previous year. It will be noted on reference to the table that while the figures favor the plot where all three applications were made these differences are probably within the limits of experimental error. Plot 4 produced only about 4 per cent less perfect apples and 3 per cent more scab than plot 3.

It is difficult to account for this failure of the omission of the first application of the spray to show greater differences in the line of scab control. Had there been an excessive amount of scab on both plots with only this amount of difference it would be fair to assume that the period which elapsed between May 8 and the time of the second spraying allowed the disease to become established. As a matter of fact when compared with plot 7, or the unsprayed check which gave nearly 40 per cent of scabby apples, it will be seen that scab control was quite efficient even in the case of plot 4. An explanation of the results which seems very probable is that while the warm period the latter part of April and the first of May was sufficient to start the flower buds it was not sufficiently prolonged to cause the liberation of the spores of the perfect stage of the fungus, which form on the fallen leaves of the season before and which are generally conceded to be the chief source of early spring infection. With the very cold period following it may be that these spores were not in a condition to be thrown off till about or shortly before the second spraying. None of the limb infection by scab like that described later in this bulletin was observed in the experimental orchard.

Dilution of lime-sulphur. In 1912 the results suggested that a dilution of lime-sulphur 20 per cent stronger than the standard could be used on Ben Davis trees with little more danger of injuring the leaves or russeting the fruit and that the increased efficiency of the spray would more than pay the added cost, particularly where the lime-sulphur concentrate is prepared at home. The results in 1913 have strengthened this position rather than weakened it. While the differences were not so marked as last season when the stronger solution produced about 23 per cent less scabby apples than the standard dilution it will be seen on comparing plots 2 and 3 that the per cent of perfect apples was greater, and the efficiency in scab control in the case of the stronger solution was almost equal to that of bordeaux mixture.

Lime-sulphur vs. bordeaux mixture. The continued use in this series of experiments of a plot sprayed with bordeaux mixture is solely for the purpose of comparison. The efficiency of bordeaux mixture in controlling apple scab and the almost certain occurrence of foliage injury and fruit russeting from its use on the variety of apples employed in the experiments are well established facts. Such a plot in conjunction with an unsprayed check is of value as a standard by which to judge the action of the other fungicides in controlling scab or in the production of spray injury. In 1912 bordeaux mixture produced a greater percentage of perfect apples than did standard dilution lime-sulphur, but the stronger lime-sulphur produced better results than either of these. In 1913 almost perfect control of scab on the fruit was obtained from bordeaux mixture but on account of russeting less than 30 per cent of perfect apples were obtained. On the other hand very efficient control of scab was secured with lime-sulphur, particularly the stronger dilution, and the percentage of perfect apples was about double that secured with bordeaux mixture. Hence the results secured during the last season are very much in favor of lime-sulphur.

"Soluble sulphur." Judging from the results of a single season alone it would seem that this compound is a fairly efficient fungicide as far as apple scab is concerned and fully equal in this respect to the standard dilution lime-sulphur as will be seen in comparing the results secured on plots 3 and 5. Unfortunately, as has already been pointed out on page 7, its use at the rate of 2 pounds to 50 gallons of water produced very severe leaf injury. Based on our own experience and that of others during the past summer, which latter is given under another heading, "Soluble sulphur," used with arsenate of lead at this strength at least, cannot be recommended as a safe summer spray for apple trees.

"Atomic sulphur." The results secured with this material were very satisfactory. No spray injury was observed on the leaves and it will be seen on comparing plots 3 and 6 that the condition of the fruit harvested from the plot sprayed with "Atomic sulphur" was practically identical with that from the standard dilution lime-sulphur plot. While these results were in every way satisfactory one is not warranted drawing final conclusions without farther comparative tests. It is admitted that the relatively efficient scab control with this material may be partly due to using it, through error, at double strength for the first application, but attention is called to the fact already pointed out that omitting an application of lime-sulphur at this time produced practically no difference in the results.

Arsenate of lead as a fungicide. In the above discussion relative to the control of scab on the different plots the action of arsenate of lead, which is added as an insecticide, has been ignored as a factor in producing the effects obtained. Moreover, this appears to be the customary attitude in dealing with experiments of this nature. The results secured on plots sprayed with different amounts of arsenate of lead alone, during the past two seasons, suggest that this is an erroneous position to take. Not only that but one is strongly tempted to go one step farther and say that there is reason to believe that so far as scab is concerned the fungicides commonly employed in spraying apple trees, when used with arsenate of lead, have been receiving in some instances much more credit than they really deserve.

However it should be mentioned that this is by no means the first time that the fungicidal effect of arsenate of lead has been observed. Waite* called attention to the fact in 1910, but stated that while this insecticide when used alone possessed considerable fungicidal value it was probably not enough to be depended upon for general use. In his experiments, however, only 2 pounds of paste were used to 50 gallons of water. Wallace, Blodgett and Hessler † in both field and laboratory tests also showed that the addition of arsenate of lead to lime-sulphur solution increased the fungicidal value of the spray. Taylor ‡ secured somewhat similar results in Missouri in the control of peach scab and brown rot but in the case of the latter disease it was thought that the effects were indirect and were the result of control of the curculio which punctures the skin and thus assists the fungus in gaining entrance to the fruit.

In our own experiments plots were sprayed with 2 and 4 pounds of arsenate of lead paste in 50 gallons of water in 1912. In 1913 the powdered form of the insecticide was substituted, this being used at the rate of 1 and 2 pounds in 50 gallons of water. The 1912 experiment was begun in the writer's absence and, unfortunately, no unsprayed check was saved. However the results obtained were quite striking. Where the larger amount of arsenate of lead paste was used alone scab was controlled as well as on any plot sprayed with the recognized fungicides, exceeding that obtained with bordeaux mixture and standard dilution lime-sulphur and only being equalled by the stronger lime-sulphur.

With the above results in mind the figures obtained in 1913 possess added significance. Where the 2 pounds of dry arsenate

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* Waite, M. B., Experiments on the Apple with Some New or Little-Known Fungicides Cir. U. S. D. A. Bur. Pl. Ind. 58, 1910.

† Wallace, E., Blodgett, F. M. and Hessler, L. R. Studies of the Fungicidal Value of Lime-Sulphur. Bul. Cornell Agr. Exp. Sta. 290, 1911.

‡ Taylor, E. P., Spraying Peaches for Brown Rot, Western Fruit Grower, pp. 20-21, Oct. 1909, pp. 16-18, Feb. 1910.

of lead were used alone in 50 gallons of water scab was better controlled than on all other plots except those where bordeaux mixture and the stronger lime-sulphur were applied. Moreover, it will be seen on reference to the table that a greater percentage of perfect apples was obtained from this plot than from any other in the series. That even small or medium applications of arsenate of lead possess a distinct fungicidal value is readily seen by comparing the check plot, number 7, with plot 8 adjoining it where one pound of the powdered form was used in 50 gallons of water. Here the amount of scab was reduced from nearly 39 to less than 16 per cent and the percentage of perfect apples obtained compared very favorably with those plots on which fungicides had been used in addition to the same amount of powdered arsenate of lead as was used on plot 8.

While the writer is not ready as yet, without repeated experimental tests, to recommend so radical a departure as placing entire dependence upon arsenate of lead alone for the control of scab and insect enemies in apple orchards in Maine the results so far obtained are certainly encouraging. It is not beyond the range of probability that efficient scab control with a minimum of fruit russeting might be obtained by using a dormant spray of strong lime-sulphur or bordeaux mixture before the leaf-buds open and then for later applications nothing but from 1 1-2 to 2 pounds of powdered or from 3 to 4 pounds of the paste form of arsenate of lead in 50 gallons of water. Since practically all the foliage and fruit injury from bordeaux mixture comes from the later applications still greater efficiency in scab control might be obtained with no added danger from russeting and leaf spotting if this is used when the flower buds are showing pink. Such a procedure would entirely eliminate lime-sulphur except as a dormant spray where its use is absolutely required in many orchards on account of the blister mite and other insects.

Objection to this use of still greater quantities of arsenate of lead might be raised on account of the claim made by some that the accumulation of arsenic in the soil from its continued use as a spray material tends to produce detrimental effects on the trees themselves. Headden has shown this to be the case in

Colorado, but here the results are brought about through the action of the alkali in the soil or irrigation water converting the insoluble lead arsenate into soluble compounds.* So far as the writer has been able to learn no evidence of similar action has been observed in the East. As a matter of fact the amounts of lead arsenate advocated for use alone are not materially greater than now used in combination with fungicides like lime-sulphur.

Russeting of fruit. One fact has been strikingly brought out in the experiments conducted during the past season which has been evident to a greater or less degree during preceding years. This is that much russeting of the fruit may be due to natural causes and all of it should by no means be charged against the spray material. Mr. Bonns observed this in 1910 and commented on it in the first report of the series.†

In 1913 a large amount of russeting was observed, even on the unsprayed plot which showed over 31 per cent of the fruit so affected. In this connection it is interesting to note that russeting was actually less on the plot where 2 pounds of powdered lead arsenate was used than on the check. However on some of the other plots, particularly the one sprayed with bordeaux mixture it was very evident that the treatment applied, directly influenced the amount of injury obtained.

There is no doubt that the excessive amount of russeting which occurred the past season irrespective of the treatment was in some way associated with the climatic conditions which prevailed when the fruit was small. While there was an absence of the so-called "frost bands" on the fruit it is very probable that late frosts associated with heavy winds and cold rains were directly responsible for the trouble.

Arsenite of zinc with lime-sulphur. Very little comment is necessary with regard to the results obtained with this combination in 1913. In 1912 it was used with perfect safety on both foliage and fruit and was so reported. While practically no russeting of the fruit could be attributed to it in 1913, when compared with the check plot, the foliage injury already

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* Headden, Wm. P., Arsenical Poisoning of Fruit Trees. Bul. Colo. Arg. Exp. Sta. 131, 1908.

† Bonns, W .W., Orchard Spraying Experiments. Bul. Me. Agl. Exp. Sta. 189, 1911.

described was sufficient to indicate that arsenite of zinc is an unsafe material to use with lime-sulphur in spraying apple orchards.

ADDITIONAL DATA REGARDING SOLUBLE SULPHUR COMPOUND.

In a letter addressed to the Director of this Station under the date of October 18 the General Manager of the Niagara Sprayer Company stated that he was very much surprised to learn that we had very unsatisfactory results with their Soluble Sulphur Compound, as the general results they were receiving from all over the United States were very favorable. He admitted that in the New England States more burning had been experienced than in other sections and attributed this to the peculiar climatic conditions of the season, but they were convinced that with one pound to 50 gallons of water with 2 1-2 pounds of arsenate of lead the results would be satisfactory. In their printed directions supplied to us at the beginning of the season it was recommended that 1 1-2 to 2 pounds of the material be used to 50 gallons, with no reference to arsenate of lead. In the experiments already described 2 pounds of Soluble Sulphur and one pound of dry arsenate of lead (approximately equivalent to 2 pounds of the paste form) were used.

Since our own report on the results obtained with this compound upon apple foliage must be an adverse one it seemed only just that an effort be made to determine whether or not this agreed with the experience of other users of the Soluble Sulphur Compound in Maine during 1913. Accordingly a circular letter was at once prepared, asking for information on this point, and sent to some over 100 orchardists in various parts of the State, mostly members of the Maine Pomological Society. Many of the replies received indicated that the general impression among the apple growers is that Soluble Sulphur Compound is simply a lime-sulphur concentrate with all of the water removed. Attention should be called to the fact that this is not the case and the Niagara Sprayer Company have never made such a claim in any of the literature which the writer has seen. In justice it should also be mentioned that nothing which is said here regarding the Soluble Sulphur Compound in any way applies to the ordinary liquid lime-sulphur concentrate put out by the Niagara Sprayer Company. So far as this Station has tested the latter material it is fully equal to any on the market with reference to its effects on the foliage and efficiency in scab control.

Sixty-three replies to the circular letter were received, and only 11 of the writers said they had used the material in question in 1913. Farther correspondence developed the fact that one of these, who reported no burning of the foliage, did not use Soluble Sulphur Compound at all but the lime-sulphur concentrate put out by the same company. Another used Soluble Sulphur Compound only as a dormant spray. A third reported that his foliage looked sickly during the early part of the season whether sprayed or not.

One case was reported from Kent's Hill where the trees were thoroughly sprayed with 1 1-2 pounds of Soluble Sulphur Compound and 2 pounds of arsenate of lead in 50 gallons of water about 10 days after the petals fell and no injury resulted. Another case was reported to the writer, but not included in the replies to the circular letter, where the owner drenched the trees with this spray without injury. In neither of these cases were the names given of the varieties of apples sprayed, and in the last it was not stated how much Soluble Sulphur Compound was used and whether or not arsenate of lead was used with it.

One case was reported where slight burning of the leaves occurred with several varieties and four reports of severe foliage injury were received. One of these came from the same town where material was used successfully. The spraying was done on about the same date, the same amount of Soluble Sulphur Compound was used but 2 1-2 pounds instead of 2 pounds of arsenate of lead was added to each 50 gallons of spray. In this case the variety used was Baldwin and the owner reported that "It burned the foliage so seriously that much of it fell". Another report was as follows: "I will say, however, that it was very unsatisfactory in our hands. It has caused considerable injury and did not seem to be as effective as the solution of lime and sulphur". The third reported injury on Ben Davis but not on other varieties.

The most severe case of injury from Soluble Sulphur Compound and arsenate of lead reported came from Winthrop: "I used it to spray my apple orchard of about 3 acres on June 17, 1913. The varieties that were sprayed were Baldwin, Nodhead, Roxbury Russet, Winthrop Greening, Rhode Island Greening, Bellflower, Northern Spy and Canada Red. Half of the foliage and a great many apples fell. I used one pound of Soluble sulphur and 3 pounds of arsenate of lead to 50 gallons of water."

Mr. Geo. A. Yeaton, County Director of farm demonstration work for the University of Maine College of Agriculture in Oxford County used the material in an experimental way in some of his demonstration work and reported variable results. In one orchard the results were entirely satisfactory. In another orchard of 248 trees the foliage of Spy and Ben Davis trees was burned, while that on Baldwin and McIntosh showed no trace of it. Another orchard showed little or no burning. State Horticulturist, A. K. Gardner, stated he had used Soluble Sulphur Compound in a limited way and in each case there was a limited amount of spray injury, probably 10 per cent more than where the liquid (lime-sulphur) was used. "Other men have claimed that it burned their foliage and a few have said that it did not. The general consensus of opinion, however, has been that the liquid has proven more satisfactory." Mr. Gardner also reported the case mentioned above where the trees were drenched with the spray and did not suffer from any injury.

All reports received by the writer regarding Soluble Sulphur Compound as a dormant spray appear to be satisfactory. It is claimed by some that the injurious action on the foliage results from arsenic set free when combined with arsenate of lead. Doubtless this is the case, but no matter how efficient a fungicide may be it is impracticable to use it as a summer spray for apple trees unless some efficient insecticide may be combined with it and the two used at the same time without danger of leaf injury.

The Source of Spring Infection by Apple Scab.*

In this country it has been quite generally conceded that the early spring infection by apple scab comes entirely from the spores of the perfect stage of the causal fungus which have been produced on diseased leaves lying on the ground during the preceding winter. In fact all the previously accumulated evidence in America is in support of this position. In Europe certain writers have agreed with this while others maintained that scab infested twigs or young branches were also an important factor. It is generally agreed, however, that the scab fungus is at times parasitic upon young branches and water shoots and in this relation, particularly in the case of susceptible varieties, may be the source of considerable injury.

Conditions during the growing season in Maine in 1912 apparently were very favorable to the development of apple scab on the limbs. Early in the following winter specimens of young apple branches attacked by scab began to come to this Station from correspondents in various parts of the State. Since limb infection appeared to be so general it seemed that an excellent opportunity existed to determine whether or not the scab fungus would remain alive on these limbs over winter and become a source of infection the following spring. Accordingly Mr. W. H. Darrow, a graduate student working in the writer's laboratory, was assigned to this problem. Acknowledgment is made to him for much time spent examining local orchards, making spore germination tests, inoculation experiments and in collecting data on the relative susceptibility of varieties. Also thanks are due to State Horticulturist, A. K. Gardner, and Assistant State Horticulturist, H. P. Sweetser, of Augusta, as well as to Mr. George A. Yeaton and Mr. Arthur L. Deering, County Directors of farm demonstration work for the University of Maine College of Agriculture in Oxford and Kennebec Counties for furnishing us with material for study from various parts of the State.

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* Morse W. J., and Darrow, W. H. Is Apple Scab on Young Shoots a Source of Spring Infection? Phytopathology 3: 265. Oct. 1913. The present discussion is a brief presentation of facts given in the previous article.

While the branches were frequently affected near the tip, in many cases the diseased area began one or 2 or even 3 inches back on last year's growth and extended back from one to several inches. The bark on the diseased portion of such branches was more or less thickly studded with light brown spots. Scattered spots were, as a rule, oval to elongate in shape, although frequently nearly circular, and were usually not much larger than a pin-head. Quite often in severe cases these spots ran together, forming a diseased patch of considerable area which appeared as a scurfy coating on the bark.

Closer examination of the light brown spots showed that they were blister-like pustules resulting from the death and pushing out of the epidermis or outer layer of the young bark. In the center of each pustule was a blackish portion composed of the olive-colored conidia or spores of the fungus.

A detailed study of the conditions in the field was made by Mr. Darrow in the vicinity of Orono. This was of necessity somewhat limited, as the location is outside of the best apple growing district of the state. It was observed that strong-growing water sprouts were more badly affected than young growth on the ends of branches. Water sprouts 2 or 3 feet long were often diseased for the last foot or more of their growth. Also the more vigorous growing twigs at the ends of the branches were the more severely attacked. Those which showed but little elongation were only slightly infested, or not at all.

In an orchard containing seven varieties, McIntosh and Fameuse were the worst attacked. Milden and Westfield ranked next in order of susceptibility. Only an occasional twig was found to be affected on the Northern Spy trees and these but slightly, while the Oldenburg and Tolman trees were entirely free from injury.

Many of the spores of the scab fungus, found in the pustules already mentioned, germinated readily when placed in proper culture media or even in water. These germinations were made at various times during the latter part of the winter and spring up to about the first of May. No exact data was secured to determine whether the spores so germinated were those formed the fall before or those which had been produced in the early spring from the mycelium of the fungus which had remained alive in the diseased branches over winter. The latter might have been the case with some of the later germinations but under the climatic conditions which exist in this State it does not seem possible where the tests were made early in March.

Young apple trees growing in the greenhouse were inoculated by spraying the foliage with spores produced from cultures of the fungus obtained from diseased limbs. In a month or 6 weeks the leaves of these trees were badly attacked by apple scab. Scab did not develop on other young trees growing in the same greenhouse and which were not so inoculated.

From the above it would seem evident that in this climate it is perfectly possible for the apple scab fungus, and the conidia of the same, to live over winter on diseased twigs and water sprouts, and that this form of the disease may be an important factor in the production of early spring infection where susceptible varieties of trees are grown. In this connection it is a matter of extreme practical importance to know how effective a dormant spray of bordeaux mixture or lime-sulphur is in controlling this phase of the disease. In the laboratory it was found that simply dipping the affected twigs for a few seconds in the winter strength lime-sulphur sufficed to kill all living spores, but no results of a regularly conducted spraying experiment were secured. However, certain observations made by the writer furnish some rather interesting data upon this subject.

These observations were made upon a block of four-year-old McIntosh trees in an orchard belonging to Mr. F. H. Morse of Waterford. This consisted of 40 trees, 5 rows of 8 trees to the row, set on an acre of land. They had been well fertilized and cultivated, were 7 to 8 feet tall and were healthy and vigorous with the exception that several limbs on practically every tree had been attacked by scab the season before. Some of these were so severely injured as to kill them back for several inches. However, the badly attacked trees were by no means confined to any one part of the block. They were visited about the first of July.

It was the original plan of the owner to spray the trees before the buds opened with a dormant spray of lime-sulphur and again with the same material diluted to summer strength, just before the flower buds opened, and a third time after the petals fell. The first application was made about the first of May, using a 33° Beaumé concentrate, diluted 1 part to 10 of water. At this time the leaf buds on one row of 8 trees were slightly in advance of the rest and were just beginning to open. The owner fearing he would injure them omitted the application of the strong spray upon this row of trees. However, the remainder of the entire block received the dormant spray at this time, and all received the two later applications.

At the time the orchard was inspected, the leaves on the 32 trees to which all three applications of the spray were made were exceedingly healthy, although scab was not entirely controlled upon them. Those upon the 8 trees where the dormant spray was omitted showed a strikingly different condition. Fully 75 per cent were attacked by scab and a large proportion of these were quite severely affected. In fact only those of recent growth were free from the disease.

It is not the contention of the writer that spores of the perfect stage of the apple scab fungus, formed on the leaves of the previous year, are not the source of a great proportion, and usually all, of the early spring infection of apple scab. It is, however, maintained that, under certain conditions and with certain varieties of trees, diseased twigs and water sprouts are an important factor in the propagation and spread of the disease at the beginning of the following year. It would also seem from our observations that where limb infection exists the application of some strong fungicide immediately before the leaf buds open will greatly reduce the amount of spring infection from this source.

The European Apple Canker in Maine

In an earlier publication of this Station it was stated that while the European Apple Canker, caused by *Nectria ditissima* Tul., might be present in Maine it had not at that time been observed.* Certain observations made during the past year by Mr. W. H. Darrow while working in this laboratory not only show that the fungus which is said to cause this disease is present in this State but that in some localities it occurs with considerable frequency. Several specimens identical in appearance with the descriptions and illustrations of canker said to be caused by *Nectria ditissima* were collected. These varied from small ones an inch or two in length to old ones 7 or 8 inches long. Figs. 3 and 4 show some of the specimens obtained.

In one young orchard they were found on the trunks of several trees while in older orchards the cankers appeared more abundant on branches an inch or two in diameter. Several of these cankers were found in crotches, suggesting that they might have followed winter injury. The larger part of them, however, showed the remains of a dead twig in the center indicating that the fungus may have gained entrance thereby.

The fruiting bodies of *Nectria ditissima* were quite constantly found on the older of these cankers and the ascospores found within these perithecia and the conidia produced in cultures agreed with the published descriptions of the fungus. This determination was confirmed by Dr. J. J. Davis of the University of Wisconsin who very kindly examined some of the material.

From cultures of the fungus isolated from some of the cankers Mr. Darrow made a limited number of inoculations of apple branches out of doors in May. These branches were about one-half inch through, and on this date, December 1, in all cases points of inoculation have every appearance of the beginning of a canker. The wounds, which were slight slits in the bark, have not healed but have enlarged—some of them covering from one-third to one-half the circumference of the limb. In one or two instances the limb itself was enlarged at the point of inoculation.

* Morse, W. J., and Lewis, C. E. Maine Apple Diseases. Bul. Me. Agr. Exp. Sta. 185: 371, 1910.

Fig. 1. Leaves injured by "Soluble Sulphur Compound" and arsenate of lead.

Fig. 2. Leaves injured by lime-sulphur and arsenite of zinc.

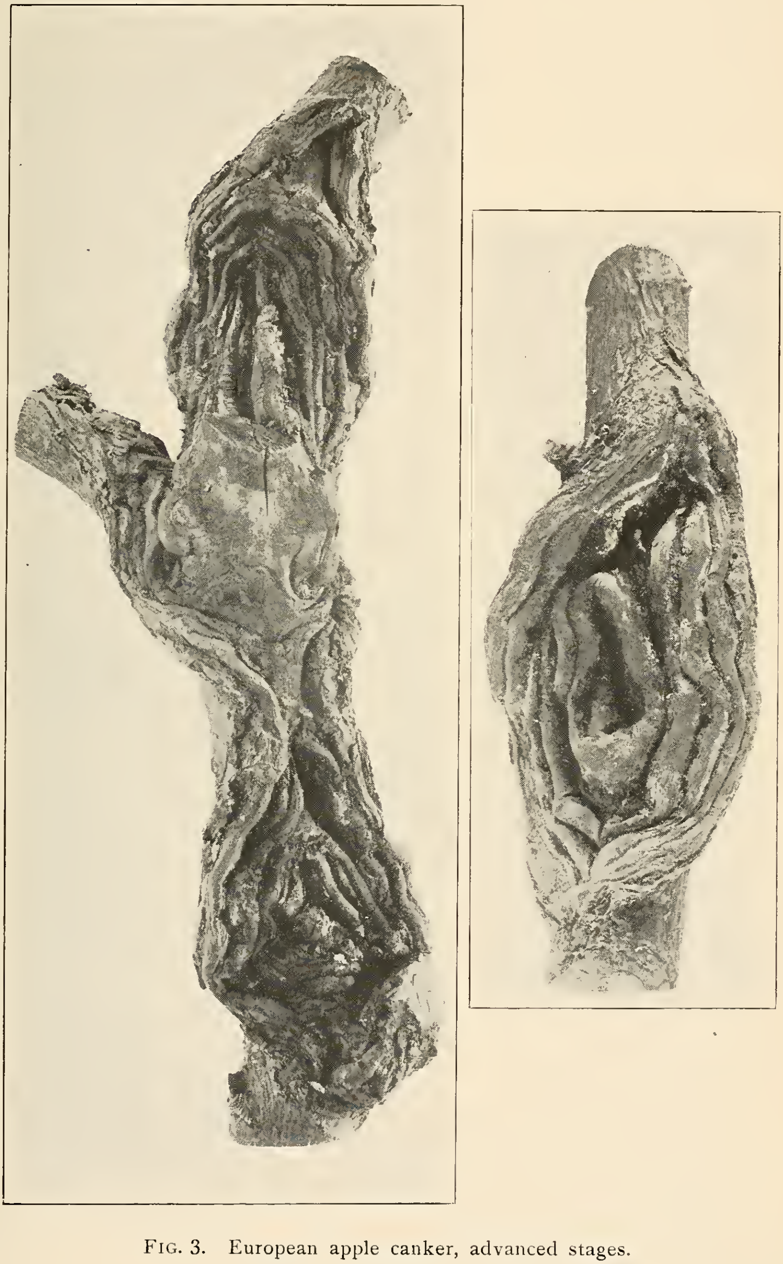

FIG. 3. European apple canker, advanced stages.

Fig. 4. European apple canker in crotch.

BULLETIN 224.

FIELD EXPERIMENTS.

REPORTED BY CHAS. D. WOODS.

The experimental work at Highmoor Farm is planned by the Director, the Biologists, the Plant Pathologist, and the Entomologist. In the following pages there are given the results of certain experiments that lie somewhat outside of the lines of work of any of the Station specialists. The carrying out of these experiments and the taking of the requisite notes devolved upon different members of the staff. In general the field work was executed under the direction of Mr. Wellington Sinclair, the Superintendent of Highmoor Farm. The notes were chiefly taken in 1910 and 1911 by Mr. Walter W. Bonns; in 1912 by Mr. George A. Yeaton, and in 1913 by Mr. Harold G. Gulliver.

TOP DRESSING EXPERIMENT ON GRASS IN 1910, 1911 AND 1912.

A fertilizer manufacturer who is an enthusiastic advocate of Thomas phosphate powder as an economical source of phosphoric acid that carries with it the lime needed to correct acidity of soil, asked that the Station undertake an experiment in top dressing grass land in which Thomas prosphate powder would be compared with acid phosphate as a source of phosphoric acid. The field best adapted to such an experiment on Highmoor Farm consisted of about five acres, half of which was seeded in 1909 and the other half in 1908. This was divided into three plots of one and three-fourths acres each in such a way that each plot contained an equal amount of each year's seeding. The grasses were a mixture of timothy and redtop with some clover and June grass. The stand was fair and about the same over the whole field. The plots ran north and south. The middle plot was left unfertilized as a check plot. To the east plot there was applied each of the three years a mixture consisting of 100 pounds of nitrate of soda, 112 pounds of muriate of potash and 600 pounds of Thomas phosphate powder. To the west plot there was applied each of the three years 100 pounds of nitrate of soda, 112 pounds of muriate of potash and 600 pounds of acid phosphate. The results are given in the table which follows:

Table showing kinds and amounts of fertilizer used and yields per plot and per acre for each year and for the three years combined.

Plot.	Kinds and Amount Fertilizer Applied Each Year.	Year.	Yield of Hay. Per plot.		Per acre.
			Pounds.	Tons.	Tons.
A	100 pounds nitrate of soda	1910	8560	4.28	2.45
	112 pounds muriate of potash	1911	3950	1.92	1.13
	600 pounds of acid phosphate	1912	5315	2.66	1.52
	Total			8.86	5.10
B		1910	5625	2.81	1.60
	No fertilizer	1911	2850	1.37	.81
		1912	3750	1.88	1.07
	Total			6.06	3.48
C	100 pounds nitrate of soda	1910	7135	3.57	2.04
	112 pounds muriate of soda	1911	3450	1.73	.98
	600 pounds Thomas phosphate powder	1912	5230	2.61	1.49
	Total			7.91	4.51

In 1910 there was an abundant rainfall in the grass growing months and the conditions were favorable for a heavy yield. In 1911 the conditions were the reverse and not enough water fell after the application of the fertilizer to render it very available to the grass plants. The conditions in 1912 were fairly favorable for a hay crop. But this was the fourth year for half of the field and the fifth year the other half had been in grass and cut for hay.

The surprising thing about this experiment is the increase due to the acid phosphate in 1910. Even if the increased yield from the Thomas phosphate plot be entirely ascribed to the muriate and nitrate the application of acid phosphate increased the yield in 1910 about four-tenths of a ton per acre and in 1911 there was a small increase in yield over the plot to which Thomas phosphate powder was applied. In top dressing experiments* on the College farm no appreciable benefit was found from the use of phosphoric acid.

The fertilizer for plots A and C would cost in these amounts about $8.50 for each of the three yearly applications or about $25 for the three years for each fertilized plot. It would seem doubtful that on this particular land any advantage was derived from the addition of the Thomas phosphate powder other than maintaining the fertility of the soil. On this plot there was for the three years 1.85 tons of hay cut more than on the unfertilized plot. As the cost of applying the fertilizer was small and the extra labor in harvesting the crop not much increased because of this increased yield the extra hay was obtained on plot C at a cost of about $13.50 per ton. On plot A the increased yield of 2.8 tons was obtained at a cost for fertilizer alone at the rate of a little less than $9 per ton.

The Station practices top dressing its mowing lands at Highmoor Farm each year with a mixture of 100 pounds of nitrate of soda, 100 pounds of muriate of potash and 150 pounds of acid phosphate. This costs for the materials applied to the land about $6 per acre. Such a mixture supplies more phosphoric acid than the crop of hay removes from the soil, about the same amount of potash as the crop of hay removes and about one-third to one-half of the nitrogen. It is doubtful if in average years more than 100 pounds of nitrate of soda can be applied without danger of loss from leaching.

Top dressing of mowing lands is profitable if the resulting increase in the hay crop is to be used and fed on the farm. At the price fixed in 1913 for the valuation of fertilizers at tide water in ton lots the fertilizing constituents of a ton of mixed hay are worth over $7. To sell hay is to sell off from the farm fertilizing materials that will cost, including the carting of the hay to a shipping point, the purchase and application of fertilizers to make good those sold in the hay at least $9 for every ton sold. Not to plan to replace the fertilizing constituents is to rob the farm of that amount of plant food.

*Bulletin 94, Maine Station.

High Ridge, Medium Ridge and Level Culture for Potatoes Compared.

EXPERIMENTS IN AROOSTOOK COUNTY.

The method of ridge culture is almost universally used by potato growers in Aroostook County. Probably over 90 per cent of the farmers practice what might be called extreme ridge culture. The ridging begins at the time of planting. The planter most used has a plow so constructed that it makes little more than a mark on the soil unless it is very light, instead of a furrow, then the disks at the rear of the machine cover the seed by throwing up a ridge perhaps 4 inches high so that the seed at the very start is practically on a level with the surface between the rows. A few farmers make a practice of going over the field with a weeder and somewhat flattening the ridge but the number that do this is comparatively few. The method most usually followed is to go between the rows with the cultivator perhaps 8 to 10 days after the potatoes are planted and then as soon as they begin to break the ground go over with the horse-hoe and bury them up also burying the weeds at the same time and thereby raising the height of the ridge. This kind of cultivation is continued until the tops are too large to pass through without injury. By this time an A shaped ridge has been formed about 12 to 15 inches high and, of course, the surface between the rows has been dropped by the continual scraping up of the soil so that the tubers growing in the ridge are considerably above the surface between the rows.

It can be readily seen that in a dry season a field so handled must suffer considerably from lack of moisture. In the rather wet seasons usual to Aroostook County no lack of moisture is felt and the drains between the rows are an advantage rather than an injury, but in an extremely dry season it would seem that the drainage is too great. The ridges being high and narrow dry out very quickly and it would appear therefore the crop must suffer more from lack of moisture than it would if the roots of the plant were below the level as they are when modified level culture is practiced.

In the years 1907, 1908 and 1909 field experiments comparing the shallow planting and high ridge cultivation common in Aroostook County with a deeper planting and a low broad ridge were carried out at Houlton. The three seasons had an abundant water supply. Indeed in 1909 there was more rainfall than the crop needed. Because of the long continued cold wet weather and early frost the yield was reduced materially. The results as given in the following table show no practical advantage of one method over the other so far as yield is concerned.

Table showing comparison of medium planted, broad low ridge with shallow planted high ridge in Aroostook County. Total area in experiments 15 acres.

Method of Culture.	Year.	Variety.	Yield of merchantable potatoes per acre.
			Bush.
Medium planted	1907	Green Mountain	333
Medium ridge	1908	Green Mountain	301
	1909	Green Mountain	216
		Average three years	283
Shallow planted	1907	Green Mountain	325
High ridge	1908	Green Mountain	291
	1909	Green Mountain	204
		Average three years	273

EXPERIMENTS IN KENNEBEC COUNTY.

The successful growing of potatoes in Aroostook County has greatly stimulated the potato industry over the whole State. The great advance in value of land in Arostook County has led farmers to sell and go to other parts of the State where land has less value. Both of these facts have led to the adoption of Aroostook County methods of potato growing all over the State. It seemed probable that the less rainfall and not infrequent drouths experienced in the more southern parts of the State might prove unfavorable to growing potatoes with the shallow planting high ridge method of cultivation. With the purchase of Highmoor Farm for the Station an experiment comparing shallow planting with high ridge cultivation, somewhat deeper planting with a lower, broader ridge, and deep planting with as level cultivation as practicable, was begun. This has been continued through four years with two varieties of potatoes. The results of the experiment are here reported. The deep planted lots were planted at a depth of 5 inches, the medium at 3 1-2 inches and the shallow at 2 inches.

Full data as to the planting, cultivation, spraying and harvesting of the crop were kept each season. But in an experiment of this type it does not seem wise to use space in reporting details that, while they are important in showing that the crop was carefully grown, have little agricultural significance beyond that fact.

The season of 1910 was favorable for a maximum crop as the rainfall was ample and the growing season greatly prolonged by frost keeping off until October. The seasons of 1911 and 1912 were not so favoable and 1913 was particularly unfavorable, although the rainfall in August was greater than the average and saved the crop from the damage that threatened from the dry July.

The time required for planting was the same on all of the plots. The planting, spraying and harvesting were the same for all of the plots with the exception that on the deep planted it was necessary to use four horses on the digger. The deep planted required less hours of cultivation; the medium planted the most. A man and team for cultivating were on the deep plots 26 hours, on the medium 39 hours and on the shallow 35 hours per acre.

There was not much difference in the difficulties of digging between the shallow planted and the medium planted. The deep planted required four horses instead of two on the digger, and a good deal of care was necessary to be sure that the digger was sufficiently deep in the ground to prevent cutting the tubers.

The yields for the four years are given in the table which follows:

Table showing comparison of deep planted, level culture, medium planted, medium ridge and shallow planted high ridge at Highmoor Farm (Kennebec County). Total area in experiments 16 1-2 acres.

METHOD OF CULTURE.	Year.	VARIETY.	Yield per acre of merchantable potatoes.
			Bush.
Deep planted	1910	Green Mountain	365
Level culture	1911	Irish Cobbler	166
	1912	Irish Cobbler	159
	1913	Green Mountain	35
		Average Green Mountain	360
		Average Irish Cobbler	163
		Average four years	261
Medium planted	1910	Green Mountain	436
Medium ridge	1911	Irish Cobbler	170
	1912	Irish Cobbler	162
	1913	Green Mountain	334
		Average Green Mountain	385
		Avergge Irish Cobbler	166
		Average four years	276
Shallow planted	1910	Green Mountain	372
High ridge	1911	Irish Cobbler	130
	1912	Irish Cobbler	147
	1913	Green Mountain	277
		Average Green Mountain	325
		Average Irish Cobbler	139
		Average four years	232

CONCLUSIONS.

In the three years experiments comparing the usual method practiced in Aroostook County with deeper planted seed and a lower, broader ridge than is commonly used there showed that so far as yield was concerned there is nothing to chose in that locality between the two methods.

The deep planted and medium planted gave practically the same yields at Highmoor Farm with the advantage (though within experimental error) in favor of the medium planted. The medium planted and medium ridge gave considerably better yields at Highmoor Farm than the shallow planted and high ridge. The medium ridge is cultivated as cheaply as the shallow ridge and is harvested nearly as easily. The deep planted are cultivated at less cost than either of the two other methods but are far more difficult to harvest.

The results indicate that for Aroostook County the shallow planted high ridge is well suited to the climatic conditions. And they also clearly indicate that for the lower counties in the State with their lesser rainfall during the growing season the medium planted with the broad low ridge cultivation is preferable to either of the others.

Soy Beans for Fodder, Silage and Seed.

In 1903 and 1904 the Station grew on the college farm at Orono several varieties of soy beans. These were grown for forage and for silage. The results were published in Bulletin 106 and made up part of the Report of the Station for 1904. The bulletin is out of print and there are very few available copies of the Report.

The soy bean carries a high percentage of oil which has very good drying qualities and on this account has attracted the attention of paint manufacturers. The Paint Manufacturers' Association of the United States have been growing in coöperation with people through the northern belt of states certain varieties of soy beans for seed with the idea of learning the yield and the amount and quality of oil yielded under different climatic conditions. Although it is not at all likely that the soy bean can ever be grown as a profitable seed crop in Maine, three varieties were grown in coöperation with the above named Association at Highmoor Farm in 1913.

As the earlier report on soy beans at this Station is out of print the earlier as well as the later experiments are here briefly given.

The soy bean was intoduced into the United States several years ago from Japan, where it is grown for human food. In this country it has chiefly been grown as a forage crop, and as it thrives best in a moderately warm climate is better known in the southern and middle than in the northern states. Some of the earlier varieties, however, will mature seed in New England. At the Massachusetts and Storrs (Conn.) Experiment Stations a few varieties have been grown quite successfully for soiling crops, for silage by itself or mixed with corn, and for the seeds.

The soy bean is an erect, annual plant, with branching, hairy stem, trifoliate, more or less hairy leaves, rather inconspicuous pale lilac or violet colored flowers, and broad, two to five-seeded pods, covered like the stem, with stiff, reddish hairs, The seeds vary in color from whitish and yellowish to green, brown and black; and in shape from spherical to elliptical and more or less compressed.

The seeds are self pollinated, and on this account are sure to produce seeds wherever the plants reach maturity.

CONDITIONS OF GROWTH.

It is believed in Japan that in northern climates, soils of a rather strong character are best adapted to the soy bean. It is usually sown about the end of May, and when used for hay is cut early in August. In both Europe and America it has been found to thrive best on soils of medium texture that are well supplied with potash, phosphoric acid, and lime. It succeeds very well, however, on comparatively light soils, often giving an abundant crop on soils too poor to grow clover.

The soy bean requires about the same temprature as corn. Professor Brooks says that the earlier sorts will mature in Massachusetts with as much certainty as will the earlier varieties of corn.

As a general thing, the soy bean is not so easily injured by frost as the common field or garden varieties of beans, and hence it can be planted earlier in the spring and can also be left in the field later in the autumn.

FERTILIZING AND CULTURE.

Like all leguminous plants, the soy bean, through the aid of root tubercle organisms, acquires atmospheric nitrogen. When the soy bean was first introduced into America it did not form root tubercles. In order to insure the growth of the root tubercles it is necessary to use seed that has been inoculated, or to inoculate the soil with the proper organism. This last is readily done by applying broadcast a small amount of soil taken from a field where soy beans developing root tubercles have been grown. At this Station no tubercles formed on plants grown in soil that had not been inoculated, but they grew abundantly where soil from infested soy bean was applied at the rate of a few barrels to the acre. According to our experience the beans will grow as well without the root tubercles as with, provided they are liberally fertilized. Their economical growth depends upon the presence of the root tubercles, as in this way they can be grown with little or no nitrogen in the fertilizer. If they are to be grown on soil containing no root tubercle organisms, they require a fairly liberal application of a complete fertilizer. If grown in good soil where root tubercles may be expected to develop, only phosphoric acid and potash need be supplied in the fertilizer. The soil should be prepared as for ordinary beans. It should be made fine, free from clods and lumps, and smooth. A good seed bed is essential to a good growth.

In this climate the soy bean should be planted a little earlier than ordinary beans, but not until the ground has warmed up considerably. The first season we planted in drills 3 feet apart. This was too far apart for the best yield. Nearly double the yield per acre is obtained when the drills are 16 inches apart. In the vase of the wide drills it was necessary to cultivate three times with the horse cultivator. With the drills 16 inches apart they were cultivated once with a hand wheel hoe. On fairly clean land good success may be had with broadcasting or still better by the use of the grain drill. If planted in rows, the seed should be sown with a hand seed drill similar to that used for beets or turnips. It will require about 3 pecks of seed per acre of the medium green soy bean when seeded in drills 16 inches apart. If the seed is broadcast, a bushel will be none too much for an acre. It will probably not be wise to attempt to grow soy beans in Maine for the seed, but if this is done, the drills should be at least 18 inches apart and the soil should be kept stirred and clean, as in the case of ordinary field beans. If wanted for silage, the beans can be grown alone or planted with corn. The latter method is quite strongly recommended, the seeds being mixed and put in the planter in the proportion of 10 quarts of corn to 7 of beans. The forage from this mixture can be fed green or cut for the silo.

YIELD OF GREEN FODDER.

The yield of green fodder that can be had in Maine will probably vary from 5 to 10 tons per acre. In the large plots grown by this Station in 1903 the largest yield was only a little over 5 tons to the acre. But the rows were twice too far apart, having been planted in drills 3 feet apart. If they had been planted at the same distance as the small plots in 1904 (16 inches) there is no reason for thinking the yield would not have been nearly or quite doubled, for at no time did the plants come near filling the space between the rows. On good land, with fair cultivation and average season, a yield of 8 tons of green fodder could doubtless be counted upon. Cured into hay this would give a yield of about 2 1-2 tons per acre.

NUTRIENTS IN SOY BEAN AND THEIR DIGESTIBILITY.

The composition of the soy bean as compared with other legumes stands high. The fodder closely resembles clover in composition. Soy bean silage, in both composition and digestibility, is the equal of clover silage. It is doubtful if any more digestible nutrients can be grown from an acre with soy beans than with clover. But in some localities they are a surer crop and need only a single season for their growth. Soy beans would be more naturally compared in this State with corn, for if grown at all they seem best adapted for silage. The chief difference between corn and soy bean is found in the high protein content of the latter. Like other beans it has the power of taking its nitrogen to form protein from the air, and since it is richer in protein than corn, it may be justly considered a desirable addition to the list of forage plants. As the price of feeds rich in protein is advancing it seems very desirable that as many legumes (plants rich in protein) that can gather their own nitrogen from the air be grown as possible.

SOY BEAN SILAGE.

The soy bean plants dried do not make desirable forage as the cured stalks are rather coarse and hard, and are therefore best fed green or made into silage. Like most leguminous plants, soy beans do not keep as well in the silo alone as when mixed with corn. Consequently, in the trials made at the Maine Station, the beans were cut and put into the silo with corn. The proportion in this case, for convenience, was about 14 of corn to 9 of beans. The silage kept perfectly and when fed out was nearly as green as when it went into the silo. The animals ate it with great relish and the sheep preferred it to clear corn silage.

YIELD OF DRY MATTER AND PROTEIN.

Soy Bean vs. Corn Fodder.

The average yield for 7 seasons at the Maine Station of fodder from corn of Sanford or similar variety that will not mature in this climate was a little over 17 tons per acre. For the same period the average yield of green fodder from matured corn was a little over 11 tons per acre. The same season that the Massachusetts Station obtained a yield of 16 tons of Longfellow corn they harvested 10 tons of soy bean fodder from one acre. If we assume an average yield of soy bean fodder at 8 tons and corn fodder at 12 tons per acre, and use in calculation the average of the 13 analyses of each material the soy bean would yield 3,560 pounds of dry matter and the corn 5,064 pounds. The soy bean would contain 576 pounds of protein and the corn 552 pounds.

It would, therefore, appear that a crop of corn will give practically as many pounds of protein as a crop of soy bean, and over 40 per cent more dry matter. Furthermore, the nutrients of the corn are more digestible than those of soy beans. The corn is probably a surer crop, but on the other hand it requires a fertilizer carrying more nitrogen (costing from $10 to $15 per acre) to grow the corn and it is necessary to handle 50 per cent more material to obtain the same weight of protein.

SOY BEANS FOR SEED.

Three varieties of seed furnished by the Paint Manufacturers' Association were tried at Highmoor Farm in 1913.

Soy bean A was a variety imported from Manchuria and supposed to carry an oil of high oxidizing properties. This variety was successfully grown in several states in 1912, and that year they found marked differences between the percentages of oil in beans grown in New Jersey and in Kentucky. The bean in North Dakota was practically the same as that in Kentucky. Variety 1002 was an American type which was stated not to mature as quickly as A. No description was furnished with Soy Bean 302, the other variety. They were all tested for germination and found to germinate well.

The soil in which they were grown was a medium sandy loam in excellent heart and tilth. It was prepared by plowing and harrowing and the application of a barrel of soil furnished by the Massachusetts Agricultural Experiment Station from a field where soy beans with the root nodules had been successfully grown the preceding year. This inoculation proved successful for all the plants examined were found to bear root nodules in abundance. There were also put on 500 pounds of a high grade fertilizer carrying 4 per cent nitrogen, 8 per cent available phosphoric acid and 7 per cent potash. It is probable that a fertilizer carrying much less nitrogen could have been equally as well used. As it was desired to give the plants every opportunity for growth a fertilizer carrying sufficient nitrogen to mature the crop was applied. They were sown in drills June 7, the rows being three feet apart. June 17 all three varieties were up. July 7, thirty days from the time of planting, the stand was good on all three of the plots, but thought to be too thick on 302 and 1002. Plants on 302 were 6 inches high; on 1002, 4 to 5 inches high; and on plot A 3 to 4 inches high.

August 5, sixty days from planting, the soy bean A plants were 10 inches high; 1002, 14 inches; and 302, 14.5 inches. Every 3 feet of row there were 8 soy bean plants A, 19 soy bean 1002, and 20 soy bean 302. No disease or insect pests, and all three plots were showing vigorous growth.

August 11 soy bean A was in blossom. August 13, 302 was in blossom. August 18, 1002 was in bloom.

September 5, 90 days from planting, soy bean A was 23 inches high and in good vigor, seed pods numerous with an average length of nearly two inches. The beans averaged three to the pod. Soy bean 1002 plants averaged 33.5 inches high, in good vigor, uniform, very few seed pods, but were still blooming vigorously. Soy bean 302 was 25 inches high with excellent vigor, quite uniform, seed pods numerous with an average length of two inches, with three beans to the pod. This variety stopped blooming and is much earlier than either of the two others.

September 15 the lower part of the field was touched by frost. October 10 soy beans A and 302 were harvested by pulling the plants. 1002 did not mature seed and was cut for fodder.

At threshing soy bean 302 yielded at the rate of 650 pounds per acre, and soy bean A at the rate of 700 pounds of shelled beans per acre. The beans were planted in rows three feet apart at the suggestion of the Paint Manufacturers' Association. This was too far apart for the two varieties that matured for a maximum yield. As found in the earlier trials, 18 inches would have been a better distance between rows. At that distance the yield would have been 75 per cent greater without doubt or a yield of 20 bushels of beans. Such a yield would carry as much protein and as much oil as 70 bushels of corn but only an eighth as much carbohydrates. While the threshed vines are readily eaten by stock they do not carry anything like as much digestible matter as the stover from 70 bushels of corn. The crop is easier handled, however, costs much less for fertilizer needed and is a soil restorer.

SUMMARY.

From the trials made at the Maine Station and those at other New England Stations the following summary is justified:

Soy beans can be grown in parts of Maine where corn thrives.

Where early corn matures, the early white soy bean will usually mature.

Where Sanford corn ears, the early medium soy bean will form pods.

Soy bean can be grown with less nitrogen than corn.

In order to grow the soy bean most economically, the soil should be inoculated with the organism that forms root tubercles.

The soil should be prepared as for corn or beans and should be free from lumps and clods.

Fertilizers carrying phosphoric acid and potash are essential and on good land no nitrogen is needed if the soil is inoculated for root tubercles.

Sown in drills 16 inches apart, about 3 pecks of seed is needed per acre. If drilled with a grain drill or sown broadcast more seed, perhaps a bushel per acre, will be needed.

Soy beans can be grown with corn, mixing the seed at the rate of 10 quarts of corn and 7 of soy beans. Thus seeded the drills should be about 3 feet apart.

When sown in drills they should be cultivated the same as common beans. In case of narrow spaces between drills, a hand wheel hoe does the work rapidly and well.

It is doubtful if it would be profitable to grow soy beans for seed in Maine. The varieties that will ripen seed in this climate make small vine growth.

The crop is best adapted for feeding green or for silage.

The crop can be harvested by hand or machine. For silage a grain reaper and binder leaves it convenient for handling and for the silage cutter.

A yield of 8 tons of green crop is an average in average seasons on average soil.

Eight tons of soy bean fodder carries about the same amount of protein as 12 tons of corn in milk ready for the silo, but it carries only a little more dry matter than 8 tons of corn.

If grown with corn, it can be cut with the corn, by hand or a corn harvester.

When grown by itself for silage, it is best mixed with corn at time of cutting into the silo. About 3 parts corn to 2 parts beans is a very good proportion.

Less protein (the most expensive part of commercial feeding stuffs) need be fed with soy bean and corn silage than with corn silage alone.

Spraying with Sulphate of Iron Solution to Control Wild Mustard in Grain and Other Sown Crops.

There are three quite closely related plants of the mustard family that are troublesome weeds, particularly in sown crops, all over the eastern part of the United States and in Europe, from whence they were brought in as weeds.

These three plants are *Sinapis avensis*, which is the common charlock or wild mustard. It is very abundant in Maine. The *Raphanus raphanistrum*, or wild radish, jointed or white charlock, is also very abundant and a persistent weed. The third, wild turnip, *Brassica tempestris*. is not so bad a weed as the other two as it rarely lasts in the land more than one or two years. These all belong to the mustard family and more or less resemble each other in their appearance. Wild turnip has a smooth leaf and stem, while both the wild radish and the wild mustard are roughened with strong hairs. It is not easy to distinguish between wild radish and wild mustard when the plants are young. The wild radish leaves, however, are much more deeply cut, the divisions between the lobes of the leaves reaching nearly to the midrib. With a small magnifying glass the stem hairs make it easier also to distinguish. Those of the wild mustard generally protrude at right angles from the stem while those of the wild radish slant downward. Wild mustard has a straight, jointless seed pod which splits open when dry and scatters its seed at the slightest touch. On wild radish the seed pod is jointed and tends to break up in segments when dry.

A somewhat superficial examination of fields indicates that perhaps 75 per cent of the oat and barley acreage in Maine is infested with "wild mustard", and that 50 per cent is so badly infested that hand pulling cannot be resorted to with profit.

In experiments which were conducted in Germany it was found that in some instances the crop was diminished so that when it was grown with the mustard there was a yield of only one-third of what was grown on the same kind of land under the same conditions where the mustard had been removed.

It has been found absolutely impossible to separate wild radish or mustard segments or seed from oats or barley by even the most improved types of fanning mills, or by floating in water. As a result, if these weeds are permitted to mature and are harvested with the grain crops, it means again seeding the fields with these weeds, or else purchasing seed grain from outside distributors. The cost of good seed oats free from weed seeds is well known. Many farmers to be relieved of this burden of buying seed oats, purchase ordinary feed oats, which as a rule are loaded with mustard seed. Thus the farmer who buys cheap seed oats encounters weed seeds in both harvesting his crop and in seeding his land.

Extensive studies have been made of this plant and methods of control in France and in Germany, particularly under the auspices of the German Agricultural Society by Gustav Schultz.

Using this work of Schultz as a basis in the years 1905 to 1908 inclusive the Maine Agricultural Experiment Station carried on extensive experiments in an endeavor to kill wild mustard in sown grain crops by spraying with iron sulphate and copper sulphate. It was found that it was perfectly possible by spraying with iron sulphate to rid the field of wild mustard at a moderate cost.

Experiments on wild radish were not so successful. Both French and German experimentors, however, claim to have killed wild radish by a 20 per cent solution of iron sulphate. In their published results, however, they use the common names and rarely distinguish between the wild radish and the wild mustard in their field experiments.

In 1912 further trials were made by this Station upon wild radish and wild turnip. It was found possible to completely exterminate wild turnip by spraying with sulphate of iron even after the plants had obtained their sixth leaf. With wild radish the plant was controlled by spraying when it had only shown its fourth leaf. The results of these experiments indicate that it is perfectly possible to handle, without injury to the grain crop, wild mustard, wild radish and wild turnip wherever they infest grain fields. While a single spraying may not kill every plant it will so reduce the number that by a small amount of work in hand pulling it will be easily possible to free a grain field absolutely from these pests.

One of the experiments in 1912 was carried on on a farm where in 1911 practically 25 per cent of the threshed yield was mustard seed. In this particular instance it was chiefly the wild turnip. In an experiment on this farm where the wild turnip was slow in starting so that the oats were well above it, a single spraying applied when the wild turnip plants were in the sixth leaf resulted in killing most of them, and where two sprayings were applied, (the second three days later, at which time the plants had developed eight leaves,) the field was entirely freed from this pant despite the fact that the oats were so tall that they partialy covered the wild turnip plants, and that the plants were far larger than they should be for treatment.

It is rarely that a field is badly infested with more than one of these varieties. If it is the wild mustard or the wild turnip it can be more readily controlled than the wild radish. However, all three of the plants can be controlled by spraying with iron sulphate at the proper time and under proper conditions.

IDEAL CONDITIONS.

While it is not always possible by any means to spray at exactly the right time and under exactly the right conditions the following are the points to be aimed at:

It is of the utmost importance to spray the plants while they are small and before the buds form. They should not be in more than the third or fourth leaf, for if they are much larger than that there is danger that the plants will not be killed but only injured by the spray. The plants should be so small that they can be completely covered by an ordinary drinking tumbler.

There should be used common iron sulphate and water. Dissolve so as to make a 17 to 20 per cent solution. The solution is made by suspending 100 pounds of the iron sulphate in the top of a barrel containing 50 gallons of water. If allowed to stand over night the major portion of the iron sulphate will be dissolved and only a small amount of labor is needed in the morning to complete the solution. This solution will have a strength of about 22 per cent, and for use should be reduced by the addition of about 20 gallons of water to make the solution contain about 17 per cent of iron sulphate.

The solution must be applied as a very fine mist. Sprinkling will not suffice. An ordinary potato sprayer which can develop power sufficient to maintain a pressure of 60 to 70 pounds to the square inch, by the use of fine nozzles, will make the desired mist.

The plants should be sprayed after the dew has dried off in a still air and on a bright sunny day. It is not usually possible to find all of these conditions. The most important thing is to spray the plants when they are of the proper size, before they get too large.

It is to be hoped that the growers of small grains that are troubled with "charlock" (whether it be wild mustard, wild radish or wild turnip) will keep this matter in mind and provide a supply of iron sulphate. The materials must be provided amply in advance; a day or two days delay may make all the difference in the world with the results of the application. The materials are applied with an ordinary spray pump, such as is used in spraying potatoes. A fine nozzle must be used and the pressure to 60 to 80 pounds to the square inch in order to develop a fine mist. Sprinkling the plants will not kill them. The material must fall upon the plants in the form of a fine mist and the spraying should be done after the dew has dried from the plants, and best on a bright day when there is no wind. Application must be made before the plants have developed beyond the fourth leaf. At this stage the plant is so small that it can be covered by an ordinary drinking tumbler.

Condensed Directions. Dissolve 100 pounds iron sulphate in 70 gallons of water, or 70 in 50 gallons, as is most convenient. Apply at the rate of about 70 gallons per acre. Use a powerful pump and have the pressure at least 60 pounds. Use a fine nozzle. This should develop a fine dust-like mist. A coarse mist will not do. Spray after the dew has dried off when the plants are in the fourth leaf. Choose if possible a bright, warm day without wind. But spray when the plants are the proper size even if the day is not all that could be desired. If the field is badly infested or the conditions of the first spraying were not satisfactory, a second spraying three days later is desirable. Later go over the field and pull by hand any plants that may have escaped.

Effect of Iron Sulphate Spray Upon Potatoes.

Because of urging growers to spray for wild mustard in oats, the writer was in the spring of 1913 the recipient of quite a number of letters of inquiry as to whether wild mustard could not be controlled in potatoes by spraying with sulphate of iron solution. The reply was sent that the treatment would kill the mustard and probably would seriously injure the potatoes as well.

In order to ascertain the effect of spraying potato plants with sulphate of iron one plot each of Irish Cobbler and Green Mountain potatoes were planted on June 10, 1913. Each plot contained four rows of about 250 feet in length.

Other than the spraying with sulphate of iron the treatment of these potatoes was in every way the same as that of other potatoes grown in 1913. The land was prepared by plowing and harrowing to make a good seed bed. Medium sized, healthy, sound tubers were used for seed. The seed was treated with formaldehyde for fungi. Fertilizer at the rate of 1700 pounds per acre, carrying 4 per cent nitrogen, 8 per cent available phosphoric acid and 7 per cent potash, was applied at planting and at first cultivation.

The plants appeared July 2 and three days later the soil was hilled around them. On July 8 the plants were 2 to 4 inches above ground. Although there were no plants of either kind of mustard on the plots they were sprayed twice on July 8 with a solution of 100 pounds of iron sulphate in 50 gallons of water. In 24 hours all the tissue that had been hit by the spray had turned black. These blackened portions of the leaf surface later shrivelled and were brown. No plants were completely killed.

On July 10 a sulky cultivator was used, straddling each row. On July 12 the plants had recovered somewhat and were growing. The tops were sprayed for the second time July 14. But one application was made this time. This spraying had the same effect as the first except that the plants did not seem to recover as rapidly. Five days later, however, the tops showed signs of recovering. On July 25 the field was cultivated and sprayed with bordeaux mixture and Arsenoid. On July 30 hardly any trace of the spray injury was visible.

The plants started blossoming August 4, 20 days later than other potatoes of the same variety planted on the same date. On August 13 the tops were from 12 to 16 inches in height and still blossoming. At this time, compared with other Irish Cobblers and Green Mountains planted at the same date, the tops and tubers were smaller and the period of blossoming later.

September 10 the Irish Cobblers had "turned" and were fallen down. The Green Mountains were still vigorous. The flea beetles were numerous. On September 14 the lower part of the field went down with the frost. On September 15 the Irish Cobblers were all dead and on September 28 they were dug. On October 13 the Green Mountains were harvested.

THE YIELDS.

Irish Cobblers. 1070 feet of row yielded 1000 pounds of tubers. This is at the rate of 15,430 pounds per acre or 257 bushels. Compared with other Irish Cobblers, the tubers were almost thee times as large, many weighing two pounds. The average yield of other Cobblers in a formaldehyde experiment was 220 bushels per acre, and in a general spraying experiment Cobblers yielded at the rate of 150 bushels per acre.

Green Mountains. 1164 feet of row yielded 1760 pounds of tubers at the rate of 24,968 pounds, or 416 bushels per acre. The average yield of other Green Mountains in a culture experiment was 303 bushels per acre.

CONCLUSIONS.

That wild mustard if it had been present would have been killed by these three applications of iron sulphate admits of little doubt.

The effect of the iron sulphate upon the potato tops was quite similar to that of a hard freeze. They recovered in much the same way as frosted vines do.

That the increased yield was due to the treatment there is little doubt. But it does not follow that similar results would happen in different seasons under other climatic conditions

The temporary checking of a tuber forming plant may have stimulated tuber growth. It is a common belief that too great a development of vine interferes with tuber setting. That the increased yield was fortuitous seems to be the more plausible explanation. The experiment will be repeated on a larger and more thorough scale at Aroostook Farm in 1914.

The experience indicates that with a field of potatoes badly infested with mustard spraying with sulphate of iron solution may be resorted to with a reasonable expectation that the yield of tubers will not be diminished. At present such a treatment can only be recommended as a rather extreme measure.

Analyses for Poison of Apples Sprayed with Arsenate of Lead in Mid-Summer.

The brown-tail moth flight in July 1913 was in the vicinity of Highmoor Farm the heaviest that has been known. Though all of the brown-tail moth nests were removed from the orchards at Highmoor Farm in the winter of 1912-13, hundreds, if not thousands, of nests must have been left in that vicinity. The removal of brown-tail moth nests by picking is laborious and expensive. It was, therefore, decided to thoroughly spray the orchards after the female brown-tail moths had deposited their eggs and at about the time when these eggs would be hatching. Therefore, all of the trees in the orchard were thoroughly sprayed with arsenate of lead the first week in August, 1913. The result, so far as the control of the brown-tail moth was concerned, was a success, for in the winter of 1913-14 the orchards were free from brown-tail moth nests, while all the unsprayed orchards in that vicinity, as well as the many trees along the roadside, are literally covered with the nests.

It was with some trepidation as to the effect upon the crop that arsenate of lead was applied so liberally when the apples were a third grown. Arsenate of lead is a double dangerous poison, not only because it contains arsenic but it also carries lead which is a so-called cumulative poison.

Therefore, at the time of harvest ten different lots of apples, aggregating about two barrels of three different varieties, that had been heavily sprayed, were picked and sent to the laboratory. Care was taken in picking and handling so that any arsenate of lead which might be clinging to the apples should not be removed. The apples in the ten lots were thoroughly and carefully washed in water at the laboratory and all of the washings saved. These were evaporated to the smallest amounts possible and the organic matter removed. The determinations of both the lead and the arsenic were made in the washings from each lot, and the amounts of lead arsenate present were calculated both from the lead found and from the arsenic found. Theoretically the amount of arsenate of lead should be exactly the same when calculated from the arsenic as when calculated from the lead. It will be noted, however, that the arsenic found was considerable in excess of the lead needed to make arsenate of lead. In other words the arsenate of lead calculated from the arsenic found is a half more than that calculated from the lead found. No explanation of this discrepency is offered. The chemical work was carefully checked. It is a matter of no practical importance but it has occupied the attention of quite a bit of the time of the chemists.

In order to make sure that all of the arsenic was removed by this washing in the laboratory samples of the washed peelings from two different lots were examined and the results show that they were entirely free from arsenic and, therefore, all of the arsenate of lead was removed by washing. The results of the analyses are given in the following table:

Table showing results of analyses of apples sprayed with arsenate of lead.

Sta. No.	Variety of Apple.	Number apples tested.		Amount arsenic oxide found.	Amount metallic lead found.	Arsenate of lead per apple calculated from arsenic lead.	
		Number	Weight grams.	Mgr.	Mgr.	Mgr.	Mgr.
11644	Baldwin	43	4600	4.305	8.673	.454	.292
11645	"	45	5600	3.690	7.853	.372	.252
11646	"	49	7100	3.690	7.853	.342	.232
11638	Ben Davis	47	5900	2.153	3.722	.208	.114
11639	" "	50	6850	2.460	5.600	.233	.162
11640	" "	45	6700	1.538	3.381	.140	.108
11641	" "	47	5450	2.460	5.258	.238	.162
11642	" "	47	7000	4.610	8.330	.445	.255
11643	" "	47	5650	4.305	8.673	.416	.267
11637	Russets	45	4100	2.460	4.917	.248	.158

Arsenic in the form of arsenious oxide is frequently administered as a tonic. The maximum dose is five milligrams and is continued at the rate of not to exceed ten milligrams per day. The washings from about ten pounds of apples carry at the most four milligrams of arsenic in the form of arsenic oxide. If any of these summer sprayed apples had been eaten without wiping the parings in any way it would have taken about half a bushel a day to get the maximum medicinal dose. Hence any danger from the eating of sprayed apples from the arsenical standpoint is a negligible quantity. Paring the apple would exclude all of the arsenic which it carries, and ordinary wiping of the apple would remove practically all of it from the skin. The poison does not penetrate below the skin and is easily wiped off or washed off.

Lead under some circumstances is a dangerous poison. It is one of the so-called cumulative poisons. This simply means that if one is constantly exposed to the poison, as a painter or manufacturer of arsenate of lead might be, the lead might be absorbed by the system faster than eliminated and this would result in a case of so-called lead poisoning. Lead, however, is not a cumulative poison in the sense that it is not eliminated from the body, but it is more slowly eliminated than many other poisonous materials.

The amount of lead arsenate carried upon these apples tested 60 days or longer after spraying varied from an eighth to a third of a milligram. This amount is insignificant and no harm could come from the continued use of apples carrying this amount of arsenate if no precautions were taken whatever in removing it from the skin if the parings themselves were eaten. Washing the apples or wiping the apples would remove practically all of the lead arsenate from them. Paring the apples would remove it entirely.

SUMMARY.

Mid-summer spraying with lead arsenate is an effective way of combatting the brown-tail moth. The spraying should be thorough and applied about the time the eggs are hatching.

The amount of arsenic or of lead that will remain at harvest upon the apples that are sprayed in mid-summer with arsenate of lead is so slight as to have no practical bearing.

BULLETIN 225.

CURRANT AND GOOSEBERRY APHIDS IN MAINE.*

EDITH M. PATCH.

During the past ten years several species of plantlice or aphids have been found feeding upon currant and gooseberry in Maine. In the spring, at which time the growing leaves and shoots are particularly susceptible to injury from sap sucking insects, these aphids are most abundant.

None of these species apparently passes the whole of its life-cycle on currants or gooseberries. *Schizoneura ulmi* (*fodiens*) winters on the elm and migrates to these bushes for the summer, while with the other species after feeding and multiplying upon these plants in the spring, each develops a winged migrant generation and departs to other vegetation for the summer, returning again in the fall to currant or gooseberry for the development of the generation of true sexes and the deposition of the winter eggs. Comparatively little active damage is done by the fall generation both because the aphids are not so numerous then and because the loss of sap to leaves through the season's growth is not so serious a matter to the plant.

This group of aphids has been both difficult and unsatisfactory to deal with. A single collection has frequently contained as many as four species with their innumerable progeny harmoniously feeding in mixed colonies on the same stem and leaves.

So little has been done with the species affecting *Ribes* in this country that I have not been able to coordinate the published fragments, and my own observations do no more than to give disjointed bits rather than to fill out any one life history

*Papers from the Maine Agricultural Experiment Station: Entomology No. 71.

as I should have liked. With so many species mixed on the same hostplants, however, Maine does not seem a very satisfactory field for following up the life cycles of the *Ribes* aphids and the present paper is prepared more especially to call attention to the perplexities of the situation in hopes that other workers may have some of the missing links to contribute.

Aphis varians, n. sp.

White cornicled currant aphid.

Figs. 5, 6, 7, 34, 39.

By far the worst of the species under consideration is a plant louse which I fail to find recognizably described. It may be *grossulariæ* Kalt, but that name has been applied to several different species and it seems best to hold this distinct at least for the present. It is abundant upon cultivated currant, flowering currant, and wild gooseberries at Orono during the months of May and June, and complaints from West Paris, Maine, accompanying specimens state that it was present there in such numbers in the springs of 1910, 1911 and 1912 as to stunt the growth of the bushes and cause the leaves to turn brownish.

In Maine the stem-mother, that is the form which hatches from the over-wintering eggs, becomes full grown early in May if the weather conditions are right. During her growth she stations heself on the underside of a currant leaf which becomes puckered from the injuries caused by her feeding punctures. There in the protecting irregularities of the leaf she has deformed, she gives birth to a numerous progeny. When mature she is dark purplish green with a black "tail" or cauda, conspicuous milk white cornicles, and a 5-jointed antenna. (Fig. 5.) Her immediate progeny, the second spring generation, are

Fig. 5. *Aphis varians*. Antenna of stem female.

dark green to dark brown. When they are first born their antenna is 4-jointed but the number of joints is increased to 5 at a subsequent molt which number it retains until the last molt when it appears with 6 joints. Like the stem-mother, the second generation is without wings.

As these insects reproduce rapidly the colony soon gets too numerous to be sheltered by a single leaf so it scatters to infest the growing shoot and underside of fresh leaves. A thriving colony will distort the shoot seriously and cause the misshapen leaves to cluster in a dense protecting mass.

In June the young aphids are found bunched along the new shoot so thick that there is hardly room for anything except their greedy beaks to become attached. Some are a pale bright tan and some are gray, the color depending apparently on the length of time from a molt. The mature wingless forms and pupæ (individuals with black wing pads, about to become winged) are dark green with short but conspicuous milk white cornicles and black cauda, and the caudal part of the abdomen is transversely striped with black. The colony in a mass, however, has a slaty appearance on account of a fine white deposit of waxy powder secreted by these plantlice and causing a "bloom" on the bodies of the apterous forms. Parasited specimens are often present and these are globular, tan brown objects retaining the milk white color of the cornicles.

The pupæ, previously mentioned, belong to the third spring generation and are abundant early in June. When these develop wings the spring migration to the summer food plant takes place. These winged forms have head and thorax black and the abdomen dark green on both the dorsal and ventral surface, with transverse black bands at and caudad the cornicles. There are three large lateral black spots on the abdomen cephalad the cornicle and a fourth just caudad the cornicle. The cauda is black, and the cornicles dark instead of milk white as in the wingless forms. Antenna with sensoria in varying numbers on III, IV, and V, 20 to 30 on III, 15 more or less on IV and few to several on V, sometimes a stray one or two on VI besides the group at base of spur. These are shown in Fig. 6 (23-10) and Fig. 7 (28-13). There is a conspicuous

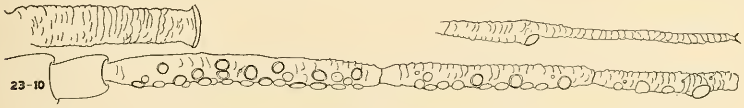

Fig. 6. *Aphis varians.* Antenna and cornicle of alate female.

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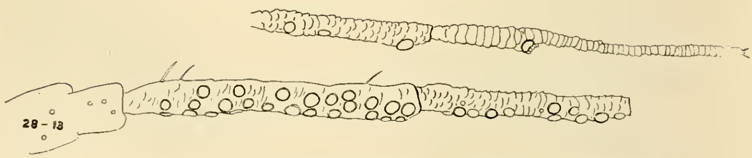

Fig. 7. *Aphis varians,* green variety. Antenna of alate female.

lateral tubercle on the prothorax, another on first abdominal segment, and a third between the cauda and cornicle. The wing is shown in Fig. 34 (23-10) and Fig. 39 (28-13).

In the fall a return migration to the currant and gooseberry occurs, the fall migrants give birth to nymphs which grow to mature males and egg laying females. Eggs are deposited upon the bushes where they remain all winter hatching in the first warm days of spring to the young stem-mother which is the point in the life cycle with which we began this account.

This species is characterized both in the winged and wingless forms by a prominent lateral tubercle on the prothorax, another on the first abdominal segment, and a third between the cornicle and cauda.

Maine collection numbers 6-04, 20-06, 48-06, 24-09, 23-10, 19-12, 16-13, 22-13, 28-13.

Aphis sanborni n. n.

Green aphid of gooseberry (23-13).

Figs. 8, 9, 10, 11, 29, 35.

Associated with the foregoing species upon wild gooseberry on the terminal shoots and ventral surface of the leaf, I found for the first time in 1913 a plantlouse at Highmoor Farm which I have named *sanborni,* thinking it probable that it is the species described without a name by Mr. C. E. Sanborn in Kansas Aphididæ (1904), p. 50-51, and Fig. 71.

The apterous forms are pale green and immaculate with water-white cornicles and pale cauda. The coloring of the pupa is the same except that the wing pads are dusky.

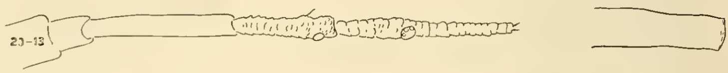

Fig. 8. *Aphis sanborni.* Antenna and cornicle of stem female.

The 5-jointed antenna of the stem mother (Fig. 8) (23-13) is not strikingly different from that of *varians* in its proportions.

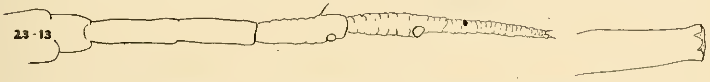

Fig. 9. *Aphis sanborni.* Antenna and cornicle of nymph.

The apterous second generation has during the nymphal stages a 5-jointed antenna, Fig. 9, which becomes 6-jointed at the last molt. Fig. 10. This is without sensoria except the usual ones on V and VI.

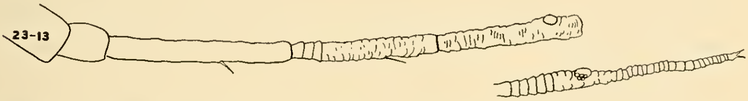

Fig. 10. *Aphis sanborni.* Antenna of apterous female.

The winged female of *sanborni* has antenna with 6 or 8 large circular sensoria in a row extending the full length of III, 6, more or less, similarly arranged on IV and none on V or VI except the terminal ones which are constant for those joints in all aphids. (Fig. 11.) The wing is shown in Fig. 35 and the imbricated cornicle in Fig. 11.

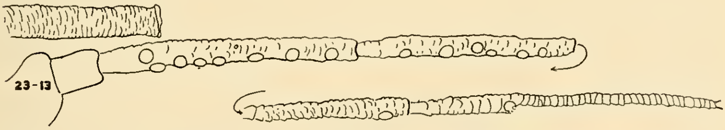

Fig. 11. *Aphis sanborni.* Antenna and cornicle of alate female.

I do not know the full cycle of *sanborni.* A collection taken May 28, 1913, from the leaves and stem shown in Fig. 29 comprised stem females, apterous females of the second generation, and pupæ with wing pads well developed. It would seem evident from this that the gooseberry is the winter host but concerning the rest of the cycle I know nothing.

Rhopalosiphum lactucæ? Kaltenbach.

Figs. 19, 20, 21, 22, 40.

A plant louse common in Maine upon currant in spring is probably the same as a similar one on sow thistle (*Sonchus* *arvensis*) in summer for it tallies with *lactucæ* recorded from *Sonchus* in Germany; and from currant, gooseberry, lettuce and sow thistle in England.*

Like the species previously discussed, this aphid winters on the currant in the egg stage, the spring generations feeding upon the sap of the growing leaves. The collections I have made from flowering currant have been mainly from the under surface of the leaves which their presence causes to curl and cluster though not in such a dense mass as those infested by *Aphis varians*. They are sometimes also found on the stem.

During the last of June winged and wingless females, pupæ and nymphs can still be found upon the currant. The winged females apparently take flight to lettuce, sow thistle, and probably to related plants, although I have not succeeded in making the transfers live under control conditions. These have shiny black heads; black antennæ with sensoria on III, IV and V, as shown in the figure; thoracic lobes black; ventral mesothoracic plate black; abdomen glabrous, light green with three large lateral black spots and one smaller one cephalad the cornicle, the cornicles being on a fourth large black spot, a mass of little black spots speckled near the cornicles and a median black blotch not quite reaching the base of cornicles; cornicles light green with black tip; cauda light green. The pupæ are uniform pale green with paler appendages; tips of cornicles and tarsi dusky; a few deeper green lines on abdomen.

Winged females of a later generation taken from sow thistle (*Sonchus arvensis*) about the first of August have the abdomen light yellowish green to olive green and the black markings as with the currant generation. The wingless females taken at the same time are entirely pale whitish or yellowish green and immaculate, and the same description answers for the nymphs. The pupæ are also pale yellowish green and immaculate like the wingless female, though the edge of the wing-pad is slightly dusky. The antennæ are shown in the figures.

In the fall winged females fly back to the currant.

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*1912. Theobald. The Journal of Economic Biology, Vol. 7, pt. 3.

Myzus ribis Linn.

Figs. 12, 14, 15, 33, 41.

It is no uncommon thing to find currant leaves puffy with reddish or yellowish blister-like deformations such as are shown in Fig. 33. These are the home of *Myzus ribis,* a delicate little aphid not so serious in its work as *varians* because it attacks directly only the leaves but still troublesome enough to interfere with the proper functioning of the leaves, cause premature ripening of the fruit, and as one currant grower in the State puts his complaint against this species: "though the fruit holds on, the plants are hurt to a certain extent and look very annoying."

The stem-mother, or form hatching from the over-wintering egg, attains its growth in Maine about mid-May. This insect is very pale green with bright green spots in two longitudinal rows on the dorsal surface. Like the other apterous forms and nymphs the stem mother is rather thickly beset with capitate hairs shaped like minute pins with the points attached to the body.

The immediate progeny of the stem-mother are apparently partly winged and partly wingless, since I have taken colonies as early as May 20 containing the stem mother surrounded by nearly mature apterous forms and pupae. The apterous females, pupæ and nymphs of this species are ordinarily pale clear lemon yellow though sometimes nearly water white, and these small pale insects would have to be very numerous to be found if it were not for the telltale danger signal of reddish puffs which give evidence of their presence.

Both winged and wingless females are to be found on currant as late as mid-July, the winged forms migrating from time to time to the summer food plant. What this alternate food plant is is not known, for although this species is of practically world-wide distribution and has been recognized as a currant pest for a century and a half it has managed to elude detection during the summer residence.

The winged form when freshly molted is a clear pale lemon yellow. Later the dorsal surface of the head, the thoracic lobes and a quadrate patch on the abdomen become black. This quadrate black patch is 3-barred at the sides and covers 3 segments, the caudal edge being about on a line with the cornicles. In some collections this black dorsal decoration extends across the abdomen in transverse bars instead of a solid patch.

Structural details of the antennæ and wing are shown in the figures. The venation is erratic and no single wing can be chosen as surely "typical".

In life it is distinguished from the species next discussed by being characteristically lemon yellow and being more flatly appressed to the leaf. The two species are frequently intermingled upon the same leaf and are very likely both confused under the name *ribis*. I do not know which species has best claim to the name *ribis* but have been guided in my usage by specimens from the collections of other entomologists.

In balsam mounts the two species are most readily separated upon antennal characters. In *ribis* the terminal sensorium of V and the sensorium at base of spur on VI approximate the articulation between V and VI much more closely than is the case with *dispar*. III is more slender in *ribis* and the sensoria are proportionately larger. This portion of the antennæ of these two species is given (Figs. 12 and 13) drawn to the same scale and shows the distinctions here described. (30-13).

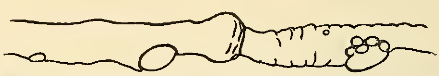


Fig. 12. *Myzus ribis* (30-13). Section of antenna of alate female for comparison with Fig. 13 which is drawn to the same scale.

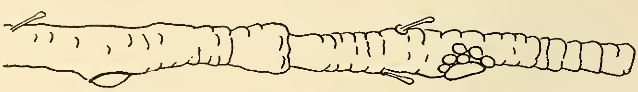


Fig. 13. *Myzus dispar* (29-13). Section of antenna of alate female for comparison with Fig. 12 which is drawn to the same scale.

Myzus dispar n. sp.

Figs. 13, 16, 17, 18, 37.

Collections of *Myzus* from gooseberry and currant in Maine show two closely allied species. The differences though rather slight and for the most part relative seem to be too constant to admit of interpreting them as varieties of a single species.

I have never taken any lemon yellow specimens of this species. The apterous viviparous females are greenish water white with longitudinal median and lateral lines (three in all) of vivid green. The winged female is very pale green with the three vivid longitudinal lines as mentioned for the apterous form and a few blackish transverse markings on caudal half of abdomen. The cornicles are water white, the cauda pale. The pupa is pale greenish white with the three green longitudinal lines, and when nearly ready for the final molt has thoracic lobes pellucid brownish like the thorax of the winged females. The hairs of this species are capitate like those of *ribis*.

Attention has already been called to the antennal dfferences of these two species. The wings of *dispar* like those of *ribis* are not uniform as to the vein angles and distances and any distinctions based on this character would be misleading. The cornicles of *dispar* are relatively shorter and less slender than those of *ribis*. (29-13).

Macrosiphum lactucæ.

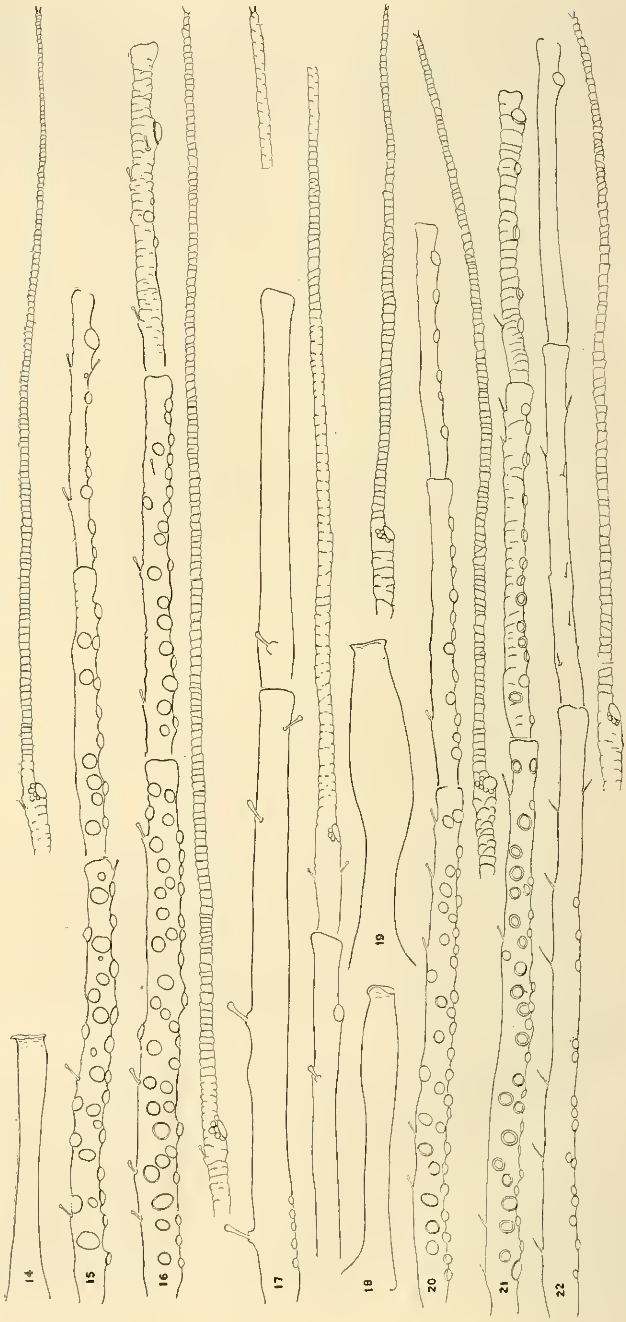
Figs. 23, 24, 25, 26, 27, 36, 38.

A common species on cultivated currant and gooseberry in Maine accords with specimens of *M. lactucæ* and I am recording it as that species provisionally for the present, athough I have not as yet made successful transfers to lettuce or *Sonchus*.

The character of the work of this aphid on gooseberry is shown in Fig. 30.

It is an alert, glistening, bristly species. The apterous viviparous females are green and without markings, with cauda and cornicles concolorous. The antenna with III slightly swollen along proximal half and with from one to several sensoria on swollen part. Fig. 25.

The winged viviparous females have the abdomen heavily marked with irregular black transverse bars, black cornicles and dark cauda. The cornicle has a few rather wrinkled reticulations at distal tip and a very faint imbrication over the rest of the surface. (Fig 24). The antennæ have sensoria on III and IV, as shown in Fig. 23. The wing is given in Fig. 38. (20-12) (27-13).


14
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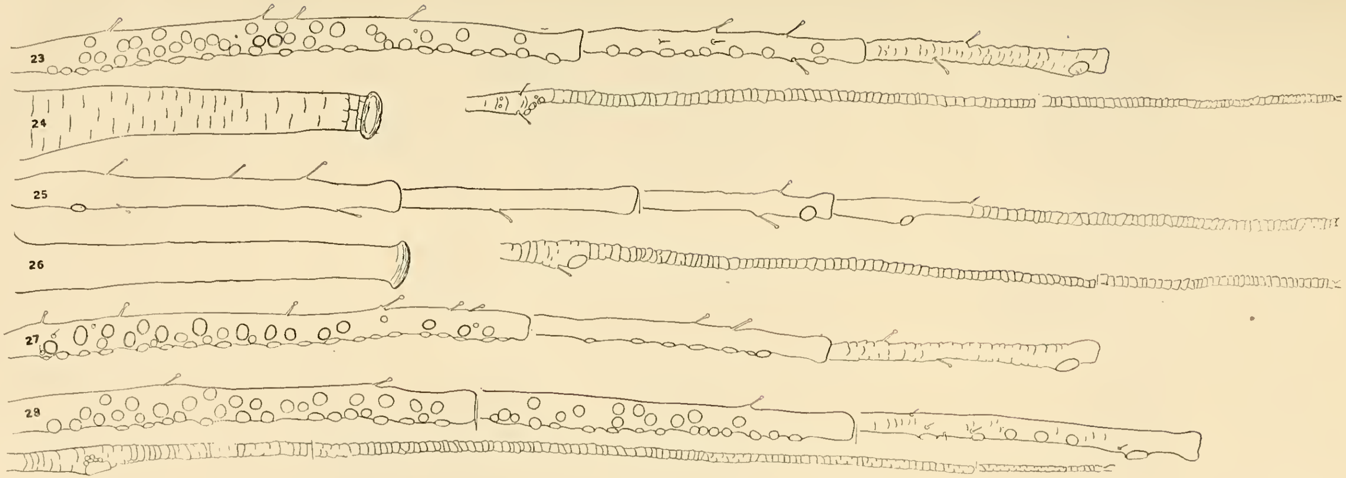


Figs. 14-15. *M. ribis,* antenna and cornicle of alate female. Fig. 16. *M. dispar,* antenna of alate female. Figs. 17-18. *M. dispar,* antenna and cornicle of apterous female. Figs. 19-20. *R. lactucae?* cornicle and antenna of alate female from currant. Figs. 21-22. *R. lactucae,* antennae of alate and apterous female from *Sonchus.* Figs. 23-24. *M. lactucae* (27-13), anntenna and cornicle of alate female from gooseberry. Figs. 25-26. *M. lactucae,* antenna and cornicle of apterous female from gooseberry, the antenna of this form having from one to several sensoria on III. Fig. 27. *M. lactucae* (20-12), antenna of alate female. Fig. 28. *Macrosiphum sp.* (20a-12), antenna of alate female.

Macrosiphum sp.

Fig. 28.

A distinct species of aphid was collected with (20-12) on currant leaf. A single winged viviparous female was preserved and as this may have been an accidental specimen resting on currant, no pains is taken to describe it here. The antenna, which is shown in Fig. 28 differs from *lactucæ* in having V with a row of sensoria, and IV thickly studded instead of with single row as in *lactucæ*. (20a-12).

Schizoneura ulmi (fodiens).

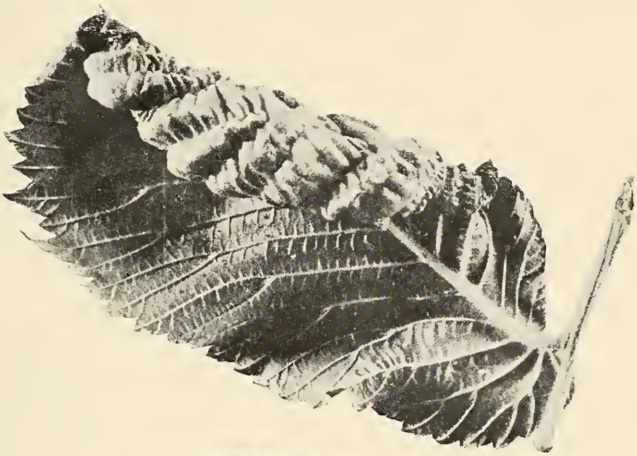
Collections of a woolly aphid curling the leaves of English elm, *Ulmus campestris,* were made in Maine during the summer of 1913. The life history of this species as worked out by European entomologists has been found to include a migration to currant and gooseberry bushes upon the roots of which the summer generations feed. Fall migrants are produced which return to the elm and the insect over winters on this tree in the egg stage. Fig. 32 shows the work of this aphid on elm. We have as yet no record of this insect as occurring upon gooseberry or currant in America, but the summer stages will no doubt be found to infest these plants here as in other countries.

A further discussion of this species is to be found in Bulletin 220 of this Station.

NOTE. All figures of antennæ and cornicles, except 12 and 13, are drawn to the same scale.

FIG. 29.—Wild gooseberry shoot infested by *A. sanborni*, and normal shoot from same bush, May 28, 1913.

FIG. 30.—Gooseberry shoot infested by *M. lactucae*, and normal shoot from same bush, June 6, 1913. FIG. 31.—Currant shoot infested by *A. varians*, June 3, 1913.



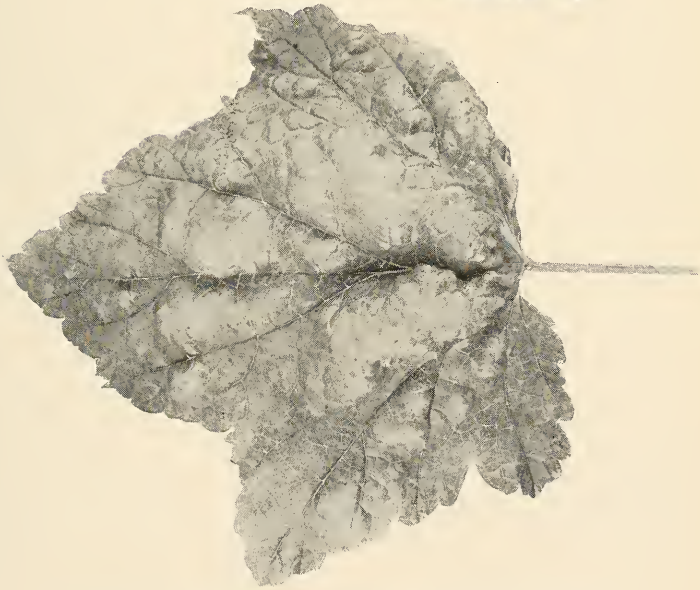


FIG. 32.—Work of *Schizoneura ulmi* (*fodiens*) on elm leaf.
FIG. 33.—Work of *Myzus* on currant leaf.

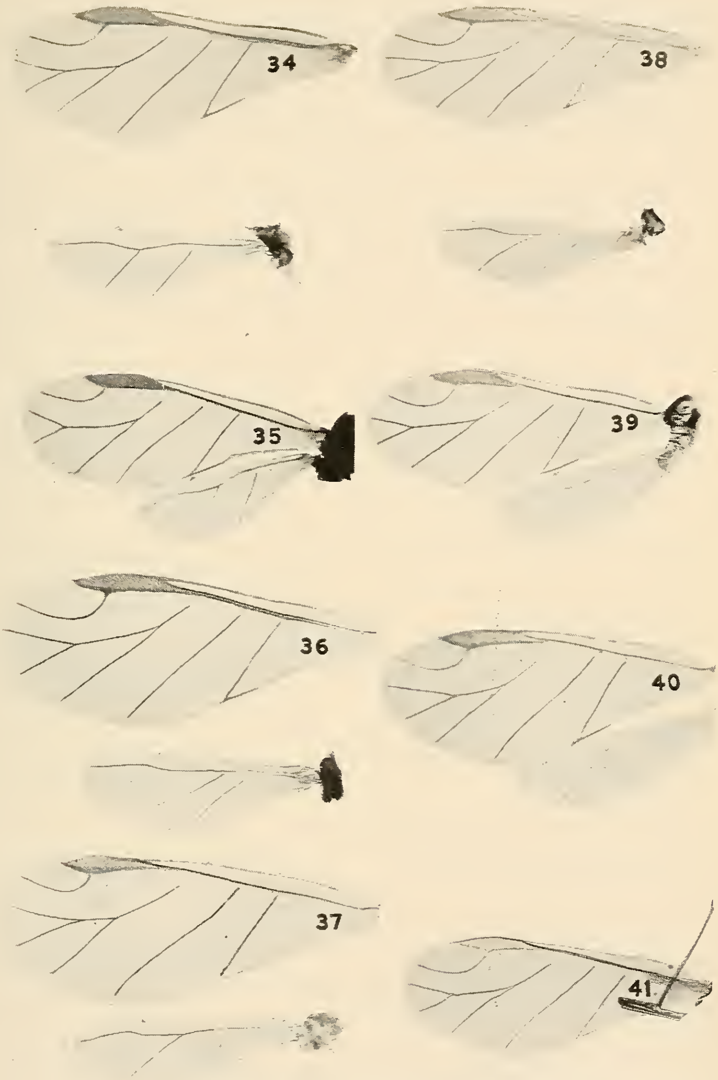


FIG. 34.—*Aphis varians* green variety (28–13); FIG. 35.—*A. Sanborni* (23–13); FIG. 36.—*Macrosiphum lactucae* from gooseberry (27–13); FIG. 37.—*Myzus dispar* (29–13); FIG. 38.—*M. lactucae* from currant (20–12); FIG. 39.—*A. varians* (24–09); FIG. 40.—*Rhopalosiphum lactucae* from *Sonchus* (86–10); FIG. 41.—*Myzus ribis* (25–09).

FOOD PLANT CATALOGUE OF THE APHIDAE OF THE WORLD.

PART IV.*

EDITH M. PATCH.

ANONACEAE. CUSTARD APPLE FAMILY.

ANONA.

A. muricata L.

Trichosiphum anonae Pergande. Pergande, 1906, p. 207.

A. rectilinata.

Aphis sassceri Wilson. Wilson, 1911, p. 59.

BERBERIDACEAE. BARBERRY FAMILY.

BERBERIS. Barberry.

B. communis.

Rhopalosiphum berberidis (Kalt.). Koch (Liosomaphis berberidis Walker). Buckton 2, p. 15.

B. vulgaris L. Common Barberry.

Rhopalosiphum berberidis (Kalt.) Davidson, 1910, p. 378.

Rhopalosiphum berberidis (Kalt.) (Aphis berberidis Fitch?) Thomas, 1879 p. 82.

B. sp.

Aphis berberidis Kalt. Kaltenbach, 1874, pp. 18-19.

Rhopalosiphum berberidis Kaltenbach. Davis, 1908 p. 254.

LAURACEAE. LAUREL FAMILY.

LAURUS.

L. laurustinus.

Aphis mali Fab. (?). Davidson, 1910, p. 377.

UMBELLULARIA.

U. californica Nutt. California laurel.

Hyadaphis umbellulariae Davidson. Davidson, 1911b, p. 559.

PAPAVERACEAE. POPPY FAMILY.

CHELIDONIUM. Celandine.

C. majus L.

Siphonophora chelidonii (Kalt.). Buckton, 1, p. 122.

Siphonophora urticae Kalt. Buckton, 1, p. 144.

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* Papers from the Maine Agricultural Experiment Station: Entomology No. 72.

GLAUCIUM. Horn Poppy.

G. sp.

Siphonophora glaucii Licht. (ined.). Lichtenstein, La Flore.

PAPAVER. Poppy.

P. dubium L. (collinum).

Aphis papaveris Fab. Mordwilko, 1899 p. 169.

P. Hydrolapathum.

Aphis rumicis Linn. Walker, 1850a, p. 18.

P. Rhoeas L. Corn Poppy.

Aphis dianthi Schrank. Walker, 1850a, p. 394.
Aphis papaveris Fab. Buckton, 2, p. 92.
Aphis rumicis Linn. Walker, 1850a, p. 18.

P. somniferum L. (setigerum) Common Poppy.

Aphis papaveris Fab. Kaltenbach, 1874, p. 269.
Aphis rumicis Linn. Walker, 1850a, p. 18.

P. sp.

Aphis aparines Schrank. Lichtenstein, La Flore.
Aphis armata Hausmann. Lichtenstein, La Flore.
Aphis balsamitae Müller. Lichtenstein, La Flore.
Aphis rumicis Linn. Thomas, 1879 p. 88.
Aphis thlaspeos Schrank. Lichtenstein, La Flore.

FUMARIACEAE. FUMITORY FAMILY.

CORYDALIS.

C. aurea Willd. Golden Corydalis.

Nectarophora corydalis Oestlund. Oestlund, 1887, p. 82.

FUMARIA. Fumitory.

F. capreolata L.

Aphis papaveris Fab. Macchiati, 1883, p. 256.

F. officinalis L. Common Fumitory.

Aphis dianthi Schrank. Walker, 1850a, p. 394.
Aphis papaveris Fab. Macchiati, 1883, p. 256.
Aphis rumicis Linn. Walker, 1850a, p. 19.

CRUCIFERAE. MUSTARD FAMILY.

ALLIARIA. Garlic Mustard.

A. officinalis Andrz.

Aphis alliariae Koch. (sonchi L.) Kaltenbach, 1874, p. 28.
Aphis dianthi Schrank. Walker, 1850a, p. 394.
Aphis erysimi Kalt. Kaltenbach, 1874, p. 28.
Macrosiphum kaltenbachii Schouteden. Theobald, 1913, Journ. Econ. Biol. p. 52.
Siphonophora alliariae Koch. Buckton, 1, p. 124. Koch, p. 177.

A. sp.

Siphonophora sonchi Linn. Lichtenstein, Flore Supplement.

ALYSSUM.

A. maratimum Lam.

Myzus achyrantes Monell. Sanborn, 1904, p. 71.

ARABIS. Rock Cress.

A. canadensis L. (mollis Raf.) Sickle-pod.

Aphis (Adactynus) arabis-mollis Raf. Rafinesque, 1818.

BRASSICA. (Sinapis) Mustard.

B. adpressa Boiss. (Sinapis geniculata).

Aphis brassicae L. (A. raphani Schrank) (A. isatidis Boyer) Macchiati, 1883, p. 238.

B. alba Boiss. White Mustard.

Aphis brassicae Linn. Kaltenbach, 1874, p. 35.

Aphis dianthi Schrank. Walker, 1850a, p. 394.

B. arvensis L. (Sinapis arvensis). Charlock.

Aphis brassicae L. Kaltenbach, 1874, p. 35.

Rhopalosiphum persicae (Sulzer) Pass. (A. dianthi Schrank) (A. vulgaris Kyber) (A. rapae Curtis) (A. dubia Curtis) (A. vastator Smee.) Passerini, 1863, p. 21.

B. campestris L. (rutabaga).

Aphis brassicae L. (raphani Schrank) (isatidis Boyer). Passerini, 1863, p. 35.

Rhopalosiphum dianthi (Schrank) Koch. (persicae, Puceron du pecher Morren) (rapae Curtis, floris rapae Curtis, dubia? Curtis) (vastator Smee) (persicaecola Boisduval) (persicae Pass.) Buckton, 2, p. 17.

B. fruticulosa Cyril.

Aphis brassicae L. (A. raphani Schrank) (A. isatidis Boyer) Macchiati, 1883, p. 238.

B. juncea (L.) (Raphanus lanceolatus).

Aphis frangulae Kalt. Hunter, 1901, p. 130.

B. napus L. Rape.

Aphis (Adactynus) brassica-napus Raf. Rafinesque, 1818.

Aphis dianthi Schrank. Walker, 1850a, p. 394.

Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 36.

B. nigra (L.) Koch. Black Mustard.

Aphis brasssicae Linn. Kaltenbach, 1874, p. 35.

Aphis dianthi Schrank. Walker, 1850a, p. 394.

Aphis maidi-radicis Forbes. Davis, 1909b, p. 124.

B. oleracea L. Cabbage. Kale.

Aphis brassicae Linn. (raphani Schrank) (floris-rapae Curtis) Buckton, 2, p. 34.

Aphis brassicae L. (raphani Schrank) (isatidis Boyer). Passerini, 1863, p. 35.

Aphis brassicae L. Sanborn, 1904, p. 55.

Aphis dianthi Schrank. Waker, 1850a, p. 394.

Aphis maidiradicis Forbes. Vickery, 1910, p. 111.

Aphis (Tychea) phaseoli Pass. Kaltenbach, 1874, p. 149.

Myzus persicae Sulzer. Gillette and Taylor, 1908, p 36.
Tychea phaseoli Pass. Karsch, 1886, p. 1.

B. Rapa L. Turnip. Ruta Baga.
Aphis rumicis Linn. Walker, 1850a, p. 19.
Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 35.
Rhopalosiphum dianthi Schrank. Buckton 2, p. 17.

BUNIAS.

B. Erucago L.
Aphis brassicae Linn. (A. raphani Schrank) (A. isatidis Boyer) Macchiati, 1883 p. 238.

B. Kakile.
Aphis dianthi Schrank. Walker, 1850a, p 394.

CAPSELLA. Shepherd's Purse.

C. Bursa-pastoris (L.) Medic (Bursa Bursa-pastoris).
Aphis brassicae Linn. Buckton, 2, p. 34.
Aphis brassicae Linn (raphani Schrank) (floris-rapae Curtis) Buckton, 2, p. 34.
Aphis capsellae Koch. Koch, p. 76.
Aphis capsellae Kalt. Kaltenbach, 1874, p. 39. Theobald, 1911-12.
Aphis dianthi Schrank. Walker, 1850a, p. 394.
Aphis erysimi Kalt. Kaltenbach, 1874, p. 39.
Aphis erysimi Kalt. Kaltenbach, 1843, p 99.
Aphis gossypii Glover (citrifolii Ashm. in part) (citrulli Ashm.) (cucumeris Forbes) (forbesi Weed?). Pergande, 1895, p. 313.
Aphis maidiradicis Forbes. Vickery, 1910, p. 102.
Aphis papaveris Fab. Kaltenbach, 1874, p. 39.
Aphis plantaginis Schrank. Del Guercio, 1909 (1910), Redia VII, p. 297.
Aphis rumicis Linn. Thomas, 1879, p. 88.
Aphis symphyti Schrank. Kaltenbach, 1874, p. 771.
Forda occidentalis Hart. Hart, 1891 and 1892, p. 96.
Geoica squamosa Hart. Hart, 1891 and 1892, p. 99.
Macrosiphum scabiosae Buckton. Theobald, 1911-12.
Macrosiphum solanifolii Ashmead. Patch, 1907, p. 244.
Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 36.
Schizoneura corni (Fab.) (S. venusta Pass.) (E. fungicola Walsh) (S. panicola Thomas) (E. cornicola Walsh). Hunter, 1901, p. 81.
Siphonophora pisi Kalt. (ulmariae Schrank) (onobrychis Boyer) (lathyri Walk.). Buckton, 1, p. 135.
Siphonophora ulmariae (Schrank) (onobrychis Boyer) (pisi Kalt.) (pisi Koch) (gei Koch). Passerini, 1863, p. 13.

CAKILE. Sea Rocket.

C. maritima Scop.
Aphis contermina Walker. Walker, 1849c, p. 31.
Aphis dianthi Schrank. Walker, 1850a, p. 394.

CHEIRANTHUS.

C. Cheiri L.

Pemphigus lactucarius Pass. (Amycla fuscicornis Koch). Buckton, 3, p. 125.

COCHLEARIA.

C. Armoracia L.

Aphis dianthi Schrank. Walker, 1850a, p. 394.

Aphis rumicis Linn. Walker, 1850a, p. 19.

C. sp.

Rhopalosiphum persicae Sulzer. Lichtenstein, Flore Supplement.

CRAMBE.

C. maritima L.

Aphis redundans Walker. Walker, 1849c, p. 32.

C. sp.

Aphis brassicae Linn. Lichtenstein, Flore Supplement.

DIPLOTAXIS.

D. tenuifolia DC.

Aphis brassicae L. (raphani Schrank) (isatidis Boyer). Passerini, 1863, p. 35.

ERYSIMUM. Treacle Mustard.

E. barbarea.

Aphis dianthi Schrank. Walker, 1850a, p. 394.

E. canescens Roth.

Aphis brassicae Linn. (A. raphani Schrank) (A. isatidis Boyer) Macchiati, 1883, p. 238.

E. officinale. See Sisymbrium officinale.

ISATIS.

I. tinctoria L.

Aphis brassicae Linn. Kaltenbach, 1874, p. 35.

I. sp.

Aphis isatidis Boyer. Lichtenstein, La Flore.

LEPIDIUM. Pepperwort.

L. Draba L.

Aphis myostidis Koch. Ferrari, 1872, p. 74.

L. incisum Roth. (Lepidium apetalum.)

Aphis maidiradicis Forbes. Vickery, 1910, p. 103.

L. virginicum L. Wild Peppergrass.

Aphis (Adactynus) acaroides Raf. Rafinesque, 1818.

Aphis gossypii Glover (citrifolii Ashm. In part) (citrulli Ash.) (cucumeris Forbes) (forbesi Weed?) Pergande, 1895, p. 313.

Aphis maidiradicis Forbes. Vickery, 1910, p. 103.

L. sp.

Aphis brassicae Linn. Lichtenstein, Flore Supplement.

Rhopalosiphum persicae Sulzer. Lichtenstein, Flore Supplement.

NASTURTIUM.

N. amphibium R. Br.
Aphis nasturtii Kalt. Kaltenbach, 1843, p. 76.
N. armoracia. See Radicula.
N. austriacum Crantz.
Aphis nasturtii Kalt. Passerini, 1863, p. 36.
N. officinale R.
Aphis dianthi Schrank. Walker, 1850a, p. 394.
N. sylvestre R. Br.
Aphis nasturtii Kalt. Kaltenbach, 1843, p. 76.
Siphonophora nasturtii Koch (A. nasturtii Kalt.?). Koch, p. 201.

RADICULA. Water Cress.

R. Armoracia (L.) Robinson. (Nasturtium armoracia). Horseradish.
Aphis armoraciae Cowen. Cowen, 1895, p. 118.
Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 36.
R. Nasturtium-aquaticum (L.) (N. officinale) (Roripa Nasturtium) True Water Cress.
Myzus persicae Sulz. Gillette and Taylor, 1908, p. 35.
R. sinuata (Nutt) Greene. (Nasturtium sinuatum).
Pemphigus populitransversus Riley (burrowi Sanborn). Sanborn, 1904, p. 19, and 1906, p. 225.

RAPHANUS. Radish.

R. lanceolatus. See Brassica juncea.
R. Landra Mor.
Aphis brassicae L. (A. raphani Schrank) (A. isatidis Boyer) Macchiati, 1883, p. 238.
R. Raphanistrum L. Wild Radish, Jointed Charlock.
Aphis brassicae Linn. Kaltenbach, 1874, p. 41.
Aphis dianthi Schrank. Walker, 1850a, p. 394.
Aphis erysimi Kalt. Kaltenbach, 1874, p. 41.
R. sativus L. Radish.
Aphis brassicae Linn (raphani) Schrank (floris-rapae Curtis). Buckton, 2, p. 34.
Aphis dianthi Schrank. Walker, 1850a, p. 394.
Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 35.

RAPISTRUM.

R. rugosum All. Fl. Pedem.
Rhopalosiphum persicae (Sulzer) Pass. (A. dianthi Schrank) (A. vulgaris Kyber) (A. rapae Curtis) (A. dubia Curt.) (A. vastator Smee). Passerini, 1863, p. 21.

RORIPA.

R. nasturtium. See Radicula nasturtium-aquaticum.

SISYMBRIUM. Hedge Mustard.

S. Alliaria Scop.
Siphonophora sonchi (L.) Pass. (A. serrutalae L. Schrank. Kalt) (S. achilleae Koch) (lactucae Koch?) Passerini, 1863, p. 17.

Siphonophora alliariae Koch. No. 1. Koch, p. 160.

S. officinale Scop. (Erysimum officinale).

Aphis erysimi Kalt. Kaltenbach, 1843, p. 99.

Siphonophora sisymbrii Buckton. Buckton, 1, p. 161.

S. sp.

Aphis nasturtii Kalt. Kaltenbach, 1874, p. 27.

THASPIS.

T. bursa-pastoris. See Capsella.

THLASPI. Penny Cress.

T. sp.

Aphis thlaspeos Schrank. Lichtenstein, Flore Supplement.

CAPPARIDACEAE. CAPER FAMILY.

POLANISIA.

P. graveolens Raf.

Aphis polanisiae Oestlund. Oestlund, 1887, p. 67.

Aphis (*Dactynus*) *polanisia-graveolens* Raf. Rafinesque, 1818.

SAXIFRAGACEAE. SAXIFRAGE FAMILY.

HEUCHERA. Alum Root.

H. hispida Pursh.

Siphonophora heucherae Thomas. Thomas, 1879, p. 66.

HYDRANGEA.

H. Hortensis Smith.

Aphis gossypii Glover (citrifolii Ashm. In part) (citrulli Ashm.) (cucumeris Forbes) (forbesi Weed?). Pergande, 1895, p. 314.

Aphis nerii Kalt. Passerini, 1863, p. 45.

PHILADELPHUS. Mock Orange. Syringa.

P. coronarius L. Mock Orange. Syringa.

Aphis gossypii Glover. Gillette, 1910, p. 404.

RIBES. Currant. Gooseberry.

R. alpinum L.

Aphis ribicola Kalt. Kaltenbach, 1843, p. 33.

Aphis ribis Linn. Kaltenbach, 1843, p. 39.

R. aureum Pursh. Missouri or Buffalo Currant.

Aphis cornifoliae Fitch. (A. gillettei Cowen). Gillette, 1910, p. 407.

Myzus ribis (Linn.) Hunter, 1901, p. 109.

R. cynosbati L. Prickly Gooseberry. Dogberry.

Macrosiphum cynosbati (Oestlund). Davis, 1909a, p. 39.

R. gracile Michx. Missouri Gooseberry.

Aphis n. sp. Sanborn. Sanborn, 1904, p. 48.

R. Grossularia L. European Gooseberry.

Aphis grossulariae Kaltenbach. (viburni Schrank?) Theobald, 1912, p. 100.

Aphis urticaria Kalt. Buckton, 2, p. 51.

Macrosiphum ribicola Kaltenbach. Theobald, 1911-12.

Myzus ribis (Linn.) Pass. (Ribifex Amyot) (Rh. ribis Koch). Buckton, 1, p. 181.

Myzus whitei Theobald. Theobald, 1912, p. 111.
Rhopalosiphum brittenii Theobald. Theobald, 1912, p. 108.
Rhopalosiphum lactucae Kaltenbach. (ribis Buckton not Linn.) Theobald, 1912, p. 106.
Rhopalosiphum ribis (Linn.) Koch, Pass. Buckton, 2, p. 10.
Siphonophora lactucae (Kalt.) Pass. Buckton, 1, p. 140.

R. leptanthum A. Gray.

Myzus Neomexicanus Cockerell. Cockerell, 1901b, p. 227. "probably R. leptanthuni").

R. nigrum L. Black Currant.

Aphis grossulariae Kaltenbach, (viburni Schrank?) Theobald, 1912, p. 100.
Macrosiphum lactucae Schrank. (A. ribicola Kaltenbach) (S. ribicola Koch) (S. lactucae Buckton, Passerini (non Koch) (ribis Frisch). Theobald, 1912, p. 104.
Myzus whitei Theobald. Theobald, 1912, p. 111.
Rhopalosiphum brittenii Theobald. Theobald, 1912, p. 108.
Rhopalosiphum ribis (Linn) Koch, Pass. Buckton, 2, p. 9.
Siphonophora lactucae (Kalt.) Pass. Buckton, 1, p. 140.

R. rotundifolium Michx.

Myzus ribis (Linn.). Williams, 1891, p. 12.
Siphonophora sp. Williams, 1891, p. 12.

R. rubrum L.

Aphis grossulariae Kaltenbach (viburni Schrank?) Theobald, 1912, p. 100.
Aphis ribis Sanborn. Sanborn, 1904, p. 46.
Macrosiphum lactucae Schrank. (A. ribicola Kaltenbach) (S. ribicola Koch) (S. lactucae Buckton, Passerini (non Koch) (ribis Frisch). Theobald, 1912, p. 102.
Myzus ribis (Linn) Pass. Buckton, 1, p. 181. Theobald, 1912, p. 110.
Myzus ribis (Linn.). Weed, 1888, p. 210.
Rhopalosiphum brittenii Theobald. Theobald, 1912, p. 108.
Rhopalosiphum lactucae Kaltenbach. (R. ribis Buckton, non Linneaus (lactucae Buckton) (lactucae Passerini) Theobald, 1912, p. 105.
Rhopalosiphum ribis (Linn.) Koch, Pass. Buckton, 2, p. 10.

R. viscossisimum Pursh.

Myzus ribis Linn. Williams, 1891, p. 12.

R. sp.

Aphis houghtonensis Troop. Troop, 1906, p. 59
Aphis n. sp. Sanborn. Sanborn, 1904, p. 51.
Myzus cerasi (Fab.) Pass. (Cerasaphis Amyot). Buckton, 1, p. 175.
Schizoneura fodiens Buckton. Buckton, 3, p. 94.
Schizoneura ulmi Linn (fodiens Buckton). Tullgren, 1909, p. 169.

NOTE. The following families have been omitted from Part IV of this catalogue and will be printed in a subsequent part: *Resedaceae, Crassulaceae, Pittosporaceae, Hamamelidaceae, and Platanaceae.*

BULLETIN 226.

NOTE ON THE ACCURACY OF BUSHEL WEIGHT DETERMINATIONS.*

By Clarence W. Barber.

In tests of varieties of grain it is essential to determine the weight per measured bushel of the grain produced by different varieties. For this purpose there is commonly used the standard grain weighing device, consisting of a one or two quart brass bucket suspended from a scale of the steel yard type. This measuring apparatus is often referred to as the grain tester. One is shown in figure 42. The beam for a two quart bucket is marked with three scales or series of divisions. One scale is in ounces and pounds allowing a little more than four pounds as the total capacity of the bucket; the second series of divisions gives the percentages of four pounds; the third, represents directly the weight in pounds (up to 65) per measured bushel. Because of the finer divisions the greatest accuracy in weight determinations by this device is attained through using the percentage scale and calculating therefrom the weight of a bushel in pounds. This bucket holds one-sixteenth of a bushel; its total capacity in weight is four pounds. Hence to derive the weight in pounds per measured bushel it is only necessary to multiply the percent by the factor 64.

Having frequently to use this standard bushel measure in the determination of the weight per bushel of oats grown in the variety tests conducted by this Station, the necessity of carrying out a particular scheme of manipulation soon made itself apparent. An inquiry made to the U. S. Bureau of Standards brought the following information about the use of the grain

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* Papers from the Biological Laboratory of the Maine Agricultural Experiment Station No. 61.

tester. "So far as the Bureau has any knowledge on the matter, there is very little care or uniformity of method used in filling the bucket with grain, although without doubt, it is a matter to which greater attention should be given as there is a decided difference in the amount of grain that may be contained in a measure according to which it is struck off level as it falls into the bucket or is first shaken down. The most common practice in the matter is, probably, to merely dip the bucket into the grain to fill and then strike off the grain as it lies." With the aim of obtaining data relative to the methods of handling this device a series of weighings of one variety of oats, namely the Lincoln, were made. It should be said that the Lincoln oat is medium in size, plump and generally free from awns.

The lot of oats amounting to five bushels from which the data presented in this paper were collected was contained in a bin 3 ft. 10 in. long by 2½ ft. wide and 2½ ft. deep. Before beginning to take weight records the oats were thoroughly stirred and piled in one end of the bin. For each weighing the bucket was filled with the grain in one end of the bin. After recording the weight the grain was emptied in the opposite end of the bin. Hence the bucket was filled for each determination with grain from one end only of the bin until all the grain in that end was removed to the opposite end. Then the grain was again thoroughly stirred or mixed and piled in one end of the bin as in the beginning. One hundred weighings, the distribution of which is shown in table 1, were made according to each of four methods. All weighings were obtained during one day by one person.

The procedure in the different methods was as follows:

Method I. The grain was poured into the bucket filling the same rounding full and was not settled in any way. Then the top was levelled off as follows: In each method a beveled straight edge laid flat on the rim of the bucket was used to smooth off the top grains in order to ensure the surface of the grain being in the same plane with the rim. The straight edge should be moved in a zigzag movement across the surface and should not be drawn directly across, for such a force drags out many grains beneath the plane of the rim leaving the bucket incompletely filled.

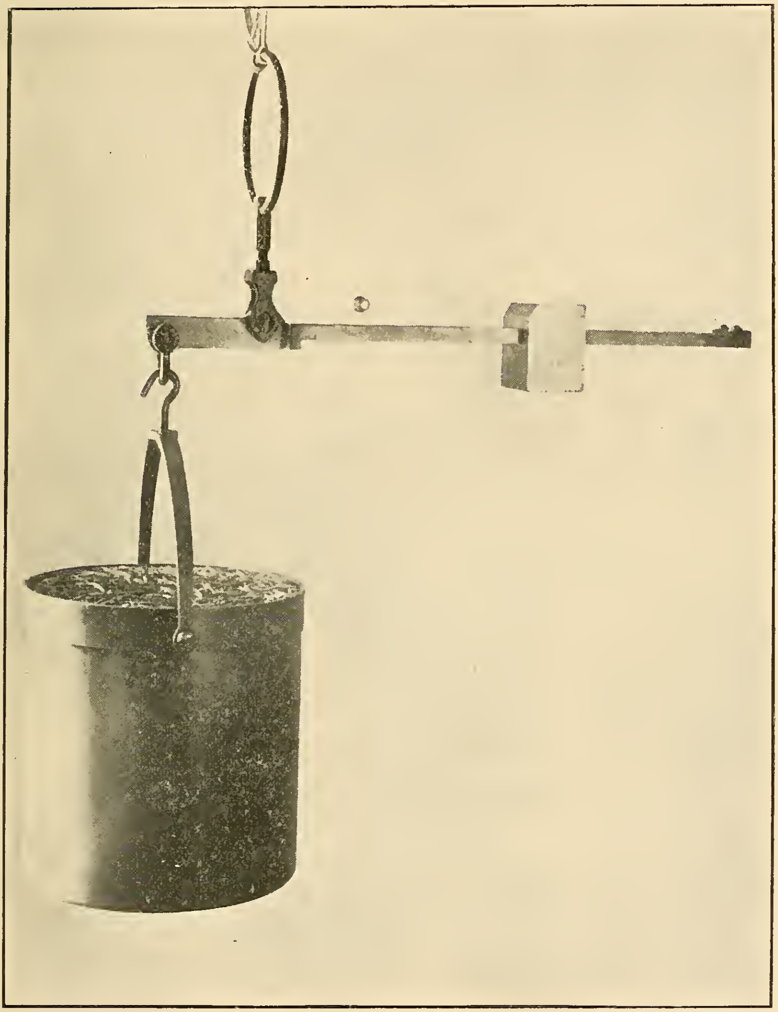

FIG. 42. Standard grain tester in position for determining the weight per measured bushel of grain.

Method II. The bucket was filled rounding full by dipping it directly into the grain. The grain was not settled in any way. Then the top was levelled as in Method I.

Method III. The bucket was filled rounding full by dipping it into the grain and then shaken down once. After shaking the top was smoothed off as in Method I.

Method IV. The grain was poured into the bucket filling it rounding full and settled by shaking down five times. After this the straight edge was used to level off the top surface as in Method I.

In case shaking settled the grain below the rim of the bucket more grains were poured on top and then levelled off. In shaking, the bucket was held firmly with both hands. Each shaking involved a short, quick downward movement of the bucket brought to an abrupt stop.

TABLE 1.

Frequency Distributions for Variation in the Percentage Determinations of Weight per bushel of Oats.

CLASS. Per cent.	I. Grain poured into bucket. Not shaken or settled.	II. Bucket filled by dipping it into the grain. Not shaken or settled.	III. Bucket filled by dipping it into the grain Shaken once to settle grain.	IV. Grain poured into the bucket. Shaken down 5 times.
52.0–52.4.......	7	–	–	–
52.5–52.9.......	6	–	–	–
53.0–53.4.......	3	–	–	–
53.5–53.9.......	27	–	–	–
54.0–54.4.......	27	–	–	–
54.5–54.9.......	16	–	–	–
55.0–55.4.......	11	–	–	–
55.5–55.9.......	3	3	–	–
56.0–56.4.......	–	8	1	–
56.5–56.9.......	–	3	1	–
57.0–57.4.......	–	18	5	–
57.5–57.9.......	–	27	16	–
58.0–58.4.......	–	20	27	–
58.5–58.9.......	–	10	19	1
59.0–59.4.......	–	8	22	3
59.5–59.9.......	–	2	6	18
60.0–60.4.......	–	1	2	36
60.5–60.9.......	–	–	1	31
61.0–61.4.......	–	–	–	10
61.5–61.9.......	–	–	–	1
Totals......	100	100	100	100

The results derived from the data collected in each method are tabulated in table 2. Here it will be noted that the mean weight per bushel increases 2.4 lbs. or 7 percent when the bucket is filled by dipping it into the grain as compared with

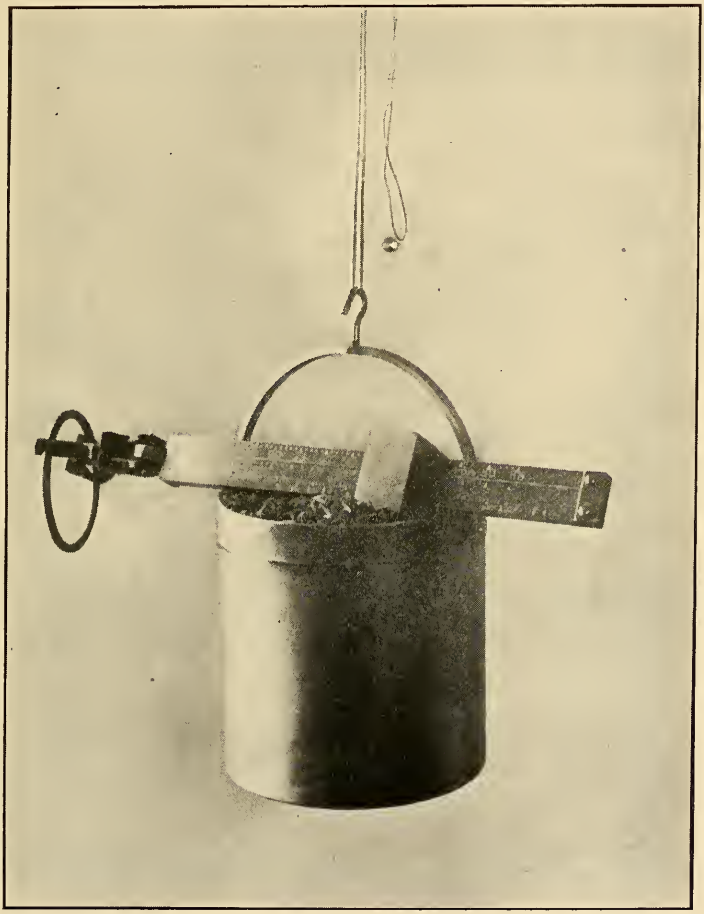

FIG. 43. Standard grain tester. Note the three scales of divisions on the beam.

filling by pouring the grain into the bucket. The probable error of this difference is $\pm.0529$, which clearly signifies that the increase is due to the method of filling and not to chance. The standard deviation of Method II is higher than of Method I. The difference .0503 is slightly less than twice the probable error $\pm.0264$ showing that the two methods are about equal in variability. Further evidence of this is shown in the coefficients of variability which differ by $.0369\pm.1044$ the difference being less than its probable error.

TABLE 2.

Variation Constants in Weight per Bushel of Lincoln Oats.

Method.	Mean.		Standard deviation —lbs.	Coefficient of variation.
	Per cent.	Weight per bushel —lbs.		
I	54.090	$34.6176\pm.0357$	$.5291\pm.0178$	$1.5284\pm.0729$
II	57.835	$37.0144\pm.0391$	$.5794\pm.0195$	$1.5653\pm.0747$
III	58.585	$37.4944\pm.0320$	$.4744\pm.0160$	$1.2653\pm.0604$
IV	60.385	$38.6464\pm.0219$	$.3254\pm.0110$	$0.8420\pm.0402$

When the grain is settled by shaking, the mean weight per bushel is greatly increased. This is seen by comparing Method IV with Method I. The mean weight per bushel according to Method IV is $4.0288\pm.0419$ lbs. higher than that of Method I. Such a difference, 100 times its probable error, clearly signifies that the higher mean is due to the method of handling the grain. In addition to raising the mean, Method IV also lowers the standard deviation by the amount of $.2037\pm.0209$ lbs. This difference is significant in that it is about 10 times its probable error. Hence it is clear that settling the grain lessens the variability of the determinations. This is further substantiated in the coefficients of variation. Here the difference is 0.6864, which is about 8 times its probable error $\pm.0833$. Similarly the effect of shaking is shown in Method III as compared with Method II. One shaking raises the mean $0.4800\pm.0505$ lbs. and lowers the standard deviation $.1050\pm.0232$ lbs. The relative variability also decreases, as is seen in the coefficients of variation, giving a difference of $0.3000\pm.0961$. In each of these the magnitude of the difference in relation to its probable error is sufficient to lead one to conclude that even one shaking in settling the grain manifests itself in a higher mean and a smaller variability.

In all of these methods it is evident that the standard deviation and the coefficient of variation are absolutely small. While shaking five times lowers the variability of the mean weight determinations as is shown in a reduction of 38.5 percent in the standard deviation and 44.9 percent in the coefficient of variation, the mean weight per bushel increases 11.6 percent. On account of its very low standard deviation and coefficient of variation Method IV has been adopted by this Station as the one giving the greatest accuracy in determinations of the bushel weight of oats. In our tests of varieties of oats the practice is to take for each variety the mean of three weighings as the weight per measured bushel. This gives us according to the results derived from data presented in this paper a measurement possessing a very high degree of accuracy. Method I we understand is the one ordinarily practised by grain dealers, and the data shown herein warrant the conclusion that determinations derived thereby also possess a high degree of accuracy. However, as already shown, this degree of accuracy is very much less than that attainable in Method IV.

The use of the standard bushel measure in getting the weight of seeds heavier than oats would undoubtedly show less variation in the determinations.

SUMMARY.

Data presented in this paper indicate the necessity of following a particular scheme of handling the standard grain tester in determining the weight per bushel of grain.

Of the four methods tried the one wherein the grain is poured into the bucket and settled by shaking five times gives the most accurate results. This method in comparison with that involving no settling of the grain lowers the standard deviation 38.5 percent and the coefficient of variation 44.9 percent.

Settling the grain not only decreases the range of variability, thus giving more accurate results, but also increases the mean weight per bushel.

In conclusion it can be said that the standard grain tester as a means of determining the weight per measured bushel of grain gives results possessing a high degree of accuracy.

NOTE ON THE INFLUENCE OF SHAPE AND SIZE OF PLOTS IN TESTS OF VARIETIES OF GRAIN.*

By Clarence W. Barber.

Experience in testing varieties of oats in rows under cultivation, in small and large plots, and under field conditions, impresses one with the widely variable results obtained in the propagation of oats in different allowances of space for development. In variety tests it is customary to surround each plot with a pathway which is generally kept clear of weeds and other plants by cultivation. This passageway not only permits close observation of the plants within the plot but also prevents the mixture of varieties at the time of planting and at harvest. Observation of oats grown in plots thus separated often presents a marked contrast in respect to the productivity of plants situated along the borders of the plots as compared with plants growing within the plot. This thriftiness of marginal plants is exemplified in a greater number of culms per plant, a higher yield of grain, and a longer period of growth. Generally the marginal plants thrive in a green condition several days after the plants in the center of the plot have begun to ripen. As an illustration of the cropping ability of a strain of oats under different conditions may be cited the performance of a Line No. 286 of oats originated by the Maine Agricultural Experiment Station. In a plant breeding garden where one seed was dropped at each three inch interval in drills one foot apart, this line of oats yielded at the rate of 11.3 grams of grain per plant. In two two-thousandth acre plots for this same line the average production of grain per plant amounted to 2.94 grams. In the latter case seed was planted at intervals of one and one-half inches in drills four inches apart. In the first instance each plant was allotted thirty-six square inches; in the second instance six square inches. The yield per plant in the larger space was nearly four times that of plants grown in the smaller space.

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* Papers from the Biological Laboratory of the Maine Agricultural Experiment Station No. 62.

Further evidence of the increased yield attending the growth of plants in an allotment of considerable space is presented in the work of Wacker.* From data given by this author Table I has been formed. In this is shown the yield of grain produced by plants developing under conditions of heavy seeding and light seeding.

TABLE I.

Yield of Grain Plants in Conditions of Heavy and Light Seeding.

	Average number of plants harvested per square meter.	Yield of Grain. Per plant —gms.	Yield of Grain. Per culm. —gms.
Winter Barley:			
Heavy Seeding	240.9	2.34	0.65
Light Seeding	21.8	29.88	1.64
Winter Rye:			
Heavy Seeding	156.6	4.20	1.35
Light Seeding	16.7	24.26	2.07
Square Head Winter Wheat:			
Heavy Seeding	221.1	2.43	0.86
Light Seeding	20.7	21.90	1.58
Spring Barley:			
Heavy Seeding	141.7	1.56	0.65
Light Seeding	27.4	9.58	1.20

Unfortunately the plots of oats in these tests, so it is stated, were damaged to such an extent as to be of no value. From the figures quoted here one is convinced of the great increase in the yield when grain plants develop in considerable space as compared with plants growing under field conditions. It should be noted that plants grown in the larger space as compared with those grown in the smaller space yield six to thirteen times as much grain per plant or one and a half to two and a half times as much per culm.

In making calculations of the relation between the marginal area and the total area of a plot it was considered a conservative estimate that all plants growing in an area six inches wide within the border of the plot receive benefit from the clean cultivation of the pathways. The basis of this assumption lies

*Wacker: Versuche mit den neuen Getreidekulturverfahren nach Demtschinsky und Zehetmayer. Landw. Jahr. Bd. XLI, 1911.

in the work of Ten Eyck ** and that of Rotmistrov.† The former states that the roots of oat plants growing in drills eight inches apart interlace within two inches of the surface. Rotmistrov found the roots of oat plants of one variety extending laterally 94 cm. or 3.08 ft., of another variety 54 cms. or 1.8 ft. Assuming all the plants in this marginal area to be better developed because of the greater space allotted each plant it may be of interest to plant breeders to point out the relation of this marginal area to the total area of plots of different rectangular shapes and sizes.

The periphery of a unit area in the shape of a square and in rectangular plots having the length 2, 4, 8 or 16 times the width, is considered in Table 2.

TABLE 2.

The Periphery of a Unit Area in Terms of x, x being the Side of a Square of Unit Area.

	Square.	Rectangle with length twice width.	Rectangle with length 4 times width.	Rectangle with length 8 times width.	Rectangle with length 16 times width.
Area	x^2	x^2	x^2	x^2	x^2
Width (in feet)	x	.7071 *	$.5000x$	$.3536x$*	$.2500x$
Length (in feet)	x	$2(.7071x)$	$4(.5000x)$	$8(.3536x)$	$16(.2500x)$
Periphery (in feet)	$4x$	$4.2426x$	$5.0000x$	$6.3640x$	$8.5000x$
Per cent. increase in length of periphery on basis of periphery of the same unit area in the form of a square	–	6.0650%	25.0000%	59.1200%	112.5000%
An area 6 inches wide within the borders in terms of x will be (in sq. ft.)	$2x-1$	$2.1213x-1$	$2.5000x-1$	$3.1824x-1$	$4.2500x-1$

Note: It should be borne in mind that x always refers to the side of a square. Hence, in the use of x the periphery of any oblong plot may be compared directly with that of a square of equal area.

* These factors to six places of decimals are .707107 and .353553. They are derived algebraically as follows:

In a plot with a length two times its width let x represent the width and 1 the area.

Then $2x^2 = 1$

$x^2 = .5$

$x = .707107$

In a plot with a length eight times its width, let x represent the width and 1 the area.

$8x^2 = 1$

$x^2 = .125$

$x = .353553$

** Ten Eyck, A. M. The Roots of Plants. Bulletin 127, June 1904. Kansas Expt. Sta.

† Rotmistrov, V. [Distribution of the Roots of Some Annual Cultivated Plants.] Zhur. Opuitn (Russ. Jour. Expt. Landw) 8 (1907), No. 6, pp. 667-705; 9 (1908), No. 1, pp. 1-24.

From Table 2 it is evident that a rectangular unit area in the form of a square possesses the shortest periphery and therefore presents the smallest number of plants along its borders. As shown in this table, a change in the shape of a unit area, for example, in the case of its elongation to a length sixteen times its width may subject as many as 112.5 per cent more plants, as compared with those of the same unit area in the form of a square, to the influences arising from marginal conditions. An increase in the length of a plot increases the number of plants along the margin.

What has been said here holds true for plots sown broadcast, as well as for those seeded in drills. Each unit within the margins of a broadcasted plot supports, according to the laws of chance, a number of plants numerically equal to those of every other unit of the plot. The same is true in drilled plots. A plot in which seed is sown in drills six inches apart is divided into equal areas six inches wide. Each of these receives on the average the same number of seeds and supports equal numbers of plants according to the laws of chance. Hence an area six inches wide within the margins of a plot contains the same number of plants as an equal area within the plot. It should be pointed out here that a circular plot of a unit area has the shortest periphery and therefore presents the smallest number of plants along the border. However, the impracticability of seeding and handling plots of this shape is obvious.

TABLE 3.

The Relation of an Area Six Inches Wide Within the Border of a Plot to the Total Area of the Plot.

SIZE OF PLOT.	Shape of plot.	Dimensions of plot.	Length of periphery.	Area of strip six inches wide within border in sq. ft.	Per cent. of total area lying in a strip six inches wide within the border.	Per cent. increase in area of six-inch strip on basis of area in square.
2000th acre	Square	4.67x4.67	18.67	8.33	38.26	–
" "	Length 2 times width	3.30x6.60	19.80	8.90	40.86	6.79
" "	Length 4 times width	2.33x9.33	23.33	10.67	48.98	28.00
1000th acre	Square	6.60x6.60	26.40	12.20	28.01	–
" "	Length 2 times width	4.67x9.33	28.00	13.00	29.85	6.56

TABLE 3—Concluded.

SIZE OF PLOT.	Shape of plot.	Dimensions of plot.	Length of periphery.	Area of strip six inches wide within border in sq. ft.	Per cent. of total area lying in a strip six inches wide within the border.	Per cent. increase in area of six-inch strip on basis of area in square.
1000th acre	Length 4 times width	3.30x13.20	33.00	15.50	35.58	27.05
500th acre	Square	9.33x9.33	37.34	17.67	20.28	–
" "	Length 2 times width	6.60x13.20	39.60	18.80	21.58	6.41
" "	Length 4 times width	4.67x18.67	46.67	22.33	25.64	26.41
250th acre	Square	13.20x13.20	52.80	25.40	14.58	–
" "	Length 2 times width	9.33x18.67	56.00	27.00	15.50	6.35
" "	Length 4 times width	6.60x26.40	66.00	32.00	18.37	25.98
100th acre	Square	20.87x20.87	83.48	40.74	9.35	–
" "	Length 2 times width	14.76x29.52	88.55	43.27	9.93	6.22
" "	Length 4 times width	10.44x41.74	104.36	51.18	11.75	25.61
" "	Length 8 times width	7.38x59.03	132.82	65.41	15.02	60.55
" "	Length 16 times width	5.22x83.48	177.40	87.70	20.13	115.26
50th acre	Square	29.52x29.52	118.06	58.03	6.66	–
" "	Length 2 times width	20.87x41.74	125.23	61.61	7.07	6.17
" "	Length 4 times width	14.76x59.03	147.58	72.79	8.36	25.43
" "	Length 8 times width	10.44x83.48	187.84	92.92	10.67	60.12
" "	Length 16 times width	7.38x118.06	250.89	124.44	14.28	114.44
40th acre	Square	33.00x33.00	132.00	65.00	5.97	–
" "	Length 2 times width	23.33x46.67	140.01	69.00	6.34	6.16
" "	Length 4 times width	16.50x66.00	165.00	81.50	7.48	25.38
" "	Length 8 times width	11.67x93.34	210.01	104.01	9.55	60.01
" "	Length 16 times width	8.25x132.00	280.50	139.25	12.79	114.23
20th acre	Square	46.67x46.67	186.68	92.34	4.24	–
" "	Length 2 times width	33.00x66.00	198 00	98.00	4.50	6.13
" "	Length 4 times width	23.33x93.34	233.35	115.67	5.31	25.27
" "	Length 8 times width	16.50x132.00	297.00	147.50	6.77	59.74
" "	Length 16 times width	11.67x186.68	396.69	197.34	9.06	113.72
10th acre	Square	66.00x66.00	264.00	131.00	3.01	–
" "	Length 2 times width	46.67x93.34	280.01	139.01	3.19	6.11
" "	Length 4 times width	33.00x132.00	330.00	164.00	3.76	25.19
" "	Length 8 times width	23.33x186.68	420.02	209.01	4.80	59.55
" "	Length 16 times width	16.50x264.00	561.00	279.50	6.42	113.36
1 acre	Square	208.71x208.71	834.84	416.42	0.96	–
1 "	Length 2 times width	147.58x295.16	885.48	441.74	1.01	6.08
1 "	Length 4 times width	104.36x417.42	1043.55	520.78	1.20	25.06
1 "	Length 8 times width	73.79x590.32	1328.22	663.11	1.52	59.24
1 "	Length 16 times width	58.18x834.84	1774.04	886.02	2.03	112.77

Table 3 shows the percentage of the total area contained in a strip six inches wide within the border of plot units commonly used in plant breeding tests. It will be noted that the part of a square plot lying in this marginal strip ranges from 0.96 percent in an acre area to 38.26 per cent in a 2000th acre area. In a plot with a length two times its width this marginal area amounts to 1.01 per cent in an acre and 40.86 per cent in a 2000th acre area. The percent of the total area lying in the strip six inches wide within the border of a long narrow plot is much greater than that of a square plot of the same area. In the cases considered the marginal area may be 6 percent to 115 percent greater in long plots than in square plots of equal size. The magnitude of this percentage depends on the relation of the length to the breadth of the plot.

Mercer and Hall * maintain that there is practically no difference in the accuracy of square plots and long narrow plots. However, it should be borne in mind that the basis of the conclusions of these authors was the yield of an acre plot selected out of a large field. This acre was divided into small units each of which was harvested separately. There were no pathways around the acre plot and likewise, and of much greater importance, none around the small units of the acre. Hence their conclusions are based on conditions where the competition among plants is that ordinarily found in any field. These authors *do not consider* the possible effect of pathways around plots. Nevertheless the marginal plants play an important part in making up the total yield of plots.

To overcome the influence of pathways it has often been suggested as advisable to discard the outside rows of a plot in order to attain a fairer test of the cropping ability of a variety of grain under so-called normal conditions. However, to throw away the outside rows of each plot is exceedingly bad practise in plant breeding work because of the possibility of such odds and ends becoming mixed up with other varieties. Further the discarding of outside rows requires a greater labor expense and also greater land area in attaining results on unit plots. Trimming plots to overcome certain effects of environment is ex-

*Mercer, S. W. and Hall, A. D. The Experimental Error of Field Trials. The Journal of Agricultural Science, Oct. 1911.

ceedingly unsatisfactory. The best practice in plant breeding work is to plant in a plot only what one wants to harvest therefrom. All in all, as long as conditions are similar for all varieties of grain in trial in a field of fairly uniform soil, the results of plot tests will show the relative yields of the varieties.

The use of small unit areas in plant breeding work is necessary in the propagation of selected plants, especially because of the great number of such selections one must try out in the search for superior individuals. It is often impossible during the first season following propagation in head rows to carry out tests on units larger than a thousandth or a five hundredth of an acre. The calculated yields per acre obtained on such small areas are generally a great deal higher than those gotten by growing the same variety in large plots. Mercer and Hall have pointed out that a large error due to soil variation and other factors is involved in tests on such small areas. These authors show that in plots smaller than a fortieth or fiftieth acre the error of the yields rises rapidly as the area of the plot diminishes. However an increase in the size of a plot above a fortieth or fiftieth acre does not give results of sufficiently greater accuracy to warrant the greater expense involved in the use of larger units. By testing varieties in four or five units of 40th or 50th acre size they show the error of the results to be much smaller. In addition to the error worked out by these authors there must be in plots surrounded by paths another factor which augments the productivity of the marginal plants. As already pointed out this factor brings the shape as well as the size of plot into consideration.

From the foregoing discussion it is evident that a means of gauging approximately the cropping ability of a variety of grain in a field on the basis of what it does in small areas would be of some service. Undoubtedly an absolutely accurate measure can not be determined for forecasting on the basis of performance in small areas the probable productivity of an oat under field conditions. However, it may be possible to arrive at a fair estimate. To be able to do this would prove of great assistance in judging the possible worth of pure lines which have been propagated to the point of enabling tests in 500th acre plots. Then, at the beginning of the search for superior strains it is desirable to approximately estimate their worth as compared with the varieties already established. Of course a check on the productivity of new varieties may be had by planting several plots to one commercial variety regularly distributed throughout the field. Even with this, an additional means of gauging the value of a new strain would be advantageous. The importance of the size and shape of a plot impresses one forcibly when it is considered that marginal plants may yield twice as much as plants within the plot. In this event any yield of a variety grown on 50th acre units would have to be considered as 106.7 percent, on a 100th acre 109 percent, on a 1000th acre 128 percent according to figures given in Table 2.

In oblong plots of these unit areas the percent would be much higher.

This problem of the influence of size and shape of plots on the results of variety tests of grain may be viewed from the standpoint of marginal drill length in comparison with the total drill length in a plot. In this the plants within six inches of the border at each end of a drill are considered subject to the conditions outside the margin and, hence, make up a row across each end of the plot.

In terms of x, x representing the side of a square, a unit area x^2 in different rectangular shapes will have the dimensions given in Table 4 Also one will note in this table the length of the marginal drills and the total drill length together with the relation between marginal drill length and total drill length.

TABLE 4.

Relation of Marginal Drill Length to Total Drill Length.

SHAPE OF PLOT.	Square.	Length 2 times width.	Length 4 times width.	Length 8 times width.	Length 16 times width.
Area	x^2	x^2	x^2	x^2	x^2
Width in feet	x	$0.7071x$	$\frac{x}{2}$	$.3536x$	$\frac{x}{4}$
Length (of rows) in feet	x	$1.4142x$	$4\frac{x}{2}$	$2.8284x$	$16\frac{x}{4}$
Total number of drills of x length in feet $\frac{1}{2}$ ft. apart	$2x$	$1.4142x$	x	$.7071x$	$\frac{x}{2}$
Total length in feet of all drills	$2x^2$	$2x^2$	$2x^2$	$2x^2$	$2x^2$
Length in feet of marginal drills	$4x-2$*	$4.2426x-2$	$5x-2$	$6.364x-2$	$8.5x-2$
Ratio of marginal drill length to total drill length	$\frac{2x-1}{x^2}$	$\frac{2.1213x-1}{x^2}$	$\frac{2.5x-1}{x^2}$	$\frac{3.182x-1}{x^2}$	$\frac{4.25x-1}{x^2}$

* In a plot in which the drills are spaced six inches apart two feet must be subtracted rom the periphery to avoid duplication of drills in the corners.

It is obvious that in oblong plots having fewer and longer drills than a square plot of the same area the ratio of the marginal drill length to the total drill length is greater.

Kiessling * refers to the fact that in small narrow plots the ratio of the plants in border rows to the total plants is greater than in large plots.

SUMMARY.

The purpose of this paper is to show:

1. That since in plots surrounded by cultivated pathways the plants along the margins are more productive than those within the plot, it is evident that shape as well as size of plot must be considered in tests of varieties.

2. Of rectangular plots of a unit area a square has the shortest periphery and accordingly presents the smallest number of plants along the borders. Therefore *a square plot is a more accurate basis for the determination of the value of varieties than any other rectangular shaped plot of equal area.* It is clear that in a long narrow plot more plants will be subjected to the conditions afforded by the pathways than in a square of the same area. Also, in small plots proportionately more plants will stand along the border than in large plots.

3. Mercer and Hall (*loc. cit.*) do not consider the effect of pathways surrounding plots. Hence their conclusion that the shape of plots does not affect the results of tests of varieties is not tenable in the case of plots surrounded by pathways.

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* Kiessling, L. Einiges aus der Praxis des Zuchtgartenbetriebes. Zeit. f. Pflanzenzüchtung, Bd. 1, Heft, 1, December 1912.

A TABLE FOR ESTIMATING THE PROBABLE SIGNIFICANCE OF STATISTICAL CONSTANTS.*

By Raymond Pearl and John Rice Miner.

The use of biometric methods in biology and related applied sciences is becoming all the time more general. The increasing use of this technique is not, however, entirely free from doubtful features. Biometric methods and biometric conclusions *per se* are not infallible. To use them safely and profitably demands a clear understanding of this real meaning, so that a specious air of profundity and infallibility may not be given to results which in reality lack these qualities. The present note is offered as a slight numerical aid to sanity and conservatism in statistical investigations.

One of the most important of the contributions of biometry is its insistence on the "probable error" as a test of the probable validity of conclusions. This is an entirely commendable tendency. But there has grown up a certain conventional way of interpreting probable errors, which is accepted by many workers, not all of whom are beginners, without any critical examination of the real basis of the conventional usage. It has been practically a universal custom amongst biometric workers to say that a difference (or a constant) which is smaller than twice its probable error is probably not significant, whereas a difference (or constant) which is three or more times its probable error is either "certainly" or at least "almost certainly" significant.

Now such statements as these derive whatever meaning they may possibly have from the following simple mathematical considerations. Assuming ** that the errors of random sampling are distributed strictly in accordance with the normal or

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* Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 63.

** In the present connection we are in no way concerned with the generality or degree of validity of this assumption. It has been extensively and adequately dealt with by Pearson and his students in many papers. In most cases this assumption is sufficiently accurate for practical purposes.

Gaussian curve it is a simple matter to determine from any table of the probability integral the precise portion of the area of a normal curve lying outside any original abscissal limits, or in other words, the probability of the occurrence of a deviation as great as or greater than the assigned deviation. To say that a deviation as great or greater than three times the probable error is "certainly significant" means, strictly speaking, that the area of the normal curve beyond 3 P. E. on either side of the central ordinate is negligibly small. As a matter of fact this is not true, unless one chooses to regard 4.3 per cent, as a negligible fraction of a quantity. There are certainly many common affairs of life in which it would mean disaster to "neglect" a deviation of four percent of the total quantity involved.

It seems likely that it may be useful to statistical workers to have at hand a small table which will set forth for a series of ratios between a statistical deviation and the "probable error"* of the error distribution, first the probability that a deviation as great as or greater than the given one will occur, and second the odds against the occurrence of such a deviation. Such a table is appended hereto. In calculating it we have used Sheppard's † tables of the probability integral, changing from arguments in terms of standard deviation to arguments in terms of probable error. The probabilities have been expressed on a percentage basis, on the ground that they will probably in this way make a more direct appeal to the average mind, since we are more accustomed to thinking in terms of parts per 100 than per any other number.

A single example will indicate how the table is to be used. Suppose one has determined the mean of each of two com-

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* As many statistical writers have pointed out, the convention of using the "probable error" rather than the standard deviation of a distribution as a measure of its "scatter" is unfortunate. Yule (Introduction to the Theory of Statistics) has made recently a strong plea for the use of the "standard error." It however seems likely that the probable error is too strongly entrenched in the common usage now to be dislodged.

† Biometrika Vol. II, pp. 174-190.

parable series of measurements. These means differ by a certain amount. The difference is found to be, let us say, 3.2 times as large as the probable error of the difference. Is one mean *significantly* larger than the other? Or, put in another way, what is the probability that the difference arose purely as a result of random sampling (as a result solely of chance)? Under the argument 3.2 in the table we find the probability of the occurrence of a deviation as great or greater than this to be 3.09. This means that in every 100 trials a deviation of this size or greater would be expected to occur, as result of chance alone, (the error of random sampling), 3.09 times. Or, from the next column, the odds against the occurrence of a difference as great or greater than this in proportion to its probable error, are 31.36 to 1, if chance alone were operative in the determination of the event. If one wants to call this "certainty" he has a perfect right to do so. The table merely defines quantitatively his particular conception of certainty.

It will be noted that after the ratio, deviation ÷ P. E., passes 3.0 the odds against the deviation increase rapidly, reaching a magnitude at 8.0 which is, practically speaking, beyond any real power of conception. We have started the table at 1.0, because this is the point where the chances are even. A deviation as large as the probable error is as likely to occur as not, and *vice versa*.

TABLE I.

Showing the Probability of Occurrence of Statistical Deviations of Different Magnitudes Relative to the Probable Error.

Deviation / P. E.	Probable occurrence of a deviation as great as or greater than designated one in 100 trials.	Odds against the occurrence of a deviation as great as or greater than the designated one.	Deviation / P. E.	Probable occurrence of a deviation as great or greater than the designated one in 100 trials.	Odds against the occurrence of a deviation as great as or greater than the designated one.
1.0	50.00	1.00 to 1	3.5	1.82	53.95 to 1
1.1	45.81	1.18 to 1	3.6	1.52	64.79 to 1
1.2	41.83	1.39 to 1	3.7	1.26	78.37 to 1
1.3	38.06	1.63 to 1	3.8	1.04	95.15 to 1
1.4	34.50	1.90 to 1	3.9	.853	116.23 to 1
1.5	31.17	2.21 to 1	4.0	.698	142.26 to 1
1.6	28.05	2.57 to 1	4.1	.569	174.75 to 1
1.7	25.15	2.98 to 1	4.2	.461	215.92 to 1
1.8	22.47	3.45 to 1	4.3	.373	267.10 to 1
1.9	20.00	4.00 to 1	4.4	.300	332.33 to 1
2.0	17.73	4.64 to 1	4.5	.240	415.67 to 1
2.1	15.67	5.38 to 1	4.6	.192	519.83 to 1
2.2	13.78	6.26 to 1	4.7	.152	656.89 to 1
2.3	12.08	7.28 to 1	4.8	.121	825.45 to 1
2.4	10.55	8.48 to 1	4.9	.095	1051.63 to 1
2.5	9.18	9.89 to 1	5.0	.074	1350.35 to 1
2.6	7.95	11.58 to 1	6.0	.0052	19,230 to 1
2.7	6.86	13.58 to 1	7.0	.00023	434,782 to 1
2.8	5.90	15.95 to 1	8.0	.000000068	1,470,588,234 to 1
2.9	5.05	18.80 to 1			
3.0	4.30	22.26 to 1			
3.1	3.65	26.40 to 1			
3.2	3.09	31.36 to 1			
3.3	2.60	37.46 to 1			
3.4	2.18	44.87 to 1			

BULLETIN 227.

POWDERY SCAB OF POTATOES.

W. J. Morse.

Following the discovery of powdery scab in Maine and adjoining portions of Canada this Station has received many letters of inquiry as to the appearance and nature of the disease, means of dissemination, methods of control, etc. Since powdery scab is of so much importance from the standpoint of the potato industry and since the demand for information on the subject has been so great, it has become necessary to prepare for circulation within the State a brief résumé of the important facts known about the disease. Naturally much of the material here presented has been obtained from European sources, but as far as possible the description of the disease and the comparisons made with potato diseases which might be mistaken for it, etc., have been based upon observations made by the writer and others in the State of Maine.

History and Distribution of the Disease.

Some difference of opinion has existed as to how long powdery scab has been recognized as a specific disease. This is based on the question of the identity of the disease described by Brunchorst,* in Norway in 1886 as caused by a slime-mold with that described by Wallroth and others in the early forties as being produced by a fungus. Pethybridge in a recent publication † has, in the writer's opinion, shown quite conclusively

* Brunchorst, J. Ueber eine sehr verbreitete Krankheit der Kartoffelknollen. Bergens Museums Aarsberetning 1886, p. 219.

† Pethybridge, G. H. On the Nomenclature of the Organism Causing "Corky" or "Powdery-scab" in the Potato Tuber, *Spongospora subterranea* (Wallr.) Johnson. Jour. Royal Hort. Soc. 38 : 524-530. 1913.

that the figures and descriptions published by these earlier writers could refer to nothing else than what we know today as *Spongospora subterranea.*

The attention of scientific men was first called to the disease by means of a paper sent by Doctor Wallroth and presented at a meeting held in Brunswick, Germany, September 22, 1841. This paper, however, was not published until the following year.* It should be mentioned in passing that the disease was already sufficiently well known at that time so that the German farmers had applied a common name to it. A study of the literature reveals the fact that during the next 10 or 15 years powdery scab or the organism causing it was described or discussed in a dozen or more different publications. From 1856 on, and up to about six or eight years ago, only a very few important articles appeared which dealt with this disease although it was figured and described in various text-books and manuals in the meantime. One of these important contributions was that of Brunchorst already mentioned and another was a short article by de Lagerheim † in which he records the occurrence of the disease on potatoes purchased at a market in Quito, Ecuador. He called attention to the significance of this fact as South America is the home of the potato, and that the disease is generally known in Quito and manifests itself on potatoes from various localities. The natives there called it "Cara" which is equivalent to the English word scab.

During the past few years several very important papers have appeared dealing with the subject of the powdery scab and the organism which produces it. These have mostly come from pathologists in Great Britain and Ireland where the disease appears to be widespread and destructive and is receiving considerable attention. The first report of powdery scab in North America was made a little over a year ago by Prof. H. T. Güssow,‡ Dominion Botanist of Canada, who stated that the first specimens were received from the Province of Quebec where

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* Amtlicher Bericht über die neunzehnte Versammlung deutscher Naturforscher und Aerzte zu Braunschweig in September 1841 : 1842.

† de Lagerheim, G. Remarks on the Fungus of a Potato Scab. Jour. of Mycology **7** : 103-104. 1892.

‡ Güssow, H. T. Powdery Scab of Potatoes *Spongospora subterranea* (Wallr.) Johns. Phytopathology **3** : 18-19. 1913.

the disease appeared to be well established in some counties. It is also recorded in isolated cases in widely separated regions of Canada, namely Cape Breton, Nova Scotia, New Brunswick, Ontario and Alberta. Certain observations made by Dr. I. E. Melhus of the Bureau of Plant Industry in the fall of 1913 showed that the disease is quite widely distributed in those portions of the Province of New Brunswick which adjoin Maine and especially common in the lower St. John Valley.

The first report of powdery scab in the United States was made by the writer on May 27, 1913, and based upon tubers received some months before from Massachusetts and Nebraska.* Almost at the same time Dr. I. E. Melhus reported the disease as being found at Presque Isle, Maine †.

Up to about February 1 of the present year it was supposed that the Presque Isle case, which had been traced to an importation of seed potatoes from Ireland two years ago, represented the only occurrence of the disease in the State of Maine. About this time potatoes which were being taken across the St. John River for shipment from one of the northern border towns of Maine were found by the Canadian inspectors to be affected by powdery scab, and so reported to Washington by the New Brunswick Commissioner of Agriculture. Acting upon this information Doctor Melhus, representing the Federal Horticultural Board, Mr. A. K. Gardner, State Horticulturist, and the writer at once began a preliminary inspection of this and adjoining territory. This was later supplemented by Mr. Gardner so as to include all the important potato growing sections of Aroostook and some of the adjoining portions of Penobscot and Washington Counties.

This preliminary inspection showed that the disease was more common in the northern part of the county, along the Canadian border. Apparently powdery scab has only recently been introduced into Maine and to date only a small percentage of the farms in the section where it has been found have become infested. Up to the present time it has not been reported in the central and southern parts of the State. Storage

* Morse, W. J. Powdery Scab of Potatoes in the United States. Science 38 : 61-62. 11 Jl 1913.

† Melhus, I. E. The Powdery Scab of Potato (*Spongospora solani*) in Maine. Science 38 : 132-133. 25 Jl 1913.

bins containing some 13,000 barrels of potatoes, grown in 5 or 6 different towns, were recently inspected by Mr. M. Shapovalov and the writer in Piscataquis County and no powdery scab was found. However, potato growers in other parts of the State should be constantly on the watch for the disease, especially if they have recently used seed from the districts now known to be infested. In this connection it may be said that there is probably less danger at present of obtaining powdery scab from these sections than in the immediate past as the system of inspection and certification established by the State Department of Agriculture in coöperation with the Federal Horticultural Board is designed to prevent the dissemination of the disease from these infected districts to other parts of this State or to other States.

Cause of the Disease.

The organism, *Spongospora subterranea* (Wallr.) Johnson, which is responsible for the production of powdery scab is quite different from the one which causes the ordinary type of scab with which Maine potato growers have been acquainted for many years. Powdery scab is produced by one of the slime molds which latter belong to the lowest order of living organisms, on the boundary line between the animal and vegetable kingdoms. It is the same type of organism as that which causes the well known club root of cabbage and allied plants. The facts we know regarding its life history may be briefly stated as follows: The earliest stage observed consists of a simple protoplasmic body of the ameba type located within the young potato cells. The nucleus of this ameba divides, and generally in the early stages of the infection this is followed by a division of the ameba itself, which process continues until a number occur in one cell. According to Osborn* who recently studied the matter quite carefully these amebæ apparently do not have the power to migrate from one cell of the potato to another, but as the potato cell divides a part of those contained in the original cell may go to each daughter cell resulting from this division. Thus the new cells become infected as soon as

* Osborn, T. G. B. *Spongospora subterranea* (Wallroth) Johnson. Annals of Botany **25** : 327-341 Ap 1911.

they are formed. These amebæ may continuously divide and increase in number as the cell in which they are located increases in size until they occupy the greater part of its area.

After the contents of the whole cell are exhausted the amebæ fuse together into a larger body called the plasmodium. This is the first stage of spore formation. Following this, certain other changes take place until finally the plasmodium is converted into a loose, spongy, yellowish or brownish body usually spherical to ovoid in shape and varying in size but averaging about 1-500 of an inch in diameter. These are the so-called "spore balls" of the organism. They are made up of aggregates of many small, spherical spores somewhat less than 1-5000 of an inch in diameter and it is the masses of these spore balls which constitute the powdery substance found in the pustules on the diseased potatoes.

Effect of the Disease upon the Host.

The early stages of powdery scab on young tubers appear in the form of small pimples with a slight discoloration of the surface. When cut open the infected areas appear purplish.* These minute pustules may occur in patches or scattered over the surface of the tubers. As they enlarge they become raised and break through the epidermis which stands up and curls back around the spots in a characteristic manner.

If the surfaces of the diseased potatoes have not been exposed to too much friction, specimens may be collected frequently in the storehouses in the winter which show distinct, raised, blister-like, dark colored spots, usually not more than one-sixteenth to one-eighth inch in diameter, in no way resembling the common type of scab. These are shown indistinctly on the surface of the apparently decayed tuber illustrated in Figure 47. If the top of one of these blisters or pustules is carefully removed by means of a needle or penknife the interior will be found to be filled with dead tissue and a dark colored or brownish powder, frequently having a slight olive tinge. Usually, however, when affected tubers come under observation they have been subjected to more or less friction which has not only removed the top of the pustule but most of the powder as well, leaving rather flat and slightly raised spots. After one acquires a slight familiarity with the

* Osborn l. c. 328.

disease he can usually recognize it without trouble, even in this stage, on account of the size, grouping, and appearance of the spots. Unless several spots have run together and coalesced they are usually oval to circular in shape, small, seldom more than one-sixteenth to one-eighth inch in diameter and frequently several occur together in clumps. Occasionally they may extend diagonally across the surface of the potato in more or less irregular, parallel lines. The ragged, turned back margins of the ruptured epidermis already mentioned are usually still in evidence after the top of the pustules have been rubbed off.

The above description of the appearance of the disease upon the affected tubers applies to all the specimens which the writer has thus far seen which have been collected from the storehouses and cellars in Maine during the present winter. However, this is by no means the only form of alteration which the parasite may produce in the normal appearance of the host. In severe attacks, especially in moist soil, a distinctly warty appearance may develop, quite different from the ordinary type of powdery scab. These warts are several times larger than the scab pustules aleady described and are usually smooth and roundish, although somewhat irregular, varying in color from a light to dark brown in the case of the few specimens which the writer has seen, and more frequently occurring at the terminal or "Seed" end of the tuber. Figure 45 represents tubers produced in the plant pathology greenhouse at this Station, under rather moist conditions from a seed potato only slightly affected by the disease. According to Horne* "The warty condition is not so evident after the potatoes have been removed from the soil for some time. The warts become flattened and discolored, so that raised, more or less chocolate-colored scars remain in their stead." The same author states that this form of the disease is known in some parts of Great Britain as "Corky-end." Still another stage is recognized of which the writer has seen only one tuber which latter came from Canada. This is a condition where considerable portions of the surface of the tuber become destroyed and eroded, leaving a distinct, hollowed-out, cankerous area. This is illustrated in Figure 44. It is apparently a very advanced stage of the

* Horne, A. S. On Tumor and Canker in Potato. Jour. Royal Hort. Soc. 37 : 362-389. 1911.

disease which the writer has not had opportunity to trace from the beginning, and such European authorities as have been consulted do not state whether it results from either the warty stage just described, or from the running together of the individual spots of the scab or blister stage in severe attacks, or from both.

A few other characteristics of the disease as observed in Maine should be noted. The most important is, perhaps, that potatoes affected by powdery scab, especially in severe or moderately severe cases, show a tendency to wither rapidly. This takes place even under good storage conditions, and it becomes very evident if the tubers are removed from the cellar and kept at the temperature of the average living room for a few days. Very frequently the skin of the potato in a circle immediately surrounding the individual scab spots becomes depressed and browned, taking on a color very similar to that produced by the common dry rot associated with the late blight fungus. This similarity to the late blight dry rot is greatly increased if the spots of powdery scab are numerous and close together so that the discolored area of the skin becomes continuous. In such cases the tissues dry out and shrink away very rapidly beneath the discolored area, giving every appearance of a form of dry rot. Cutting through these blackened areas of the surface usually reveals simply a thin layer of dry, dead tissue resting on the apparently sound and healthy flesh of the tuber below. Frequently a distinct stratum of dry rot has been found beneath some of these discolored areas but whether or not this is due simply to secondary infection by some fungus I am not yet able to say.

Diseases Which May be Mistaken for Powdery Scab.

Common Scab. No doubt the chief reason that powdery scab was not recognized earlier by the potato growers in the sections where it is now known to occur is that they failed to distinguish the disease from the ordinary scab which has been common and widely distributed for many years. In comparing the two it may be said in the first place that the lesions produced by the common scab are on the average much larger. They are apt to be more irregular in size and shape and never appear as distinct warts or pustules containing a brownish powder.

They never produce a browning of the surrounding skin resembling decay, nor a pronounced shrinkage of the tubers, and never form large, deep, eroded pits or cankered areas in the tissues.

While portions of the epidermis may appear turned up, surrounding the spots of common scab, this characteristic is by no means so common or so apparent to the unaided eye as is the case with powdery scab. If the affected potatoes are wet and carefully washed to remove superfluous dirt another distinct characteristic can be observed. When wet, the spots produced by powdery scab are invariably darker colored than those of the common type. Common scab is, as a rule, nothing more than a surface ulcer, resulting from the irritation of the growth of the parasite in the superficial cells of the tissue. On account of the character of the lesions thus produced the keeping qualities of the tubers are practically uninjured and the value for food purposes is not materially lessened. It simply makes them unsightly and less easy to prepare for the table.

Silver Scurf. This disease, which is caused by *Spondylocladium atrovirens* Harz., has been given the name of "scab" and "dry scab" by some writers. Melhus* who has very recently described the nature and distribution of this disease in the United States maintains that we are not justified in applying the name scab to it as we already have two or three other different types of scab. Moreover as the disease ordinarily occurs on potatoes it is not a typical scab. Silver scurf is quite easily detected on light skinned varieties like Irish Cobbler and Green Mountain if the tubers are washed. According to the writer's observations the early stages of it appear as small, faint, roundish, or irregular discolorations on the skin of the tuber, and which may be easily overlooked if the latter is somewhat dirty. These discolored spots are usually from one-eighth to one-fourth inch in diameter. Later these may enlarge, run together, and cover considerable of the surface area of the potato. If conditions are moist the spots take on an olive color due to the fruiting of the fungus. In advanced stages the discolored areas change so that they present a silvery or glistening appear-

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*Melhus, I. E. Silver Scurf, A Disease of the Potato. Cir. U. S. D. A. Bu. Pl. Ind. 127 : 15-24. 1913.

ance when washed. A little later the whole tuber may become shrunken and shriveled, but this condition the writer has not seen under the cool storage conditions of this State. In later stages also, fine black dots may appear on the surface of the tuber representing sclerotia of the fungus. These are quite readily made out by means of a hand lens.

While the above description applies very well to the most common type of the disease, the writer recently collected several tubers showing spots undoubtedly caused by Spondylocladium which, when compared with powdery scab and common scab, proved to be confusing to several individuals who were quite familiar with both of these diseases. The affected spots usually varied from one-eighth to one-fourth inch in diameter, they were approximately circular in outline, and usually either level with the surface of the tuber or slightly depressed. On the same tuber all stages could be found from the small discolored areas on the skin which are typical of the earlier stages of silver scurf to the spots described as resembling scab. These scab-like spots were brownish in color, the central portion being frequently, although not invariably, darker than the periphery. The spots are also frequently surrounded by a somewhat lighter brown ring. This seems to be made up of densely interwoven, light brown threads of the fungus. These latter also are usually found entirely covering the whole spot. If the spots are large and somewhat irregular they may, on superficial examination, be classed as common scab. If they are small, unless one has given the matter considerable attention he is apt to call them spots of powdery scab the surfaces of which have been removed by friction in rubbing against other potatoes. Figure 49 represents a potato affected by this type of the disease.

Rhizoctonia Scab. The fungus *Hypochnus solani* P. & B. commonly known as Rhizoctonia from its non-fruiting stage has been attributed in some instances as the cause of a type of scab. In inspecting potatoes for powdery scab tubers showing lesions apparently produced by this fungus are sometimes found. These spots, particularly in advanced stages, are more of a pit than a scab and should not be confused with powdery scab, although potatoes have been sent to this Station on the supposition that they represented this last type of disease.

The beginning of these pits is usually indicated by a slight circular browning on the surface of the potato in the region of a lenticel. As the diseased area increases it becomes slightly depressed and brown in color. Usually the margin is somewhat more sunken forming a sharp boundary line between the healthy and diseased tissues. Occasionally diseased areas like this will reach the size of from one-eighth to one-fourth of an inch without any other superficial changes. More frequently the tissues surrounding the lenticel soon begin to shrink away leaving an opening in the center of the diseased area. This may widen out into a broad, shallow pit, or if the disease penetrates any depth into the flesh it may develop into a canal following the center of this area. Figure 52 represents a potato affected in this manner.

Rhizoctonia is very common in New England potato soils and the sclerotia of the fungus are frequently seen on the surfaces of potato tubers. These are small black, or dark brown, often irregular shaped bodies, commonly flattened and closely attached to the skin of the tuber. They can usually be removed with more or less difficulty by means of a stiff brush or by pressure with the thumb nail, leaving the skin of the tuber beneath, entirely sound and uninjured. These sclerotia are in reality very compact masses of densely woven threads of the fungus and serve as a resting stage to carry it over winter, but the housewife usually considers them to be closely adhering particles of dark colored soil. If the sclerotia are rounded, fairly regular in shape, of proper size, and appear on potatoes more or less covered with dirt they may be taken for pustules of powdery scab. Their true nature is readily shown if the tubers are washed or the dark spots are scraped off with a knife or by means of the thumb nail. Fig. 51 illustrates a potato covered by sclerotia of Rhizoctonia, and photographed after being washed.

Wart disease. This disease which is caused by *Chrysophlyctis endobiotica* Schilb., and is also known as potato canker and potato tumor is not known to occur on the mainland of North America. When both diseases occur together in England it is said that the warty stage of powdery scab may sometimes be mistaken for the true wart disease, but it is stated that if whole plants are dug up and examined the differences can usually be detected. Spongospora warts are usually smooth and rounded, while those produced by Chrysophlyctis are generally irregular and broken, soon taking on a coral-like structure and always begin around the eyes of the tuber.

Economic Importance of Powdery Scab.

While experience in this State is yet too limited to be made the basis of any definite conclusions the opinions expressed by those who have studied the disease most carefully in Great Britain and Ireland seem to warrant the conclusion that powdery scab is without doubt the most serious disease with which the Maine potato growers have ever had to contend. It has already been pointed out that observations made in this State indicate that potatoes badly affected by the ordinary type of powdery scab wither very rapidly and frequently show a discoloration of the surface resembling a dry rot. Also in case of severe infection large warty outgrowths or cankerous areas may be produced.

One of the most specific statements recently made regarding the economic importance of the disease appeared in an article by Güssow* in which he says: "The disease should by no means be regarded lightly. Severe attacks occur when potatoes are planted year after year on infected land. Where this is practiced the result will be potatoes hardly superior in quality to those affected by canker (wart disease). This fact is worthy of notice, especially since, as in the case of canker, no preventive measures have proved of much value." Pethybridge in 1912 called attention to the fact that the organism causing powdery scab not only may attack the tuber, but is also capable of producing galls on the roots as well as on the underground tuber bearing stems of the potato, and the spore-balls produced on these root-galls are for the most part liberated in the soil. Perhaps the most important fact from the economic standpoint is that the disease in addition to being carried by the seed tubers may persist in infected soil for some time, thus making it worthless for potato culture. Pethybridge has also stated

*l. c. 19.

that manure of a pig fed with potatoes affected with powdery scab carried the germs of the disease. Certain other writers have pointed out the fact that contaminated manure may be a means of spreading the infection.

It is claimed that healthy potatoes which have been in contact with diseased ones may carry powdery scab. This naturally leads to the supposition that it may be spread by mean of sacks or other containers or by means of tools such as planters, etc. Another possibility is that plows, harrows or other tools used for working infected land may carry with them the germs of the disease to contaminate portions of the farm now free from powdery scab. Little data are to be had on this phase of the subject and until we know more about the matter the possibility of spreading the disease in this way should be kept in mind and guarded against as far as possible.

Preventive Measures to be Employed against the Disease.

For the length of time powdery scab has been known it is surprising how little has been done toward solving the problem of its control and eradication as indicated by published work. So far as the writer has been able to learn Doctor Pethybridge of Ireland is about the only investigator who has conducted experiments along the line of soil and seed treatment.

Speaking of work done in 1909 Dr. Pethybridge says,* "Experiments on treating affected seed potatoes with disinfectants showed that such seed, if planted subsequently on clean land, gave a clean crop after steeping for two or three hours in a solution of formalin (formaldehyde) at the rate of half a pint of 40 per cent formalin in fifteen gallons of water——"

The following year he gives the details of several new experiments †. Seed only slightly affected gave over 54 per cent of the crop scabbed, and 67 per cent of the crop was diseased where badly affected seed was used. Soaking in formaldehyde one part to 600 for 3 hours reduced the amount of scab to 2.6 per cent, showing a high degree of efficiency. Wetting the surface of the tubers and rolling them in flowers of sulphur eliminated all of the scab except about one per cent. A one

* Jour. Dep. Agr. and Tech. Inst. Ireland **10** : 254-256. 1910.
† Jour. Dep. Agr. and Tech. Inst. Ireland **11** : 26-29. 1911.

per cent solution of copper sulphate and soaking the potatoes for 3 hours gave even better results but the copper sulphate produced injuries sufficient to materially reduce the yield. Bergundy mixture (copper sulphate and sal soda) was nearly as efficient as formaldehyde but its effect on the crop was similar to the copper sulphate solution alone. Rolling moistened seed tubers in calcium cyanamide destroyed their germinating qualities. The same treatment with superphosphate destroyed four-fifths of the seed tubers but gave a clean crop.

These results coming from a recognized authority on potato diseases are very suggestive as to what may be done along the line of seed disinfection but the fact should not be lost sight of that a perfect score was only obtained at the expense of a largely reduced crop. Also it is doubtful if Dr. Pethybridge himself would care to predict how effective these methods of seed treatment would prove to be under Maine conditions. His results, however, do indicate promising lines of attack upon which to base experimental work in this State. No treatment of this nature should be absolutely relied upon till it has been tried out by a number of investigators, under a variety of conditions.

It will be noted that in his second series of experiments Dr. Pethybridge used a much weaker solution of formaldehyde (1 to 600) than is customary to recommend in this country for treating seed potatoes, but soaked for a longer time, 3 hours. This Station has always used and recommended one pint of 40 per cent formaldehyde in 30 gallons of water (1 to 240) and soaking the potatoes for 2 hours in this. This strength of solution has been found to be very effective in treating for the ordinary type of scab and for blackleg. Doubtless it would be more efficient than the weaker solution for a longer period.

Reasoning apparently on *a priori* grounds, since liming soils tends to control club root of the cabbage, also caused by a slime mold or myxomycete, led one English writer to recommend this for powdery scab. Pethybridge* has since shown that not only is lime not a soil disinfectant with reference to powdery scab but as is the case with common scab its application to the land

* Pethybridge, G. H. Jour. Dep. Agr. Tech. Inst. Ireland. **10** : 254-256. 1910, **11** : 26-29. 1911, **12** : 19-22. 1912, **13** : 459-461. 1913.

actually increases the virulence of the disease. In the same series of articles this writer has given results which indicate that sulphur is of considerable value for soil treatment.

There is every reason to believe that the presence of powdery scab in Maine has been detected in time so that it will be possible to prevent its farther spread and possibly to eventually entirely eradicate it. However this can only be done through the coöperation and concerted action of all parties interested. In the section where the disease occurs no land should be replanted to potatoes in 1914 unless it is shown beyond doubt that the 1913 crop was free from powdery scab. For the coming year no seed stock should be used unless it is known to be free from contamination. Land known to be infected should not be used for potatoes again till more data has been accumulated with regard to the length of life of the organism within the soil.

No potatoes should be planted without first disinfecting them with formaldehyde or corrosive sublimate, for if by chance the healthy seed has become contaminated this would tend to eliminate the danger from this source. In fact there are many arguments in favor of planting no potatoes whatsoever without first disinfecting them. By careful selection of only sound, thoroughly healthy seed tubers, and then disinfecting it is possible to entirely eliminate blackleg, prevent the spread of ordinary scab, and also to overcome some of the losses from seed decay and so-called imperfect germination. There is no doubt that if careful selection of seed, along with disinfection had been generally adopted by our potato growers, and rigidly carried out in the past powdery scab, blackleg, etc., would not have gained a foothold in the State.

After the sound, healthy seed tubers have been disinfected great care should be taken not to contaminate them by allowing them to come in contact with, sacks, barrels or planters, etc., which may carry the germs of the disease.

Disinfection of Seed Potatoes, Implements and Storage Houses.

Many inquiries have been addressed to this Station asking for information as to the best method of disinfecting seed potatoes, implements and storage houses for powdery scab. As already stated only a comparatively small amount of attention has been given to this subject and some phases of it have not been touched at all. However there is available a large amount of data regarding the effects of certain disinfectants like formaldehyde and corrosive sublimate used for treating seed tubers for common scab, blackleg, Rhizoctonia, etc. The conclusions derived from this, taken in connection with the work of Pethybridge on powdery scab in Ireland, may serve as a tentative basis for recommendations as to disinfection, in the absence of any experimental results obtained in this country.

Formaldehyde, sometimes called formalin, as ordinarily used is perfectly safe to handle. A large number of trials by different investigators have shown it to be fully equal to corrosive sublimate for treating potatoes for common scab. The writer has also found it to be efficient in the case of the blackleg disease. Corrosive sublimate is a very active poison and should be handled with great care. It cannot be used in iron vessels and tubers treated with corrosive sublimate should not be fed to stock or left where animals can get at them.

According to the recent work of Gloyer* corrosive sublimate is much more efficient than formaldehyde in the treatment of seed potatoes for Rhizoctonia in that it thoroughly penetrates and kills the sclerotia of the fungus, while the latter does not. Hence where both Rhinzoctonia and scab of either type are present corrosive sublimate is to be preferred. It is also possible that the greater penetrating power of corrosive sublimate claimed by Gloyer may make it more efficient for treating for powdery scab. However until accurate experimental work demonstrates the superiority of one over the other when used against powdery scab it is impossible to say which is the most effective with reference to this disease. The amounts of the disinfectants to use and the length of time for treating seed potatoes are as follows:

FORMALDEHYDE.

Formaldehyde, 40 per cent..........	1 pint
Water	30 gallons

Soak tubers 2 hours in this solution.

* Gloyer, W. O. The Efficiency of Formaldehyde in the Treatment of Seed Potatoes for Rhizoctonia. Bul. N. Y. Agr. Exp. Sta. 370. 1913.

Corrosive Sublimate.

Corrosive sublimate	4 ounces
Water	30 gallons

Soak tubers 1 1-2 hours in this solution.

Planters and other tools which have in any way come in contact with the germs of powdery scab should be washed clean with water and then thoroughly washed or sprayed with a strong solution of formaldehyde and allowed to stand a few days before using. Barrels or other containers may be handled in the same way. Sacks can be disinfected by soaking in formaldehyde but the same results could doubtless be obtained at less expense by steam sterilization at some central station. Sacks should be purchased only under a guarantee that they are free from contamination with powdery scab.

Special attention should be given to storage houses. All loose dirt and rubbish, including decayed poattoes or other culls, should be removed from the interior and from around the outside of the house. As much of this material as possible should be burned. What remains unburned should be thoroughly soaked with a strong solution of copper sulphate. After all rubbish has been removed from the potato house the interior walls and floors should be thoroughly sprayed with a solution of copper sulphate 5 pounds to 50 gallons of water.

More complete disinfection of empty houses may be secured by the use of formaldehyde gas following spraying with copper sulphate. To accomplish this make all outside doors and windows as tight as possible. For every 1000 cubic feet of contents use 23 ounces of potassium permanganate and 3 pints of formaldehyde. Spread the permanganate evenly over the bottom of one or more large vessels like a wash tub or half of a kerosene barrel, these latter arranged in the central parts of the house or rooms. Pour the formaldehyde quickly over the permanganate, being sure that it is well mixed with the latter. Leave and tightly close the house at once. Allow to remain closed 24 hours or longer. Barrels and tools, if clean, can be disinfected at the same time, although probably not so thoroughly and efficiently as by washing with formaldehyde solution.

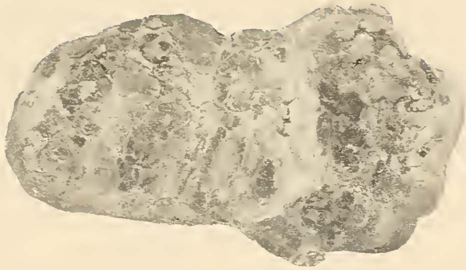

FIG. 44. Powdery scab, canker stage.

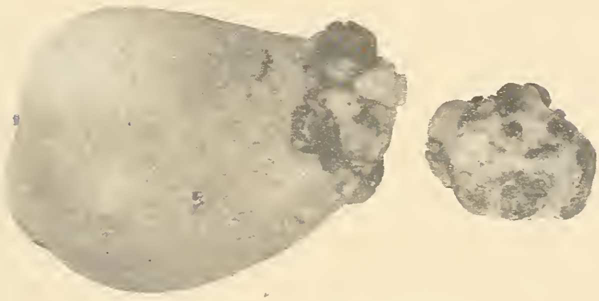

FIG. 45. Powdery scab, warty stage.

FIG. 46. Powdery scab, ordinary stage after having the tops of the pustules removed by rubbing against other tubers—the usual appearance when collected from storage bins in winter.

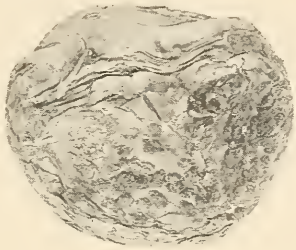

Fig. 47. Powdery scab showing apparent decay following a severe attack. The pustules are still in their original condition and in no way resemble scab spots.

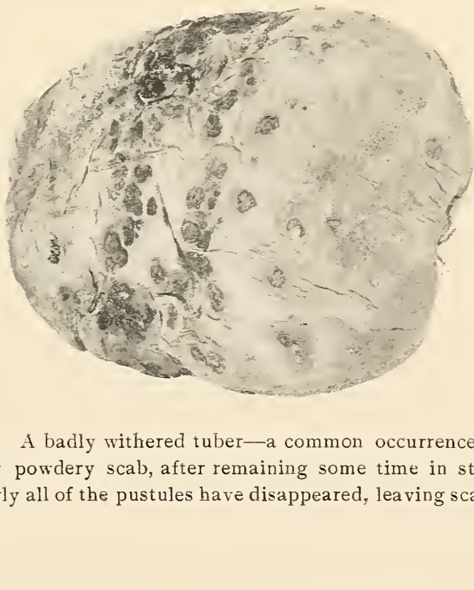

Fig. 48. A badly withered tuber—a common occurrence with tubers affected by powdery scab, after remaining some time in storage. The tops of nearly all of the pustules have disappeared, leaving scab-like spots.

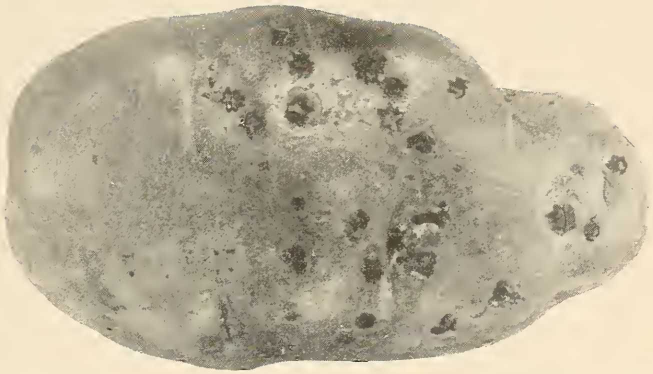

Fig. 49. Scab-like spots caused by *Spondylocladium atrovirens* Harz. Not common.

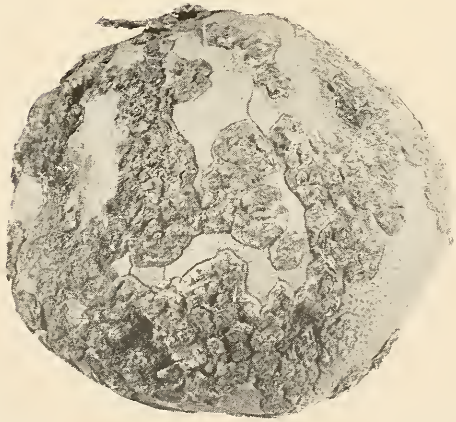

Fig. 50. Common scab, caused by *Oospora scabies* Thaxter.

FIG. 51. Sclerotia of Rhizoctonia (*Hypochnus solani* P. & D.)

FIG. 52. Scab-like spots produced by Rhizoctonia.

BULLETIN 228.

FACTORS INFLUENCING THE SIZE, SHAPE AND PHYSICAL CONSTITUTION OF THE EGG OF THE DOMESTIC FOWL.*

MAYNIE R. CURTIS.

In a study of the physiology of reproduction in the domestic fowl one must soon recognize the fact that the number of eggs produced is only a rough measure of the reproductive activity for the eggs produced are not all equivalent. The complicated physiological processes involved in the production of an egg are so influenced by both heredity and environment that they result in quite unequal products. Eggs differ greatly in every character. The scientific and economic importance of differences in size and quality is obvious.

Investigations on inheritance in poultry have been in progress at this laboratory for several years. In this work the eggs of about two hundred hens of one breed are handled individually each season. The variation in these eggs is very great. The four following facts in regard to it are apparent.

1. The eggs of different individuals of the same strain vary in size, shape, color and markings.

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* This paper is an abstract, setting forth the more important results and conclusions, of an extended paper by the same author, published under the following title: "A Biometrical Study of Egg Production in the Domestic Fowl. IV. Factors Influencing the Size, Shape and Physical Constitution of Eggs," in Archiv fuer Entwicklungsmechanik der Organism (Roux). Bd 39, pp. 217, 1914. The three previous papers in the series are:

Pearl, R. and Surface, F. M. A Biometrical Study of Egg Production in the Domestic Fowl. I. Variation in Annual Egg Production, U. S. Department of Agr., Bur. of Animal Industry, Bul. 110, pp. 1-80, 1909. II. Seasonal Distribution of Egg Production. *Ibid.* pp. 81-170, 1911. III. Variation and Correlation in the Physical Characters of the Egg. *Ibid.* pp. 171—, 1914.

2. The eggs of an individual are more like each other than they are like the eggs of other individuals of the same strain.

3. In spite of this resemblance between the eggs of the individual they nevertheless show a certain degree of variation in all their characters.

4. The first eggs laid by the pullets are smaller than those laid by the same birds later.

An analysis of the factors underlying this individuality and variation in the quantitative characters of the egg offers a new point of attack in the study of the physiology of egg production. A statistical study was made of the quantitative characters of all of the eggs laid by twenty-two Barred Plymouth Rock birds during their first two laying years. These birds were all from the Maine Agricultural Experiment Station strain, the purity of which has been amply proven by breeding experiments.

This paper presents briefly the results of this investigation of the shape and size, both absolute and relative, and the proportion of parts of the successive eggs of each of these birds. It includes (a) a study of the individuality of the eggs of each bird and the variation among them; (b) a study of the relation of the individuality of the eggs to other facts known about the bird, such as body weight, relative size of the several visceral organs, age, number of eggs laid, and tendency to broodiness; (c) the variation in egg characters in relation to the age of the bird, the seasonal reproductive cycles and the intensity of the reproductive activity, including the grouping of the successive eggs into clutches and litters, the size of these groups and the position of the eggs within them.

The Individuality of the Eggs of Each Bird in Regard to Shape, Size, and Size and Proportion of Parts.

It was not necessary to resort to mathematical calculation to demonstrate the fact that the eggs of the different individual birds used in this investigation varied considerably in respect to size and shape. This inter-individual variation was easily seen by comparing the eggs of the different individuals. The eggs of one bird were from one-fourth to one-third larger than the eggs of one of the others. Some of the birds laid eggs which were long and narrow, others those which were short and broad. The eggs of some individuals were distinctly pointed, while those of others were not.

Not only was it possible to see this individuality by comparing the eggs of the different individuals laid at the same season, but by preserving some of the shells of the eggs of each bird at various seasons it was possible to see that the relative size and the shape of the eggs of a fowl are to a large extent permanent characteristics of the individual.

The present investigation deals primarily with the quantitative or measurable characters of the egg, but that the individuality of the different birds manifests itself also in certain qualitative characters is illustrated by a comparison of the color and markings of the eggs of the different birds.

This variation which is seen by a comparison of the eggs themselves is shown equally clearly by a comparison of the measurements of the characters. It is not confined to the externally visible characters (dimensions, shape and size) but extends to the size and the proportion of the parts which make up the egg.

A statistical analysis of the data shows the following points:

INTER-INDIVIDUAL VARIATION.

1. The characteristic eggs of the different individuals show variation in all egg characters.

2. They differ more in size than in shape, and they differ more in the amount of albumen and shell than in the size of the yolk.

3. There is a general correlation between the various characters of the egg. That is, when a bird's eggs are large they are both long and broad and contain a large yolk with a large amount of albumen and shell. The amount of yolk, however, is not *proportionately* large, so that the birds which lay large eggs lay eggs which have a relatively small percentage of yolk.

4. In spite of this general relationship the eggs of one individual may vary disproportionately in any one of the characters measured.

5. There is an evident individuality among the birds also in the amount of variation in the egg characters. The uniform-

ity (or variability) of the egg characters of an individual tends to be general, but may manifest itself in different characters to quite different degrees.

6. A comparison of the relative degree of variation in the individual and in the race shows that in general the eggs of an individual resemble each other much more closely than do a random sample of the eggs of the same strain. The eggs of certain individuals, however, show a much higher percentage of the variation of the race than those of some of the other individuals. In certain egg characters there is a general tendency for the individual variation to approach more nearly the limits of the race variation than in other characters. Finally certain characters may display a variation relatively greater in a particular individual than in the race. This indicates that the egg characters are determined by an interaction of hereditary and environmental forces which may cause a particular character to reach or surpass the racial limits of variation within the eggs of one individual.

INTRA-INDIVIDUAL VARIATION.

The different degree of variation shown by the several egg characters in each individual is also clearly seen. The four following relationships between the degree of variation in the separate characters are clearly demonstrated, either by comparing the average individual variation for each character taking the group of birds as a whole, or by considering separately the several coefficients for each bird.

1. *The egg varies more in respect to weight of shell and weight of yolk than in respect to any of the other characters.* A few individuals show significant differences between the amount of variation in these characters. The eggs of some individuals vary more in respect to the one and some in respect to the other.

2. *Egg weight and albumen weight are about equally variable. They are decidedly less variable than shell weight and yolk weight and much more variable than either length or breadth.* The difference between the variation for these two characters is significant for very few individuals.

3. *Both length and breadth are much less variable than any of the weight characters of the egg.*

4. *The egg is more variable in length than in breadth.* In a few individuals the difference between the variation in these characters is not significant.

The following list arranges the egg characters in the order of their variability.

Egg weight.
Yolk weight.
Albumen weight.
Shell weight.
Length.
Breadth.

It is especially worthy of note than the variation coefficients for yolk and shell are much higher than for the whole egg, and the coefficient for albumen is at least as high. There must then be a compensatory variation among the parts. The data show also that the eggs of the breeding season have disproportionately large yolks and a consequent smaller percentage of albumen than the eggs at other seasons.

The eggs of each individual (as well as the means of the different individuals) vary less in respect to the dimensional characters than in respect to weight. The eggs must vary simultaneously in both dimensions.

Whereas a comparison of the means for the different individuals shows that intra-racially the eggs are more uniform in yolk weight than in the weight of the other parts or of the whole egg, within the eggs of the individual the yolk weight is almost as variable as the shell weight and much more variable than the weight of the albumen or of the whole egg.

THE RELATION OF EGG CHARACTERS TO OTHER CHARACTERS.

The factors which bring about the individuality in the eggs of the different birds are too complex for analysis from the data in hand. Other facts known about the birds were investigated to discover possible relationships between the variation in egg characters and variation in other characters. The results were as follows:

1. The early hatched birds laid earlier in the fall than those hatched during the middle of the season, while the late hatched birds did not lay until spring.

2. Among the birds which began to lay in the fall there is no relation between the number of eggs laid and the time of hatching or the exact date of the first egg.

3. Among the whole flock there is no relation between the mean size of the egg and either the time of hatching or the time of laying the first egg.

4. Correlations calculated between body weight and number of eggs and size of eggs, and between number of eggs and size of eggs were all significantly zero.

Autopsy data were taken on the thirteen birds which completed their second year. The number of birds is too small for statistical analysis. They show an apparent relationship between the size of the inactive oviduct and the time which has elapsed since the last egg and the amount of yolk present in the ovary. The size of the active oviduct appears to be related to the body size. It is not possible to determine whether or not there is a relationship between the size of the active oviduct and the size of the egg.

The Interrelation of the Dimensions, the Shape, Size of Egg and the Size and Proportion of the Parts.

The individuality of the birds in respect both to the mean size and to the amount of variation of each egg character was discussed in preceding paragraphs. In this discussion it was noted that there was a general relationship between the various characters, that is when an individual laid large eggs her characterisitc egg was both long and broad and each one of the component parts was relatively large. It was also noted that the eggs of an individual evidently varied coincidently in both diametral dimensions since they were less variable in either dimension than in size. It was further noted that within an individual there was a compensatory variation in the size of the parts since the variation in the whole egg is less than the variation in the parts.

The purpose of the present part of the paper is to show the interrelation or more strictly correlation of the various egg characters within the eggs of each of the several individuals.

The results of an analysis of the data may be summarized as follows:

1. Different pairs of egg characters show a decided difference in the degree of correlation.

2. There is a general tendency for a given pair of characters to be similarily related in the eggs of the several individuals.

3. Individuals, however, show significantly different degrees of correlation in any pair of characters. The range of the individual variation is wider and the number of individuals which differ significantly from each other is larger for some pairs of characters than for others.

4. Length and breadth are positively but not highly correlated.

5. Both length and breadth are highly positively correlated with weight.

6. Breadth-weight correlation is as a rule higher than length-weight correlation but an individual may show the reverse relation.

7. Index and weight correlation when significant is negative and low.

8. The relation between length and breadth, length and weight, and index and weight is much closer within the eggs of an individual than within the eggs of the strain, but breadth and weight are as closely related within the eggs of the strain as within the eggs of an individual.

9. In eggs of the same weight the two dimensions are negatively correlated but the degree of correlation varies greatly in the different individuals.

10. Either dimension is highly correlated with weight when the other dimension is constant. The correlation between breadth and weight is higher than the correlation between length and weight. The individual variations are less than in the gross correlations or in the correlations between length and breadth in eggs of the same weight.

11. The weight of each of the three parts of the egg (albumen, yolk and shell) is positively correlated with egg weight. The heaviest part, albumen, is invariably very closely correlated. Yolk is also closely correlated but there is a greater individual variation in the value of the coefficients. Shell, the lightest part, is much less closely correlated and the individual differences are much greater than in the case of the two heavier parts.

12. The correlation between either of the two large parts and the whole egg when the other part remains constant is high and shows insignificant individual differences. The albumen-weight correlation is slightly* higher than the yolk-weight correlation.

13. The correlation between albumen and yolk is higher than the correlation between either of these and shell. In general the albumen shell correlation is higher than that for yolk and shell. The range of correlation for any of these pairs of characters, however, varies in different birds from insignificance to high correlation.

14. In eggs of the same weight any two parts are negatively correlated. The yolk-albumen correlation is highly negative and the different individuals show little variation in the value of the coefficient. The yolk-shell and albumen-shell correlations are significantly negative for most individuals but the value of the coefficients for the different individuals varies greatly.

15. Length and breadth are positively correlated with the weight of each part of the egg. When there is a significant difference between the correlation of length and any part and the correlation of breadth and the same part the breadth correlation is higher.† There is, however, a great deal of individual variation in the degree of these relationships.

16. Albumen and yolk correlations with either dimension are higher than the shell correlation. Albumen correlations are significantly higher than yolk correlations for several individuals. The reverse is true in only one case.

17. In eggs of the same weight the correlation of either dimension with any part is often not significant. The different birds show a great deal of variation in these coefficients. The most usual relationship is for breadth to be positively correlated with yolk and negatively correlated with albumen and shell.

An Analysis of the Variation Among the Eggs of the Same Bird.

It has been shown that while the eggs of an individual resemble each other more closely than do eggs forming a

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* This difference may not be significant.

† There are two exceptions to this statement.

random sample from other birds of the same strain, there is nevertheless a high degree of variation among them. This variation is appreciable in every egg character but the several characters show it in decidedly different degrees. The means of the individual coefficients of variation are given in Table 1.

TABLE 1.

Showing the Mean of the Individual Coefficients of Variation for each Egg Character.

Egg Character.	Mean of the Individual Coefficients of Variation.
Shell weight	10.43
Yolk weight	9.84
Albumen weight	6.43
Egg weight	6.36
Length	3.32
Breadth	2.38

The purpose of the present part of the paper is to investigate further this variation among the eggs of the individual.

The data collected in the present investigation offer material for the study of the following phases of this variation in the eggs of the individual. First the variation due to the age or maturity of the bird, second that due to the seasonal distribution of the laying, third that due to the general physiological conditions, i. e., health of the bird, fourth variation due to the tendency of the birds to lay in litters and fifth that related to the tendency to lay in smaller groups or clutches.

1. THE VARIATION RELATED TO THE AGE AND MATURITY OF THE BIRD.

The data used in this study are the measurements taken on all the eggs laid by each of the twelve birds which lived and continued to lay through two years. To illustrate certain points it is possible to supplement this with the data on the eggs of other birds which did not complete their second year.

The progressive change in egg weight associated with the maturity of the bird is shown by the monthly mean egg weight. In the case of each individual the egg weight at the end of the second year is decidedly greater than at the beginning of the first year. From the beginning of laying until the beginning of the first breeding season the eggs increase rapidly in size. From this time on the weight of the egg is subject to quite perceptible seasonal fluctuations which will be discussed later; but with very few exceptions the eggs of the second year are decidedly larger than the eggs of the corresponding months of the first year. That is the eggs of a bird continue to increase in weight with the increased maturity of the bird at least up to the end of the second laying year. After the beginning of the first breeding season the increase in weight is much slower than during the few months which precede.

The weight of the egg is made up of the weight of the three parts albumen, yolk and shell. Each of these parts are also variable in weight. In fact, each is more variable than the weight of the whole egg.

A study of the progressive change in each of these parts can be made in a manner similar to the above study of egg weight.

The monthly mean yolk weights show ever more uniformily than the weight of the whole egg that the weight increases rapidly to the beginning of the first breeding season and from that time on more slowly. The yolk weight shows the seasonal fluctuations shown by the egg weight; but their magnitude is smaller.

The monthly mean albumen weights show a less abrupt rise during the first three months and greater seasonal fluctuations than the monthly mean egg weights or yolk weights. In general, however, they show an increase in albumen weight with an increase in the age of the bird.

The monthly mean shell weights are larger for the second than for the first year but they show a large proportional variation which is usually related to the variation shown by the other parts but may be independent and in the opposite direction. For example during the first three months laying all but one of the birds show a decrease in shell weight which is as decided as the increase in the weight of the other two parts.

In order to generalize the study of the increase in the weight of eggs and of each of its parts as the bird grows older it is desirable to bring together the results of the study on the individual birds.

The birds used in this investigation form a more homogeneous group than is often available for statistical work. They were "pure-bred" in the fancier's sense and line-bred and were within a few weeks of the same age. They had lived under the same environmental conditions since hatching and they began to lay at very nearly the same time. Further there are only slight differences in the degree and direction of variations in the monthly means of the same weight character for the several birds.

The material has been brought together by calculating directly for each weight character the monthly mean of all the eggs laid by the twelve birds.

The means are given in Table 2.

TABLE 2.

Showing for Each Month the Number of Birds Laying, the Number of Eggs Laid and the Mean Egg Weight, Yolk Weight, Albumen Weight and Shell Weight for the Twelve Birds which Completed their Second Year.

Month.	No. birds laying.	No. eggs laid.	Mean egg weight, gms.	Mean yolk weight, gms.	Mean albumen weight, gms.	Mean shell weight, gms.	Mean temperature in degrees, F.
1910							
October	1	3	48.56	13.66	28.13	6.17	48.40
November	12	137	47.48	12.87	29.11	5.46	34.95
December	11	206	48.99	13.39	30.38	5.22	19.55
1911							
January	12	110	50.37	14.24	30.88	4.84	18.15
February	10	100	53.53	16.27	30.94	5.37	14.56
March	12	224	54.25	16.18	32.46	5.63	25.20
April	12	210	54.42	16.43	32.48	5.54	40.90
May	12	192	53.73	16.23	32.12	5.39	59.25
June	12	144	53.66	16.25	32.23	5.13	62.30
July	11	158	52.22	16.31	30.83	4.87	71.20
August	11	170	54.75	16.72	32.53	5.46	66.20
September	11	132	55.44	16.88	33.13	5.41	57.20
October	9	86	56.68	17.61	33.23	5.55	46.10
November	4	15	58.51	17.41	35.57	5.43	34.40
December	4	43	59.20	17.50	35.93	5.77	28.00
1912							
January	5	29	61.30	17.90	37.72	5.67	10.90
February	8	39	54.73	17.85	31.88	5.08	17.70
March	11	179	59.03	18.46	34.71	5.68	27.00
April	12	130	56.12	17.47	33.10	5.08	43.50
May	12	138	55.63	17.71	33.47	5.31	57.10
June	11	148	58.10	18.45	34.30	5.62	63.80
July	12	137	56.97	18.31	33.46	5.32	67.20
August	10	88	57.16	18.16	33.61	5.39	62.50
September	11	123	58.46	18.19	34.69	5.53	57.50
October	9	83	61.64	18.19	37.20	6.23	49.80

From this table it is seen that in the case of the flock, as in the case of individual birds, the yolk weight increases more constantly than the weight of the other two parts or of the whole egg. That is it shows smaller irregular fluctuations.

The flock monthly mean yolk weight increases very rapidly at first. The increase in weight is actually greater during the first four months than during the next twenty months. The yolk weight, however, continues to increase during the second year. This suggests that the increase in yolk weight is following a logarithmic curve of the form $y = A + Bx + C \log x$ where y=yolk weight, x= time, and A, B and C are constants. This type of curve was fitted as a first trial.

The resulting curve is

$$y = 12.6728 - .0261x + 4.5669 \log x.$$

When the ordinates of this curve are calculated and plotted together with the observation curve the smooth curve shows an excellence of fit which indicates that the increase in weight of the egg yolk in these birds is in fact expressed analytically by this logarithmic curve. In other words this shows that *the mean yolk weight increases with each successive month from the beginning of laying at least to the end of the second year but the rate of increase diminishes with the successive months.*

The data on which these calculations were based were taken from the eggs of birds which began to lay at an age of from five and one-half to six and three-fourths months. It is interesting to know the size of the egg yolks at the beginning of laying and the direction and rate of change in yolk weight when a bird is older or younger than this at the time she begins to lay. For this reason three birds that began to lay February 23 were added to the individuals under investigation. These birds were eight and three-fourths to nine months old, i. e., they were from two to three and one-half months older than those pullets just discussed. It is not so easy to investigate pullets which begin to lay younger, as the Barred Plymouth Rocks, at least under the methods of hatching and handling employed at this station, rarely lay before they are five months old. We are indebted to Mr. Walter Gerald of Unity, Maine, for the opportunity to obtain data on the first ten eggs of a pure bred Barred Plymouth Rock pullet which began to lay when she was exactly three months old and before she had moulted her chicken feathers. The eggs of Mr. Gerald's pullet were very small and the yolks were only about one-half the size of the yolks of the five to six months old pullets. Also the yolk weight increased considerably during the fifteen days observations.

The case of this precocious pullet adds evidence to the view suggested by the data from the flock investigated, namely that the egg yolks increase in weight as the bird matures and that this increase is more rapid at early than at later stages of development. There is further evidence of this fact from the data on the birds which began to lay in February. These birds were from eight and three-fourths to nine months old when they began to lay.

The relation of the age of the bird at the beginning of laying to the size of the first yolk is shown by the data given in table 3.

TABLE 3.

Showing the Relation of the Age of the Bird to the Size of the 1st Yolk.

Bird No.	Age at laying 1st egg.	Weight of 1st yolk.	Mean.
Mr. Gerald's pullet,	3	6.21	6.21 (1 bird).
218	$5\frac{1}{2}$	10.19	
516	$5\frac{3}{4}$	10.75	10.945 (4 birds).
478	$5\frac{3}{4}$	9.30	
236	$5\frac{3}{4}$	13.74	
446	6	13.09	
184	6	12.22	
441	6	12.63	
259	$6\frac{1}{4}$	10.68	
212	$6\frac{1}{4}$	11.74	
235	$6\frac{1}{4}$	14.05	
192	$6\frac{1}{4}$	10.51	
204	$6\frac{1}{2}$	12.27	12.236 (13 birds).
198	$6\frac{1}{2}$	11.53	
139	$6\frac{3}{4}$	11.51	
211	$6\frac{3}{4}$	12.28	
205	$6\frac{3}{4}$	13.22	
243	$6\frac{3}{4}$	13.35	
137	7	13.75	
172	$7\frac{1}{4}$	13.27	13.51 (2 birds).
459	$8\frac{3}{4}$	14.19	
489	$8\frac{3}{4}$	17.63	
514	9	15.11	15.643 (3 birds).

Data on the eggs of the birds which began to lay in February show also that in these cases the yolk weight does not begin small and increase very rapidly, as in the case of the birds which begin to lay in the fall. In fact with one exception the yolk weight shows a slight decrease for the first few months.

This is evidently a seasonal decrease as it is shown by several of the birds that began to lay in November. Unfortunately none of these birds laid through the second year but up to within a month of death these birds showed monthly means very similar to the means for others of the flock during the same months.

Another bird (No. 236) laid one egg in November but did not lay again until March 31. She may therefore be considered as a bird without laying experience until she was practically nine and three-fourths months old. The one egg in November however indicates the size of eggs she would have laid at that period.

A comparison of the monthly mean yolk weight for these four birds with those for the other birds of the flock shows that the first eggs laid by birds which do not lay until they are nine months old have yolks as large as the yolks of the eggs laid at the same time by birds of practically the same age which began to lay some months earlier. The rate of change in yolk weight also is similar to that shown during the same time by the birds which had laid younger. The one observation in November for bird No. 236 is also in accord with the observations for the other birds at that time.

It is also interesting to note that the yolk weights shown by any bird at any month are dependent upon the size typical for the individual and upon the time of year. It is apparently independent of whether the bird has been laying during the previous months, or, in fact, of whether or not she has ever laid before. That is *the increase in yolk weight does not seem to be due to a perfection of the morphegenetic activity due to physiological practice but seems rather to be due to the stage of development or differentiation of the individual.*

Since the birds used in this investigation were very nearly the same age it is not possible to separate absolutely the effects of the age of the bird and of the season of the year. Certain undoubted seasonal variations will be discussed later. It seems however that the general tendency for a continued increase in yolk weight at a constantly diminishing rate through all seasonal conditions must be due to the general stage of maturity of the bird. The small but rapidly increasing yolks in the precocious pullet also supports this view. This gradually diminishing increase in yolk weight is represented by a logarithmic curve. This curve which represents analytically the law of the increase in yolk weight with the age of the bird is of the same type as the curves which have been found to fit various kinds of growth data in both animals and plants.

The first interpretation that suggests itself is that this increase in the size of the yolk is a direct effect of the analogous increase in the size of the individual. That the body weight as well as yolk weight normally continues to increase at least to the end of the second year was seen by comparing the body weights at the beginning, middle and end of the observations. However, the curve showing the increase in yolk weight is not parallel to a curve which shows the increase in body weight at the same period. During the period of most rapid increase in yolk weight the increase in body weight was too small to be certainly distinguished from the fluctuations due to temporary variations in the amount of food and waste present in the body. This indicates that *the stage of development or differentiation which determines the size of yolk is not accurately measured by the body weight.* It is of course well known that the different organ systems of the body show different growth stages at the same time and that the reproductive system shows most rapid growth not long before the beginning of its functional activity.

In yolk weight we find a logarithmic approach of successively formed structures to a type. Pearl* ('07) found this true of leaf number per whorl in Ceratophyllum and later ('09)† of egg shape in a domestic fowl. *In the case of yolk weight, however, it is certain that this is not due to the continued production of the like parts but to the condition of the individual at the time the part is produced.*

The change in yolk weight due to the age or maturity of the bird has been discussed at length because the weight of this part of the egg seems to be most closely related to the age of the bird and least affected by the other natural causes of variation in egg size. The weight of albumen and shell also both

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* Pearl, R., Pepper, O. M. and Hagle, F. H. Variation and Differentiation in *Ceratophyllum*, Carnegie Institution Publ. No. 58, pp. 1-136. 1907.

† Pearl, R. Regulations in the Morphogenetic Activity of the Oviduct. Jour. Exp. Zoöl., Vol. VI, 1909, pp. 339-358.

increase with the age of the bird but the fluctuations are much greater than in the case of yolk weight. Since the weight of each of the parts increases with the age of the bird the weight of the egg must show this relation also. In the case of the yolk weight we have seen that the rate of increase is quite precisely logarithmic. The fluctuations from this type are small. Albumen weight shows a tendency to this type of increase but certain fluctuations are very great. The increase in shell weight is not logarithmic. The weight of the whole egg shows an increase in weight distinctly logarithmic although less precisely so than yolk weight.

The different nature of the physiological processes involved in the formation of the parts of the egg affords ample basis for an independent variation. The weight of the yolk is determined by the amount of yolk deposited while it is within the ovarian follicle. The albumen weight depends upon the amount of secretion of the albumen glands of the entire oviduct, while the weight of shell depends only upon the secretions of the shell forming glands of the uterus. It is conceivable that a disturbance of the processes involved in the formation of one part of the egg may have little or no effect on the processes involved in the formation of the other parts. The results given above indicate that the factors which determine the size of the yolk are less disturbed by temporary conditions than are those which determine the amount of albumen and shell secretion.

2. VARIATION RELATED TO THE SEASON OF THE YEAR.

Yolk weight and albumen weight show in general similar seasonal variations. Both parts increase in weight from the beginning of the fall laying to the beginning of the breeding season in February or March. This increase is proportionately greater in albumen weight than in yolk weight. At the beginning of the breeding season the yolk weight increases while the albumen weight either remains constant or decreases. The yolk weight remains nearly constant during the breeding season and the following summer, but the albumen weight tends to fall off especially as the molt is approached. Thus the proportion of yolk in the eggs during the spring and summer is larger than during the fall and early winter.

When the monthly mean shell weight is compared month by month with the monthly mean albumen weight many of the same fluctuations will be noted. There is one decided exception. During the first three months shell weight is decreasing proportionately more rapidly than the albumen weight is increasing. The fluctuations shown at other seasons are proportionately much greater in shell weight than in albumen weight.

The variation in weight which is associated with the change in season is to a certain extent similar in the case of each part of the egg. The parts, however, vary greatly in the proportional magnitude of the seasonal variations. The difference is so great that the proportion of the parts is altered in different seasons. *Yolk weight is apparently least affected by these seasonal factors. Albumen weight shows very large fluctuations which have a decided tendency to repeat themselves in successive years and therefore appear to be undoubted seasonal fluctuations. The fluctuations in shell weight are proportionately greater than in either of the other parts, but do not show the same tendency to repeat themselves in the successive years. It therefore seems possible that some of the large fluctuations in shell weight may be due to some other circumstances than the normal change in season.*

Showing that certain changes in yolk weight and albumen weight are correlated with change in season does not indicate the fundamental cause of these changes. The solution of this problem must be by controlled experiments. Two interpretations suggest themselves. 1. The fluctuations may be due to the direct effect of seasonal changes in environment. 2. They may be due to the general changes in metabolic processes which also find expression in the differentiation of a breeding season and a fall molt, and which are probably due in part to environment and in part to heredity.

In general it seems probable that while the seasonal fluctuations in egg weight may be to some extent the direct effect of environmental conditions, yet to a much greater extent they are the indirect effect of such conditions. That is they are due to general physiological changes in the individual.

3. VARIATION RELATED TO THE STATE OF HEALTH.

One of the birds (No. 441) used in this investigation offers an opportunity to study the effect of the state of health upon the weight of the egg. This bird laid 179 eggs during her pullet year. These eggs increased in size exactly in accordance with the general rule for the flock. Her body weight increased from 2003 gms. in November and December 1910 to 2325 gms. in September, 1911. That is up to the first fall month she was a normal bird. She stopped laying for the molt October 17, 1911, and did not lay again until March 4, 1912. From this time until August 17 she laid quite well for a second year Barred Plymouth Rock, producing 90 eggs in this time. These eggs were smaller than the eggs of the previous year. Nothing abnormal was seen in the appearance of the bird until during the summer when she began to appear somewhat sick. She continued to lay until August 17. After this she became more dumpish. In September it was apparent that she would not recover and lay before the close of the investigation in November. She was therefore, killed and autopsied September 10, 1912.

At autopsy her body weight was 2190 gms., a slight decrease from the weight a year before. The following lesions were recorded: 1. The liver was congested and friable. 2. The lungs were congested and showed yellowish lesions. 3. There was some peritoneal disturbance which had caused a greenish deposit on the intestinal mesentery. That is the bird at autopsy showed evidences of disturbances which were probably of some time standing.

A comparison of the egg data for this bird with the corresponding data for the other birds show that during the first year each egg part increased in weight in the normal manner. The bird was then no doubt in good physical condition. The bird did not lay from October, 1911 to March, 1912. Throughout the second year the weight of each egg part decreased. This decrease was most rapid after the bird was observed to be sick but had been going on for three months before this. Evidently the physiological disturbances had affected the size of the egg before they affected the behavior of the bird.

Five other birds died or were killed during the investigation.

None of these were affected by long standing diseases and none showed a diminution in egg size greater than normal variation.

It is clear that a diseased condition of a bird may cause a decrease in the weight of each part of the egg without causing a cessation of laying. It is also clear that other disturbances sufficient to cause death may not affect the size of the egg produced on the day of death.

Féré* studied the effect of morphine intoxication on the weight of the egg. He found that a stupefying dose caused a diminution in the weight of the egg which was laid on the day of the intoxication and which must have been nearly formed at the time of the injection of the morphine.

The effect of the morphine interrupted the laying for four days and when it was resumed the first two or three eggs were smaller than before the intoxication. This shows that an experimentally altered physiological condition may cause a diminution in the weight of the egg.

It has been shown that, in general, the monthly mean egg weight increases with the age of the bird, fluctuates with the season of the year and is affected by the state of health. The fact now to be considered is that during any month the eggs ot each bird show a very considerable variation in egg weight and in the weight of each of the egg parts.

Before considering the nature of this variation in the weight of the successive eggs it is important to notice the following points in regard to the rate of production of the bird.

1. Periods of production alternate with periods of non-production. That is the bird lays in litters.

2. The length of the periods of production and the number of eggs laid in one litter vary at different seasons of the year.

3. Throughout the warm months (April to September) the period of non-production is typically a period of broodiness. That is the instinct of the bird is to lay a litter of eggs and then incubate them. While thirteen of the birds show this instinct, nine were never broody. It is also interesting that broodiness or non-broodiness is typical of the individual, for

* Féré, M. Ch. Note sur la puissance toxiane et la puissance tératogène de la morphine sur le poulet. Bull. et mém. de la Soc. méd. des hop. de Paris, Vol. 14, séries 3, pp. 608-617, 1897.

when a bird was broody the first year she was also broody the second year and if she was not broody the first year she did not show this instinct the second year. Typically a bird which was broody at all was broody four or five times during a season but the number of times varied from 1 to 7 with the individual. The nine birds which were never broody show all degrees of a tendency to lay in litters from zero in the extreme case of one bird which laid from February to the end of the year at a nearly uniform rate, i. e., in clutches of 1 to 3 usually two eggs separated by one or two days on which no egg was laid, to the opposite extreme of a bird which had exactly the same definite periods of non-production as the birds with typical broody periods but she lacked the instinct to incubate the eggs.

4. Within a litter the laying is broken up into clutches. The eggs of a clutch are laid on successive days. The clutches are separated by one or two (occasionally more) days on which no eggs are produced.

5. The number of eggs in a clutch and the number of days between clutches vary in the different birds in the same season and in the same bird at different seasons. During the part of the year when the bird is not laying in litters succeeded by broody periods the size of the clutches is small. The birds which lay continuously (i. e., do not lay in litters) lay in small clutches throughout the season. During the part of the year when periods of production alternate with periods of broodiness the litters show a decided tendency to start and end with small clutches while the number of eggs in the intermediate clutches is larger. An individual may nevertheless start or end a litter with large clutches.

These facts, in general, accord with the hypothesis of Pearl and Surface.* "The actual visible egg production in each individual bird tends to occur in definite cycles or periods of varying lengths, alternating with non-productive periods."

"The rate of fecundity (amount of egg production per unit of time conceived in the sense of the differential calculus) is in any bird a minimum at the beginning of the cycle of produc-

* Pearl, R. and Surface, F. M. A Biometrical Study of Egg Production in the Domestic Fowl. II. Seasonal Distribution of Egg Production. U. S. Dept. of Agr., Bul. An. Ind. Bul. 110, Pt. II, 1911.

tion, increases to a maximum at what may be termed the height of the cycle, and decreases to a minimum as the end of the cycle is approached."

In order to make a study of the variation in the physical characters of the successive eggs of an individual in relation to the variation in her rate of production, the weight of each egg and of each of its parts was plotted as ordinate and the date of laying as abscissa. Such diagrams were made for each bird. A study of these shows the relation of the weight of the egg and of each egg part to its position within the clutch and litter.

4. RELATION OF THE WEIGHT OF THE EGG TO ITS POSITION IN IN LITTER.

Féré's † statement that, in general, the eggs at either end of the litter are smaller than the intermediate ones but that this relation is not absolute is verified by the observations on the birds used in the present investigation. In fact the weight of the egg in relation to the position within the litter approximates a curve of the type of the hypothetical "rate of fecundity" curve proposed by Pearl and Surface ‡ (1911). It thus seems possible that the same conditions which cause fluctuations in the rate of production may also be responsible for the cyclic fluctuation in the egg weight. It is certain, however, that the weight of the egg is also related to the position of the egg in the clutch and that the position of the egg in the clutch and in the litter may have opposite effects on the size.

5. RELATION OF WEIGHT OF THE EGG TO ITS POSITION IN THE CLUTCH.

When an egg was produced on each day for a number of successive days, as a rule, the eggs decreased in weight from the first egg to the end of the series. The first egg after a day on which no egg was laid was larger than the egg at the end of the preceding series. That is the eggs of the clutch decrease

† Féré, M. Ch. Note sur le poids l'oeuf de poule et sur variation dans les pontes successives. Journal de l'Anatomie et de la Physiologie. T. 34, pp. 123-127, 1898.

‡ Pearl and Surface. *Loc. cit.*

in size from the first egg. The first egg of a new clutch is larger than the last egg of the preceding clutch. There are a few exceptions to this especially where a litter begins with a long clutch.

The fact that in general the eggs laid on successive days decrease in size while after a day or two on which no egg is produced the egg size increases seems to indicate that there is either an exhaustion of material available to elaborate into the various egg parts or that there is a fatigue of the reproductive organs which causes a decrease in the amount of material elaborated. A variation in the supply of available materials or a variation in the physiological tone of the organ would account for the cases of unusual size relations between successive eggs.

It has now been shown that the variation in egg weight is related to the age of the bird, the season of the year, the state of health and the rate of egg production.

The weight of all the eggs and egg parts for the individual birds for two years furnish material to test Pearl's* ('07) "second law of growth" i. e., that the variability of successively produced like parts decreases with the number of such parts produced. If this law was operating during the production of successive eggs the magnitude of the fluctuations in egg weight would decrease with the number of eggs laid. The diagrams described on page 125 show that the fluctuations in egg weight and weight of each of the egg parts are as large at the end of the second as at the beginning of the first year. It is evident then that this law does not hold for the variation in weight of successive eggs. Pearl † ('09) found no evidence that this law was acting in regard to the shape of the eggs of a fowl on which he studied regulation in shape.

This section of the paper has shown that *the weight of any part of a bird's egg depends, first upon the hereditary constitution of the bird, second her physical constitution or state of health, third, her stage of development, fourth, the season of the year, and fifth, the position of the egg in its clutch and*

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* Pearl, R. *Loc. cit.*

† Pearl, R. *Loc. cit.*

litter. It has also shown that *the variation in successive eggs is as great at the end of the second as at the beginning of the first year's laying.*

Discussion of Results.

Only a beginning of the analysis of the factors which produce variation in the eggs of the domestic fowl is possible from the results of this investigation.

Since the individual variation in egg characters is less than race variation, and since the association of various pairs of egg characters is greater within the egg of an individual than within the eggs of the race, it is concluded that an individual inherits or, at least, possesses at sexual maturity, the tendency to lay eggs of a certain particular and individual shape, size and physical constitution.

The seasonal and cyclic fluctuations in the eggs of the individual on the other hand show that this predisposition toward eggs of a particular type and size may be influenced by physiological and possibly also environmental conditions.

That the individuality in egg characters is related to individuality in other characters seems certain. The fact that the large varieties of hens lay larger eggs than bantams indicates that within broad limits the size of the egg is related to body size. The insignificance of the correlation coefficient between egg size and body size for the egg of the individuals studied however shows that this relation does not necessarily obtain within narrow limits. It is not possible to decide the limits of the relation of body size to egg size from so small a number of individuals. The point is open to further investigation.

In the study of egg characters it must be kept in mind that eggs are quite different material than is usually employed in biological studies of variation. They are not organs or parts of organs that owe their size and shape to growth, i. e., the proliferation of the cells of which they are made up. Each egg is one modified cell and represents the accumulated results of the activity of a great many cells, not a part of it. The different parts of the egg arise from different organs or parts of organs (the ovary and the parts of the oviduct) and by quite distinct physiological processes (yolk deposition and albumen, membrane, and shell secretion.)

The egg then represents not a normal organic part of the individual but a discrete unit of production of certain correlated organs. The size and form of such units are to a certain extent dependent upon the size and form of these organs. But the size, form and frequency are necessarily also dependent upon the physiological tone of the organs and of the entire organism.

It is not strange that the same individual at different seasons and different individuals throughout the year may show variations in egg size and in the number of eggs produced which are out of proportion to the variation in body size. It is quite possible that egg production like milk production * is related to the amount of food consumed above maintenance. That is the bird which lays large eggs and many of them is one which in addition to the organic potentiality to lay eggs of this size possesses also both the physiological capabilities of digesting a large amount of food above the amount required for the maintenance of the body and of using this absorbed food for the production of yolk, albumen, etc. The fact that the same individual lays larger eggs and more of them at certain seasons than at others may be due to the fact that she is capable of digesting and utilizing for egg production more food at those seasons. It has in fact been shown by Rice ** that the number of eggs produced by a flock is positively correlated with the amount of food consumed, and the fluctuations which he found characteristic for the amount of food consumed are very similar to the seasonal fluctuation in egg weight. The work of Riddle † on yolk formation also supports this view.

In general the conditions which favor the production of a large number of eggs also favor the production of large eggs (i. e., large for the particular individual). Yet there are

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* Eckles, C. H., and Reed, O. E. A Study of the Cause of Wide Variation in Milk Production in Dairy Cows. Mo. Agr. Expt. Sta. Research Bul. No. 2, 1910, pp. 107-147.

** Rice, J. E. The Moulting of Fowls. Cornell Univ. Exp. Sta. Bul. 258, 1908, pp. 21-68.

† Riddle, Oscar. On the Formation Significance and Chemistry of White and Yellow Yolk of Ova. Journal of Morphology, Vol. 22, 1911, pp. 456-484.

limits to this relationship. When a number of eggs are produced in succession each successive egg is smaller than its predecessor. There is probably either an overdemand on the amount of available material or there is a fatigue of the reproductive apparatus which hinders the formation of the egg parts.

A study of the interrelation of the different parts of the egg is a study of the correlation of the activities of the different organs and parts of organs by which they are formed. The fact that the oviduct of a bird approaching a period of laying enlarges as the yolks enlarge has been long recognized. The observations on the domestic fowl at this laboratory agree in general with those of Bartelmez * on pigeons. There are nevertheless some specific differences between fowls and pigeons. In a bird in the non-laying condition the oviduct is a small straight tube and there are no oocytes in the ovary which contain a perceptible amount of yolk. About the time a group of oocytes enters upon the final growth period (when they begin to enlarge above 6 mm.) the oviduct begins to enlarge. The stimulus which initiates these activities in fowls is not known. There is no evidence that it is connected with mating as has been shown for the pigeon.† The presence of the male is certainly not necessary and no behavior on the part of a fowl has been observed to indicate that she is physically mated with another female or with anything else. Whatever the stimulus that starts the reproductive mechanism going, it is true that while the first yolk is forming the oviduct enlarges to functional size.

This correlation between the ovary and oviduct is now commonly attributed to the action of the internal secretion of the ovary. Bartelmez ‡ states that "interstitial cells of the ovary show much greater signs of activity in functioning ovaries than do those in ovaries of birds that had not laid for a long time." That the enlargement of the oviduct is due to the in-

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* Bartelmez, George W. The Bilaterality of the Pigeon's Egg. Jour. of Morph., Vol. 23, 1912, pp. 270-310.

† Harper, E. H. The Fertilization and Early Development of the Pigeon's Egg. Am Jour. Anat., Vol. 3, 1904, pp. 344-381.

Craig, W. Oviposition Induced by the Male in Pigeons. Jour. of Morph., Vol. 22, 1911, pp. 299-305.

‡ Bartelmez, G. W. *Loc. cit.*

ternal secretion of the ovary has not been completely demonstrated by any means. Certain observations made in connection with other researches make the conclusion somewhat doubtful. They certainly show that enlargement of the oviduct is not necessarily connected with yolk formation although this is the normal relation.

The observations referred to are:

1. The oviduct of the hermaphrodite fowl described by Pearl and Curtis * was at autopsy in essentially the same condition as that of a normal fowl that had recently completed or was soon to begin an egg laying period. Yet this bird had never laid and the histological examination of the ovary failed to demonstrate the presence of oocytes in any stage of development. The ovary of this bird was about the size of a functioning ovary after the large yolks have been removed. It was composed of a highly cellular stroma like tissue penetrated from the stalk by a very vascular connective tissue and covered externally by a layer of peritoneum. The presence of interstitial cells could not be demonstrated, but this may have been due to poor fixation.†

2. In the routine autopsy work in this laboratory there has been noted several cases of birds which had not laid for a long time and which had no oocytes with any yolk but which possessed nearly functional sized oviducts. There were in these cases ovarian tumors which seemed here to be associated with the enlarged oviducts. None of these ovaries were examined for interstitial cells which may or may not have been present.

That the mere increase in weight of the ovary may stimulate the enlargement of the oviduct is not altogether impossible. These pathological ovaries may however have furnished the normal internal secretion in quantities sufficient to cause the enlargement of the oviduct. It is nevertheless certain that whatever the stimulus may be it is not absolutely dependent

* Pearl, R., and Curtis, M. R. Studies in the Physiology of Reproduction of the Domestic Fowl. A Case of Incomplete Hermaphroditism. Biol. Bul., Vol. XVII, pp. 271-286, 1909.

† The whole reproductive apparatus and the dorsal part of the body was preserved in formalin and dissected for anatomical study. The histological sections of this formalin tissue showed rather poor fixation.

upon the deposition of yolk. The teleological view that the oviduct enlarges in order to be ready to lay the first egg is not tenable. Normally the oviduct enlarges while the yolks enlarge and reaches functional efficiency by the time the first yolk is mature.

The stimuli which initiate the peristaltic action of the oviduct and attract the funnel to the mature folicle are among the unsolved problems of physiology. The yolk is already oriented in the follicle before the funnel encloses it. In pigeons * both chalazal and polar axes are determined in the primordial follicle; the first by the long axis of the oocyte and the second by the eccentric germinal vesicle. The polar orientation of the egg in the follicle is due to the action of gravity after the yolk becomes movable in the follicle (at the time of the formation of the zona radiata). The vegetative pole is heavier than the animal pole, hence the animal pole comes to lie beneath the stalk of the follicle.

Due to the pressure of the inclosing funnel and to increased internal pressure, the yolk ruptures the follicle and becomes free in the duct. At this time the secreting activity of the duct begins. Again the precise nature of the stimulus is not certainly known. It is normally connected with the presence of the yolk; but albumen secretion followed by normal membrane and shell formation have been induced in functioning oviducts by the insertion of artificial yolks. Results of this kind are reported by Weidenfeld † and Tarchanoff.‡ Unpublished investigations at this laboratory have also shown that an egg may be formed around an artificial yolk or the artificial yolk may be fastened in the upper part of the oviduct and an egg may be formed which contains chalazae, both kinds of albumen, normal membrane and shell. This last result as well as the not infrequent occurrence of small yolkless eggs which contain all the other normal egg parts show that the secretory process may

* Bartelmez, G. W. *Loc. cit.*

† Weidenfeld. Verh. der Ornithol. Gesellschaft, Bayern, 1905, p. 112.

‡ Tarchanoff, J. R. Ueber die Verschiedenheiten des Eiereiweisses bei befierdert geborenen (Nestfluchter) und bei nackt geborenen (Nesthocker) Vogeln und über die Verhaltnisse zwischen dem Dotter und dem Eiereiweiss. Pflüger Archiv für Physiologie, Vol. 33, 1884.

be started off by some adequate stimulus (probably in the case of the yolkless eggs by the presence of a yolk in the oviduct which is later expelled into the body cavity) and may then continue to completion without the presence of the yolk. These results with artificial yolks indicate that the stimulus may be mechanical but the experiments of Tarchanoff § and unpublished work done in this laboratory also show that an egg is not always formed around an artificial yolk introduced into an oviduct which is in functional condition. Until the other conditions necessary for the formation of eggs with artificial yolks are determined it cannot be certainly said that the only stimulus necessary is mechanical.

That the amount of albumen secretion of the oviduct is related to the degree of the stimulation by the yolk is shown by the significant correlation between the weight of the yolk and the weight of the albumen. Since the secretion of the duct does not begin until the yolk has completed its growth and severed its connection with its follicle this seems to be the only possible explanation of the correlation. To this evidence that the degree of stimulation influences the amount of secretion may be added that from abnormal eggs which contain unusual large or small quantities of yolk. On the one hand are the double and triple yolked eggs and on the other the "cock-eggs" or "witch-eggs" which contain little or no yolk. Pearl* ('10) showed that "the relation of the observed size of the entire egg (measured here by the weight) to the number of yolks is very accurately described by a parabola." He pointed out that this indicated that the amount of albumen secreted was related to the amount of the immediate mechanical stimulation due to the quantity of yolk present in the oviduct.

The formation of the egg membrane is a discrete process. As an egg passes from the albumen portion into the isthmus as much of it as is within the isthmus is covered with mem-

§ Tarchanoff, J. R. *Loc. cit.*

* Pearl, R. A Triple Yolked Egg. Zoölogischer Anzeiger, Bd. XXXV, pp. 418-423, 1910.

† Coste, M. Histoire du dévelopment des corps organéses. Paris, 1874.

brane.† The membrane becomes thicker during the passage through the isthmus ‡ probably by the addition of successive layers of secretion.

When the egg enters the uterus it is enclosed in a firm tough membrane and is often if not always already shaped. It contains the yolk with chalazae and 60 to 70 percent of its albumen.§

Within the uterus the egg receives the rest of its albumen (by osmosis) and its shell. The nature of the stimulus which sets up the shell secreting activity was investigated by Pearl and Surface.* The conclusions from their preliminary experiments were that the nature of the immediate stimulus which sets the shell secreting activity going in an oviduct in active functional condition is mechanical, and that shell formation is a local reflex not immediately dependent upon a specific activity of other portions of the reproductive apparatus.

That the weight of the shell is significantly correlated with the weight of each of the other parts indicates that the amount of secretion is influenced by the degree of stimulation. The larger the egg the greater the mechanical stimulation and hence the heavier the shell. The higher correlation between albumen and shell than between yolk and shell is probably due almost entirely to the fact that the albumen is heavier than the yolk. It may be partly due to the fact that 30 to 40 percent of the albumen is secreted in the uterus and that the periods of the albumen secretion and shell secretion overlap although the former is evidently complete before the latter has advanced very far.†

Abnormally thin shelled eggs are as likely to be large as small and no doubt represent either a premature expulsion of the egg or an early arrest of the shell secreting activity.

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‡ Pearl and Curtis. Studies in the Physiology of Reproduction of the Domestic Fowl. V. Data Regarding the Physiology of the Oviduct. Jour. Exp. Zoöl., Vol. 12, 1912, pp. 99-124.

Membranes on eggs just completely past the cranial end of the isthmus weigh .24 to .28 grams. Those at the caudal end .53 to .58 grams.

§ Pearl and Curtis. *Loc. cit.*

* Pearl, R. and Surface, F. M. Science, N. S.. Vol. XXIX, pp. 428-429, 1909.

† Pearl and Curtis. *Loc cit.*

The shape of the egg is almost certainly due to the interaction of the two layers of muscle fibers in the oviduct walls.‡ The inner layers of fibers is circular, that is they pass around the duct. The outer layer is longitudinal and somewhat spiral and extends into both the dorsal and ventral ligaments. Further work on the physiology of these muscles is necessary to determine the exact way in which they act. From their position and from observed activities of the duct it seems that the contraction of the circular fibers contract the duct and move the egg forward. The contraction of the longitudinal fibers, which have a somewhat spiral course, expand the duct, diminishing the resistance to the passage and also give the egg the spiral motion. If the resistance is slight, i. e., if the contractions are so timed that the duct ahead of the egg is expanded at the time of the contraction of the circular fibers behind, the egg will be long, narrow and pointed. On the other hand, if the resistance is great the egg will be short and broad.

The individuality of the eggs of a bird in respect to shape must be due to an individuality in the coördination of these two sets of muscle fibers and similarily the variation must be due to a variation under different conditions in the degree of coördination.

Breadth is more closely correlated with weight of the whole egg or with the weight of any of the parts than is length. This may be explained by the assumption that the larger the egg (beginning with the yolk) the greater the resistance to its passage and hence the broader it will be in proportion to the actual weight. This may be simply the mechanical effect of a larger body passing through the elastic tube or it may be due to an unequal increase in the effective stimulation of the two sets of muscle fibers.

General Summary.

This paper is an analysis of the normal variations in the size, shape, and physical constitution of the eggs of the domestic

‡ Curtis, M. R. The Ligaments of the Oviduct of the Domestic Fowl. Ann. Rept. Me. Agr. Expt. Sta., 1910, pp. 1-20.

Surface, F. M. The Histology of the Oviduct of the Domestic Hen. Ann. Rept. Me. Agr. Expt. Sta., 1912, pp. 395-430.

fowl. The data on which it is based are the measurements of all of the eggs laid by twenty-two Barred Plymouth Rock birds. For thirteen of these birds records were taken on every egg laid up to the end of the second laying year. For the remainder records were taken covering the eggs of the first laying year. The thirteen birds which were alive at the beginning of their second adult molt were killed at that time. The more important results of the investigation may be summarized as follows:

I. *The Individuality of the Eggs of the Same Bird.*

1. The individuality of a bird is expressed in each physical character of her eggs.

2. This individuality is more pronounced in respect to the size than the shape of eggs and also in respect to the weight of albumen and shell than weight of yolk.

3. There is a tendency for the several egg characters to be related to each other in such a way that when the eggs of an individual are large they are both long and broad and each of the parts is large; but the hens which lay large eggs lay eggs with a smaller proportion of yolk than hens which lay small eggs. Also individuals may show a decided tendency to vary from the flock type in quite different degrees in different characters.

4. The eggs of an individual tend to be either uniform or variable in all the egg characters but certain individuals may be variable in certain egg characters and uniform in others.

5. An individual is in general less variable than the race in respect to egg characters; but certain individuals may show a variation in an egg character which is relatively as great as the variation in the race. Also certain egg characters (particularly yolk weight) show a decided tendency to approach the race variation in several individuals.

6. The factors which bring about the individuality in respect to egg characters are too complex for analysis from the data at hand.

II. *Correlation of Egg Characters.*

1. Each egg character is related to every other egg character, but different pairs of characters show a decidedly differ-

ent degree of correlation. There is a general tendency for a given pair of characters to be similarly related in the eggs of the several individuals, but different individuals may show significantly different degrees of correlation in any pair of characters.

2. Length and breadth are significantly but not highly correlated. Both length and breadth are significantly correlated with the weight of the whole egg and of each of the egg parts. Breadth is as a rule more highly correlated with these weight characters than is length. The shape of the egg as measured by the length-breadth index is negatively correlated with the weight of the egg and with the weight of each of the egg parts.

3. The weight of each part of the egg is positively correlated with the weight of both the other parts.

III. *Intra-individual Variation.*

1. The variation among the eggs of the same bird is shown to be related to certain other changes in the bird.

2. The egg weight and the weight of the egg parts, especially the weight of the yolk, increases as the bird matures. The rate of this gain in weight decreases with the successive months.

3. Each part of the egg shows a seasonal fluctuation in weight which is apparently related to the general seasonal fluctuation in the physiological activities of the bird, expressed also in the curves for food consumption and egg production.

4. The state of health also may affect the size of the egg.

5. The size of the egg is related to the rate of production as it expresses itself in the laying of litters. As a rule the first and last eggs of a litter are smaller than the intermediate ones.

6. When eggs are produced on successive days they tend to decrease in weight while the egg laid on a day after one on which no egg is produced is larger than the last egg of the preceding series.

BULLETIN 229.

STUDIES ON OAT BREEDING.

I. VARIETY TESTS, 1910-1913.[1]

BY

FRANK M. SURFACE AND CLARENCE W. BARBER.

Owing to the shortness of the growing season as well as to other factors, it is not possible for Maine to compete, on a large scale at least, with more southern states in the production of certain crops. For example the growing of field corn on a moderate scale and for home consumption is a very profitable venture for the Maine farmer, yet owing to the small and early varieties which it is necessary to grow he cannot hope to compete with the corn belt of the middle west in the growing of field corn as a "money" crop. On the other hand, there are certain crops to which the climate of Maine is particularly well adapted. Under our conditions of climate and soil, potatoes, sweet corn and apples acquire particular characters of texture and flavor which have made the trade mark "Maine grown" a guarantee of their ready sale at prices well above the general market.

A consideration of the climatic conditions of Maine indicate that of the cereal crops, oats is the one most suitable for this state. The statistics of oat production show that they do best in a northern climate. Oats require cool weather and an abundance of moisture to do their best. They do well on soil that is not too fertile so that fields which are often unprofitable in corn will do well in oats.

[1]Papers from the Biological Laboratory of Maine Agricultural Experiment Station, No. 67.

The statistics collected by the United States Department of Agriculture show that at the present time oats is one of the most important crops in Maine. According to the current estimate of the Department of Agriculture[2] the value of the 1913 oat crop in Maine was on December 1, $3,080,000. Only two crops, namely, hay and potatoes, exceed oats in the total amount of wealth produced within the state. Further, the average yield per acre of 40 bushels is some ten bushels above the average for the country as a whole. These figures serve to indicate that the crop is well adapted to our conditions.

The ease with which the oat crop can be seeded, its resistence to late frosts, its adaptability to our climate and soil conditions and the high price which the grain brings in the eastern market, recommend it as a profitable crop. More attention to cultural methods and to seed selection are certain to bring greatly increased returns with this crop. Many of the poor yields of oats are due to poor seed.

The acquisition of Highmoor Farm in the summer of 1909 made it possible for the Maine Agricultural Experiment Station to undertake more extensive experiments in plant breeding. For the reasons given above and on account of the importance of the crop to this state, it was proposed to undertake some breeding or seed improvement work with oats.

Three general lines of work have been undertaken with oats. The scope and purpose of these are indicated in the following paragraphs.

1. *Variety tests.* In starting the work with oats the logical thing to do first was to test a considerable number of the existing varieties of oats which have yielded well in other localities. In order to be of any great value such tests must be continued for a number of years. In this way it is hoped to find out which of these existing varieties are most suitable for Maine conditions. In addition to these more immediate results the variety tests furnish material for definite breeding work with this crop as outlined below. Further the continuation of these tests from year to year establishes a standard with which the production of any new strains originated in our breeding work can be compared.

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[2]The Agricultural Outlook, U. S. Dept. of Agr., Farmers' Bulletin No. 570, Dec. 27, 1913.

2. *Pure line selections.* The second and third lines of work have to do with the production of new strains or varieties which will yield better under our conditions. In the pure line selections, individual plants are first selected from the general plots. The following year the grain from each plant is planted in a separate row and each row harvested separately. The next year the grain from the most promising rows is planted in small plots and in the third year this grain, all of which originated from a single plant, is planted in a larger plot and tested under field conditions. In this way it is hoped to obtain some strains which will do better, under our conditions, than any of the existing varieties.

3. *Hybridization.* The third line of work includes the crossing of varieties or strains, each of which are superior in some characters, and then to isolate from the progeny new varieties combining the desirable qualities of both parents.

Aside from the more immediate practical objects in view, as noted above, this work is planned so as to furnish scientific data on general questions of heredity.

The work with oats was begun in the season of 1910. A considerable amount of data on these several lines of work are already in hand. It is expected that the present bulletin, which deals with the results of the variety tests for the past four years, will serve as an introduction to a series of papers dealing with problems of breeding and inheritance in oats. In this paper we shall describe (1) the cultural and experimental methods used in these variety tests, (2) the seed used and the source from which it was obtained, and (3) some of the results of these four years tests.

METHODS.

SIZE AND LOCATION OF PLOTS.

For the years 1910, 1911 and 1912 the variety tests were carried out in one-tenth acre plots, usually allowing only one plot to each variety. In the season of 1913 a different method was adopted. On the basis of a series of careful experiments at the Rothamstead Experiment Station in England, Mercer and Hall[3]

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[3]Mercer, W. B. and Hall, A. D. The Experimental Error of Field Trials. Jour. of Agr. Science, Vol. IV, Pt. II, pp. 107-132, 1911.

have shown that much more accurate results will be obtained, as to the comparative yield of varieties, if each variety is planted in several small plots located in different parts of the field than if a single large plot is used. The reason is that unless the soil is very uniform one of the large plots may lie in very favorable soil, while another plot may lie in very poor soil. Such differences in soil may more than outweigh any intrinsic differences in the two varieties. On the other hand, if several small plots of the same variety are placed in different parts of the field there is much less chance of all of them falling in very good or very poor soil. Consequently an average of the yield of several small plots will give a better idea of the inherent yielding capacity of the variety.

Accordingly in 1913 each variety was planted in four one-fortieth acre plots. Thus in all there was a tenth acre of each variety grown but instead of being in a single plot it was in four plots placed in widely separated parts of the field. The results with this method have been very satisfactory for the past season and it is proposed to use this method in future variety tests.

The adoption of this method of planting has involved the use of different methods of seeding and harvesting. These will be discussed at the proper places in the following pages.

Figure 53 shows a map of Highmoor Farm on which the location of the oat variety test plots for the years 1910, 1911, 1912 and 1913 are indicated. It will be noted that in general these oat varieties have not been planted on the same piece of land in successive years. In 1912 that portion of the field east of the buildings marked A_1 had been in the 1911 variety test. In all other cases the land had not been in oats the preceding year.

CHARACTER OF THE SOIL.

The soil of Highmoor Farm varies from a light sandy loam to a medium clay loam. The natural drainage of this land is very good excepting in a few places where the hard-pan subsoil forms pocket-like depressions. With the exception of the 1913 plots the fields on which the oat tests have been carried out are, in the main, a medium loam. The 1913 field is a rather sandy loam and very well drained. In the several years it has not always been possible to avoid the few wet places in the

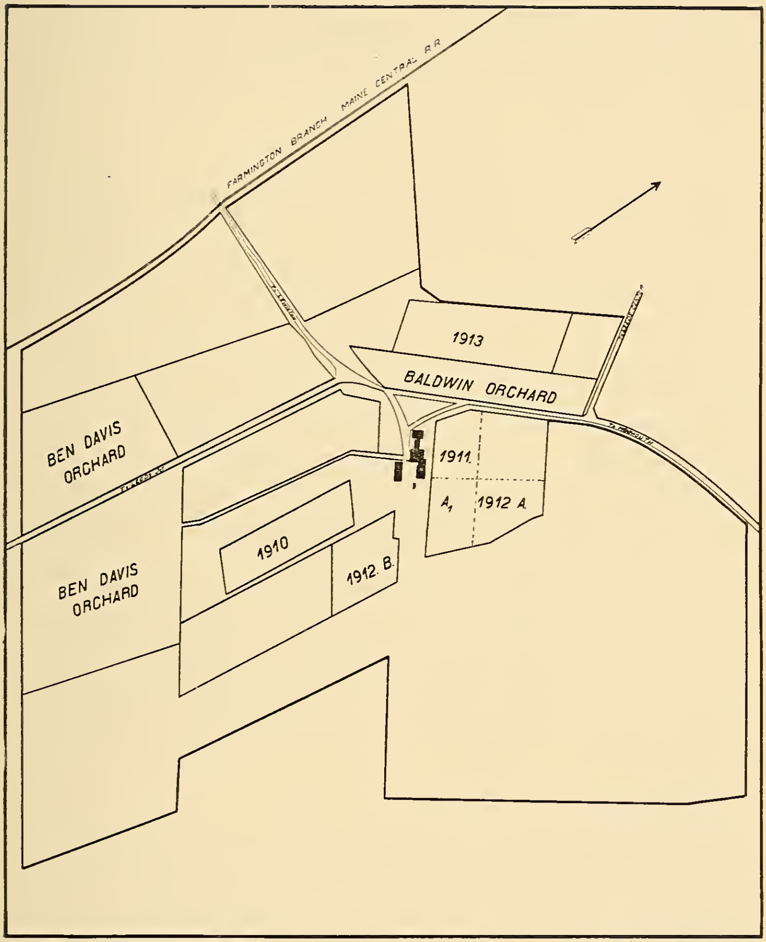


Fig 53. Outline map of Highmoor Farm showing the location of the oat variety test plots in the years 1910 to 1913 inclusive.

fields. Further in certain fields there have been ledges coming near the surface of the soil and these have interfered with the yield of certain plots. However, these influences, which have been comparatively slight, have not affected the same variety more than one year. Consequently the average of the four year tests should give a fairly accurate measure of the capacity of a variety to yield under the conditions at Highmoor.

PREPARATION OF THE LAND.

In the following paragraphs the methods of preparing the land and the amount of fertilizer used are given for each year.

The varieties tested in 1910 were sown on land that had been plowed the previous summer and kept clean by working over about once a week with cutaway and springtooth harrows. Before the farm was placed under the management of the Station this land had laid in sod for many years becoming quite densely infested with witch grass. The summer fallow and clean cultivation resulted in freeing the field from this weed. Immediately before planting the soil was disked with a double action cutaway harrow, going lengthwise and then crosswise of the field. Following this, spiketooth harrows were used to smooth and level the ground in preparation for the seed. At the time of plowing 5½ cords of manure were put on each acre and at the time of seeding 900 lbs. of a fertilizer containing 3.3 percent of nitrogen, 10 percent of available phosphoric acid and 7 percent potash were applied to the 31 tenth-acre plots in the variety tests of this year. The location of these plots is shown in Fig. 53.

In 1911 the variety tests of oats were carried out on land which produced potatoes in the season of 1910. This land was plowed in the fall of 1910 and at that time eight cords of manure were added. This was thoroughly disked in. In the spring of 1911 the ground was again disked by means of cutaway harrows, the harrowing being done crosswise and lengthwise of the field. To smooth and level the field, spiketooth harrows were used. At the time of seeding fertilizer analyzing 4 per cent of nitrogen, 8 percent of phosphoric acid, and 7 percent of potash was applied at the rate of 500 lbs. per acre. As in the year 1910, seed and fertilizer were sown by means of a grain drill.

In 1912 each variety of oats was planted in duplicate. One one-tenth acre plot was sown in field A in the north half of the farm and its duplicate in field B in the south half. (cf. Fig. 53). Field B being better drained was ready for seeding before field A. Field B produced potatoes in 1911 and in preparation for the oat variety tests was plowed in the fall of that year. Before planting this field was thoroughly harrowed twice, once lengthwise and once crosswise, with cutaway harrows. Then smoothing and leveling of the land was accomplished by using spiketooth harrows. The soil is a medium loam, one which works up in excellent shape becoming mellow and finely pulverized. Such preparation makes a splendid seed bed. With the exception of one small area this field is naturally well drained, having a good slope so that no water stands on the surface.

Field A is not so quickly drained as field B and as a result could not be harrowed and seeded until nearly three weeks later. This field comprises practically the same soil conditions as field B. This field was harrowed three times with springtooth harrows finally smoothed and leveled with spiketooth harrows. Owing to the frequent heavy rains and lateness of the season for seeding oats the soil could not be worked into the most mellow and desirable condition for a seed bed.

Each of these fields was fertilized at the rate of 500 lbs. per acre of a high grade fertilizer containing 4 percent nitrogen, 8 percent phosphoric acid and 7 percent potash. In past seasons the fertilizer had been applied in the drill at the time of seeding. This year the fertilizer was broadcasted and harrowed in before planting.

In 1913 the variety test plots were located in the light sandy field to the north of the Baldwin orchard (cf. Fig. 53). This field slopes rather sharply towards the northwest. In 1910 this field was planted in oats without fertilizer of any kind in order to test the uniformity of the soil. In 1911 a crop of buckwheat was turned under for green manure. In 1912 this field was in potatoes. The field was plowed in the fall of 1912. In the spring of 1913 the ground was harrowed several times with springtooth harrows. Owing to the light soil this was sufficient to produce a good seed bed. Just before seeding the field was fertilized at the rate of 650 lbs. per acre of a 4-8-7 fertilizer.

the same as used on the oat plots in the two preceding seasons. The fertilizer was broadcasted and harrowed in before seeding as in the previous year.

TREATMENT OF THE SEED.

Each year all the grain raised at Highmoor is recleaned and graded before it is sown or offered for sale. The cleaning is done with an ordinary fanning mill. This removes all the light, unfilled or immature grains. This practice is undoubtedly of great value and if it were followed by the farmers of the state it would result in better stands and better grain.

Just before sowing the oats are treated with a formalin solution to kill the loose smut spores which may be clinging to the grain. In this treatment a bag containing the oats is immersed for twenty minutes in a solution containing one pint of commercial formalin (40 percent) to 50 gallons of water. The oats are then spread out to dry so that they may be sown in the drill. This method has proved very successful. There have been practically no smutted heads in any of our plots.

SHAPE OF PLOTS AND METHODS OF SEEDING.

The shape of the one-tenth acre plots varied in different years according to the fields upon which they were planted. In general the length of these plots was always several (5 to 12) times its width. On the other hand the one-fortieth acre plots were all in the form of a square, each side of which was 33 feet long. It has been the practice in most variety tests in this country to use long narrow plots. If, as is usually the case, cultivated pathways are allowed between these plots the plants on the margin grow much more vigorously than those in the interior. In the case of small plots the total yield may be very greatly affected by the proportionate number of these marginal plants. It has recently been shown by one of us[4] that the marginal area is reduced to a minimum in plots in the form of a square. In such plots there is much less chance for the yield to be affected

[4]Barber, C. W. Note on the Influence of Shape and Size of Plots in Tests of Varieties of Grain. Ann. Rept. Maine Agr. Expt. Stat. 1914, pp. 76-84. (Bulletin No. 226).

by the more vigorous growing marginal plants than in the case of long and narrow plots. A plot in the form of a square more nearly approaches the conditions found in a general field than a plot of equal size in any other shape.

All of the grain sown at Highmoor in plots of 1-10 acre or larger is planted in drills seven inches apart by means of a large disk grain drill. This machine drops the seed under forced feed. Eleven rows are planted at a time. This method of seeding insures that the grain is covered at an even depth and gives a much more even stand than does the usual method of broadcasting.

In the case of fortieth acre plots in the form of a square it is obviously impossible to use a large drill. In these plots the ground is first thoroughly prepared and then marked off in rows six inches apart. The grain is then planted with a small hand drill which plants one row at a time. Three of these drills were used in planting the 1913 plots.

The rate of seeding has been uniformly two bushels per acre for each variety in each year. However, in 1910 the rate was two bushels by measure, while in 1911, 1912, and 1913 it was two bushels by weight. For many varieties characterized by large grains two bushels per acre does not give a sufficient stand. The basis for seeding oats should take into account the number of grains per bushel. However, the four year test of these varieties with uniform rate of seeding gives us a kind of data that could not be obtained by other methods.

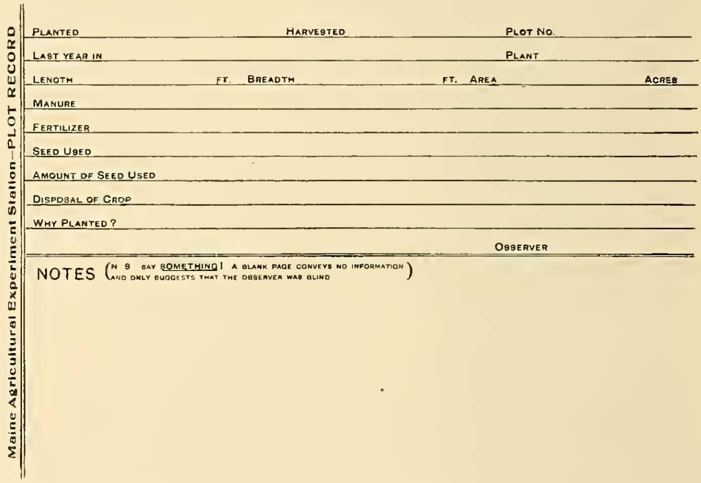
HARVESTING AND THRESHING.

The general practice in harvesting has been to allow the grain to mature as much as possible without shattering. This means that the plants will have lost practically all the green color and the grain will be fairly hard. In the case of the larger plots it is then cut with a binder, shocked and allowed to dry. On the fortieth acre plots it is necessary to cut the grain with a cradle and bind it by hand. When completely cured each plot is hauled to the scales and threshing machine. In order to facilitate handling the grain from the fortieth acre plots, large canvasses 12 x 12 feet were used to wrap around all the grain from a single plot. In this way a number of small plots could be hauled at once without danger of mixing the grain.

The threshing machine used is the so-called Baby Vibrator, made by the A. B. Farquhar Company. This machine has a 12 inch cylinder. In threshing a series of small plots containing different varieties it is necessary to see that the machine is thoroughly cleaned after each plot. If this is not done the varieties very soon become badly mixed. In order to facilitate cleaning it has been necessary to remodel this machine in several respects so that now it is possible to open up all parts of the machine and remove any lodged grain after threshing each plot.

RECORDS.

An important element in this kind of experimental work is the keeping of accurate notes about each variety. To facilitate this work we have devised a system of printed loose leaf blanks.


Maine Agricultural Experiment Station—PLOT RECORD

PLANTED ____ HARVESTED ____ PLOT NO. ____

LAST YEAR IN ____ PLANT ____

LENGTH ____ FT. BREADTH ____ FT. AREA ____ ACRES

MANURE ____

FERTILIZER ____

SEED USED ____

AMOUNT OF SEED USED ____

DISPOSAL OF CROP ____

WHY PLANTED? ____

OBSERVER ____

NOTES (N. B. SAY SOMETHING! A BLANK PAGE CONVEYS NO INFORMATION AND ONLY SUGGESTS THAT THE OBSERVER WAS BLIND)

Fig. 54. Facsimile of Plot Record sheet used in the oat variety tests.

Figure 54 shows a facsimile of the Plot Record blank. This blank, which may be used for any crop, provides for the size of plot, fertilization, seed used and for general notes about the plot.

Figure 55 shows a facsimile of the blank on which data regarding the straw, leaves, heads, grain, yield, disease resistance, etc., are recorded.

Maine Agr. Expt. Stat. - Oat Breeding and Plot Records.

Seed Year Plot No. Row No.

STAND		STRAW		HEADS		YIELD	
Full		Height		Symmetrical		Total weight	
% of full		Weak		Spreading		Grain "	
Even		Medium str.		Close		Straw "	
Uneven		Stiff		Side		Bu. (32 lb.) per A	
MATURITY		LEAVES		Branches stiff		Bu. (Act.) per A	
Early		Broad		" drooping		Lbs. per bu.	
Medium		Medium		" short		Seeds in gm.	
Late		Narrow		" long		GRAIN	
Matured well		Color dark		Large		White	
" fairly		" medium		Small		Yellow	
" poorly		" light		Long		Brown	
STOOLING		DISEASE		Short		Black	
Heavy		Smut: Much		% Spikelets filled		Mixed	
Medium		" Little		% " Barren		Good	
Light		Rust: Much		Pins enclosed		Fair	
General score		" : Little		" free		Poor	

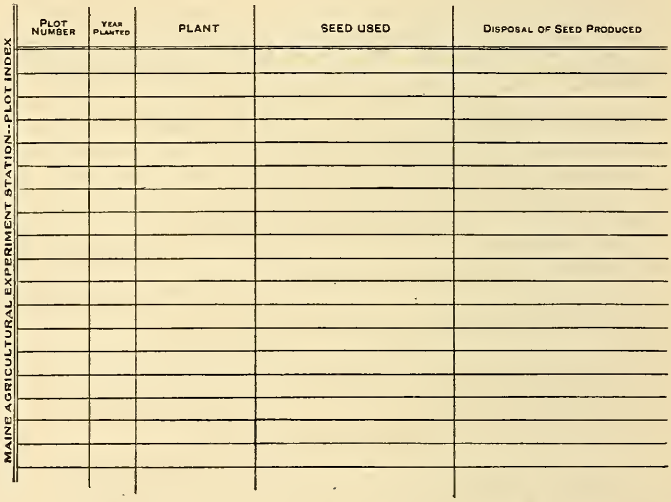
Fig. 55. Facsimile of Oat Breeding record used in the oat variety tests

Finally Figure 56 shows the plot index. Plot numbers are never duplicated so that by the use of this index it is possible to trace back the pedigree of any strain. This same blank is used for all plant breeding work. Hence, in the third column, under the heading "Plant," the kind of crop, whether oats, corn, beans, etc., is indicated. Under the heading "Seed used" there is given both the variety and the source of the seed.

In 1910 the variety tests were under the supervision of one of the writers (F. M. Surface). In 1911 the tests were in charge of Dr. E. P. Humbert, at that time Associate Biologist in the Station. In 1912 and 1913 the tests were again under the supervision of one of the writers (C. W. Barber). To Dr. Raymond Pearl is due the credit for the continuity of these tests during the several years and for many suggestions during the course of the work.

Varieties Tested.

The number of commercial varieties of oats appears to be unlimited. In a great many cases the chief difference between these so-called varieties is in the name. On the other hand, there are a number of distinct varieties separated from each other by marked morphological or physiological characters. The remaining so-called varieties are simply strains selected out of one of the fundamental varieties. Many of these strains are characterized by stiffer straw or greater yield than that of the mother variety. Inasmuch as these strains tend to breed true to these characters it is perhaps justifiable to designate them as separate varieties.



MAINE AGRICULTURAL EXPERIMENT STATION--PLOT INDEX

Plot Number	Year Planted	Plant	Seed Used	Disposal of Seed Produced

Fig. 56. Facsimile of Plot Index sheet used in the plant breeding work.

Table 1 gives the name and the source of the seed of all the varieties which have been tested at any time in the past four years. In some cases several strains of the same variety were obtained from different sources. In general only one such strain of a variety has been continued after the first year. Several varieties appeared to be so poorly adapted to our conditions that they have been dropped after one or two years' trial.

TABLE I.

Varieties Tested.

Variety introduced in	Accession number.	VARIETY NAME.	SEED PURCHASED FROM
1910	1	Danish Island	W. A. Burpee, Philadelphia, Pa.
1910	2	Burpee's Welcome	W. A. Burpee, Philadelphia, Pa.
1910	3	White Tartar King	W. A. Burpee, Philadelphia, Pa.
1910	4	Tartar King	J. Levasseur, Tessierville, Que.
1910	5	Black Tartarian	Iowa Seed Company, Des Moines, Iowa.
1910	6	Kherson (Univ. No. 1)	Griswold Seed Company, Lincoln, Nebr.
1910	7	Kherson	Iowa Seed Company, Des Moines, Iowa.
1910	8	Irish Victor	Iowa Seed Company, Des Moines, Iowa.
1910	9	Early Champion	Iowa Seed Company, Des Moines, Iowa.
1910	10	Prosperity	Iowa Seed Company, Des Moines, Iowa.
1910	11	Silver Mine	Iowa Seed Company, Des Moines, Iowa.
1910	12	Lincoln	Iowa Seed Company, Des Moines, Iowa.
1910	13	Regenerated Swedish Select	Garton-Cooper Company, Chicago, Ill.
1910	14	Regenerated Swedish Select	Griswold Seed Company, Lincoln, Nebr.
1910	15	Regenerated Swedish Select	L. L. Olds, Company, Madison, Wis.
1910	16	Swedish Select	L. L. Olds, Company Madison, Wis.
1910	17	President	Garton-Cooper Company, Chicago, Ill.
1910	18	Senator	Garton-Cooper Company, Chicago, Ill.
1910	19	Victor	Garton-Cooper Company, Chicago, Ill.
1910	20	Old Island Black	E. E. Arsenault, Urbinville, P E. I.
1910	21	White Egyptian	T. J. Wigginton, Bridgetown, P. E. I.
1910	22	Newmarket	C. R. Gies, Heidelburg, Ontario.
1910	23	Imported Scotch	H. L. Goltz, Bardsville, Ontario.
1910	24	Early Blossom	D. Innes, Tabique River, N. B.
1910	25	Unnamed White, Maine grown	Geo. B. Haskell Co., Lewiston, Maine.
1910	26	Banner	W. H. Pawsen, Cooldale, Alberta.
1910	27	Banner	Geo. Boyce, Meridale, Ontario.
1910	28	Banner	W. M. Black, Creelman, Saskatchewan.
1910	29	Banner	W. E. Palmer, Scotch Lake, N. B.
1910	30	Ligowo	D. Carmicheel, West Lorne, Ontario.
1910	31	Unnamed White, Maine grown	Prof. G. H. Hamlin, Orono, Maine.
1911	32	American Clydesdale,	J. M. Thornburn Co., New York, N. Y.
1912	33	White Plume	L. L. Olds, Company Madison, Wis.

TABLE 1—Concluded.

Variety introduced in	Accession number.	VARIETY NAME.	SEED PURCHASED FROM
1912	34	Rebred 60-day	L. L. Olds Company, Madison, Wis.
1912	35	Daubeney	C. R. Giles, Heidelburg, Ontario.
1912	36	Siberian	Wm. Lewis, Dunsford, Ontario.
1912	37	Abundance	James Furgeson, Dalmeny, Ontario.
1912	38	Gold Rain	Experiment Station, Charlottetown, P. E. I.
1912	39	Minnesota No. 26	Garton-Cooper Co., Chicago, Ill.
1912	40	Early Pearl	R. L. Copeland, Brewer, Maine.
1913	41	Garton No. 5	Garton-Cooper Co., Chicago, Ill.

Of the 41 varieties in this list seven are duplicates in the sense that they are strains of a given variety obtained from different sources. This leaves 34 varieties bearing distinct names.

The general characters of these varieties are shown in Table 2. In this table the varieties used are classified under their chief distinguishing characters.

TABLE 2.

Classification of the Varieties Tested.

I. OPEN SPREADING HEAD.

A. Early Oats.

a. White grain.
9*. Early Champion.
35 . Daubeney.

b. Yellow grain.
6–7. Kherson.
34. Rebred 60-day.

B. Medium Early Oats.

a. Yellow grain.
23. Imported Scotch.

C. Medium Late Oats.

a. White grain

11. Silver Mine.
8. Irish Victor.
40. Early Pearl.
12. Lincoln.
2. Burpee's Welcome.
39. Minnesota No. 26.

*The number before the variety name refers to the accession number as given in Table 1.

TABLE 2—Concluded.

25, 31. Unnamed White.
4. Tartar King.
30. Ligowo.
10. Prosperity.
1. Danish Island.
13–16. Swedish Select.
17. President.
26–29. Banner.
36. Siberian.
37. Abundance.
22. Newmarket.

b. Yellow grain.

38. Gold Rain.

c. Black grain.

19. Victor.
20. Old Island Black.

II. CLOSE SIDE HEAD (Horse Mane Oats.)

A. Medium Oats.
a. White grain.
18. Senator.
3. White Tartar King.
21. White Egyptian.
24. Early Blossom.
33. White Plume.

b. Black grain.

5. Black Tartarian.

III. INTERMEDIATE HEAD.

A. Medium oats.
a. White grain.

41. Garton No. 5.

IV. MIXED TYPE.

A. Medium Oats.
a. White grain.
1. American Clydesdale.

It would be very desirable if we could know something of the origin and history of these different varieties. However, in the main it is impossible to learn anything of importance regarding their origin. In the case of certain varieties we do know when they were imported to this country, or occasionally how they arose.

On the following pages there is given a brief description of the more important varieties which we have tested. In some cases notes on the history of the variety will be included. The descriptions of these varieties are based entirely upon our own observations. The reader is reminded that strains of these varieties coming from different sources or grown under different conditions are likely to vary somewhat from the characters given here.

EARLY VARIETIES OF OATS.

Early Champion. This is an early oat maturing at about the same time as the Kherson. In our plots it has been ready to cut in from 85 to 90 days after planting. The straw has fine small sized stems showing a tendency to weakness. The average height is about 36 inches. The leaves are narrow, medium green in color. The heads are small, symmetrical, and spreading. The grain is long, slender, and white in color. It resembles the Kherson in all but color.

Daubeney. This oat presents practically the same characters as the Early Champion. In our experience the straw is slightly weaker and shows an average height of 30 to 32 inches. The grains are a little more plump than the Early Champion and of a good white color.

Kherson and Rebred 60-Day. These two varieties are practically identical in appearance. Both were introduced into the United States from adjoining provinces in southern Russia. The Kherson was introduced in 1896[5] and the 60-day variety in 1901.[6] Both have fine small straw averaging 30 inches in height. In our experience the Kherson straw is slightly stiffer than that of the 60-Day. The leaves are very narrow, and rather light green in color. The heads are small, short, symmetrical and spreading. The grain is long and slender, yellow in color. (Figure 57). These varieties mature in from 85 to 90 days.

Owing to their small heads and small slender kernels these early oats are not very attractive in appearance. However, in the majority of variety tests they have made a creditable showing in respect to yield.

MEDIUM EARLY VARIETIES OF OATS.

Imported Scotch. This is a medium early variety maturing in about 95 days. The straw is medium sized, averaging about 36 inches in height. It has a tendency to lodge on rich soil. The leaves are of medium width, dark green in color. The heads are of medium size, symmetrical and spreading. On the

[5]Nebraska Agr. Exp. Sta. Bulletin 84.

[6]U. S. Dept. of Agr., Bur. of Pl. Ind.. Bulletin 66.

average the heads bear a relatively large number of spikelets in proportion to their length. The grain is long and slender but larger than the Kherson. The grain may be described as yellow in color but our strain throws a small percent of white grains.

MEDIUM LATE VARIETIES WITH WHITE GRAIN AND SPREADING HEADS.

The great majority of oat varieties grown in this country belong to the medium oats with white grain and spreading heads. While there is some slight variation in the time of

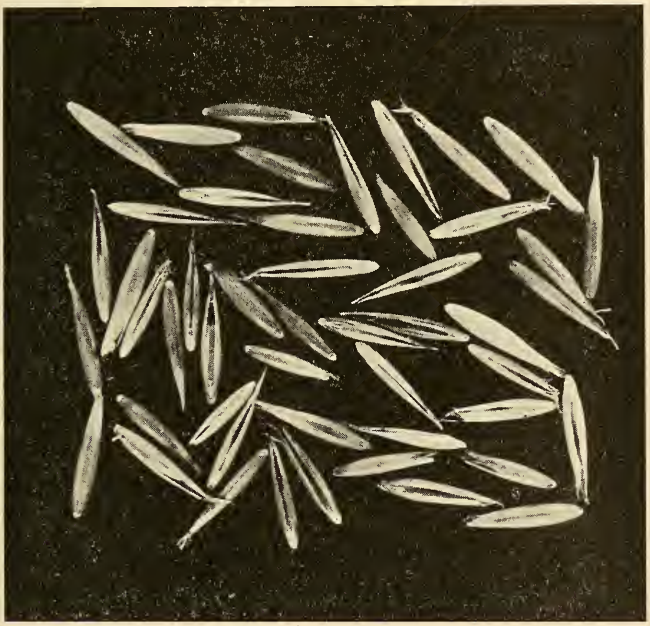


Fig. 57. Photograph showing the long slender type of grain characteristic of the Kherson variety. Compare with Fig. 58.

maturity they all ripen under our conditions in from 95 to 100 days from the time of planting. On the basis of type of kernel these varieties may be still further subdivided in two groups. The distinction between these sub-groups is not very marked and for that reason was not included in the scheme of classification given above. The first of these groups is characterized by medium sized but slender straight grains. The varieties Silver Mine, Early Pearl and Lincoln are typical of this group. These varieties all have medium coarse straw varying from 37 to 40 inches in height. The leaves are of medium width and vary from medium to dark green in color. The heads are medium sized, symmetrical and spreading. The varieties belonging to this group and which have been continued in these tests are Silver Mine, Irish Victor, Early Pearl, Lincoln, Minnesota No. 26, Prosperity and Danish Island. Of these the *Silver Mine* and *Irish Victor* have particularly slender grains. The straw of each is medium stiff with a slight tendency to lodge on rich soil. The Silver Mine averages 40 to 41 inches tall, while the Irish Victor varies from 37 to 39 inches under our conditions.

The *Lincoln* and *Prosperity* resemble each other in many respects. The Prosperity has slightly coarser straw and its grains are shorter and more plump.

Minnesota No. 26. This variety was originated at the Minnesota Experiment Station. It represents a selection from the variety known as the Early Gothland. The Minnesota No. 26 has been very widely grown in the middle west and has proved to be a good yielding variety.

This variety has medium coarse straw and is somewhat shorter than the other varieties in this group. It averages 36 to 37 inches in height. The grains are long and well filled, of a good white color.

The Early Pearl. This variety was secured from Mr. R. L. Copeland of Brewer, Maine, who writes of it as follows: "I can truthfully claim this oat originated with myself. The first seed was obtained from a bunch growing by the roadside some twenty years ago, presumably from one seed. It was examined and showed such merit that it was cut and preserved for seed. Although the first seed was not secured by me personally, it soon after came into my possession. The oat seemed to possess excellent qualities and as it matured fairly early and had a pearly tint to the hull, I gave it the name of Early Pearl. It must have always contained real merit for it is only in recent years that I have tried to improve it."

This variety breeds true and in all respects appears to be a pure line. It has stiff straw of medium size, averaging 38 to 40 inches in height. The leaves are medium in width, of a dark green color. The grain is long and plump.

The second sub-group of medium white oats is characterized by larger and more plump grains A typical variety is the Swedish Select. Other varieties belonging in this group are the Banner, Siberian, Abundance and President.

The *Swedish Select* has been a very popular variety in this country. It has rather weak, coarse straw, averaging 40 to 42 inches in height. Its leaves are of medium width and dark green in color. The grains are large and plump. The kernels are considerably shorter than the glumes giving the grain in many cases a peculiar notched appearance.

The *Regenerated Swedish Select* is the same oat to which the so-called regenerating process has been applied by the Garton-Cooper Seed Company. The method by which this regeneration is secured is to cross fertilize two plants of the same variety. The oat flower is normally always fertilized by its own pollen. That is, it is very closely inbred. If this self-fertilization is prevented and the flower fertilized with pollen from another plant it is claimed to produce a more vigorous strain. This variety shows the same characters as the Swedish Select except perhaps slightly larger grains.

The *Banner* and *Siberian* present practically the same characters. Both have stiff, medium coarse straw from 40 to 44 inches in height. The leaves are rather broad and dark green in color. The grains are plump, medium sized and well filled.

The *President* oat was introduced to the trade in 1908 by the Garton-Cooper Seed Company and was called "Garton's New Breed of White Oats"' It is claimed to be especially adapted to "hot, dry and otherwise unfavorable conditions." In our experience the straw is large and coarse, averaging 38 to 42 inches in height. The leaves are broad and dark green in color. The grains are very large and plump.

MEDIUM LATE VARIETIES WITH YELLOW GRAIN.

The *Gold Rain* variety would belong to the first of the two sub-groups given above in respect to type of grain. However, its yellow color removes it to a different class. This oat was produced at Svalöf, Sweden, as a pedigreed selection from the old Probstier variety. It has proved to be a very high yielder at Svalöf giving an average of over 100 bushels per acre in a nine year test.[7]

It has very stiff excellent straw, medium coarse and varies from 38 to 40 inches in height. The heads are symmetrical and spreading. The grain is long, fairly plump and yellow in color.

MEDIUM LATE VARIETIES WITH BLACK GRAINS.

Two black grained varieties with open heads have been tested, but only one, the *Victor,* has been continued. In addition to its black grain, this oat possesses a number of peculiar characteristics. This oat was produced by the Garton-Cooper Seed Company. According to their description it was "bred from six different parents, two of which are fall oats." It has stiff medium coarse straw and grows very tall, averaging 46 to 59 inches. The leaves are broad and dark green in color. The heads are very long, symmetrical and very wide spreading with long drooping branches. The grain is very large and plump, similar in shape to the President but of a jet black color. This variety stools well. It is further peculiar in the manner of growth of the young plant. There is a very marked tendency for the young culms to spread out over the ground after the fashion of a true winter cereal.

MEDIUM LATE VARIETIES WITH CLOSE SIDE HEAD.

Two varieties of typical side oats or so-called "Horse Mane Oats" are being continued in the variety tests.

The *Senator* is an exceptionally large grained oat. The straw is very coarse, averaging from 44 to 48 inches in height. The leaves are very broad, averaging about three-fourths of an inch in width and of a dark green color. The heads are very large, typical side heads. It is not uncommon to find heads with 100 to 140 spikelets. The variety stools very little and this undoubtedly accounts in part for its low yield under a system of uniform seeding. The grains ave very large and plump (Fig. 58) and of a good white color. In this variety and pin oats are very often enclosed within the hull of the mother oat. On account of its large head and large grain this is a very attractive oat.

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[7]Newman, L. H. Plant Breeding in Scandinavia, p. 129, Ottawa, 1912.

The *White Plume* variety is listed here as a side oat although the particular strain which we have shows a few open heads every year. This is not such a large variety as the Senator. The straw is a little weaker, of medium size and from 36 to 40 inches tall. The grain is long and plump.

MEDIUM LATE VARIETIES WITH INTERMEDIATE HEAD.

In 1913 a new variety was introduced from the Garton-Cooper Company known as *Garton No. 5*. The head of this oat is intermediate between an open head and a true side head. This oat originated, according to the Garton-Cooper Company,

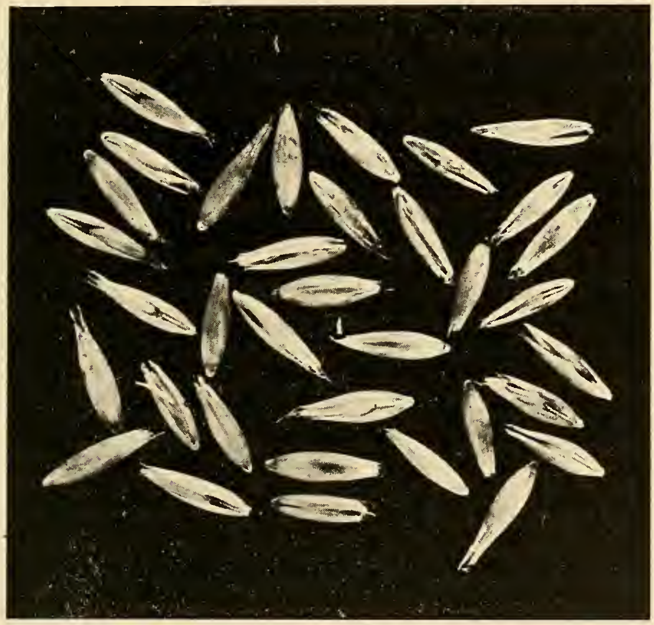

Fig. 58. Photograph of the Senator grain. The grains are very large and plump and the pin oat is usually enclosed in the glumes of the so-called "mother" oat. (Compare with Fig. 57.)

from a cross between the Senator and the Regenerated Swedish Select. Its intermediate type of head, large grain and low stooling ability indicate its Senator parentage.

The straw of this variety is medium coarse, averaging about 40 inches in height. The leaves are broad and dark green in color. The head has a node a few inches below the lower whorl as in typical side oats. The branches are stiff and remain nearly upright but the spikelets tend to fall to all sides of the main stem. The grains are very large and very plump, although they are not so large as those of the Senator. This variety stools very poorly.

MEDIUM LATE VARIETIES OF MIXED TYPE.

Finally there is the variety purchased under the name of *American Clydesdale.* This variety is a mixture, about 50 percent are side oats, while the remainder have open heads. This mixture has yielded fairly well and for this reason has been retained in the tests. The straw is stiff, of medium size and 38 to 40 inches in height. The grains are long and fairly plump. The majority of the grains are white but a small percent are yellow. The seed which we are using is undoubtedly a mixture of several types.

RESULTS OF THE 1910 VARIETY TEST.

Table 3 gives the detailed results of the 1910 test. In this table the varieties are arranged in the order of their yield of grain. In addition to the variety name there is given the number of the plot upon which it was grown and also the accession number which corresponds to the number given the varieties in Table 1. By means of these numbers it is possible to find the original source of the seed of any variety. The data given include the yield of straw and grain per 1-10 acre; the yield of grain calculated in bushels per acre[8]; the weight per measured bushel and the number of days which it took the variety to mature. It will be noted that in some cases several plots were planted with the same variety. In these cases the seed for each plot came from different sources (cf. Table 1).

All of the plots were planted on May 5 and 6. Plots Nos. 6, 7 and 9 were harvested on July 29, plot No. 23 on August 5, and the remaining plots on August 9.

[8]This refers to bushels by weight, allowing 32 pounds to the bushel.

Table 3.

Variety Test in 1910.

Accession number*.	Name of Variety.	Plot number.	Yield per 1-10 Acre. Straw. Pounds.	Grain. Pounds.	Bushels. Per acre.	Weight per mearured bushel.	Number of days to mature.
15	Regenerated Swedish Select..........	15	280.0	234.5	73.3	41.0	95
13	Regenerated Swedish Select..........	13	284.3	230.7	72.1	44.0	95
11	Silver Mine........................	11	278.0	227.0	71.0	39.4	95
26	Banner............................	26	248.5	226.5	70.8	39.7	96
8	Irish Victor........................	8	312.0†	225.5	70.5	37.9	95
12	Lincoln............................	12	299.0	224.0	70.0	40.0	95
14	Regencrated Swedish Select..........	14	279.5	222.5	69.5	41.3	95
6	Kherson (Univ.)....................	6	250.3	222.3	69.4	30.2	84
28	Banner............................	28	253.5	221.5	69.2	–	96
17	President..........................	17	261.7	218.3	68.2	40.0	95
4	Tartar King........................	4	297.5	215.5	67.3	–	95
22	Newmarket.........................	22	254.0	213.5	66.7	–	96
30	Ligowo............................	30	277.5	212.5	66.4	–	96
5	Black Tartarian....................	5	263.5	211.5	66.1	–	95
9	Early Champion....................	9	264.5	211.5	66.1	42.8	84
31	Maine Grown (Hamlin)...............	31	242.7	210.3	65.7	–	96
16	Swedish Select.....................	16	245.3	209.7	65.5	–	95
10	Prosperity.........................	10	287.5	209.5	65.5	38.9	95
27	Banner............................	27	254.5	208.0	65.0	–	96
29	Banner............................	29	245.3	206.7	64.6	–	96
7	Kherson...........................	7	234.0	203.5	63.6	33.8	84
25	Maine Grown.......................	25	222.3	193.3	60.4	–	96
23	Imported Scotch....................	23	243 0	192.0	60.0	34.8	91
19	Victor.............................	19	261.5	190.5	59.5	41.6	95
3	White Tartar King..................	3	260.7	185.3	57.9	–	95
2	Burpee's Welcome...................	2	231.7	181.3	56.6	–	95
21	White Egyptian.....................	21	289.7	181.3	56.6	–	96
24	Early Blossom......................	24	286.3	178.7	55.8	–	96
20	Old Island Black...................	20	244.5	178.0	55.6	–	96
18	Senator............................	18	248.7	171.2	53.5	40.8	95
1	Danish Island......................	1	235.3	149.2	46.7	37.0	95
	Average.........................		262.5	205.4	64.2	39.0	94

*The "accession number" in this and the following tables refer to the arbitrary numbers given to the varieties in Table 1 (p. 149). By means of these numbers it is possible to find the original source of the seed of any variety.

†Straw damp when weighed.

From Table 3 it will be noted:

1. That the yield of grain varied from 73.3 to 46.7 bushels per acre. The average for all the varieties was 64.2 bushels.

2. The Regenerated Swedish Select (Nos. 15 and 13) gave the highest yield. The third sample of Regenerated Swedish Select (No. 14) yielded very nearly as well (69.5 bushels).

3. The varieties Silver Mine, Banner (Nos. 26 and 28), Irish Victor, Lincoln, Kherson (No. 6) and President all gave very good yields.

4. Of the four lots of Banner Oats the two (Nos. 26 and 28) which came from Alberta and Saskatchewan, Canada,

yielded much better than Nos. 27 and 29 which came from Ontario and New Brunswick.

5. The yield of straw varied from about 3000 to 2200 pounds per acre. The average for all the varieties was 2625 pounds per acre.

6. The weight per measured bushel is given for the varieties which were continued in 1911. The weights varied from 44.0 pounds in the Regenerated Swedish Select (No. 13) to 30.2 pounds in the Kherson (No. 6). The average for all sixteen varieties is 39.0 pounds per bushel.

7. The Kherson and Early Champion plots matured in 84 days, the Imported Scotch in 91 days and the remaining varieties in 95 to 96 days.

RESULTS OF THE 1911 TESTS.

Seventeen varieties were tested in 1911. With the exception of the American Clydesdale (No. 32) the seed was derived from our 1910 plots. In general only those varieties were continued which showed special promise in the 1910 test or which showed special characters which it was wished to study further. In many respects the 1911 test was very unsatisfactory. The early portion of the season was very unfavorable. Certain difficulties were experienced in seeding so that the plots did not have an even stand in all cases. Further it appears that the grain was harvested too early and was probably not fully matured. It will be noted from Table 4 that the average number of days to mature for all varieties was only 88 in 1911, while in the other years it ranged from 94 to 101. All of the plots were planted May 9 and 10.

Table 4 gives the detailed results of this test. In the following discussion the points mentioned in the above paragraph should be borne in mind.

TABLE 4.

Variety Test in 1911.

Accession number.	Name of Variety.	Plot number.	Yield per 1-10 Acre. Straw. Pounds.	Yield per 1-10 Acre. Grain. Pounds.	Bushels per acre.	Weight per measured bushel.	Date harvested.	Number of days to mature.
23	Imported Scotch	55	260.3	199.7	62.4	36.4	Aug. 4	86
8	Irish Victor	46	279.5	178.0	55.6	36.9	Aug. 1	83
32	American Clydesdale	43	249.0	176.0	55.0	39.3	Aug. 5	88
19	Victor	54	245.5	174.5	54.5	41.7	Aug. 14	96
11	Silver Mine	49	237.0	173.0	54.0	39.8	Aug. 4	86
10	Prosperity	48	286.0	169.0	52.8	39.2	Aug. 1	83
7	Kherson	57	225.0	160.0	50.0	34.2	July 27	78
17	President	52	261.5	158.5	49.5	41.6	Aug. 5	87
6	Kherson	45	297.0	153.0	47.8	33.1	July 26	77
12	Lincoln	50	242.5	152.5	47.7	40.0	Aug. 14	96
1	Danish Island	44	198.0	152.0	47.5	39.0	Aug. 8	90
26	Banner	56	335.0	146.5	45.8	39.8	Aug. 14	96
14	Regenerated Swedish Select	58	360.0	139.5	43.6	42.6	Aug. 14	96
13	Regenerated Swedish Select	51	219.0	131.0	40.9	42.8	Aug. 14	96
9	Early Champion	47	299.7	125.3	39.1	38.6	July 22	73
18	Senator	53	297.5	122.5	38.3	41.5	Aug. 14	96
15	Regenerated Swedish Select	59	273.0	122.0	36.7	39.5	Aug. 8	90
	Average		268.8	154.9	48.3	39.2		88

From Table 4 the following points may be noted:

1. The yield in bushels per acre ranged from 62.4 to 36.7. The average for the seventeen varieties was 48.3 bushels. This was nearly 16 bushels less than the average for 1910.

2. The Imported Scotch far outyielded any other variety. The varieties which came next in point of yield were the Irish Victor, American Clydesdale, Victor, Silver Mine and Prosperity.

3. The Kherson (Nos. 6 and 7), President, Lincoln, Danish Island and Banner (No. 26) yielded at intermediate rates.

4. It is of interest to note that the three strains of Regenerated Swedish Select which yielded so well in 1910 were very poor yielders in 1911. Curiously enough the Regenerated Swedish Select No. 15 which was the best yielder in 1910 was the very poorest in 1911. This strain yielded only half as many bushels per acre in 1911 as in the previous year.

5. The yield of straw varied from 3600 pounds to 1980 pounds per acre. The average for all varieties was 2688 pounds, practically the same as in the previous year.

6. The weight per measured bushel varied from 42.8 pounds in the case of the Regenerated Swedish Select (No. 13) to 33.1

pounds in the Kherson (No. 6). The average for all varieties was 39.2 pounds, practically the same as the weight for the same varieties (excepting American Clydesdale) in 1910.

7. Attention has already been called to the fact that the average number of days to maturity was much smaller in 1911 than in any other year. This probably accounts in part for the small yield.

Results of the 1912 Test.

In 1912 eight new varieties were introduced. These were the White Plume, Rebred 60-Day, Daubeney, Siberian, Abundance, Gold Rain, Minnesota No. 26 and the Early Pearl. In addition to these, the thirteen different varieties grown in 1911 were continued. However, only one strain of the Regenerated Swedish Select and one of the Kherson were continued.

It has already been stated that in 1912 each variety was planted in duplicate 1-10 acre plots. In each case the two plots of a variety were in different fields (Cf. Fig. 53). It has further been noted that field A was very poorly drained and consequently could not be planted until nearly three weeks after field B. In nearly every instance the yield in the late seeded plot was lower than the duplicate plot in field B. In the case of four varieties, viz., Gold Rain, Siberian, Abundance, and Daubeney both plots were planted late. This was due to the wet condition of the soil at one place in field B. No doubt the average yield of these varieties is somewhat less than if the one plot had been seeded early.

Table 5 gives the results of the 1912 test. In this table the detailed results of each plot are given separately, together with the average for the two plots of each variety. The varieties are arranged in the order of the average yield of grain from the two plots.

TABLE 5.

Variety Test in 1912.

Accession number.	Name of Variety.	Plot number.	Yield per 1-10 Acre. Straw. Pounds.	Yield per 1-10 Acre. Grain. Pounds.	Bushels per acre.	Weight per measured bushel.	Date harvested.	Days to maturity.
12	Lincoln	181	254.0	226.0	70.6	39.7	Aug. 16*	104
		182	334.3	210.7	65.9	33.2	Aug. 31	100
	Average		*294.2*	*218.4*	*68.3*	*36.5*		
10	Prosperity	177	281.0	234.0	73.1	39.2	Aug. 16*	104
		178	257 5	197.5	61.7	35.5	Aug. 31	100
	Average		*269.3*	*215.8*	*67.4*	*37.4*		
40	Early Pearl	199	286.5	243.5	76.1	37.7	Aug. 16*	104
		200	173.0	167.0	52.2	33.3	Aug. 31	100
	Average		*229.8*	*205.3*	*64.2*	*35.5*		
26	Banner	193	249.5	225.5	70.5	37.7	Aug. 16*	104
		194	265.0	175.0	54.7	33.0	Aug. 31	100
	Average		*257.3*	*200.3*	*62.6*	*35.4*		
23	Imported Scotch	191	157.3	202.7	63 3	36.7	Aug. 16*	104
		192	259.7	195.3	61.0	32.6	Aug. 31	100
	Average		*208.5*	*199.0*	*62.2*	*34.7*		
8	Irish Victor	173	216.3	198.7	62.1	39.0	Aug. 16*	104
		174	234.5	195.5	61.1	34.9	Aug. 31	100
	Average		*225.4*	*197.1*	*61.6*	*37.0*		
17	President	185	363 0	222.0	69.4	37.3	Aug. 13*	101
		186	273.5	171.5	53.5	34.2	Aug. 31	100
	Average		*318.3*	*196.8*	*61.5*	*35.8*		
1	Danish Island	169	264.0	196.0	61.3	38.4	Aug. 16*	104
		170	192.0	173.0	54.1	33.0	Aug. 31	100
	Average		*228.0*	*184.5*	*57.7*	*35.7*		
19	Victor	189	314.0	221.0	69.1	42.9	Aug. 13*	101
		190	220.5	142.8	44.6	38.3	Aug. 31	100
	Average		*267.3*	*181.9*	*56.9*	*40.6*		
13	Regenerated Swedish Select	183	420.0	178.0	55.6	43.3	Aug. 13*	101
		184	214.7	183.3	57.3	35.3	Aug. 31	100
	Average		*330.8*	*180.7*	*56.5*	*39.3*		
32	American Clydesdale	167	394.0	206.0	64.4	39.3	Aug. 12*	100
		168	172.5	142.5	44.5	34.2	Aug. 31	100
	Average		*283.3*	*174.3*	*54.5*	*36.8*		
38	Gold Rain	203	222.0	163.0	50.9	36.4	Aug. 31	100
		204	244.0	181.0	56.6	37.6	Aug. 31	100
	Average		*233.0*	*172.0*	*53.8*	*37.0*		
18	Senator	187	273.5	196.5	61.4	37.2	Aug. 16*	104
		188	238.9	145.8	45.6	33.1	Aug. 31	100
	Average		*256.7*	*171.2*	*53.5*	*35.2*		
11	Silver Mine	179	452.0	145.0	45.3	42.2	Aug. 13*	101
		180	223.6	193.7	60.5	36.2	Aug. 31	100
	Average		*337.8*	*169.4*	*52.9*	*39.2*		
39	Minnesota No. 26	207	219.7	150.3	47.0	38.3	Aug. 31	100
		208	188.5	186.5	58.3	37.5	Aug. 31	100
	Average		*204.1*	*168.4*	*52.7*	*37.9*		
6	Kherson	171	202.3	164.7	51.5	35.3	Aug. 5*	93
		172	163.0	172.0	53.8	35.4	Aug. 21	90
	Average		*182.6*	*168.4*	*52.7*	*35.4*		

TABLE 5—Concluded.

Accession number.	NAME OF VARIETY.	Plot number.	YIELD PER 1-10 ACRE. Straw. Pounds.	Grain. Pounds.	Bushels per acre.	Weight per measured bushel.	Date harvested.	Days to maturity.
9	Early Champion	175	248.0	187.0	58.4	35.3	Aug. 5*	93
		176	194.5	135.5	42.3	35.2	Aug. 16	85
	Average		*221.3*	*161.3*	*50.4*	*35.2*		
36	Siberian	205	246.3	148.7	46.5	30.6	Sept. 5	105
		206	284.0	171.0	53.4	31.2	Sept. 4	104
	Average		*265.2*	*159.9*	*50.0*	*30.9*		
37	Abundance	209	209.7	155.0	48.5	34.5	Sept. 5	105
		210	173.5	151.5	47.3	35.0	Aug. 31	100
	Average		*191.6*	*153.3*	*47.9*	*34.8*		
34	Rebred 60-Day	197	135.0	163.0	50.9	32.5	Aug. 5*	93
		198	149.0	141.0	44.1	34.3	Aug. 21	90
	Average		*142.0*	*152.0*	*47.5*	*33.4*		
33	White Plume	195	190.0	170.0	53.1	38.1	Aug. 16*	100
		196	168.0	112.0	35.0	30.0	Aug. 31	100
	Ave.age		*179.0*	*141.0*	*44.0*	*34.1*		
35	Daubeney	201	171.0	139.0	43.4	36.3	Aug. 21	90
		202	142.0	138.0	43.1	37.0	Aug. 21	90
	Average		*156.5*	*138.5*	*43.3*	*36.7*		
	Average of plots planted May 4	–	*276.5*	*198.8*	*62.1*	*38.5*	–	101
	Average of plots planted May 23	–	*217.1*	*164.4*	*51.4*	*34.7*	–	98
	Ave age of all plots	–	*240.1*	*177.7*	*55.6*	*36.1*	–	99

*Plots marked with (*) were planted May 4, the remaining plots were planted May 23.

From this table the following points may be noted:

1. The average yield for the two plots ranges from 68.3 bushels per acre in the case of the Lincoln variety to 43.3 bushels in the Daubeney. The average yield of all the plots is 55.6 bushels per acre. The average yield of the early seeded plots in field B is 62.1 bushels, while the average of the late seeded plots is only 51.4 bushels. This decrease in yield of 10.7 bushels or nearly 18 percent is due mainly to the late seeding.

2. The highest yield of any plot in field B was at the rate of 76.1 bushels per acre for the Early Pearl variety. Three other plots in this field yielded above 70 bushels per acre. The highest yield in field A was from the Lincoln plot which yielded at the rate of 65.9 bushels per acre. Only four other plots in this field yielded more than 60 bushels per acre.

3. Of the 10 varieties ranking highest in point of yield, nine were varieties which had been tested in the two preceding years. Only one of the varieties introduced in this year, the Early Pearl, ranked among the first 10.

4. The Imported Scotch which yielded best in 1911 ranked fifth in point of yield in 1912. The Regenerated Swedish Select which was one of the best yielding varieties in 1910, but very poor in 1911, ranked tenth in yield in this year. The Senator which yielded poorly in the two preceding seasons gave an average yield in 1912. The Senator plot in field B yielded very well. The Silver Mine which had yielded well in the two previous years gave only an average yield in this year. It is to be noted that the late seeded plot of this variety yielded best. This was also true of a few other varieties.

5. The average yield of straw for all plots was 2401 pounds per acre. This is slightly less than the average for the preceding year. The early seeded plots gave 2765 pounds per acre, while the late seeded plots gave only 2171 pounds.

6. The average weight per measured bushel for all plots was 36.1 pounds. This is about three pounds less than for either of the previous years. The fact that a number of new varieties were grown this year may in some measure account for this decrease. It will further be noted that the grain from the early seeded plots average to weigh nearly four pounds more per bushel than grain from the late seeded plots.

7. The average number of days from planting to harvesting was 99.5 days.

Results of the 1913 Test.

It has already been stated that in 1913 different methods were adopted in the variety test work. The chief difference was in the use of four small plots (1-40 acre) in place of a single, or as in 1912 duplicate, 1-10 acre plots. The four plots of any one variety were scattered through the field so that on the average the four plots of any variety were more likely to encounter average soil conditions than if they were in a single large plot. Each 1-40 acre plot was in the shape of a square, each side being 33 feet long. It has been shown by one of the writers[9] that this

[9]Barber, C. W. *Loc. cit.*

is the most desirable shape for a small plot. The field containing these plots was slightly irregular in shape but with the exception of four plots all of these plots were in five tiers. Four of these tiers contained 17 plots each, while the fifth tier had only 12 plots. It will thus be seen that all the plots were arranged in a compact group.

In table 6 there are given the detailed data relative to each plot, together with the averages for all four plots of each variety. The varieties are arranged in the order of their average production of grain. The yield of straw is given both for the 1-40 acre and also the calculated yield per acre. These latter figures are easily compared with the yields for the 1-10 acre plots given for the previous years.

It should be said that each 1-40 acre plot was remeasured before harvesting. In a few plots the actual area varied slightly from 1-40 acre. The plots in Table 6 which are marked with an * have had the actual yield calculated to the base of 1-40 acre so as to be directly comparable with the remaining plots.

All of the plots were planted on May 5, 6 and 7. The Kherson and Rebred 60-Day plots were harvested July 31 to Aug. 2. The Daubeney plots were harvested between July 31 and Aug. 7. The remaining varieties were harvested between Aug. 11 and 20.

In all, 21 commercial varieties were tested in 1913. Two varieties, The Danish Island and Early Champion, which had been tested in the three preceding years, were dropped from the test. One new variety, viz., Garton No. 5, was added in this year.

Table 6.

Variety Test in 1913.

Accession number.	Name of Variety.	Plot number.	Straw Yield. Lbs. per plot.	Straw Yield. Lbs. per acre.	Grain Yield. Lbs. per 1-40 acre plot.	Grain Yield. Bu. per acre.	Weight per measured bushel.	Days to maturity.
36	Siberian....................	477	98.5	3940	60.5	75.6	–	105
		498	81.5	3260	50.5	63.1	35.0	104
		519	80.0	3200	55.0	68.8	34.9	105
		540	87.5	3500	61.5	76.9	34.0	105
	Average		*86.9*	*3475*	*56.9*	*71.1*	*34.7*	*105*
40	Early Pearl.................	474	71.0	2840	54.0	67.5	33.3	105
		495	101.5	4060	67.5	84.4	32.8	103
		516	59.0	2360	51.0	63.7	–	10
		537	66.5	2660	50.5	63.1	33.9	104
	Average		*74.5*	*2980*	*55.8*	*69.7*	*33.3*	*103*
39	Minnesota No. 26............	478	81.5	3260	53.5	66.9	35.1	105
		499	73.5	2940	58.5	73.1	36.6	104
		520	53.5	2140	48.5	60.6	36.8	98
		541	84.7	3388	56.3	70.3	36.0	105
	Average		*73.3*	*2932*	*54.2*	*67.7*	*36.1*	*103*
23	Imported Scotch............	470	65.5	2620	55.5	69.4	35.8	100
		491	64.5	2580	52.5	65.6	35.2	100
		512	54.0	2160	52.0	65.0	–	99
		533	79.5	3180	56.5	70.6	33.6	105
	Average		*65.9*	*2635*	*54.1*	*67.7*	*34.9*	*101*
8	Irish Victor................	462	64.0	2560	50.0	62.5	36.6	101
		483	77.0	3080	58.0	72.5	35.5	105
		504	82.5	3300	52.5	65.6	–	102
		525	77.0	3080	54.0	67.5	36.0	97
	Average		*75.1*	*3005*	*53.6*	*67.0*	*36.1*	*101*
12	Lincoln.....................	465	94.0	3760	57.0	71.3	33.1	107
		486	84.5	3380	52.5	65.6	–	107
		507	71.5	2860	51.5	64.4	–	105
		528	66.0	2640	50.0	62.5	33.6	105
	Average		*79.0*	*3160*	*52.8*	*65.9*	*33.3*	*106*
38	Gold Rain..................	476	92.5	3700	60.5	75.6	36.7	107
		497	66.5	2660	39.5	49.4	–	105
		518	75.0	3000	54.0	67.5	–	105
		539	70.5	2820	54.5	68.1	36.2	104
	Average		*76.1*	*3045*	*52.1*	*65.2*	*36.4*	*105*
37	Abundance.................	479	72.5	2900	53.5	66.9	35.4	106
		500	54.0	2160	47.0	58.8	39.0	97
		521	71.0	2840	51.0	63.7	36.8	102
		542	85.0	3400	54.0	67.5	36.3	105
	Average		*70.6*	*2825*	*51.4*	*64.2*	*36.8*	*103*
33	White Plume................	472	57.5	2300	49.5	61.9	37.3	99
		493	71.0	2840	49.0	61.3	35.2	103
		514	68.0	2720	43.0	53.7	36.8	97
		535	83.5	3340	61.5	76.9	35.4	104
	Average		*70.0*	*2800*	*50.8*	*63.4*	*36.2*	*101*
10	Prosperity..................	463	66.0	2640	50.0	62.5	35.8	103
		484	80.0	3200	57.0	71.3	35.6	103
		505	52.5	2100	47.5	59.4	40.3	97
		526	65.0	2600	47.0	58.7	34.9	105
	Average		*65.9*	*2635*	*50.4*	*63.0*	*36.7*	*102*
7	President...................	467	67.5	2700	58.5	73.1	35.6	105
		488	69.0	2760	49.0	61.3	–	106
		509	54.5	2180	45.5	56.9	–	104
		530	56.5	2260	48.5	60.6	36.0	105
	Average		*61.9*	*2475*	*50.4*	*63.0*	*35.8*	*105*

TABLE 6—Concluded.

Accession number.	NAME OF VARIETY.	Plot number.	Straw Yield. Lbs. per plot.	Straw Yield. Lbs. per acre.	Grain Yield. Lbs. per 1-40 acre plot.	Grain Yield. Bu. per acre.	Weight per measured bushel.	Days to maturity.
32	American Clydesdale........	460	81.5	3260	53.5	66.9	33.9	105
		481	55.0	2200	45.0	56.3	36.5	101
		*502	76.9	3077	49.8	62.2	36.5	104
		523	74.5	2980	52.5	65.6	34.6	102
	Average		*72.0*	*2879*	*50.2*	*62.8*	*35.4*	*103*
26	Banner....................	471	88.5	3540	55.5	69.4	33.9	107
		492	66.0	2640	44.0	55.0	–	106
		513	54.0	2160	44.0	55.0	–	104
		534	78.7	3148	57.3	71.6	34.8	105
	Average		*71.8*	*2872*	*50.2*	*62.7*	*34.3*	*106*
13	Regenerated Swedish Select..	466	72.0	2880	49.0	61.2	34.2	105
		*487	61.8	2472	49.2	61.6	34.6	106
		*508	51.1	2042	42.3	52.9	–	105
		*529	82.5	3300	54.4	68.0	36.4	106
	Average		*66.9*	*2674*	*48.7*	*60.9*	*35.1*	*106*
6	Kherson..................	461	64.0	2560	53.0	66.3	35.6	89
		482	60.5	2420	48.5	60.6	–	87
		503	63.5	2540	44.5	55.6	36.9	87
		524	70.5	2820	48.5	60.6	–	87
	Average		*64.6*	*2585*	*48.6*	*60.8*	*36.2*	*88*
19	Victor....................	469	68.0	2720	46.0	57.5	35.2	105
		490	78.0	3120	55.0	68.7	36.8	106
		511	52.0	2080	40.0	50.0	39.7	99
		532	73.5	2940	49.5	61.9	35.7	101
	Average		*67.9*	*2715*	*47.6*	*59.5*	*36.8*	*103*
11	Silver Mine...............	464	56.0	2240	48.0	60.0	36.5	103
		485	50.0	2000	42.0	52.5	–	102
		506	73.0	2920	50.0	62.5	37.1	106
		527	52.0	2080	45.0	56.3	–	101
	Average		*57.8*	*2310*	*46.3*	*57.8*	*36.8*	*103*
34	Rebred 60-Day.............	473	35.5	1420	35.5	44.4	36.2	87
		494	62.5	2500	56.5	70.6	35.1	88
		515	41.0	1640	39.0	48.8	36.4	86
		536	49.0	1960	43.0	53.7	36.2	85
	Average		*47.0*	*1880*	*43.5*	*54.4*	*35.9*	*87*
35	Daubeney.................	475	76.5	3060	56.0	70.0	34.4	98
		496	40.5	1620	36.5	45.6	–	86
		517	54.5	2180	35.5	44.4	–	86
		538	71.0	2840	39.0	48.7	37.8	92
	Average		*60.6*	*2425*	*41.8*	*52.2*	*36.1*	*91*
18	Senator..................	468	68.5	2740	50.5	63.1	30.7	105
		489	75.0	3000	51.0	63.7	34.0	105
		510	44.5	1780	37.5	46.9	–	97
		531	80.5	3220	26.5	33.1	–	105
	Average		*67.1*	*2685*	*41.4*	*51.7*	*32.4*	*103*
41	Garton No. 5..............	*480	87.8	3510	48.6	60.8	31.5	106
		501	49.3	1972	32.7	40.9	–	93
		522	73.0	2920	30.0	48.7	–	105
		543	70.5	2820	44.5	55.6	–	104
	Average		*70.1*	*2806*	*41.2*	*51.5*	*31.5*	*102*
	Average all varieties.....		*68.8*	*2751*	*49.6*	*62.0*	*35.5*	*101*

*Size of plots varied from 1-42 to 1-50 acre. Yields of these calculated to 1-40 acre basis.

The following points are brought out in Table 6:

1. The average yield of the four plots of the several varieties ranged from 71.1 bushels per acre in the Siberian to 51.5 bushels in the Garton No. 5. This is a range of about 20 bushels between the best and the poorest variety. This range is some 5 to 7 bushels less than in any of the preceding years. This is no doubt due, in a large measure, to the fact that these are averages of four plots rather than the yield of a single plot.

2. The highest yielding single plot was the Early Pearl Plot No. 495 which yielded at the rate of 84.4 bushels per acre. The lowest yielding single plot was the Garton No. 5 (plot 501) which gave 40.9 bushels per acre. The difference between the highest and lowest single plot is 43.9 bushels.

3. The average yield for all the varieties was 62 bushels per acre. This is a better average production than in any of the preceding years except 1910. This comparison is hardly fair, however, since the varieties tested in different years were not all the same. The yield of those varieties which have been tested for all four years will be discussed in a later paragraph (Cf. p. 175).

4. Of the ten highest yielding varieties in 1913, six were varieties introduced in 1912. It will be remembered that in the discussion of Table 5 it was pointed out that only one variety, the Early Pearl, introduced in 1912, was among the ten best producers of that year. It is probable that this result is in part due to acclimatization. It will be remembered that the Early Pearl variety was originated in Maine. The other varieties imported in 1912 were from Canada and the Middle West. They did very poorly the first year but very much better the second. This point is also discussed on page 177.

5. The four out of the ten best yielding varieties which were introduced before 1912 are in order, the Imported Scotch, Irish Victor, Lincoln and Prosperity. It will be shown later (Fig. 59) that these are the four best yielding varieties on a four year average.

6. The Siberian which yielded best in 1913 was a very poor producer in 1912, yielding only 50 bushels per acre. The Early Pearl, on the other hand, yielded very well in 1913, standing third in order of productiveness. The Senator which yielded very poorly in 1910 and 1911 is again at the bottom of the list in

1913. Also the Silver Mine which yielded relatively very well in 1910 and 1911 yielded relatively very poorly in both 1912 and 1913.

7. The average yield of straw per acre varied from 3475 pounds in the Siberian to 1880 pounds in the Rebred 60-Day. The average yield of straw for all varieties is 2751 pounds per acre. This is a slightly higher average yield than in the preceding years.

8. The average weight per measured bushel for all varieties was only 35.5 pounds. This is considerably lower than in the previous years, especially 1910 and 1911. This will be discussed more in detail at another place (cf. p. 186).

9. The average length of time from planting to harvesting was 101 days, a slightly longer average growing period than in the other years.

VARIATION IN THE YIELD OF THE 1913 PLOTS.

The use of four plots of each variety situated in different parts of the same field gives an opportunity to study the effect of the environment on each variety. The seed for each of the four plots of any variety was all taken from the same bag. For all practical purposes the seed for any set of four plots may be regarded as identical. The differences in the yield of the plots of any variety may, therefore, be attributed in the main to the effect of differences in soil of other environmental factors. Undoubtedly different varieties of oats differ greatly in their ability to adapt themselves to different environments. This fact is well recognized by the commercial seed growers. Statements are common in the literature to the effect that one variety is especially adapted to withstand a drought or will yield well on poor land, while another variety is described as especially adapted to rich soil, etc. Now the variety which will yield well under all kinds of conditions is in many cases a much more desirable variety for the average farmer than a variety which will yield higher but only under certain favorable conditions.

The data on the 1913 plots offer an opportunity to study the effect of such environmental influences. The data are by no means sufficient to warrant far-reaching conclusions. Experiments involving a much larger number of plots for each variety or else carried on for a number of years would be necessary to settle such questions definitely. However these data together with certain other observations to be discussed later enable us to reach fairly definite conclusions regarding certain varieties.

What we wish to know in this connection is the amount of variation between the different plots of the same variety. Thus, that variety in which all four plots yield at nearly the same rate is, so far as we can judge from this experiment, less affected by the environment than a variety in which there is a wide difference in the yield of different plots. In order to measure this variation resort must be had to certain mathematical methods. Two mathematical constants may be calculated, viz., the standard deviation which measures the variation in absolute units and the coefficient of variation which measures the variability as a percent of the mean.[10] For comparative purposes it simply needs to be remembered that a variety with the smaller constant (standard deviation or coefficient of variation) is the less vari-

[10]For any readers who are unacquainted with the use of biometrical methods the following brief explanation may be of assistance.

The standard deviation denoted by the Greek letter sigma (ς) is obtained by finding the difference between each observation and the mean of all the observations. These differences are then squared which makes them all positive in sign. The sum of these squared deviations is next divided by the number of observations (n) and the square root of this result is then obtained. The result technically expressed as the square root of the mean squared deviations is the standard deviation.

The formula is $\varsigma = \sqrt{\frac{\Sigma\ (D^2)}{n}}$, where $\Sigma\ (D^2)$ is the sum of the squared deviations. The standard deviation expresses the variation in terms of unit value, for example as bushels per acre in Table 7, or as pounds per bushel in Table 12.

In order to reduce this concrete value to a relative basis so that bushels may be compared with pounds resort may be had to the coefficient of variation. The coefficient of variation is obtained by dividing the standard deviation by the mean and multiplying the results by 100.

$$\text{Coeff. of variation} = \frac{\varsigma \times 100}{\text{mean.}}$$

This expresses the variation as a *percent* of the mean. It is the best method known of expressing the variation of a series of observations in a single mathematical term.

able and, therefore, within the limits of the experiment, less affected by differences in soil and environment.[11]

Table 7 gives the average number of bushels per acre for the four plots of each variety in 1913. The probable error of this mean is also tabled. The last two columns of the table give respectively the standard deviation and the coefficient of variation for the yield of these plots together with their probable errors. The varieties have been arranged in the table in the order of the size of their coefficients of variation. The standard deviation in these cases run nearly parallel with the coefficients of variation so that in most instances the varieties are also in the order of their standard deviations.

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[11]In discussing the significance of such variation constants it is always necessary to take into account the statistical probable error to which they are subject. This probable error in no way takes account of any experimental errors. It simply tells us the amount of confidence, on the basis of chance, that can be put in the given constant. Thus we know that if we repeat an experiment a number of times under the same conditions we feel certain that the average of all the results gives a more nearly true value than any one of the results alone. The greater the number of the separate trials, the more confidence one can put in the average results. The probable error tells how much confidence we can put in the given result. It is of such size that the chances are equal that the true value lies within the limits obtained by adding and substracting the probable error from the calculated value. The probable error is always preceded by the plus or minus ($\pm$) sign.

The method of calculating the probable error of various constants is given in the current treatises on biometrical and statistical methods. A brief discussion of these is given in Part I of Bulletin 110, Bureau of Animal Industry, U. S. Dept. of Agr., pp. 22-24, 1910.

TABLE 7.

Constants of Variation in Yield (Bushels per acre) for the Four 1913 Plots of Each Variety.

VARIETY.	Mean.	Standard Deviation.	Coefficient of Variation.
Imported Scotch	67.66±0.81	2.40 ±0.57	3.54 ±0.85
Lincoln	65.94±1.11	3.28 ±0.78	4.97 ±1.20
Abundance	64.22±1.16	3.45 ±0.82	5.37 ±1.28
Irish Victor	67.03±1.22	3.63 ±0.87	5.42 ±1.30
Kherson	60.79±1.28	3.79 ±0.90	6.23 ±1.49
American Clydesdale	62.75±1.38	4.10 ±0.98	6.53 ±1.56
Silver Mine	57.81±1.28	3.78 ±0.90	6.55 ±1.57
Minnesota No. 26	67.74±1.57	4.66 ±1.11	6.83 ±1.64
Prosperity	62.97±1.69	5.02 ±1.20	7.96 ±1.91
Siberian	71.10±1.87	5.55 ±1.32	7.81 ±1.87
Early Pearl	69.68±2.00	5.93 ±1.42	8.52 ±2.05
Regenerated Swedish Select	60.93±1.81	5.36 ±2.28	8.80 ±2.11
President	62.97±2.05	6.08 ±1.45	9.66 ±2.09
Victor	59.53±2.29	6.80 ±1.62	11.42 ±2.76
Banner	62.74±2.63	7.79 ±1.86	12.41 ±3.00
White Plume	63.44±2.84	8.41 ±2.01	13.26 ±3.22
Garton No. 5	51.52±2.52	7.47 ±1.78	14.51 ±3.53
Gold Rain	65.16±3.25	9.64 ±2.30	14.79 ±3.61
Rebred 60-Day	54.38±3.35	9.93 ±2.37	18.26 ±4.50
Daubeney	52.19±3.51	10.41 ±2.48	19.95 ±4.94
Senator	51.72±4.28	12.68 ±3.02	24.51 ±6.19
Average	62.01	6.20	10.35

The mean yields for 1913 have been discussed in connection with Table 6. They are repeated here for convenience and also to give some idea of their probable errors.

The following points are brought out by this table:

1. The standard deviation ranges from 2.4 bushels per acre in the Imported Scotch to 12.68 bushels in the Senator. The average for all the varieties is 6.2 bushels.

2. These standard deviations are subject to probable errors ranging from one-half bushel to three bushels.

3. The coefficient of variation in the Imported Scotch is 3.54 percent and in the Senator it is 24.51 percent. As measured by the coefficient of variation the Senator plots in 1913 were seven times more variable than the Imported Scotch plots. The average coefficient of variation for all varieties is 10.35 percent.

4. Of the varieties tested in 1913 the Imported Scotch was by far the least variable. It may be stated here that so far as could be ascertained by observation the four Imported Scotch plots were grown under as widely different conditions as the plots of any other variety. It may, therefore, be tentatively

concluded that the Imported Scotch variety is much less affected by varying external conditions than are the other varieties.

5. The variety showing the next smallest variability is the Lincoln. The Abundance, Irish Victor, Kherson, Clydesdale, Silver Mine and Minnesota No. 26 all show comparatively small coefficients of variation. Under the conditions in 1913 the four plots of each of these varieties yielded at relatively uniform rates.

6. The varieties Banner, White Plume, Garton No. 5 and Gold Rain showed a large amount of variation. The Rebred 60-Day, Daubeney and the Senator showed an extremely large variability. These figures indicate that the yield of these varieties are very greatly affected by the difference in soil or other conditions which may be present in any field.

It must be pointed out again that the above conclusions are only tentative. Only four plots of each variety were used. It is always possible when such a small number is used that all four plots of one variety fell under much more similar conditions than the plots of another variety. In the course of time we hope to have this information for these varieties over a series of years. The present data would seem to indicate that the Imported Scotch is less affected by environmental changes than the other varieties, while the Senator is very greatly influenced by such differences.

The Average Yield of Grain.

In the following paragraphs the average yearly yield of grain together with the variation in yield from year to year for each variety will be discussed.

Of the 41 varieties or strains listed in Table 1 only 11 have been tested for all four years. Of the remaining varieties a few have been tested three years and a number for two years. Those varieties which have been tested for only one year will be omitted from this discussion. For purposes of comparison the varieties which have been tested for four years will be tabled separately from the others.

A. Varieties Tested for Four Years.

Table 8 gives the yield of grain for the eleven varieties tested all four years. The varieties are arranged in the order of their average yield for the four years. The yield of each variety for each year is given together with the four year means and their probable errors. Finally the standard deviations and coefficients of variation for each variety are given.

TABLE 8.

Yield of Grain, Varieties Tested Four Years.

Variety.	Bushels per Acre.						Coefficient of Variation.
	1910	1911	1912	1913	Mean.	Standard Deviation.	
Irish Victor	70.5	55.6	61.6	67.0	63.68 ±1.90	5.64 ±1.34	8.85 ±2.13
Imported Scotch	60.0	62.4	62.2	67.7	63.08 ±0.96	2.83 ±0.67	4.49 ±1.07
Lincoln	70.0	47.7	68.3	65.9	62.98 ±3.01	8.94 ±2.13	14.19 ±3.45
Prosperity	65.5	52.8	67.4	63.0	62.18 ±1.89	5.61 ±1.34	9.02 ±2.17
President	68.2	49.5	61.5	63.0	60.55 ±2.31	6.85 ±1.63	11.30 ±2.73
Banner	70.8	45.8	62.6	62.7	60.48 ±3.07	9.10 ±2.17	15.05 ±3.67
Silver Mine	71.0	54.0	52.9	57.8	58.93 ±2.43	7.20 ±1.72	12.23 ±2.96
Kherson	69.4	47.8	52.7	60.8	57.68 ±2.82	8.37 ±2.00	14.51 ±3.53
Victor	59.5	54.5	56.9	59.5	57.60 ±0.70	2.08 ±0.50	3.61 ±0.86
Regenerated Swed. Select	72.1	40.9	56.5	60.9	57.60 ±3.78	11.19 ±2.67	19.43 ±4.81
Senator	53.5	38.3	53.5	51.7	49.25 ±2.15	6.36 ±1.52	12.94 ±3.14
Average	66.4	49.9	59.6	61.8	59.46	6.74	11.42

The yearly yields for these eleven varieties are displayed graphically in Figure 59.

From Table 8 and Figure 59 the following points may be noted.

1. The highest average yield of any variety for the four years was 63.68 bushels for the Irish Victor. The imported Scotch ranked next with 63.08 bushels. The Lincoln and Prosperity yielded at nearly the same rates. The President and Banner gave 60.5 bushels. The Silver Mine, Kherson, Victor and Regenerated Swedish Select averaged to yield at a slightly lower rate. The Senator shows the lowest yield, 49.25 bushels.

2. The average yield of these eleven varieties for the four years was 59.5 bushels. In 1910 these same varieties averaged 66.4 bushels per acre; in 1911 they averaged 49.9; in 1912, 59.6 and in 1913, 61.8 bushels. Thus the best yield was obtained in the first year. Further an inspection of Fig. 59 shows that with one exception (Imported Scotch) each of these varieties yielded as well or better in 1910 than in any other year. There are several possible reasons for this. In the first place the 1910 plots were seeded with two bushels per acre by *measure,* while

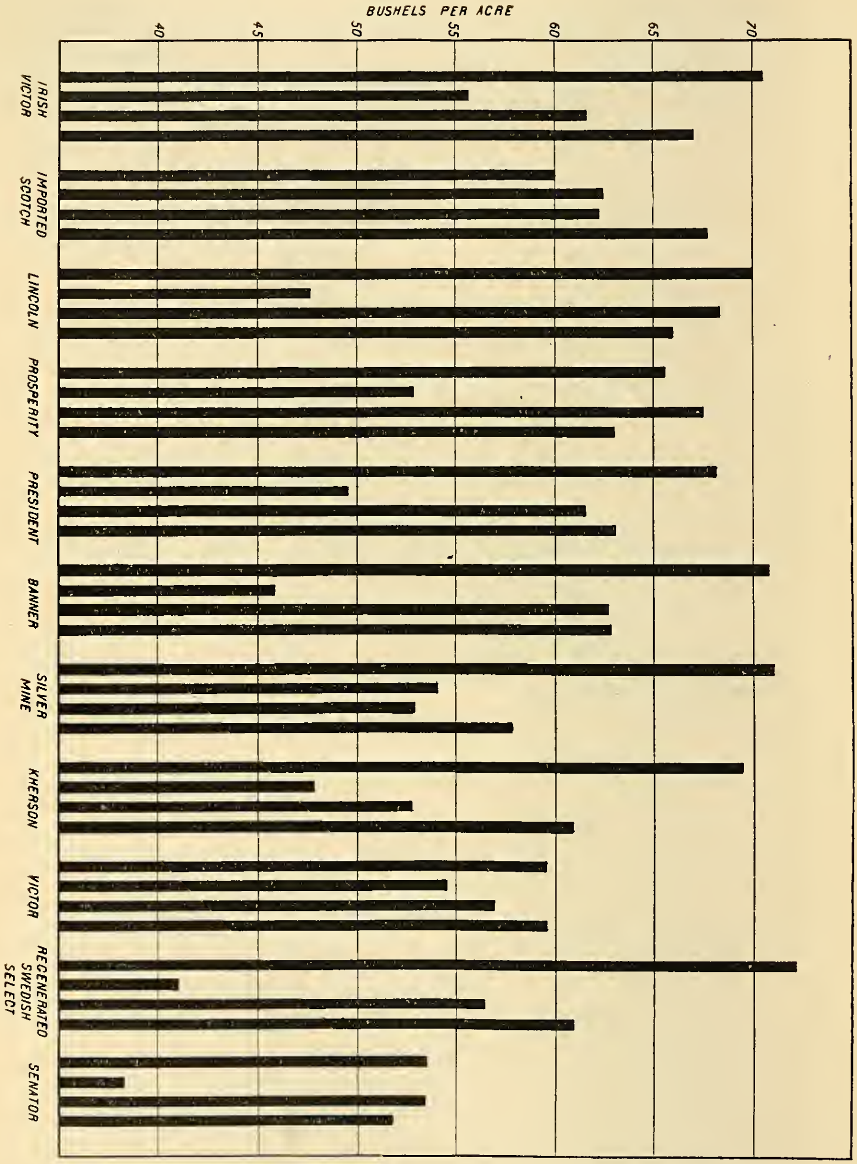

Fig. 59. Showing the yearly yield of grain for each of the eleven varieties tested for four years. The varieties are arranged in the order of their average yield for the four years.

in the remaining years the rate was two bushels by *weight*. It is possible that this difference in seeding accounts for the increased yield.

Another thing that may have influenced the yield is, that the seed of all these varieties was obtained in Canada and the Middle West. There is a persistent opinion among many farmers that foreign grown seed will yield better than home grown seed of the same variety. Where this question has been tested by experiments little or no grounds have been found for such a belief. For example the Iowa Experiment Station[12] tested twenty varieties by importing seed of each one, every year for three years and comparing with home grown seed. Their results show that on the whole the imported seed was no better than home grown. In fact the varieties usually did better after they had become acclimated by one or two seasons' growth in Iowa In view of these and other results we are not inclined to attach any significance to the suggestion that the better yields of 1910 were due to imported seed. As a matter of fact the results of the 1912 and 1913 tests contradicted this suggestion. The seven varieties imported from out of the state in 1912 all yielded very poorly in that year. In 1913, however, the majority of these varieties grown from our own seed yielded very well (cf. tables 5 and 6).

INTER- AND INTRA-SEASONAL VARIATION.

The question of the reliability of the results of a series of variety tests is one which has attracted more or less attention. Recently Harris[13] has proposed the inter-plot correlation as a measure of the reliability of such tests. However, it appears to us that the variation constants (standard deviation and coefficient of variation) together with the probable error of the mean give a very desirable measure of the confidence which can be placed in the average of a series of such tests. These constants together with the mean production form a very good guide as to the desirability of a given variety.

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[12]Burnett, L. C. Some Data for Oat Growers. Iowa Agr. Exp. Sta. Bul. No. 128, pp. 93-127, 1912.

[13]Harris, J. A. On the Significance of Variety Tests. Science, N. S., 36, pp. 318-320, 1912.

In the long run the most desirable variety is that one which will give a high yield under any of the conditions that are likely to be met with in any season. A variety which yields very highly in a favorable season may not be so desirable as one which yields moderately well every year regardless of the season. The standard deviation and the coefficient of variation as given in Table 8 measure the amount of variation in the yield of a given variety for the four years. We have already discussed the variation in the 1913 plots in connection with Table 7. In any one year all the plots are subjected to the same seasonal conditions. When the yields of several seasons are compared we are taking account of the effect of differences in the seasons as well as of differences in the soil. It will be of interest to compare the variation of the plots in a single season with the variation during several years. For this purpose we may compare the two coefficients of variation for the eleven varieties discussed above. These constants have been brought together in Table 9. The varieties are arranged in this table in the order of their variation coefficients for the yield of the four years.

TABLE 9.

Comparison of the Variation in Yield of the Plots in Four Different Years with the Plots in a Single Year.

VARIETY.	Coefficient of Variation for 4 years production.	Coefficient of Variation for the 1913 plots.	Difference.
Victor	3.61 ±0.86	11.42 ±2.76	-7.81 ±2.89
Imported Scotch	4.49 ±1.07	3.54 ±0.85	+0.95 ±1.37
Irish Victor	8.85 ±2.13	5.42 ±1.30	+3.43 ±2.50
Prosperity	9.02 ±2.17	7.96 ±1.91	+1.06 ±2.89
President	11.30 ±2.73	9.66 ±2.09	+1.64 ±3.44
Silver Mine	12.23 ±2.96	6.55 ±1.57	+5.68 ±3.35
Senator	12.94 ±3.14	24.51 ±6.19	-11.57 ±6.94
Lincoln	14.19 ±3.45	4.97 ±1.20	+9.22 ±3.65
Kherson	14.51 ±3.53	6.23 ±1.49	+8.28 ±3.83
Banner	15.05 ±3.67	12.41 ±3.00	+2.64 ±4.74
Regenerated Swedish Select	19.43 ±4.81	8.80 ±2.11	+10.63 ±5.22
Average	11.42	9.32	+2.20

From this table we may first discuss the variation coefficients for the yield of the four years as given in the second column. It will be noted:

1. That these coefficients vary from 3.61 percent to 19.43 percent. The average for the coefficients of the eleven varieties is 11.42 percent.

2. The Victor shows the lowest coefficient for the four years. The coefficient for the Imported Scotch is only slightly larger. These two varieties are by far the least variable in the four year test. So far as these data go they indicate that these varieties are much less affected by seasonal variations than any of the other varieties.

3. The Irish Victor and the Prosperity show roughly twice as much variation as the Imported Scotch.

The President, Silver Mine and Senator show variation coefficients in the neighborhood of 12 percent. They are nearly three times as variable as the Imported Scotch. The Lincoln and Kherson proved quite variable in the four year test with coefficients of over 14 percent. The Banner showed a variability of 15 percent of its mean, while the Regenerated Swedish Select gave a coefficient of 19.43 percent or more than 4 times as great as the Imported Scotch.

Comparing the coefficients of variation for the four years with those of the 1913 plots the following points may be noted.

1. The average coefficient for the eleven varieties is 2 percent higher for the four year yields than for the 1913 plots. Similarily with two exceptions (the Victor and the Senator) each variety shows a lower coefficient in the case of the 1913 plots. A difference in this direction is to be expected since, when all the plots are grown in one year, they are all subject to the same seasonal conditions. When different years are considered there are differences in the climatic conditions as well as in the soil. Hence it is to be expected that there would be a larger variation in the latter case.

2. The fourth column of Table 9 shows the difference between the two coefficients of variation for each variety. When the coefficients for the four years production is the greater the difference has been regarded as positive. From this column it will be seen that while the differences are often large numerically, in no case is a given difference as large as three times its probable error. It is customary in statistical work to regard the difference between two constants as not certainly significant unless the difference is at least three times its probable error.

Pearl and Miner[14] have recently pointed out that a deviation of three times its probable error may be expected to occur, on the basis of chance alone, more than 4 times out of a hundred trials. So that a deviation of even three times the probable error cannot be regarded as "certainly significant."

Consequently it is not possible to say of any individual variety that it is certainly more or less variable in the four year test than in the one year test. However, the fact that all but two varieties show a larger variability in the four year test and the fact that the sum of the plus differences is more than twice the sum of the minus differences tends to show that the results of tests made in different seasons are on the whole more variable than the results of tests made in a single year. As pointed out above this is what might be expected. Very probably a larger number of tests of each variety would show a significant difference in the coefficients.

3. The Victor which gave such a small variation in the four year test shows a very large variability in the 1913 plots. The difference between these two tests is 7.81 percent and the probable error of this difference is ± 2.89 percent. The difference is not quite three times its probable error and cannot be considered as certainly significant.

In the case of the Senator the variation in the 1913 plots is again greater than that of the yearly production. In this case the difference is 11.57 ± 6.94 percent. Here, while the difference is large, it is less than twice its probable error and cannot be considered as statistically significant. It is quite possible that the plots of these two varieties were distributed in very unequal soil in 1913 and hence that their variation is relatively much larger than it ought to be. The results of future tests will help to settle this question.

4. The Imported Scotch shows practically the same variability in both cases. The difference between the two coefficients is much less than its probable error. On the whole the Imported Scotch has been much less affected by environmental conditions, whether inter- or intra-seasonal, than any of the other varieties.

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[14] Pearl, R., and Miner, J. R. A Table for Estimating the Probable Significance of Statistical Constants. Me. Agr. Exp. Sta. Ann. Rept. 1914, pp. 85-88. (Bulletin 226).

In addition it is an excellent yielder. It ranks second in point of yield in the four year test.

So far as the results of these tests go the Imported Scotch has proved itself the most desirable variety of any tested for all four years.

B. VARIETIES TESTED TWO AND THREE YEARS.

There are eleven varieties that have been tested more than one year but less than four. It will be of interest to examine very briefly the average yields of these varieties and the amount of variation shown. Of course two or even three seasons is too short a time to judge the yielding ability of a variety. These data are given for what they are worth, simply an indication of what these varieties may do.

In Table 10 these eleven varieties are arranged in the order of their average yield per acre. The standard deviations and coefficients of variation have been calculated although in many instances the probable errors are so large that the constants have little meaning.

TABLE 10.

Yield of Grain, Varieties Tested Two and Three Years.

VARIETY.	BUSHELS PER ACRE.						Coefficient of Variation.
	1910	1911	1912	1913	Mean.	Standard Deviation.	
Early Pearl	–	–	64.2	69.7	66.9 ±1.31	2.75 ±0.93	4.11 ±1.39
Siberian	–	–	50.0	71.0	60.5 ±5.01	10.50 ±3.54	17.35 ±6.03
Minnesota No. 26	–	–	52.7	67.7	60.2 ±3.58	7.50 ±2.53	12.46 ±4.27
Gold Rain	–	–	53.8	65.2	59.5 ±3.20	6.70 ±2.26	11.26 ±3.85
American Clydesdale	–	55.0	54.5	62.8	57.4 ±1.48	3.80 ±1.05	6.62 ±1.83
Abundance	–	–	47.9	64.2	56.1 ±3.89	8.15 ±2.75	14.53 ±5.00
White Plume	–	–	44.1	63.4	53.7 ±4.60	9.65 ±3.25	17.97 ±6.25
Early Champion	66.1	39.1	50.4	–	51.9 ±4.31	11.07 ±3.05	21.33 ±6.14
Rebred 60 Day	–	–	47.5	54.4	50.9 ±1.65	3.45 ±1.16	6.78 ±2.30
Danish Island	46.7	47.5	57.7	–	50.6 ±1.95	5.01 ±1.38	9.90 ±2.75
Daubeney	–	–	43.3	52.2	47.7 ±2.10	4.40 ±1.48	9.22 ±3.14
Average	56.4	47.2	51.5	63.4	55.94	6.63	11.96

From this table it will be seen that the Early Pearl gave the best yield of any of these varieties. In fact its average for the two years of 66.7 bushels is larger than any of the four year averages in Table 8. It has given a better average for the two years that it has been tested than any other variety except the

Lincoln. Further it has shown very little variation in the two years. Its coefficient of variation, 4.11 percent, is practically the same as that of the imported Scotch for the four year period. All that can be said at present is that this is a very promising variety for our conditions.

A number of these varieties have averaged to yield very poorly. Four show an average yield of only about 50 bushels. Two of these varieties, the Early Champion and Danish Island, have been dropped from the test. The remaining two will be continued for comparative purposes.

Yield of Straw.

Varieties of oats differ widely in the amount of straw produced from a given area. Further there is a great difference in the relation of the amount of straw to the amount of grain. The most marked differences in the yield of straw are between the early and late varieties. While in many cases the early varieties are able to equal the later ones in the yield of grain they show a much smaller yield of straw. In the following paragraphs the average yield of straw for the varieties tested four years will be discussed. The data relative to the straw yield of the other varieties are given in Tables 3 to 6, but will not be discussed farther in this bulletin.

The data relative to the yield of straw of the eleven varieties tested for four years are given in Table 11. The means, standard deviations and coefficients of variation have been determined for each variety. This table also shows the number of pounds of straw produced for each pound of grain for the averages of the four years.

TABLE II.

Yield of Straw, Varieties Tested Four Years.

Variety.	Pounds of Straw per Acre. 1910.	1911.	1912.	1913.	Mean.	Standard Deviation.	Coefficient of Variation.	Lbs. straw to 1 lb. of grain.
Lincoln	2990.0	2425.0	2942.0	3160.0	2879.3 ± 92.6	274.48 ± 65.45	9.53 ±2.29	1.43
Banner	2485.0	3350.0	2573.0	2872.4	2820.1 ±114.0	337.98 ± 80.60	11.98 ±2.90	1.46
Irish Victor	3120.0	2795.0	2254.0	3005.2	2793.6 ±112.0	332.60 ± 79.32	11.91 ±2.88	1.37
Prosperity	2875.0	2860.0	2693.0	2635.2	2765.8 ± 35.0	103.86 ± 24.77	3.76 ±0.90	1.39
Regenerated Swedish Select	2842.5	2190.0	3308.0	2674.0	2753.6 ±134.8	339.76 ± 95.33	14.52 ±3.54	1.49
President	2617.5	2615.0	3183.0	2475.2	2722.7 ± 91.7	271.94 ± 64.85	9.99 ±2.40	1.41
Silver Mine	2780.0	2370.0	3378.0	2310.0	2709.5 ±144.4	428.24 ±102.12	15.81 ±3.86	1.44
Senator	2487.5	2975.0	2567.0	2685.0	2678.7 ± 62.4	184.98 ± 44.11	6.91 ±1.66	1.70
Victor	2615.0	2455.0	2673.0	2715.2	2614.6 ± 33.3	98.75 ± 23.55	3.78 ±0.90	1.42
Kherson	2502.5	2970.0	1826.0	2585.2	2470.9 ±138.9	412.02 ± 98.26	16.68 ±4.08	1.33
Imported Scotch	2430.0	2602.5	2085.0	2635.2	2438.2 ± 73.7	218.42 ± 52.09	9.96 ±2.15	1.21
Average	2704.1	2691.6	2680.2	2704.8	2695.2	278.46	10.35	1.42

The mean yield of straw of these varieties is displayed graphically in Fig. 60.

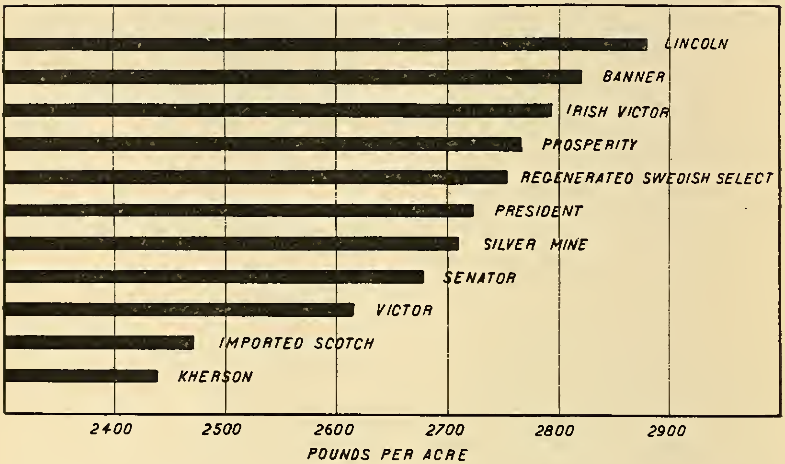

Fig 60. Showing the average yield of straw for the four years 1910 to 1913 inclusive.

From this figure it is seen that the Lincoln variety produced the largest amount of straw. The Imported Scotch and the Kherson produced the smallest amounts. Curiously enough the Victor which grows very tall produced a comparatively small amount of straw. Further this variety shows a very small amount of variation in respect to straw weight. Its coefficient of variation is 3.78 which is practically the same as its coefficient for yield of grain (Table 8).

The amount of variation in the yield of straw for the four years varies rather widely in the different varieties. The average coefficient of variation for all eleven varieties is 9.94 percent. Comparing with table 3 it is seen that these varieties are slightly less variable in respect to yield of straw than for yield of grain. The difference between the averages of the two sets of coefficients is 1.34 percent. This difference is subject to a rather large probable error and probably is of little significance.

The Prosperity and Victor show the smallest coefficients of variation for straw weight. The Senator comes next with a coefficient of 6.91 percent. The Lincoln and Imported Scotch have coefficients of 8.81 and 8.96 percent respectively. The Silver Mine and Regenerated Swedish Select proved to be the most variable.

In regard to the relation of straw to grain the average for all eleven varieties was 1.41 pound of straw to a pound of grain. The Senator gave as much as 1.7 pounds of straw to a pound of grain. On the other hand the Imported Scotch gave only 1.21 pounds and the Kherson 1.23 pounds.

VARIATION IN THE WEIGHT PER MEASURED BUSHEL.

In tables 3 to 6 there is given the weight in pounds of a measured bushel of each of the varieties that have been continued in the test. These weights were obtained by using an ordinary two quart standard grain tester. Further the determinations were all made by the same method and by the same person (C. W. Barber). It has recently been shown by one of us[15] that variations in the method of taking bushel weights may affect the result very materially. The method used in these varieties was to pour the grain into the tester, shake the tester five times and then stroke with a zig-zag movement. This method gives a slightly higher average weight (ca. 1.6 pounds per bushel) than the usual method but it has the great advantage of being subject to much less random fluctuation and hence a smaller probable error. (Cf. Barber *loc. cit.*).

It has further been shown that tested on 100 samples of Lincoln oats this method gave a standard deviation of $0.3245 \pm .0110$ pounds. On the basis of this result we would not expect to get deviations of more than one pound from the mean in either direction in any sample drawn from the same lot of seed and measured by this method. Consequently differences in the bushel weight of one pound or more indicate clearly a difference in the character of the oats.

In all cases the oats have been run through the fanning mill once before the bushel weights were determined. Of course it is not always possible to run different lots of seed, especially in different years, through the fanning mill in exactly the same way. However, it appears that only in exceptional cases would the difference in fanning make as much as one pound difference in the bushel weight of a given sample.

[15]Barber, C. W. Note on the Accuracy of Bushel Weight Determinations. Me. Agr. Exp. Sta. Ann. Rept. 1914, pp. 69-75. (Bul. 226).

We may next examine the data relative to weight per bushel on the eleven varieties tested for four years. The average weights per bushel for each variety and each year are brought together in Table 12. The means, standard deviations and coefficients of variation for the four year tests are also given. In the case of the 1912 crop the weight per bushel of the early seeded plots are given, rather than the average of the two plots for each variety. It has already been pointed out that the late seeded plots showed a much lower bushel weight than the early seeded ones. It is well known that the bushel weight of oats is very markedly affected by different climatic and seasonal conditions. Since the early seeded plots of 1912 correspond in time of seeding and other conditions with the plots of other years it seem desirable to use these rather than an average of the two.

TABLE 12.

Weight per Measured Bushel.

VARIETY.	POUNDS PER BUSHEL.						Coefficient of Variation.
	1910	1911	1912*	1913	Mean.	Standard Deviation.	
Regen. Swed. Select	44.0	42.8	43.3	35.1	41.30 ±1.21	3.60 ±0.86	8.71 ±2.09
Victor	41.6	41.7	42.9	36.8	40.75 ±0.79	2.34 ±0.56	5.74 ±1.37
Silver Mine	39.4	39.8	42.2	36.8	39.55 ±0.65	1.92 ±0.46	4.85 ±1.09
President	40.0	41.6	37.3	35.8	38.67 ±0.76	2.26 ±0.54	5.84 ±1.40
Prosperity	38.9	39.2	39.2	36.7	38.50 ±0.35	1.04 ±0.25	2.70 ±0.64
Lincoln	40.4	40.0	39.7	33.3	38.35 ±0.99	2.93 ±0.70	7.64 ±1.83
Senator	40.8	41.5	37.2	32.4	37.97 ±1.21	3.60 ±0.86	9.48 ±2.28
Banner	39.7	39.8	37.7	34.3	37.87 ±0.75	2.22 ±0.53	5.86 ±1.40
Irish Victor	37.9	36.9	39.0	36.1	37.45 ±0.38	1.12 ±0.27	2.99 ±0.71
Imported Scotch	34.8	36.4	36.7	34.9	35.70 ±0.29	0.86 ±0.21	2.41 ±0.57
Kherson	30.2	33.1	35.3	36.2	33.70 ±0.79	2.33 ±0.56	6.91 ±1.66
Average	38.88	39.34	39.14	35.30	38.16	2.22	5.74

*Early seeded plots only.

From table 12 it is seen:

1. That the average weight per bushel for all varieties for all four years is 38.16 pounds. The Regenerated Swedish Select and the Victor averaged to weigh the most per bushel. The Imported Scotch and Kherson show the smallest weight per bushel.

2. In the first three years there was very little difference in the average weight per bushel of these eleven varieties. The highest average was in 1911 (39.34 lbs.) and the lowest in 1910 (38.88 lbs.). The difference is less than one-half pound.

3. In 1913, however, there was a very decided drop in the bushel weight of all varieties except the Kherson. The average of all eleven varieties in 1913 was only 35.3 pounds. This is a decrease of nearly 4 pounds from the averages obtained in the other years. This decrease in bushel weight in 1913 is probably due to the seasonal conditions. The weather was very dry during the time that the grain was filling. Further the 1913 plots were on lighter soil which dried out more quickly than the plots of other years. It seems probable that these conditions caused the lighter weight.

4. It is of interest to note that the Kherson variety showed an increase in weight in 1913. This may be accounted for by the fact that the Kherson matures earlier than the other varieties and hence formed its grain before the dry weather.

5. It is further of interest to note that the Kherson oats show a progressive increase in the weight per bushel. In 1910 this variety weighed only 30.2 pounds per bushel; in 1911, 33.1; in 1912, 35.3 and in 1913, 36.2 pounds. Thus in 1913 the Kherson was among the heaviest oats grown. Whether this change is simply a fluctuation due to seasonal conditions or whether the variety is being changed by its growth under Maine conditions cannot be ascertained at present. It will be of interest to follow the bushel weight of this variety in later years.

6. The average standard deviation of these eleven varieties is 2.2 pounds and the average coefficient of variation is 5.74 percent. Comparing this coefficient of variation with those for grain and straw weight of the same varieties (Tables 8 and 11) it is seen that they are considerably less variable in bushel weight than in other characters.

7. The Senator and the Regenerated Swedish Select show the largest variability for the four years. The Prosperity, Irish Victor and the Imported Scotch show the least variability. In the latter variety the standard deviation is less than seven-eighths of a pound and is not beyond the limit of experimental error.

It is of interest that the Imported Scotch which was one of the least variable varieties in respect to other characters also shows the smallest variability in regard to bushel weight. In all of its characters this variety has proven itself to be one of those least affected by external conditions.

Summary and Conclusions.

The present bulletin is one of a proposed series of papers on breeding and inheritance in oats. This paper deals with the results of the tests of commercial varieties of oats which have been carried out during the past four years. The object of these variety tests is first to find out which of the more popular commercial varieties of oats are best adapted to our conditions and second to furnish material for further breeding operations with this crop.

These variety tests have been carried on for four years. It is realized that this is too short a time to draw final conclusions regarding the comparative value of the varieties. However, the data already obtained offer certain indications which should be of much value to those farmers who are looking for better varieties than they already have.

In the present bulletin the character of the soil and the methods of growing and handling of the crop are discussed in detail. The source and the chief characters of each variety used are given. A more detailed description is given of some of the more important varieties.

In 1910 and 1911 each variety was grown on a single one-tenth acre plot. In 1912 duplicate one-tenth acre plots were used. In 1913 each variety was grown in four one-fortieth acre plots. These plots were distributed over the field in a regular manner so that differences in the character of the soil were more evenly distributed among the different varieties.

Tables 3 to 6 inclusive give the detailed data regarding each plot grown. For the years 1912 and 1913 the averages of the several plots of each variety are also given.

During the four years, thirty-four differently named varieties have been tested. In some instances several strains of the same variety have been tested. In most instances such strains differed very markedly from each other in their yielding abilities. For example as shown in Table 3, four strains of the

Banner variety were tested in 1910. These strains came from widely separated provinces in Canada. The strains from Alberta and Saskatchewan yielded much better than the strains from Ontario and New Brunswick.

Of the eleven varieties which have been tested for all four years the Irish Victor gave the best average yield (63.7 bushels per acre). The Imported Scotch, Lincoln and Prosperity averaged to yield at nearly the same rate. The Senator, a horsemane oat, with very coarse straw and large plump grains, gave the lowest average yield (49.3 bushels).

A study of the variation constants (standard deviation and coefficient of variation) for the four year period shows that the Victor (a black oat) and the Imported Scotch were by far the least variable of any of the varieties tested. This indicates that these varieties are much less affected by seasonal differences than the others. Further as shown in Table 7 the Imported Scotch shows less variation between its four plots in 1913 than any of the other varieties. Consequently the present data indicates that the yield of this variety is less affected by environmental conditions than that of the other varieties tested.

It is pointed out in this paper that the variation constants measure a very important character of a variety. A variety which will yield very highly under favorable conditions but very poorly under unfavorable ones is not so desirable in the long run as a variety which will yield moderately well under any of the conditions that are likely to be met in any season. Further the variation constants and the probable errors calculated with their aid give a very desirable measure of a series of tests.

The yield of straw and its variability in the four years is discussed. Also the relation between the amount of straw and the amount of grain is shown in Table 11. The Lincoln, Banner, and Irish Victor gave the largest average yield of straw. The Imported Scotch, Kherson and Victor gave the smallest amounts of straw. The Senator and the Regenerated Swedish Select gave the largest proportion of straw to a given weight of grain.

while the Imported Scotch gave the smallest relative amount of straw.

The weight per measured bushel is shown in Table 12. The Regenerated Swedish Select and the Victor gave the highest average weight, about 41 pounds per bushel. The Kherson and the Imported Scotch gave the lowest weight per bushel. These were still well above the legal weight of 32 pounds. It is of interest to note that the Kherson shows a progressive increase in its weight per bushel for the four years that it has been grown in this state.

In addition to the eleven varieties tested for four years, three varieties have been tested for three years; eight varieties for two years; and one variety for one year only. Two or even three years is too short a time to get a reliable measure of the yielding ability of a variety. However the data for the yields of these varieties are summarized in Table 10.

Of the eight varieties introduced in 1912 seven were from Canada and the middle west. None of these varieties gave satisfactory yields in 1912 although a number of them did very well in 1913. The eighth variety, the Early Pearl, originated in Maine and it yielded very well the first year.

These data indicate that possibly there is an advantage in having varieties that are acclimated to the conditions under which they are to be grown.

Of the varieties which have been tested for four years the Irish Victor, Imported Scotch, Lincoln and Prosperity have made the best showing. With the exception of the Imported Scotch there appears to be but little choice between these varieties. The Imported Scotch has shown much less variability in respect to all its characters (with the exception of straw weight) than any of the other varieties. This is true both of inter-and intra-seasonal variation. Under the conditions of seeding and growth at Highmoor this variety can be expected to produce a little over 60 bushels per acre every year. The chief objections to this variety are its relatively small weight per bushel and the yellow color of its grain. This latter objection is not very serious although yellow oats do not meet with so much favor on the market as the white varieties.

The other three varieties named above are more variable in their characters but nevertheless they appear to be very well adapted to our conditions.

Of the varieties tested less than four years the Early Pearl appears to be the most promising. The Siberian and Minnesota No. 26 also yielded very well in 1913.

It is expected to continue these tests and to publish the results from time to time. The performance of these varieties will form a standard with which the yield of new varieties originated in our breeding work may be compared.

BULLETIN 230.

THE RHIZOCTONIA DISEASE OF POTATOES.

W. J. Morse and M. Shapovalov.

The fungus formerly known as *Rhizoctonia solani* Kühn, more recently as *Corticium vagum* var. *solani* Burt and considered by some writers as identical with *Hypochnus solani* P. & D. is a common inhabitant of New England potato soils. In fact its occurrence is so universal that it is practically impossible in most localities in this part of the country, with which the writers are familiar, to examine a barrel of potatoes without finding from a few to many tubers carrying at least some sclerotia of the Rhizoctonia stage of the fungus. Fig. 61 shows a potato so affected. Every housewife who prepares potatoes for the table is familiar with the fungus in this form, but the sclerotia are commonly considered to be closely adhering particles of black soil which for some reason are difficult to wash off from the surface of the potato. The fact that these hard, brownish or black, often flattened, closely appressed bodies, which vary greatly in size and shape, are made up of closely interwoven threads of a fungus which serve as a means of carrying this fungus over winter and of distributing it from place to place, is not generally understood by those who grow potatoes or prepare them for the table.

While the appearance of such potatoes is affected and extra labor is required to wash them, the sclerotia are entirely superficial and not even the skin of the tuber is injured. Although Rhizoctonia has been classed as an active parasite of the potato in some localities in this and other countries the senior writer has, in the past, shared the opinion of certain other students of the subject with whom he has conferred that it is not an important factor in the production of potato diseases in New England. Work which we have done and observations which we have made recently in Maine, particularly during the past year, however, lead us to the conclusion that a more extended study of the subject will show that this position is by no means in accord with the facts. The significance of these observations and of the results of the experiments here reported is more evident when the latter are considered in connection with some of the previous work in this country upon the parasitism of the same fungus or closely related species. No attempt is made, however, to review the literature upon Rhizoctonia as a whole.

Previous Studies in America upon Plant Diseases Caused by Rhizoctonia.

The first important report on the economic aspects of Rhizoctonia in America is that of Pammel (10) in 1891, who studied a beet root-rot in Iowa which he stated was caused by *Rhizoctonia betae Kühn* (*R. solani* Kühn). The following year Atkinson (1) published the details of certain studies and experiments in which he showed conclusively that a sterile fungus was the cause of "sore-shin" or damping off of cotton in Alabama. Later, in 1905, the same writer (2) found a similar parasite causing a damping off of beans, lettuce, radishes, egg plants and cabbages in New York. Duggar (4) in 1899 reports Rhizoctonia as the cause of beet root-rot in New York and also as producing a damping off of beet seedlings, lettuce, beans, radishes, cucumbers and occasionally many other seedlings, as well as a crown rot of radishes.

A very important contribution to the literature upon Rhizoctonia as a cause of plant diseases in America is that of Duggar and Stewart (5, 6) which appeared in 1901. They showed that this fungus attacks a large number of different hosts, including some 30 species of cultivated plants in the United States. Their conclusions regarding its parasitism are briefly stated in the following paragraph quoted from the summary:

"Rhizoctonia is the cause of a destructive root-rot of the sugar beet, a destructive stem-rot of the carnation, a leaf-rot of greenhouse lettuce, a leaf-rot of ornamental asparagus, and a root-rot of the carrot; and is of common occurrence on the stems and tubers of the potato. It is a frequent cause of damping-off of various seedling plants, such as beet, carnation, celery, lettuce, cabbage, etc. It is also the suspected cause of disease in the bean, rhubarb, cotton and some other plants. Further observations will probably show that many other plants are infested by it."

Speaking specifically regarding Rhizoctonia on the potato they mention the fact that while a disease caused by *Rhizoctonia solani* Kühn has long been common in Germany and known under the name of "Grind" or "Pockenkrankheit" so far as they have been able to ascertain there was no record of the occurrence of the fungus as a parasite upon the potato in America. Their observations did show that potatoes in the United States may be quite generally infested by a species of

Rhizoctonia. Their discussion leads the reader to infer that at that time they considered this occurrence of the fungus on the potato in this country as of minor economic importance. However, they mention one instance observed by Mr. F. M. Rolfs where there was good evidence that the fungus killed a considerable number of potato plants.

Rolfs (11), working in Colorado in 1902, was the first to demonstrate conclusively that Rhizoctonia may be responsible for a serious disease of the potato in the United States. The importance of this and a later publication (12), as bearing upon potato diseases in other parts of the country, apparently has not been fully appreciated by American phytopathologists. This is doubtless due to the fact that they felt that in the irrigated districts of Colorado Rolfs was working under conditions somewhat dissimilar to those which obtain in other potato growing sections and, therefore, would be liable to encounter difficulties which would not be expected elsewhere.

The first publication was simply a preliminary report in which he points out some of the important characteristics of the disease and presents certain evidence tending to show that Rhizoctonia is the cause of conditions observed. It does, however, contain many observations which he was able to confirm later, and which the present writers have been able to duplicate in Maine under decidedly different conditions with regard to soil and moisture. Cases are reported where the plants were apparently thrifty and gave promise of an abundant yield, but at harvest time only a few potatoes were found in a hill. Less frequently the plants set an abnormally large number of tubers and these were small and clustered near the surface of the ground, giving rise to the term "Little potato disease." Another characteristic was the formation of aerial tubers or the production of green, tuber-like out-growths in the axils of the leaves and branches above ground. The author claimed that these conditions resulted from the attacks of the fungus upon the parts of the plants below ground. He also stated that the young plants were often severely injured or even killed before they reached the surface.

In the second report already mentioned Rolfs gives the results of additional studies upon the life history of the fungus, the nature of the injuries upon the host, factors concerned in the spread and propagation of the disease, methods of control, etc. Perhaps the most important contribution made in this paper was the publication of the discovery of the Corticium or fruiting stage of the fungus.

Laboratory studies showed that to grow best the fungus required plenty of moisture and a temperature equivalent to that which is experienced out of doors in mid-summer. Likewise, according to Rolfs experience, the disease was more virulent where the ground was wet and soggy. This taken in connection with other field observations led him to suggest that over-watering the plants in the irrigated districts materially increased the severity of the attacks of the fungus.

As regards preventive measures Rolfs found that treating the seed with corrosive sublimate gave marked gains where the crop was raised in new ground. Less favorable results were obtained with formaldehyde, and neither coating the seed with sulphur nor applying lime to the soil at the rate of 3,000 pounds per acre produced any apparent beneficial effect.

About the same time that Rolfs was working on the Rhizoctonia disease of the potato in Colorado, Selby (13) was making similar studies in Ohio. Selby was attracted by certain above-ground signs of disease of potato plants in various parts of that state. He states that for at least 3 years previous to the publication of his paper complaints had been received of the early dying of potato plants, apparently from some disease below ground, before the formation of many tubers. A prominent characteristic of the affected plants was an excessive branching and in general a conspicuous clustering of these branches or of the terminal leaf groups. This condition or appearance he designated as "Potato Rosette." While recognizing that other below ground injuries of the stem might produce similar effects on the tops he was satisfied that the rosette appearance of the foliage was associated with or a secondary effect of the attacks of the Rhizoctonia fungus on the parts of the plants below ground similar to those described by Rolfs.

Selby also carried on experiments to test seed disinfection as a means of preventing the disease. These, apparently conducted on a smaller scale, gave quite different results from those obtained by Rolfs with regard to the relative efficiency of corrosive sublimate and formaldehyde as is indicated by the following quotation:*

"The warranted conclusion, drawn from the tests of two seasons with formalin and the extended work of many seasons at the Station with corrosive sublimate seed treatment appears to be that the corrosive sublimate seed treatment does not prevent the rhizoctonia disease to any appreciable extent, while the formalin seed treatment, as shown conspicuously by the study of the growing plants and usually in the yields of tubers, does prevent the disease to a very marked extent."

Clinton (3) in 1904 mentions the occurrence of the fungus on potatoes in Connecticut. After examining several potato fields he says: "Apparently the plants did not suffer so severely from the fungus as some writers claim elsewhere. However, the relative injury caused here by the fungus is a subject which needs further attention, since the parts attacked occurring under ground the injury and cause may easily escape notice."

Orton (9) in 1909 states that Rhizoctonia causes a stem blight of potatoes and a surface cracking or russeting of the tubers in heavy western soils, particularly San Joaquin County, California.

Güssow, the Dominion Botanist of Canada, in his report of 1912 (8) gives a summary of the important characteristics of the Rhizoctonia disease of the potato but does not state where or to what extent it occurs in Canada, in conversation with the senior writer after the above was written Prof. Güssow stated that the disease is common in various

* p. 58.

parts of Canada, producing injuries on the growing stems similar to those observed in Maine. He does state that in his experience the fruiting stage of the fungus is not abundant but some good specimens have been obtained from British Columbia and Alberta.

An experiment where seed tubers bearing numerous sclerotia of the fungus were soaked in corrosive sublimate and formaldehyde and then planted at the Central Experimental Farm is described. Judging from the numbers of sclerotia observed on the crop in the fall, corrosive sublimate, used at one-half the strength usually employed, was decidedly more efficient than formaldehyde. The crop obtained where the former was used was practically clean while that produced where the formaldehyde treated seed tubers were planted was almost as badly covered with sclerotia as the original lot of potatoes used for seed.

Recently Gloyer (7) has made a comparative study of the efficiency of formaldehyde solution, formaldehyde gas, and corrosive sublimate for disinfecting seed tubers affected with Rhizoctonia. His conclusions were that neither formaldehyde gas nor formaldehyde solution can be depended upon to kill all of the Rhizoctonia sclerotia but, "The standard corrosive sublimate treatment is thoroughly efficient. Even with a 1 to 2,000 solution (half standard strength) all Rhizoctonia sclerotia are killed."

Rhizoctonia as a Cause of Potato Disease in Maine.

As has already been pointed out, potatoes in Maine, in common with the rest of New England and apparently many other parts of the United States, frequently show the so-called "black scurf" or the sclerotia of the Rhizoctonia fungus upon their surfaces. In fact the fungus is common and widespread in the State and probably does not cause a great amount of damage except to certain varieties of potatoes and in certain types of soil. However, complaints have been received from time to time, more especially from the southern and central portions of the State, regarding poor and uneven stands of potatoes, unexpected low yields, sometimes associated with "early ripening" or death of the tops from no apaprent cause but resembling an abnormally early maturity. Undoubtedly these various troubles result from a variety of causes, depending upon the conditions. Some of these the writers have recognized for a number of years, but the fact that Rhizoctonia is a factor, and often a very important factor in the production of certain of the conditions mentioned has been largely overlooked until recently.

Ever since Highmoor Farm in Monmouth came under the control of this Station several acres of potatoes have been grown each year up to the present. The Green Mountain, a late variety, has produced some large and very satisfactory crops on this farm, even in relatively dry seasons.

There is at present a large and constantly growing demand for Maine grown seed potatoes of early varieties like the Irish Cobbler for southern planting. Much trouble has been experienced in the past in getting a sufficient supply of this seed stock which is free from the germs of blackleg and which does not contain mixtures of late varieties like the Green Mountain. It has been maintained at this Station that these difficulties could be overcome by a little careful work and that once the Irish Cobbler seed was freed from mixtures and blackleg it could be kept pure at practically no expense. Largely for this reason a change was made to the early variety for the main crop on the farm and the results obtained as far as the original object was concerned were entirely satisfactory.

However, the crops of Irish Cobbler obtained, even with the best of care and spraying, have been disappointing from the standpoint of final yield of tubers. As a rule this has not equalled the average production for the same variety in the better potato producing sections of the State and at first this was attributed to the fact that the central part of the state is frequently subject to a period of mid-summer drought which is seldom the case in the more favored potato regions of the north, which also have the advantage of a soil of greater water-holding capacity. This is no doubt a contributing factor but it is by no means the primary cause of the low yields as the following discussion will show.

The crops for the past two seasons were much below the average, although the appearance of the fields in each case to the casual observer was most promising up till a few weeks before this variety would normally reach maturity. In fact an experienced farmer on seeing the 1913 field early in August stated that it was the best appearing field of Cobblers which he had seen that year.

In 1912 nothing wrong was noted with the plants until the tops suddenly died late in August following a period of dry weather. Our attention was not called to this field until the plants were practically all dead, and when examined there was considerable evidence of flea-beetle injury and some early blight caused by *Alternaria solani.* Although the field had been well sprayed with bordeaux mixture it was thought that the early dying of the tops might be the combined results of the factors mentioned. While the possibility of some below ground trouble was suggested Rhizoctonia was not considered.

When dug it was found that the tubers produced on the field in question averaged small and that many of them showed varying amounts of Rhizoctonia sclerotia upon their surfaces. However, neither of us had an opportunity to make a detailed examination of them. A barrel of the cleanest tubers which could be storted out were shipped to Orono to be used as seed in the greenhouse for growing plants for various experimental purposes during the winter.

Even with this selected seed it was found that when the tubers were planted in the greenhouse in pots of steam sterilized soil the sprouts frequently failed to reach the surface. Examination showed that such sprouts were usually strong and vigorous when they started but later they had either been partially or wholly cut off. Fig. 62 shows a single sprout from an uncut tuber planted in a pot of sterilized greenhouse earth. It will be noted that it is entirely cut off at the base and another, smaller lesion occurs near the apex. These lesions in such cases were brown in color and more or less covered with coarse, brownish fungous threads, apparently Rhizoctonia. Both colorless and brown threads were observed.

The stems of young potato plants grown in the greenhouse from this seed frequently showed an abundance of the fruiting or Corticium stage of the fungus. This consisted of a whitish to yellowish gray felt, sometimes rather delicate, growing up around the base of the stem. As a rule this growth extended but a short distance above the surface of the soil, but in some instances it ran up 4 or more inches on the stems and leaf petioles and lower sides of the leaf blades. Fig. 64 illustrates an instance of this kind, the lighter color of the under sides of the 3 lower leaves being due to a dense coating of the fungous threads.

Lesions similar to those described later as occurring below ground on plants in the field were, in some instances, found on plants in the greenhouse. Frequently plants were noted which produced apaprently healthy and normal tops, except there was a tendency to form tuber-like outgrowths in the axils of the leaves and branches, particularly the lower ones. Examination showed that the fungus had attacked the tuber-bearing branches of the stem below ground and cut them off before or soon after the tubers had set. This resulted in stimulating the plant to produce tubers or tuber-like outgrowths close to the surface or above ground. Fig. 68 shows the base of such a plant grown in a 10-inch flower pot.

Field Studies and Observations.

The behavior of plants in the greenhouse, even when grown from samples of the cleanest tubers produced on the field of Irish Cobblers in 1912, furnished a clue to the cause of the difficulty that season. Accordingly about two acres of the original field was replanted in 1913 with seed tubers produced on the same land the year before, in order to provide an opportunity to study conditions with regard to the crop throughout the summer. The seed tubers were treated with formaldehyde for scab the same as had been done in 1912. In fact an effort was made to have conditions as nearly like those of the previous season as possible except that the crop was being planted the second time on the same land.

Brown lesions of various sizes began to appear on the sprouts below ground soon after they started from the seed-pieces However, the injury did not begin soon enough or was not severe enough to prevent many of the sprouts reaching the surface. About the same time Mr. C. A. Day discovered a field of potatoes in the eastern part of Washington County where the same disease occurred. Fig. 63 is a reproduction of a photograph of a potato seed-piece found on this field by Mr. Day. This seed-piece had 3 sprouts and when received one was entirely killed and half of it gone, another was practically dead, and a third so badly injured that it would never reach the surface of the ground.

Early in July on the field at Highmoor Farm, the plants averaged 6 or 8 inches high after having been covered twice in cultivation. As a whole they appeared strong and healthy above ground, but one or two per cent of them extended but slightly or at the outside not over two or three inches above the hills made by the cultivator and horse hoe. Except that they were much below the average in size some of these plants were normal in general characteristics, but many of them had begun to show some evidence of disease in that they were slightly yellowish in color or at least lighter green than normally, often having the beginning of a rossette appearance of the leaves. Frequently these might readily pass from outward appearances for plants suffering from an early attack of blackleg.

An examination of such plants showed that their stems were invariably diseased below ground. These stems which at first had been kept covered as fast or faster than they grew, by the method of cultivation or hilling, had blanched so that they were nearly perfectly white. As a result the lesions produced by the fungus stood out in marked contrast on this background. Frequently, even though the crown of leaves on the shoot appeared green, the stem would be so nearly cut off that it would be impossible to remove the plant from the row without having it break off. Figs. 65 and 66 illustrate the appearance of some of the plants at this stage. Other instances were found where one or more shoots from a seed-piece would reach the surface of the soil before becoming badly diseased while other sprouts from the same seed-piece had been killed back entirely soon after they were put forth. In this connection it may be mentioned that several bags of tubers produced on the field in 1913, after having stood in a warm cellar for some time, were examined by the writers in the spring of 1914. At this time the tubers bore sprouts from two to six inches long. A considerable per cent of these sprouts showed lesions similar to those observed on shoots in the soil the year before and in many instances the sprouts had been entirely killed. Both in the field and in the sacks the lesions on the shoots and sprouts were plentifully covered with the threads of the Rhizoctonia fungus which could be made out readily by the aid of a small hand lens. As a rule the healthy shoots and sprouts did not show the presence of these threads upon their surfaces. However, cases were observed in the field, much more frequently on the Green Mountain than on the Irish Cobbler and more especially on plants which showed the Corticium stage above where the filaments of the fungus grew up over the parts below ground without any apparent injury to them.

Plants attacked by Rhizoctonia at the stage described above may be readily distinguished from those affected by blackleg when they are dug up. The latter always show inky-black discolorations of the stem and the disease always starts at the bottom at its junction with the seed-piece and works upward through the stem. In the case of the Rhizoctonia trouble the diseased areas are brown in color, may occur anywhere on the stem below ground, and work from the surface inward. In later stages, where the attacks of Rhizoctonia have not been sufficiently severe to cause the early death of the plant a large part of the surface of the diseased stems below ground may become browned.

About the middle of July a large number of hills, so selected as to give as accurate sample as possible of the entire field, were uncovered in an endeavor to estimate the per centage of plants affected at that time. Fully 50 per cent showed the slightly sunken, brown lesions, overrun with Rhizoctonia threads, varying in size from a mere dot to those which covered from two-thirds to three-fourths of the under-ground surfaces of the stems.

A similar examination was made on August 4, taking care that a different but equally representative lot of plants was selected. By careful estimate 91 per cent of the stems showed evidence of the attacks of the Rhizoctonia fungus below ground. (Only about 17 per cent of the Green Mountain plants on an adjoining portion of the same field at this time showed evidence of similar lesions below ground. Here the attacks were not serious and apparently the damage was slight. The latter conclusion was confirmed when the crop was dug). At this time the plants were large and the tops nearly covered the ground. The gaps made by the previous death of the more severely attacked plants were entirely obscured by the growth of the others. To the average observer this looked like a healthy and exceedingly promising potato field. A careful inspection revealed the fact that slightly abnormal plants, showing a clustering of the leaves or a suggestion of a rosette effect were by no means uncommon.

In many instances the stems gave evidence of partial recovery as the plants grew older, the lesions appeared to be healed, showing simply a dark, russeted surface. In more severe cases, but not severe enough to cause the death of the entire shoot, side branches were thrown out below the severed portion of the stem which, on reaching the surface, developed into normal tops. How deceptive such plants may be with regard to the parts below ground is well shown in Fig. 67. One of the stalks, at least, the tops of which were removed before photographing appeared strong and vigorous, but such a hill could produce no merchantable potatoes.

The evidence obtained at this second examination of the parts below ground indicated that the fungus had little effect on the older and more woody portions of the stems. As the plants grew older it confined its attacks to the younger and more succulent parts, particularly the young, tuber-bearing stolons. Many instances were observed where these stolons were killed and the young tubers cut off from the parent stem almost as soon as formed, or before they had attained any material size. Frequently cases were found where the disease spread back along the stolons and attacked the young tubers.

Regarding the ability of the potato Rhizoctonia to attack healthy plants Gloyer makes the following statement:* "That a wound appears to be necessary for the fungus to enter the tissue is suggested by Clinton's observations. He has found the 'inconspicuous grayish mealy growth' of the Corticium or fruiting stage on the stalks of the potatoes near the surface of the ground, and no injury was done to the stem at that point." After looking up Clinton's article the writers feel that Gloyer has misinterpreted Clinton's meaning and has drawn an inference which was not intended. The Corticium stage occurs above the surface of the ground and so far as we have observed is never associated with a stem injury at that point. In fact all injuries of the stem which we have attributed to Rhizoctonia have occurred below ground. Plants showing the Corticium stage were numerous on the field in question in August 1913 and the same thing was frequently observed in the greenhouse, either on plants from infected tubers planted in steam sterilized soil or on those from clean seed in sterilized soil and the soil later infected either directly or indirectly through attempts to inoculate parts of the plants with pure cultures of the fungus.

* l. c. page 419.

We have found that potato stems showing the Corticium stage usually, but by no means always, present some evidence of at least old lesions somewhere on the parts below ground. We have some reason for thinking that the Corticium stage may occur with considerable regularity on the stems of the more resistent varieties of potatoes without any evidence of injury. This, however, in no way weakens the contention that the fungus may be and is, under certain soil conditions and with certain varieties of potatoes, an active and very injurious parasite.

During the latter part of August the potatoes on the field under consideration began to take on an appearance similar to normal ripening and this developed with considerable rapidity so that by September 8 all the plants were dead. Different parts of the field had been sprayed differently and a portion was only sprayed with an insecticide to kill the potato beetles. The strip which received no fungicide lived nearly as long as one which had been sprayed with bordeaux mixture every 10 days or two weeks after about the first of July, using 4 spray nozzles per row and applying over 200 gallons per acre at each application. Hence the early death of the tops could in no way be attributed to attacks of leaf diseases. Moreover, the adjoining field of Green Mountains, which showed a much smaller percentage of plants attacked by Rhizoctonia, and none of these severely, remained green till frost came a month or more later.

The crop of Irish Cobblers was harvested as soon as possible after the tops died and at this time a careful study was made of the effects of the fungus upon the tubers. The most striking characteristic to be noted by the casual observer was the abnormal number of small potatoes produced. Hills were frequently found where the yield was similar to that shown in Fig. 69. Apparently tubers of all sizes, varying from those just formed to those weighing half a pound or more were cut off from the main stem by the fungus. As has already been stated, in many cases the fungus followed along the tuber bearing branches of the stem and attacked the young potatoes themselves.

The appearance of such tubers was very characteristic. The lesions were at the basal ends and always surrounded the point of attachment of the tuber with the stolon. In mild cases there was simply a browning of the surface closely resembling the beginning of late blight or Phytophthora decay. This browning varied from a circle around the stem a centimeter or less in diameter to a large, discolored area covering the entire basal end of the tuber. The lesions were dry in nature, and in the more advanced stages brownish black in color, and more or less covered with Rhizoctonia filaments. The fungus appeared to be entirely superficial. As far as could be judged by microscopical examinations it did not penetrate beneath the skin to any extent. Occasionally discolored streaks following the line of the vascular bundles penetrated the flesh for a short distance but not trace of fungus mycelium could be found in them

A much more serious or advanced form of the injury of the stem end of the tuber was of frequent occurrence. On such cases after the branch stem is killed back to its junction with the tuber there begins a progressive degeneration or necrosis of the tissues of the latter from this point in all directions, forming deep cavities, sometimes two or three centimeters in diameter and extending a like distance into the flesh of the potato. This is well shown in Fig. 70. Here again the fungus does not penetrate deeply into the tissues. The interior of the cavity is lined with a dark, brown colored material which appears to be made up of interwoven masses of Rhizoctonia filaments and the remains of dead cell walls which show more or less corky developments, mixed with large quantities of free starch, which latter appears to be entirely unchanged. This form of the disease need not be confused with the decay of the stem end of the tuber caused by the blackleg organism.

The fungus appeared to be able to attack tubers independent of infection spreading from the stem. The lesions thus produced may be divided roughly into 3 different groups, two of which, and possibly all 3, are stages of the same thing. One of these is characterized by a pronounced russeting of the skin over areas of varying dimensions, leading into a corky development somewhat resembling common potato scab. The potato may largely recover from these attacks, the corky layer slough off, or be easily rubbed off, leaving slight oval depressions covered by healthy skin which had formed beneath the cork. These resemble quite closely the healed wounds on tubers which have been eaten by white grubs.

The second form of injury no doubt is a more severe stage of the first. In this the surface of the potato becomes diseased over large areas and growth on the surface is checked. The tension of the expanding tissues beneath ruptures the surface, eventually forming large cracks. These cracks enlarge as the potato grows and the fungus spreads over the tissues thus exposed and doubtless assists in enlarging and deepening them. Finally the potato becomes badly deformed and misshapen. Specimens of this form of the disease which were not especially common are shown in Fig. 71.

Still another form of the disease starts, apparently, from the lenticels. A critical examination of potatoes from a large number of sources, including those from other states, has convinced the writers that it is fairly common. Ordinarily this is an oval pit from 3 to 5 millimeters in diameter as shown in Figs. 72 and 73. It usually contains a mixture of corky remains of dead cell walls, free starch and Rhizoctonia filaments. This pitting was first noted in making a critical examination of a large number of different samples of potatoes received from different parts of the country as illustrating forms of potato scab, particularly abnormal types, in the localities from which they came.

Potatoes affected in this way and received from Nebraska and Wisconsin were planted in the greenhouse in pots of sterilized soil and the crop produced later showed different stages of the formation of the pits and the close association of Rhizoctonia with them. The young tubers showed small holes, apparently formed at the lenticels and largely filled with Rhizoctonia filaments. The tissues lining the pits were dark brown and water-soaked in appearance. Pure cultures of Rhizoctonia were obtained from the pits in the young tubers produced in the greenhouse. This, however, was previous to undertaking most of the work here recorded, particularly the greenhouse studies described in a later section.

Potatoes from the field under consideration frequently showed the pitting in various stages of development at harvest time. A study of the development of these pits, as shown by these different stages, showed plainly that they were not of insect origin. The beginning of a pit was indicated in tubers at harvest time by a slight circular browning in the region of the lenticel. Microscopic examination of these spots, as small as they could be detected on the surface, invariably showed them to be made up of brown, collapsed cell walls and free starch with Rhizoctonia filaments running through the mass.

As the diseased area increases it becomes slightly depressed and brown in color. Usually the margin is somewhat more sunken, forming a sharp boundary line between the healthy and affected tissue. Occasionally diseased areas like this will reach the size of from two to five millimeters in diameter without any other superficial change. More frequently the tissues surrounding the lenticel begin to shrink away, leaving an opening in the center of the diseased area. This may widen out into a broad, shallow pit or if the disease penetrates any depth into the flesh it may develop into a canal leading from the center of the affected area on the surface. Such canals are popularly supposed by the farmers to be the work of wire worms or some other animal pest, but the canals are quite different from those made by wire worms.

A distinct wall of rather firm texture exists at the junction of the diseased and healthy tissue. This is firm enough so that when the tubers have been dug a few weeks if the point of a knife is placed under one edge the entire diseased area can be removed occasionally intact, leaving simply a clean pit in the healthy tissues. When the tubers are boiled the firmness of this lining of the pits or canals is still more apparent for they readily pull out and remain firmly attached to the skin when the later is removed.

Rolfs (12) mentions that the Rhizoctonia stage produces two kinds of mycelium, one light and one dark. The latter, he says, develops deeper in the tissues, is more actively parasitic and frequently produces a wet rot of the stem in old seed tubers. We have observed no wet rot or decay of potato plant parts whatever that we could attribute to Rhizoctonia. However, it should be noted that our observations were made under quite different soil conditions. Rolfs was working in the irrigated districts of Colorado, and attributed much of the trouble to over-watering, resulting in the soil becoming wet and soggy. The land on which our most careful field observations were made was a well-drained loam with some mixture of sand. At no time during this season till after the crop was harvested did this field suffer from an excess of moisture, but, on the other hand, the moisture supply was deficient during a good part of July and August.

Greenhouse Experiments.

Mention has already been made of certain results secured in the greenhouse. The details of this work were mostly carried out by the junior writer but the observations were carefully checked by both of us. While these experiments are not as extended in some instances as might be wished, they do in a large measure confirm and extend the observations made in the field. Their chief value lies in the fact that they were conducted under the control conditions and that all inoculation experiments of growing plants and other tests, the nature of which made this precaution necessary, were carried on in pots of soil that had been thoroughly sterilized with steam under pressure of at least 20 pounds. In growing plants for inoculation experiments seed tubers were used which showed no evidence of Rhizoctonia on their surfaces, but as a further precaution were disinfected before planting.

Soil inoculation. Three series of pots containing a dozen or more in all were inoculated by burying just beneath each seed tuber small sclerotia or masses of fungous threads from pure cultures of Rhizoctonia. In no case did the fungus seriously attack the young plants or young tubers but numerous sclerotia were found on the latter when harvested. In a similar experiment described later and designed to test the effect of lime on the soil more positive results were obtained both with limed and unlimed soils. In the last mentioned test the more recently isolated culture of the fungus appeared to be more virulent. It is possible that in the experiments described above the strain used had been so long in culture that it had lost its virulence.

Inoculation of young, growing tubers. Young, growing tubers on plants in pots were inoculated with pure cultures in several instances. In some cases the surfaces of the tubers were first injured by pricking with a sterilized needle and in others small masses of the fungus mycelium were simply laid against the uninjured skin. Regardless of the manner of inoculation all plants inoculated in this way developed cases of

Rhizoctonia injury similar to that observed in the field, including typical lesions on the stems below ground and on the basal ends of the tubers.

About a month after the plants came up large clusters of small tubers could be seen just at the surfaces of the pots and in one case aerial tubers were formed in the axils of the leaves to a considerable height. It is of interest to note that this particular plant was inoculated without any injury to the stem or tuber. Check plants, the tubers of which were both punctured and untouched, remained healthy.

Inoculation of young, living potato stems. On account of limited space in the greenhouse only 3 pots were used in this experiment. When the young plants had reached the height of from one to one and one-half inches above the soil in the pots they were uncovered to their junction with the seed-piece and small particles of pure cultures of Rhizoctonia were applied to the surface of the base of the shoot, after which the stem was carefully recovered with soil. After two months the plants were dug up and examined. One was apparently healthy while the others showed the characteristic clusters of numerous, small tubers close to the stem at or near the surface of the soil. One of these showed the typical brown lesions on the stem below the surface.

Planting diseased tubers in sterilized soil. Whenever diseased tubers or those showing Rhizoctonia sclerotia were planted in sterilized pots of soil the fungus practically always appeared on the growing plant or tubers in some form or other. In such instances tubers bearing sclerotia were produced almost invariably. Stem lesions, clusters of little potatoes near the surfaces of the pots with or without browning of the surface of the stem end of the young tubers or other injury usually occurred. Less frequently, though by no means uncommonly, the Corticium or fruiting stage of the fungus appeared on the plants in the greenhouse.

Attempts were made on a small scale to determine if particular forms of the disease could be transmitted to the crop. That there was a possibility of this was indicated by the results obtained when the tubers from Nebraska and Wisconsin were planted. In one instance a badly pitted tuber of the type already described on page — was planted in one pot and in another, one which was a typical specimen showing the decay or necrosis at the stem end with more or less cracking of the surface. The plants were dug up and examined about 4 months after planting. The tubers produced in each case were small, deformed and grouped in clusters close around the stem, largely above the surface, with some of the aerial tubers or tuber like outgrowths in the axils of the leaves and branches. The plant obtained from the pitted tuber was the less severely attacked of the two. In both cases the surfaces of the young tubers showed the characteristic browning and necrosis at the stem end, but no pitting or cracking was observed.

Three tubers of a long, slender, purple-skin variety of potatoes, variety unknown, but locally known as "Blacks" were obtained in Lewiston at the meeting of the Maine Seed Improvement Society in December, 1913. These were covered with pits filled with Rhizoctonia threads and dead tissue. These tubers were cut into 3 pieces and planted, making 9 pots in all. When the plants were mature there was no evidence of pitting on the crop produced, but many of the tubers were covered with Rhizoctonia sclerotia.

It will be seen, therefore, that what little experimental evidence we have been able to secure by planting pitted tubers or other tubers affected with Rhizoctonia, except in the case of the tubers obtained from Nebraska and Wisconsin, fails to support the assumption that Rhizoctonia is the cause of the pitting. However, it must be remembered that the character of the soil and the conditions under which the potatoes were grown in the greenhouse in the experimental tests were quite different from those where this form of the disease was observed in the field. Moreover the appearance of the pitting only in the presence of other injuries plainly due to Rhizoctonia would seem to indicate that this fungus is in some way directly or indirectly the cause of it. In the field, as has already been described, the formation of a pit could be traced in various stages from its beginning at a lenticel infected with a few threads of the fungus. At the same time it is recognized that the presence of considerable quantities of Rhizoctonia filaments constantly associated with the pits is by no means conclusive evidence that it is the primary cause of their formation. In this connection the experiments described in the following section are of interest.

Inoculation of tubers after digging. The writers have frequently observed dead, spongy areas beneath spots of the so-called common potato scab, extending in some distance from the surface. These spots varied from light to dark brown and Rhizoctonia filaments were constantly observed in microscopical mounts of the diseased tissues. Quite recently a large quantity of potato tubers, obtained from many different localities in the State of Maine, have been examined for various tuber diseases. Several cases were observed where a dry, spongy rot had developed over half an inch under the apparently uninjured skin. Many of these tubers were plainly affected with the dry rot caused by Phytophthora. However, when portions of the decayed tissue showing the other type of rot were removed from the interior of these spots, under aseptic conditions, and placed in plates of potato agar pure cultures of Rhizoctonia developed in 4 out of 6 instances.

In order to test the ability of the fungus to attack potato tubers after they had been removed from the soil, 10 clean, sound, healthy tubers about two inches in diameter were thoroughly washed, wet with full strength hydrogen peroxide for about 3 minutes, well rinsed in sterilized water and then treated as follows. Slight punctures were made on one side of each of 5 tubers with a sterilized needle and small masses of the fungus from pure cultures were laid on the surface over the punctures. Check punctures were made on the opposite side of each tuber to which nothing was applied. Five other tubers were inoculated in the same way except that the material was simply laid over a lenticel without puncturing the skin. The potatoes were then placed in a covered jar without providing additional moisture.

In 3 days a distinct, discolored and somewhat sunken area could be seen around a part of the punctures to which the fungus had been applied. At the end of one week one of these discolored areas around a puncture had attained a diameter of 6 millimeters. In two weeks this was only slightly larger, two others were somewhat over 3, while a fourth was about two millimeters in diameter. The surface of the diseased area was smooth, somewhat sunken with a slight ridge at the junction with the healthy skin. The latter surrounding the sunken spots was somewhat puckered, due to the shrinking of the tissues beneath. The fifth inoculated puncture developed no decay. These and the other inoculated tubers were later placed in a moist chamber but no more injury developed. No decay or discoloration appeared on the check punctures or where the fungus was placed on the surfaces over lenticels.

We have, therefore, been unable to present any conclusive evidence that Rhizoctonia produces a true decay of stored or growing potatoes. However, on the latter in the soil after the tubers had been cut off from the parent stem a distinct necrosis of the surface which works slowly inward, often producing deep cavities in the basal end is by no means uncommon in severe attacks of the disease.

Experiments with germicides and disinfectants. Field experiments with germicides and disinfectants both upon soil and seed are now under way. The present discussion will, however, be confined to certain rather limited greenhouse experiments. A review of the previous work on formaldehyde and corrosive sublimate as a means of disinfecting seed tubers for Rhizoctonia has already been given and it has been shown that data obtained to date indicate that corrosive sublimate is the more effective of the two. Our own experience in using sterilized soil in the greenhouse indicates that formaldehyde is of some value but even under the best of conditions was not always effective.

In one lot of 40 ten-inch pots of soil sterilized for two hours at 20 pounds steam pressure, planted with formaldehyde disinfected potatoes which had been first thoroughly washed and a large percentage of the sclerotia removed, the crop produced in two of these pots showed Rhizoctonia sclerotia on their surfaces. In another case out of 25 pots one plant developed the Corticium stage of the fungus on the stem.

Six tubers badly covered with sclerotia were selected and planted in sterilized soil after first disinfecting 3 of them with formaldehyde in the usual manner. In both lots bad cases of the disease developed. The yield consisted exclusively of little potatoes, close to the surface and covered with sclerotia. One plant from each lot of disinfected and undisinfected tubers showed typical stem lesions below ground and one plant from each series produced the Corticium or fruiting stage above ground.

In another trial formaldehyde was much more effective. In this test 6 tubers badly covered with the sclerotia and 6 badly pitted were used. Three of each lot were disinfected with formaldehyde before planting in the pots of sterilized soil. The untreated tubers in each case produced potatoes covered with sclerotia, some of them seriously deformed, some russeted and a part showed the "little potato" characteristics of the disease. The disinfected tubers produced a crop nearly free from sclerotia and free from other characteristics of the disease except for some slight russeting of the tubers.

A number of different tests were made where a considerable number of medium sized sclerotia were removed from the surface of potatoes and soaked for one hour in 1 to 1,000 and 1 to 2,000 corrosive sublimate and 1 to 240 and 1 to 480 of 40 per cent formaldehyde. In no case did any of these sclerotia germinate on being transferred to plates of potato agar after first being rinsed in distilled water, while untreated sclerotia soaked in pure water for an equal length of time grew vigorously in every instance.

Lime has been recommended for treating soil for Rhizoctonia but this was not found to be successful by Rolfs. To test this in the greenhouse under control conditions 12 pots of sterilized soil were planted with clean tubers. Lime was added to 6 of them at the rate of 3,000 pounds per acre. Previous to planting a mass of the fungus from a pure culture was placed in the soil in each plot just below the seed tuber. Two different strains of Rhizoctonia were used, one isolated the year before and one recently obtained.

Two of the tubers in the lime pots failed to grow and entirely decayed. The remainder produced a crop no better than that where the lime had not been applied. In all cases the new tubers were small, deformed, blackened or browned at the stem end, and more or less russeted. The potatoes were more seriously affected where the more recently isolated strain of the fungus was introduced into the pots.

Economic Importance of the Rhizoctonia Disease of Potatoes.

A large part of the foregoing discussion has been based upon observations made on one field with one variety of potatoes. Also most of the greenhouse experiments were made with the same strain of Irish Cobblers produced on the field in question during two different seasons. If the disease occurred in this State with equal severity generally, especially in the sections largely given over to potato raising, the growers would have long since gone out of business and Maine would not hold the position which it now has as a potato producing State. However, this does not mean that what we have described is necessarily an isolated case, although it is undoubtedly more severe than the average. The writers predict that a more thorough study of the situation with regard to Rhizoctonia in New England and other parts of the country will show that it is by no means a negligible factor as a cause of potato diseases in the United States.

By the nature of its attacks Rhizoctonia produces a most insidious type of potato disease. In cases like the one described not enough plants are killed outright before they reach the surface to excite suspicion on account of the missing hills. The one or two per cent of plants which early in the summer are seen to be much under average size are accounted for as due to "weak stock" or it is explained that these are the plants where the seed-pieces fell with the eye down. Except to a critical observer the majority of the plants may appear normal and unless a period of dry weather occurs they may look reasonably healthy and vigorous nearly or quite to the average time of harvest, when the owner discovers for the first time that something is wrong.

While no other case has been seen where the disease was so common and widespread as on the field at Highmoor Farm during the summer of 1913, it has been found to some extent in quite a percentage of the fields of Irish Cobblers which have been examined in the central and southern parts of the State during the past two seasons. Judging from yet too limited observations upon which to base definite conclusions the disease does not occur as generally or in so severe a form in Aroostook County as in some sections farther south. Observations made and specimens collected by Mr. C. A. Day and Mr. M. D. Jones, in charge of farm demonstration work for the College of Agriculture in Washington and Penobscot Counties, would seem to indicate that it is widespread and common in some parts of the State and is no doubt an important factor in cutting down the yields of Irish Cobblers in this section. It is well known that yields of Irish Cobblers are frequently disappointing farther west in the central part of the State, where good crops of Green Mountains and certain other late varieties are secured without difficulty. No doubt climatic conditions have something to do with this but there is every reason to believe that Rhizoctonia contributes its share in bringing about these undesirable results the same as it did at Highmoor Farm, which is located in the same section.

That there is considerable difference in the resistance of different varieties of potatoes to the disease and possibly a difference in the resistance of different strains of the same variety is indicated by our somewhat limited observations upon this phase of the subject. Just what varieties are the most susceptible and what are the most resistant remain to be determined. That soil conditions are important factors with reference to the virulence of the attacks of the fungus seems probable but just what these conditions are is also unknown.

Preventive Measures.

The main object of the present publication is to prove that Rhizoctonia is a real, though previously largely unrecognized, cause of potato disease in the East, that at times with certain varieties and under certain soil conditions it may become of considerable economic importance, and to point out the prominent characteristics by which it may be recognized. While field and greenhouse experiments are being conducted along the line of preventive measures we have secured no results which add to the knowledge of this phase of the subject. Any advice as to control measures then must be based upon previous work or consist of recommendations of a more or less general or empirical nature.

The first thing to do is to determine by examination of germinating and growing plants whether or not the fungus, which is common in most potato soils, at least where potatoes have been grown for any length of time, actually causes any material injury to the varieties grown, under the soil conditions which exist. If not it may be ignored unless one is growing seed potatoes for a trade which requires seed free from the fungus. If the latter is the case or trouble is experienced from the disease, a supply of seed tubers which show no evidence of sclerotia of the fungus on their surfaces should be secured, if possible. For a seed disinfectant before planting, corrosive sublimate should be used. This has certain disadvantages but it appears to be the most effective agent for destroying the fungus upon the tubers that has yet been found and it is equally as efficient as formaldehyde for treating potatoes for scab. No doubt the fungus lives over year after year in the soil without the presence of a crop of potatoes for it readily grows as a saprophyte and is a parasite on a wide range of unrelated hosts. However, rotation of crops and allowing as long a time to elapse as possible between successive crops of potatoes is desirable. Planting crops of potatoes on the same land two years or more in succession should not be practiced.

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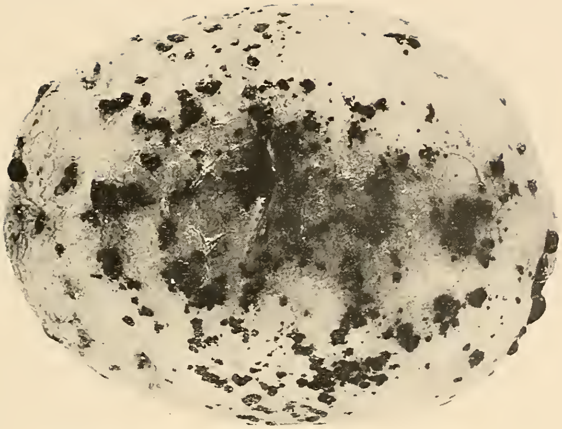

FIG. 61. Potato tuber showing "black scurf" or sclerotia of Rhizoctonia.

FIG. 62. Potato tuber planted in the greenhouse. The base of the single sprout is entirely destroyed and a second lesion has appeared near the apex.

Fig. 63. Potato seed-piece the sprouts of which have been killed by Rhizoctonia before reaching the surface of the ground.

Fig. 64. Young potato plant upon which the Corticium stage of the fungus occurred. Note the growth on the under sides of the 3 lower leaves as well as upon the base of the stem.

FIG. 65. Young potato plant showing lesions produced on the stem below ground early in the season.

FIG. 66. A more advanced and a more severe case of the same form of Rhizoctonia stem-injury as shown in figure 65.

FIG. 67. Base of potato plant showing lateral branching and partial recovery following the killing of the top of the original sprout early in the season. The tops, which were removed before photographing, were nearly normal in size but the plant would produce no merchantable tubers.

FIG. 68. Clusters of tubers formed at the surface of the ground after the parts below had been badly injured by Rhizoctonia.

FIG. 69. A typical hill of potatoes showing the "little potato disease."

Fig. 70. Necrosis of the stem end of the tuber following bad attacks of Rhizoctonia on the parent stem.

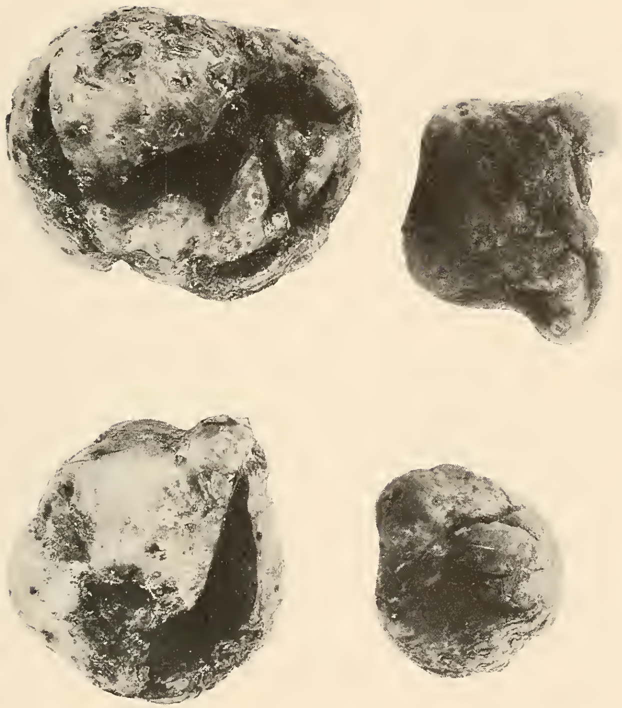

FIG. 71. Splitting and cracking of the tubers following severe attacks of Rhizoctonia.

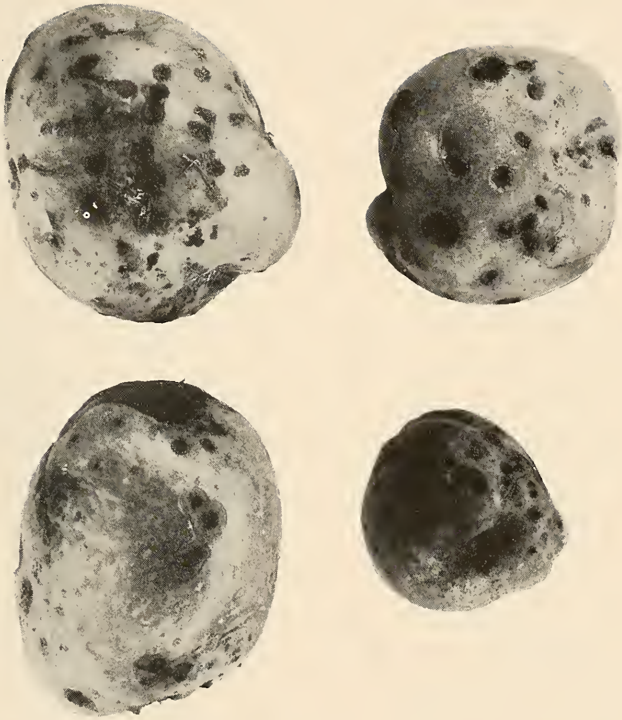

Fig. 72. Pitting of the tubers which is frequently associated with bad cases of Rhizoctonia injury on other parts of the plant.

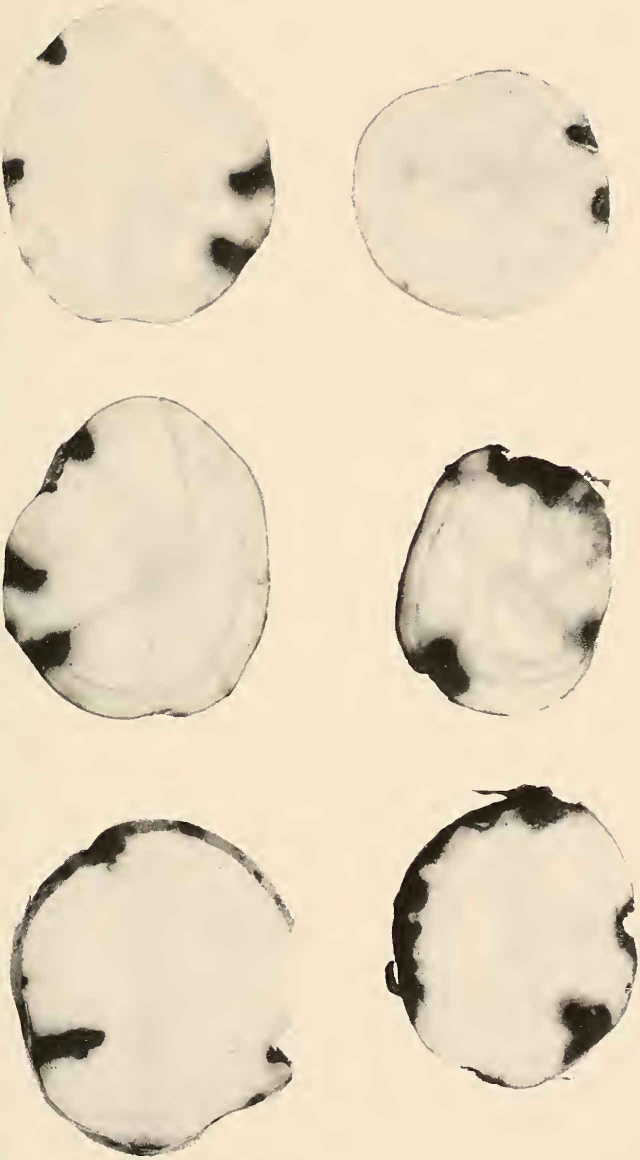

Fig. 73. Cross sections of tubers through the pits.

BULLETIN 231.

IMPROVING EGG PRODUCTION BY BREEDING.[1]

By RAYMOND PEARL.

It is safe to say that never has there been so keen and widespread an interest in the improvement of poultry in respect to egg production as exists at the present time. All over the world poultry keepers are waking to the fact that some hens lay more than others; that it costs no more to hatch, rear and care for those which lay more; and that they want this sort in their flocks.

There would seem to be little doubt that this awakening is due in considerable degree, at least, to the rapid development during the last ten years of egg laying contests in different parts of the world. We are indebted for the inauguration of such contests on a large scale to the enterprise of the Australians. In recent years we have seen their development in this country. It seems likely that we shall see a much further growth of the laying contest idea in the United States, as well as in European countries. To be sure some writers for the poultry press, who apparently see little or nothing of value in laying tests of any sort, have been predicting that the laying competition has about run its course, and that the end is now in sight; that we are, in point of

[1]The substance of this paper was presented as an address to the American Poultry Association at its annual meeting in Atlantic City, August 13, 1913. The address as originally read has been widely published in the poultry press. For some time past the Maine Agricultural Experiment Station has anno.nced that there would be published a popular discussion of the scientific results regarding the mode of inheritance of egg producing ability set forth in Bulletin 205. It has seemed best to meet the demand for such a publication by taking as a basis the Atlantic City address and adding to it such amplifications and illustrations as seem to be necessary. This accordingly has been done in the present bulletin. The fact that the material was put into form originally for the purpose of the spoken address, accounts for the personal style.

fact, witnessing its last decline before utter extinction. Unprejudiced observation, however, would seem to indicate that these contests make a strong appeal to the poultry public. It is difficult to conceive of any single measure better calculated to arouse general interest in poultry keeping and to call attention to the results which follow good care and breeding. In other words, the educational value of laying contests would seem to be beyond question. That they can be so conducted as to contribute to existing knowledge of the laws of egg production also is beyond doubt. I have recently had the opportunity of examining the detailed plans for the conduct of a series of such laying competitions, which are to be undertaken, with government subsidies, in two European countries. There can be no question that these plans, if carried out, will contribute materially to scientific knowledge of the laws of egg production.

Underlying the immediate stimulus afforded by the laying contest are to be found two fundamental reasons for the present interest and activity in the direction of improving egg production. These are:

(a) The poultryman's belief that egg production is an inherited character. In holding this opinion he is certainly correct. One might indeed, say "knowledge" instead of "belief" here.

(b) His belief that any character which is inherited is capable of improvement by intelligent breeding. Again, this belief is entirely well founded, provided only that an exception be made for characters (if there are any such) in which all possible improvement in innate hereditary constitution has already been made.

Egg Production is Inherited.

To say, as we have above, that "egg production" is an inherited character is not quite enough. This might be taken to mean only the fact that the mode of reproduction characteristic of birds, which is to say reproduction by means of eggs with albuminous and calcareous envelopes—is an innate and hereditarily fixed matter in the fowl. But the poultryman is interested, as well as the investigator in the field of genetics, in something more than this. He wants to know whether the *differences* which he observes in egg-laying capabilities amongst different breeds, or flocks, or finally individuals, are inherited. General observations indicate to the poultryman that at bottom the foundation of a great many of these differences in laying ability with which he is familiar is heredity. But how? And under what limitations? For plainly this is not a simple matter. If it were, none of our hens now would ever lay less than 200 eggs per annum, except in the case of remote back woods regions, where the gospel of the trap-nest had not yet penetrated. Trap-nest selection of high preducers has opened the eyes of the poultryman to one thing certainly, even though it may have obscured his vision in other directions. This thing which is clearest is that all high-producing hens are not equally capable of transmitting this valuable quality to their progeny. So that while it may be perfectly certain that the difference between a 200-egg producer and a 50-egg producer is in some way or other an hereditary difference, we shall not get far towards a practical utilization of this fact until we know something more about its nature.

So, then, the first essential step to be taken towards the improvement of egg production by breeding is to find out the way in which variations or differences in producing ability are inherited. For some six years past considerable attention has been devoted to this problem, with results which have been set forth in detail in a series of papers from the Biological Laboratory of the Maine Agricultural Experiment Station. Of the more recent of these papers is Bulletin 205, which has the title "The Mode of Inheritance of Fecundity in the Domestic Fowl." This bulletin is technical in character. It was not written for the poultryman but for the professional student of genetics. On this account it has apparently not been quite clearly understood by some poultrymen, and the results and conclusions have, in some cases, been misinterpreted. It will be the endeavor here, as briefly as possible, to make clear the essential results of these studies.

Facts about Inheritance of Fecundity.

First as to the facts: The following are simple statements of the actual results, obtained in trap-nesting Barred Plymouth Rocks and Cornish Indian Games, and all possible sorts of crosses between these breeds, over a period, collectively, of nearly fifteen years. The total number of birds involved in these trap-nesting operations has been large, aggregating, all told, between five and six thousand individuals. Out of these records, the following facts clearly appear.[2]

1. The record of egg production of a hen, taken by itself alone, gives no definite, reliable indication from which the probable egg production of her daughters may be predicted. Furthermore, mass selection on the basis of egg laying records of females alone, even though long continued and stringent in character, failed completely to produce any steady change in type in the direction of selection.

2. Differences in egg producing ability are, in spite of the above results, certainly inherited. There are two lines of evidence showing that this is the case. The first is that derived from the general observation that there are widely distinct and permanent (under ordinary breeding) differences in respect to egg laying ability between different races, strains and breeds of fowls. In the second place, a study of pedigree records of poultry at once discovers blood lines in each of which a definite particular degree of egg producing ability constantly reappears generation after generation, the "line" thus "breeding true" in this particular. With all birds kept under the same general environmental conditions such a result can only mean that the character is in some manner inherited.

3. The number of visible oöcytes on the ovary bears no definite or constant relation to the actually realized egg production.

4. This can only mean that observed differences (variations) in actual egg production depend upon differences in the complex physiological mechanism concerned with the development of oöcytes, and the separation of them from the ovary and the body (laying).

For reasons which cannot be gone into fully here on account of lack of space, attention has been focused during the later phases of the study, on winter egg production.

Primarily these reasons are two: first, that winter production is economically the most important in the case certainly of poultrymen in northern latitudes; and second that winter production gives a more accurate and reliable measure of the bio-

[2]More detailed discussion of these results, together with direct references to the evidence on which they are based will be found in Bulletin 205, pp. 377-391.

logical variable which it is desired to measure—namely the maximum innate ability of the individual to produce eggs—than the record over any longer period.

The first of these points has never been in dispute. Regarding the second there has been a good deal of doubt on the part of some students of trap-nest records. They argue that because they find now and then a case which seems to them an exception to the general rule that the pullet winter production is correlated with total production, that therefore winter production is not a reliable measure of fecundity. It is pointed out that a bird which produces no eggs, for example, in her pullet winter period sometimes makes a very high two year or three year record.[3] This may certainly happen but it has no particular bearing on the general point at issue. These seems to be a misunderstanding or confusion of thought more or less widely prevalent with reference to what it really is that one *wants* to measure by means of trap-nest or milk scale, as a guide to breeding orperations. I may perhaps make the point here clearer by concrete illustration. Any poultryman knows that by damp, dark, unventilated houses, unpalatable and improper good, fed in insufficient amount he can prevent the finest laying strain in the world from producing many eggs. Yet clearly no one would accept a trap-nest record made under such circumstances as measuring the bird's inherent capacity as a layer. What it is really desired to know about, however, is just this *inherent capacity*. One wants to be able to know, that, for example hen A is a good layer, while hen B is a poor layer, *when both are under the absolutely most favorable circumstances for egg production* in every particular, so that full opportunity shall be given for every innate inherited *potentiality* to come to actual, visible expression. But plainly the longer the time unit chosen for the record, the more impossible it becomes even measurably to approach the continued realization of the "absolutely most favorable conditions" for egg produc-

[3]But why stop at two or even three years? *Every single one of the arguments* to the effect that a three year record is a "better" measure of a hen's fecundity than her pullet winter record, can, *with even greater force*, be used to defend the thesis that a twenty year record is a "better" measure than a three year one, hens having been known to produce eggs up to that age.

tion. The shorter the time unit the more nearly possible will it be to realize these conditions over the period of the test. It is, in this regard, exactly with the hen as with the cow, where the recent researches of Gavin[4] as well as those of Wilson,[5] have demonstrated most clearly that the most adequate time unit for the measurement of a cow's innate milk producing ability taking all things into account is *not* the year test, nor the 30 days test, nor even the 7-day test, but the *one* day test when production reaches its maximum. This (revised as suggested by Gavin) gives us the measure of what each cow is hereditarily and physiologically *capable* of doing if the attendants, the weather and every other external relation, will do their parts.

We have then to choose a particular short period for getting our reliable measure of a hen's fecundity. Why take winter production? Because, in a word, it is in this period that the *differences* in innate reproductive capacity between different individuals are most strongly marked.[6] It is probable that a shorter and earlier period would furnish a still better measure of innate fecundity than the winter period, particularly as the environmental conditions in mid-winter are not the best. For practical purposes, the poultryman who operates his trap-nests after the fall and early winter months, is paying a high price for knowledge which is of very little use to him from the

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[4]Gavin, W. The Interpretation of Milk Records. Jour. Roy. Agr. Soc., Vol. 73, 1913.

Studies in Milk Records: The Influence of Foetal Growth on Yield. Jour. Agr. Sci., Vol. V, 1913, pp. 309-319.

Studies in Milk Records: On the Accuracy of Estimating a Cow's Milking Capability by Her First Lactation Yield. *Ibid,* Vol. V, pp. 377-390, 1913.

[5]Wilson, J. The Inheritance of Milk Yield in Cattle. Proc. Roy. Dublin Soc., Vol. XIII, pp. 89-113, 1911.

The Elimination of the Unprofitable Cow. Jour. Dept. Agr., Ireland, Vol. XIII, No. 4, 1913.

[6]It may be noted here that the writer's conclusions on the above point have been independently confirmed by Professor James Wilson and Miss Murphy, working upon Irish laying records (cf. Jour. Dept. Agr. Ireland, Vol. XIV, No. 2). The results of the English Utility Poultry Club's 12-month laying competition at Harper-Adams College also show clearly the importance of the early fall and winter laying as a measure of innate fecundity.

breeding standpoint. The intelligent breeder trap-nesting his flock not over three months in the year, can make practically just as rapid progress in breeding for increased egg production as his neighbor who trap-nests twelve months in the year.

To return from this digression to the main line of discussion, it will be remembered, then, that in what follows reference will be to *winter* egg production unless the contrary is specifically stated.

5. It is found to be the case that birds fall into three rather well-defined classes in respect to winter egg production. These include (a) birds with *high* winter records, (b) birds with *low* winter records, and (c) birds which do not lay at all in the winter period. The division point between *a* and *b* for the Barred Plymouth Rock used in these experiments falls at a production of about thirty eggs.

The next step is to inquire for each of these classes separately how egg producing ability is inherited within the class. We may first deal with high production.

6. High productiveness may be inherited by daughters from their sire, independent of the dam. This is proved by a mass of detailed evidence, presented in the complete paper. This evidence consists of the results of mating after mating, in which the same proportions of daughters of high laying ability are produced by the same sire, whether he is mated with dams which are poor layers or with dams which are high layers.

7. High laying ability is *not* directly inherited by daughters from their dam. This is proved by a number of distinct and independent lines of evidence, of which the most important are: (a) that continued selection of high producing dams does not alone alter in any way the mean egg production of the daughters. If an alteration does appear in any case following such selection, further analysis shows that some additional element other than the dam's egg record came into account in making the selections of breeders. (b) The proportion of high producing daughters is the same whether the dam is of high or of low fecundity, provided both are mated to the same male; (c) the daughters of a high producing dam may be either high layers or poor layers, depending upon their sire; (d) the proportion of daughters which are medium or poor layers is the same whether the dam is a high or a poor producer, provided both are mated to the same male.

8. Mediocre or poor laying ability may be inherited by the daughters from either sire or dam, or both.

Now, all of these eight points are merely statements of fact. They are the results which any intelligent person who examined our extensive trap-nest and pedigree records would be bound to reach. They depend in no way upon any "theory" of inheritance. I can assure those to whom Mendelism is as the proverbial red rag to the bull that nothing which has been said so far is even to the slightest degree tainted with this dreadful (?) doctrine.

Suggested Mendelian Interpretation of Facts.

An isolated fact does not alone contribute to the body of organized knowledge known as science. Its relation to other facts must first be understood. Now, the facts regarding egg production which have been set forth above, do, as a matter of fact, accord in a remarkably clear manner with a Mendelian interpretation of the inheritance of fecundity in the fowl. Such an interpretation has been worked out in detail in Bulletin 205. Through this interpretation this isolated group of facts is brought into relation with a much wider range of facts about inheritance in poultry and other animals. In this way we are better able to understand (in light of present knowledge) the meaning of our facts, and, on this basis, make plans for investigations which shall take us again a little farther into the realm of the unknown, beyond the boundaries of our present knowledge.

But what is the good of all this? How is it going to help John Smith to win the first prize in an egg laying competition? It must be said at the outstart that, much to my regret, neither the facts nor their Mendelian interpretation, will furnish any neat little rule-of-three whereby all John Smiths can win all first prizes. Successful poultry breeding will continue in the future, as it has in the past, to demand a lot of intelligence, thought, skill and rationally directed effort. I hope and believe, however, that the results discussed above may be of some help in efforts to improve egg production by breeding. It is farthest from my desire to claim too much for them, but I do think they help us a little in certain general directions. In the first place these results, by showing that the inheritance of egg producing ability is not a simple, uncomplicated transmission of something from dam to daughter without change, make it somewhat easier to bear the disappointments which attended devotion to the gospel of the trap-nest, in its original inspirational form. In the second place, they help us to make a more just and adequate distribution of emphasis on the different basic elements of a systematic plan for the improvement of poultry in egg production. Finally, by furnishing a generalized mode of interpretation of observed results, or in other words, by giving a clearer and broader *understanding* of how egg production is inherited, these results help us to interpret, and profit in our own breeding operations by the experience of others.

It would be very easily possible to make out a system of matings, on the basis of the results of Bulletin 205, showing in great detail how to proceed towards building up a laying strain. Indeed, such specific plans have been worked out by a number of my friends. I have refrained from doing this, however, because it seems to me to be of doubtful practical utility. Lest I should seem to be repudiating both my results and my friends, let me hasten to give the reasons for this doubt. The reasons are general in character and are found in the fact that such schemes of mating are essentially *mechanical,* whereas both the things to be bred in accordance with the scheme (the fowls), and those who are to carry out the plans (the poultryman) are essentially *living.* Perhaps in final analysis the basis of life may be mechanistic, but certainly living things do not in practical every day life behave with that precision and definiteness which we expect from a machine. Being a little acquainted with the frailties of both poultry and poultrymen, I am not too optimistic as to the outcome of trying to breed chickens by formula.

A Plan for the Practical Breeder.

It seems to me that possibly it may be more helpful to draw out from these results some general principles in breeding for egg production, which every poultryman can apply. What then are the basic elements in a well-directed effort towards the improvement of poultry in egg production by breeding? I should put them in this way.

1. Selection of all breeding birds *first* on the basis of *constitutional vigor and vitality* making the judgment of this so far objective as possible. In particular the scales should be called on to furnish evidence. (a) There ought to exist, for all standard breeds of fowls, normal growth curves, from which could be read off the standard weight which should be attained by a sound, vigorous bird, not specially fed for fattening, at each particular age, from hatching to the adult condition. These curves we shall sometime have. (b) Let all deaths in shell, and chick mortality, be charged against the dam, and only those females used as breeders a second time which show a high record of performance in respect to the vitality of their chicks, whether in the egg or out of it. This constitutes one of the most valuable measures of constitutional vigor and vitality which we have. If for no other reason than to measure this breeding performance, a portion of the breeding females each year should be pullets. In this way one can in time build up an elite stock with reference to hatching quality of eggs and viability of chicks. (c) Let no bird be used as a breeder which is known ever to have been ill, to however slight a degree. In order to know something about this, why not put an extra leg-band on every bird, chick, or adult, when it shows the first sign of indisposition? This then becomes a permanent brand, which marks this individual as one which *failed,* to a greater or less degree, to stand up under its environmental measures of constitutional vigor. (d) Many of the bodily stigmata by which the poultryman, during the last few years, has been taught to recognize constitutional vigor, or its absence, have, in my experience, little if any real significance. Longevity is a real and valuable objective test of vigor and vitality, but it is of only limited practical usefulness, because of the increasing difficulty with advancing age of breeding successfully on any large scale from old birds of the American and other heavy types.

2. The use as breeders of such *females* only as have shown themselves by trap-nest records to be high producers, since it is only from such females that there can be any hope of getting males capable of transmitting high laying qualities.

3. The use as breeders of such *males* only as are known to be the sons of high producing dams, since only from such males can we expect to get high producing daughters.

4. The use of a pedigree system, whereby it will be possible at least to tell what individual male bird was the sire of any particular female. This amounts, in ordinary parlance, to a *pen* pedigree system. Such a system is not difficult to operate. Indeed, many poultrymen, especially fanciers, now make use of pen pedigree records. It can be operated by the use of a toe-punch. All the chickens hatched from a particular pen may be given a distinctive mark by punching the web between the toes in a definite way. If one desires to use a more complete *individual* pedigree system, he will find the system described in Bulletin 159 of the Maine Agricultural Experiment Station a very simple and efficient one. It has been in use at this Station for seven years, with entire satisfaction, on the score of both accuracy and simplicity.

5. The making at first of as many different matings as possible. This means the use of as many different male birds as possible, which will further imply small matings with only comparatively few females to a single male.

6. Continued, though not too narrow, *inbreeding* (or line breeding) of those lines in which the trap-nest records show a preponderant number of daughters to be high producers. One should not discard all but the single best line, but should keep a half dozen at least of the lines which throw the highest proportions of high layers, breeding each line within itself.

Items 4, 5, and 6 imply the carrying over of a considerable number of cockerels until some judgment has been formed of the worth of their lines, through the performance at the trap-nest of their sisters.

Item 6 assumes, as an absolutely necessary prerequisite that item 1 will be faithfully and unfailingly observed.

Some indication of the manner in which the application of such a plan of breeding as that outlined will work out is given in Figs. 74, 75 and 76. These figures show, in a diagrammatic manner, the results of mating male birds of different hereditary constitutions with respect to egg laying capacity, with females which have been shown by the trap-nest to be high producers. In these diagrams different geometrical patterns are used to indicate, in the case of the female performing ability, and in the case of the male the ability to transmit high laying quality to his progeny.

In accordance with the paragraph numbered 2 above only females will be used by the practical breeder which have been shown by trap-nest records to be high producers. All such females will, in the terminology used in Bulletin 205, fall in either Class 1 or Class 2 of females. In the diagrams a high producing female is shown in solid black; a mediocre or low producer (female) is indicated by fine cross-hatching; a very poor producer, which lays few eggs in its lifetime and *none at all* in the winter period, is indicated by a mere outline without any filling whatever.

It is shown in Bulletin 205 that there are nine different types of males, with respect to inherited qualities of egg production. These are numbered in order 1 to 9. In the diagrams the results of mating each one of these nine different types of males with a flock of high laying hens is shown. In making these diagrams it is assumed that one-half of the flock of high laying females will be Type 1 females and one-half will be Type 2 females, as described on page 306 of Bulletin 205. This is a fair assumption from the practical standpoint. By trap-nest records alone the breeder cannot tell whether a given high laying bird is of Type 1 or Type 2. He can only judge of this from her progeny. Experience indicates, however, that about one-half of all high laying birds will fall in one of these types and one-half in the other. It is assumed in the diagrams that each pair of parents will produce 32 off-spring, of which 16 will be males and 16 females.

The way in which the diagrams are to be read may be illustrated by a particular example. Let us consider Mating C. We have here the mating of a Type 3 male bird with the high laying flock of females, as indicated by the solid black hen. This mating produces a flock in which nearly all the females (14 out of 16) are high layers. Two out of 16 are mediocre layers (poor winter producers). Three different kinds of male birds are produced from this mating. Six out of the 16 are of Type 1, as indicated by the solid black bird, 8 out of 16 are of Type 3 like the sire, and 2 out of 16 are Type 7 males, indicated by very narrow bars. Now if a breeder gets from a mating of some particular male with a flock of high laying hens, which he has selected by the use of the trap-nest, a flock which is made up of different sorts of producers in about

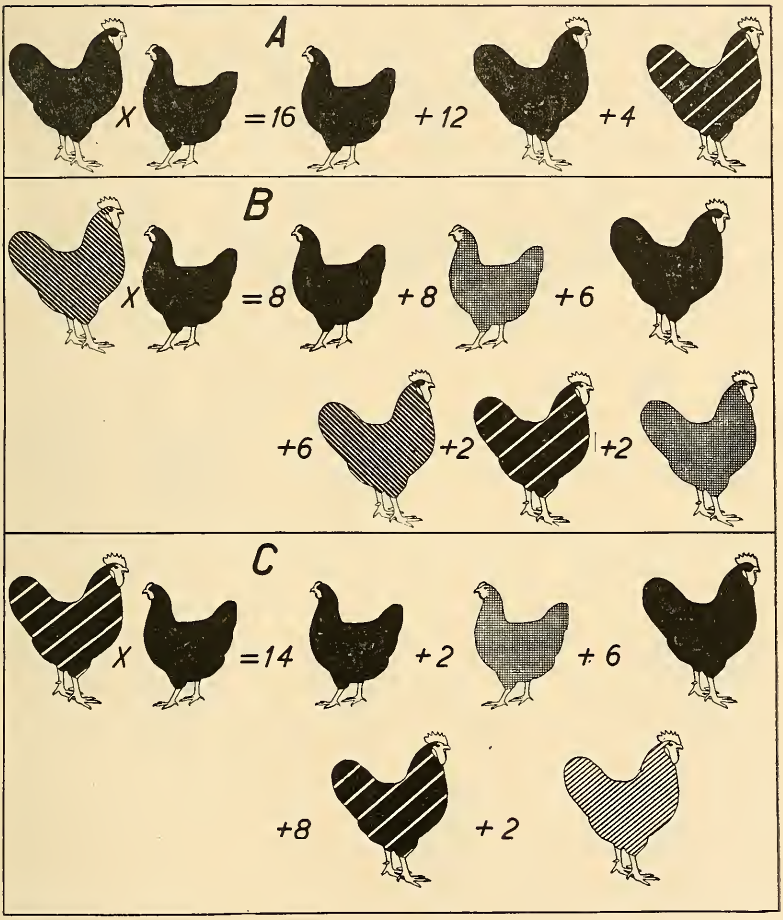

Fig 74. Diagrams showing the results of matings: A, a Type 1 male: B, a Type 2 male; and C, a Type 3 male, with high laying hens. In these and the following diagrams, a solid black hen means a high winter producer, a cross-hatched hen a low winter producer, and a clear white hen a zero winter producer.

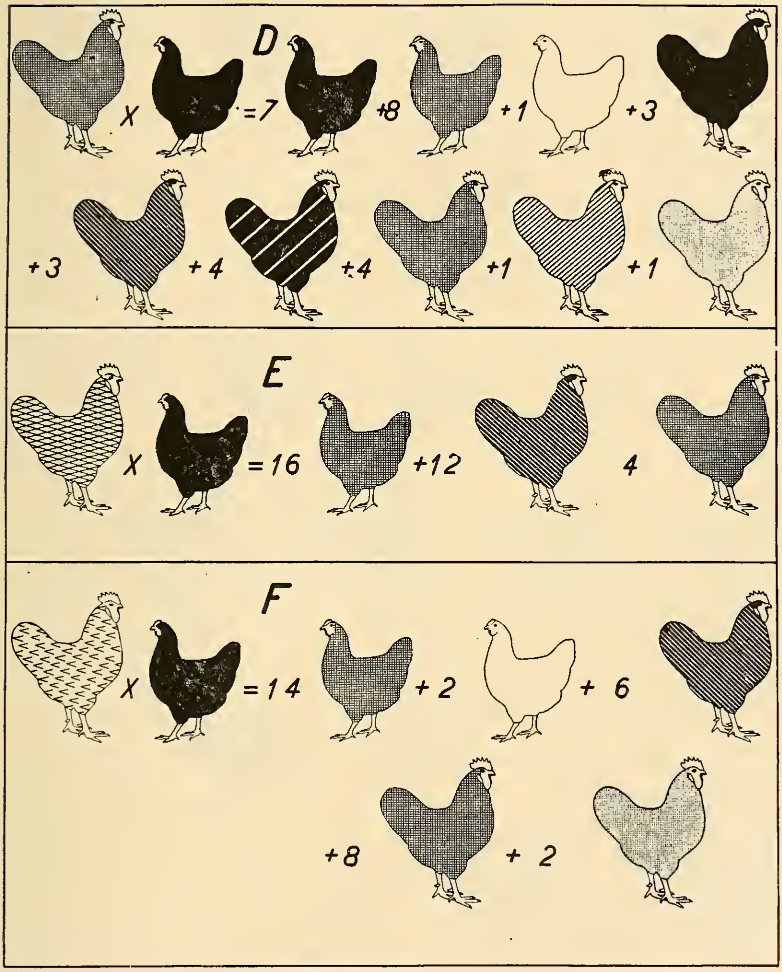

Fig. 75. Diagrams showing the results of mating: D, a Type 4 male; E, a Type 5 male, and F, a Type 6 male, with high laying hens.

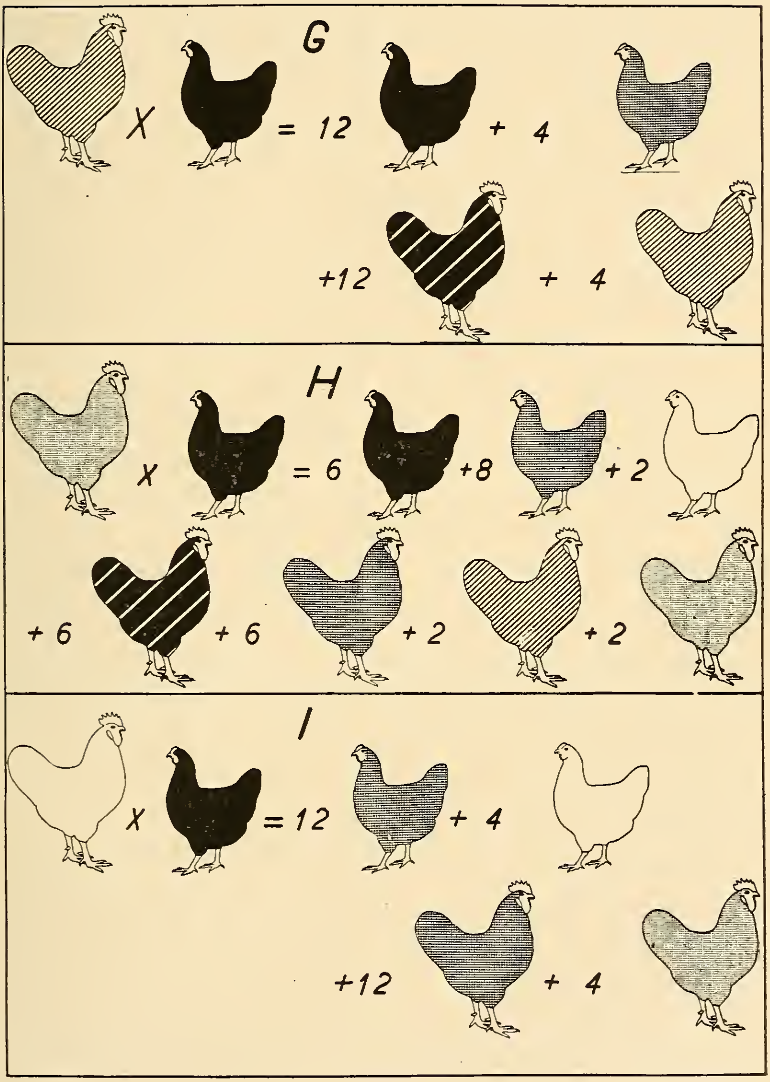

Fig. 76. Diagrams showing the results of mating: G, a Type 7 male; H, a Type 8 male; and I, a Type 9 male, with high laying hens.

2

the proportions indicated in Fig. 1, Mating C; that is if about $\frac{7}{8}$ of the pullets are high producers, he may conclude with great probability that the sire he used was a Type 3 male, and that he will do well to use the brothers of the high laying pullets as breeders next year. In other words, the proportion of pullets of different laying capacities furnishes the guide to the breeder as to the probable hereditary constitution of their sire, and furthermore serves as a guide to him as to what male birds to select for use the following year. Of course this implies that one will carry over during the winter a larger number of male birds than is customarily the case. This is rather important since our only guide to the probable worth of the males, at least at the outstart, is through the performance of their sisters and their dams.

We may contrast the results shown in the mating just described with the results shown in Mating H, Fig. 3 which is of a Type 8 male with the flock of high producing hens. Here we see from the diagram that there are produced all three sorts of pullets—high producers, mediocre producers (under 30 winter producers), and very poor producers (zero winter layers). These are in the proportions indicated in the diagram—namely 6 high layers to 8 mediocre to 2 poor. An examination of the male part of the equation shows that here we have 6 Type 3 males and 6 Type 4 males and two each of Types 7 and 8. This is a flock of distinctly different constitution than the one described before. It is clear that some of the males from this family will be nearly worthless as breeders for improved egg production in succeeding generations.

In making these diagrams the following general rule has been followed for the practical guidance of the breeder. Males which are desirable to use as breeders for egg production are indicated either by a solid black or a barred pattern, and in the case of birds with the barred pattern the more black in the pattern the more desirable the birds are as breeders for egg production. With this general rule in mind the intending breeder for increased egg production will find it of interest to study these diagrams and compare them with the results obtained in his own breeding, when he keeps any sort of pedigree system even such as that described in paragraph 4 above.

The first question which will occur to the breeder's mind is as to whether there are any external characters by which the nine different types of males can be distinguished one from another. Unfortunately no such external criteria have yet been discovered. If it could be done it certainly would be of a great aid in breeding for egg production. The only way that we know now, however, by which it is possible to form a judgment as to a male bird's innate, inherited qualities in respect of egg production is through his progeny. We must find out what his daughters do. Then the proportion of mediocre layers and poor layers amongst his progeny furnish at once a clue as to his probable composition. The diagrams show how one may form this judgment.

One interesting point brought out by the diagrams is that, with the exception of a Type I male (Fig. 74, A), the mating of any sort of male with high producing hens *only*, results in a flock of male offspring of better average quality, taken as a whole, than the sire himself. In other words, the use of high producers, proven by the trap-nest, as the *only* females for breeding purposes, "grades up" very rapidly the cockerels produced.

The whole system of breeding here outlined is an application, in the simplest form possible of two principles, one general and the other special to the present case.

The first is the general principle of *the progeny test in breeding for performance*. This is the principle which has led the plant breeder to such notable triumphs during the last fifteen years. In my judgment no system of breeding for performance in animals not fundamentally based upon it will ever achieve any permanent success. The second principle, is *the recognition of the significance of the male in breeding for egg production*. It has been the custom in trap-nesting work to reckon pedigrees in the female line only. This we can now see to be an essentially futile procedure, so far as concerns the daughters. To say that "this pullet is the daughter of Lady Splendissima (with a tremendous record)" is perhaps good advertising. It, however, conveys no information of any special value to the breeder, until he knows who was the Lady's consort in this particular reproductive venture

In closing conviction may be expressed that the plan of breeding for egg production set forth, which involves nothing in principle or practice which any poultryman cannot put into operation, will not fail, if consistently and intelligently followed for a period of years, to bring about a material increase in the productiveness of the flock. The evidence which leads to this conviction is the best of all evidence; the plan has been tried and it works.

BULLETIN 232.

THE HISTOLOGICAL BASIS OF THE DIFFERENT SHANK COLORS IN THE DOMESTIC FOWL.*

By H. R. Barrows.

In this laboratory studies on the inheritance of various characters in poultry have been in progress for some time. Among other characters which have been dealt with from this point of view is the color of the shank (10), (11).† In connection with this work on inheritance, the question arose as to what histological conditions are associated with the different shank colors observed in fowls. As is common knowledge, shank colors, like other characters vary with the breed. Among the shank colors commonly occurring in *Gallus,* and observed in the breeding work here are: white, yellow, blue, black, green, black over green, black over white (dusky), black over yellow (dusky), black over white (dense), black over yellow (dense), black over blue, blue under white, pink, and red. These colors and variations may, in part, appear in individual scales as well as in the shank as a whole. The problem was to determine for each of the above markings the following points:

1. The color of the ultimate pigment granules.
2. Their general nature—whether fatty oils (lipochrome pigments) or granular substance.
3. Their location—In the scales, lower epidermis, dermis, or all three.

Considerable literature on the general histology of the shank of birds is available. Of the earlier writers, Hanau (3) and Jeffries (4) were the first to make exhaustive studies of the dermal structures of birds. The work of the former on the

* Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 72.

† Throughout the paper figures in parentheses refer to the literature list at the end.

corium, and that of the latter on the epidermis is particularly complete. Other writers had, however, made a beginning. Hanau quotes frequently from Leydig (8), whose histological researches included the bird. His contributions extended from 1829 to 1873. Other writers mentioned by Hanau are: Ribbert (14), Müller (9), etc. Krukenberg (7) and Bogdanow (1) investigated feather coloring and incidentally made some observations as to pigmentation of the skin. Kölliker (6) did considerable work on the origin of the pigment cell, and Kerbert (5) on the skin of vertebrates. Of comparatively modern workers, Reichenow (12) on the skin of the legs and feet of birds, and Gadow (2) on their general histology should be noted. While some of these writers, particularly Hanau, dwell to considerable length on pigmentation, none of them correlate the pigmentation with the specific colors which occur in the shanks of the different breeds of poultry. This paper is an attempt to make such correlation.

Methods.

As this study was concerned with the color of the tissues, methods were used which interfered, as little as possible, with the natural condition of the skin. No technique which involved the use of such fat solvents as xylol or absolute alcohol was employed, save for the general histological work. Immediately after dissection from the bird, the material was placed in a weak solution of formalin, about 10%, where it was left until required. Free hand sections were then cut and mounted in liquid glycerine. This method has the advantage of preserving the natural color of the pigment, and also of rendering possible the cutting of sections thick enough to make the dilute oils visible without the presence of a stain. Fat indicators, like Sudan III do not discriminate between oils which are concerned in giving color and those that are not. Nuclear stains render it difficult to decide whether colored particles are pigment granules or nuclear elements. A number of free-hand sections were subjected to various stains, and were found valuable in certain cases, as Sudan III in the study of yellow pigment, and eosin for the location of blood vessels.

For checking previous work on the general histological structure the ordinary paraffin and celloidin methods were employed. Though many fixing solutions and stains were tried, generally with satisfactory results, the best sections were made by the use of formalin, hematoxylin, eosin, and Sudan III.

The External Structure of the Shank.

A brief review of the structure of the external shank will not be out of place. The outer layer of the epidermis is modified into scales, which vary in size, according to their location on the leg, and the breed of the bird. Two well-defined rows of scales cover the anterior portion in most varieties (2). That row which is located nearest the mid-line usually has the largest scales. These in some cases have a length of one cm. and a breadth of 1.5 cm. Their shape is imperfectly quadrilateral, with the corners slightly rounded. In some birds the arrangement is irregular, and their shape may vary from round to polyhedral. Adjoining the large scales on both sides of the shank are two or three rows of smaller incompletely developed ones, in shape more oval than quadrilateral. On the posterior side we again find two rows similar in size to those on the anterior part. But, as Reichenow (12) has pointed out, "Uebergänge zu den vorigen Formen entstehen, indem die beiden vorderen Reihen von Quertafeln verschmelzen, oder die hinteren in kleine Schilder sich auflösen, oder die kleinen Seitenschilder auch noch zu Quertafeln verwachsen." In the larger scales there is an imperfect adhesion to the under-lying epidermal layer, save at the upper edge and along the sides. The lower edge which is free touches the scale below, and, in the birds studies, over-lapped it for a distance of perhaps a tenth of a centimeter. Jeffries (4), however observed no such over-lapping. The small lateral scales are attached to the under epidermis throughout.

Histology.

The skin of the bird, like that of all vertebrates, consists of two layers; the outer or epidermis, and the inner or corium, cutis, or dermis (2).

THE EPIDERMIS.

A thorough study of epidermal structures, as has been stated, has been made by Jeffries (4). The following statements agree in the main with his observations. The outer portion of the skin of the tarsal region is differentiated into two distinct regions; the rete of Malphigi, and the stratum corneum or horny layer. The latter, which lies outermost, consists of fusiform cells, much flattened, lying in fairly regular rows. Traces of nuclear elements are visible in most specimens, but the outlines of cells are rarely discernible, for the corneum is but a compact mass of cell remnants which has lost the texture of living tissue. This is evidenced by its failure to take protoplasmic stains. It is this layer which is modified to form the scales. As Hanau (3) has noted, the epidermis is invariably thinner than the dermis; it reaches its maximum thickness in the anterior scales of the tarsal region.

The cells of the rete of Malphigi may be divided into three groups according to size and position, although they are of the same origin, springing from the lower layer. All cells of this division are held together by a homogeneous intercellular substance. The basement group comprises but a single layer of columnar cells which are regular in form. It is from these that the other rete as well as the horny layer are derived. This basement stratum lies directly over and in contact with the corium. Immediately above are several layers of polyhedral transition cells, some cells of which project downward between the upper portions of those beneath. A gradual flattening is noted as these transitional cells approach the layer bordering on the corneum. This last group is made up of fusiform cells still more flattened, the outlines of which can be only indistinctly seen. There appear to be no transitional cells between those of the upper Malphigian layer and the corneum. The former resemble the latter in shape but they take protoplasmic stains. No blood vessels or nerves extend into the epidermis.

THE CORIUM.

The histology of this portion of the skin of birds has been thoroughly studied by Hanau (3). Its location is directly under the epidermis. Its structure is that of connective tissue, and consequently it is not made up of strata corresponding to the rete and corneal layers of the outer skin. The upper portion consists of fine bundles of connective tissue and elastic fibres closely interlaced and running in all directions. Below lies a much looser fabric of larger and more or less horizontal bundles in which fibres predominate. Stained sections show numerous round or oval cells in the upper portions. Below the dermis proper is the subcutaneous connective tissue interspersed with the masses of the panniculus adiposus. The lower and middle corium is richly supplied with blood vessels which give off capillaries. These capillaries penetrate the portions bordering the epidermis, which they appear to touch without penetrating. Nerves also, according to Hanau, are numerous, the fine branches of which in like manner run to the epidermal border without extending beyond. Fatty masses, in varying quantities, are frequently to be found scattered through all parts of the dermis.

Pigmentation.

The various colors seen in the shank are due to the presence of pigment of two kinds; orange-yellow, and brownish-black. (3), (4), (2).

Yellow.—This is a lipochrome pigment, which, when present, is diffused through all parts of the cell; when dilute, it gives a yellow hue; when concentrated, orange. It is found in the epidermis and in the fatty masses of and beneath the corium, and is probably identical with the yellow fat color found in other portions of the body. Various names have been given it. Gadow (2) says, concerning feather color: "Ontochrin, Kühne, der gelbe Dotterfarbstoff aus den Hühnereiern, ist wahrscheinlich identisch mit dem gelben Farbstoffe der Fussbekleidung der Vögel. . . . Krukenberg nennt diesen Stoff Coriosulfurin und hält ihn wie Zoonerythrin und Zooxanthin für ein gefärbetes fettes Oel. Möglicherweise ist es dasselbe wie Zooxanthin."

Black-brown.—The dark color is carried in microscopic pigment granules, which may be scattered through the ordinary cells or be confined to special pigment cells. The former are confined to the epidermis, while the latter may occur in both layers, but infrequently in the epidermis. When granules are present in the flattened cells of the corneum, they occupy that position which would have been held by the nuclei, had they not degenerated. Instead of being oval groups as are those in the under portions of the Malphigian layer, they lie in short thin lines, which is to be expected, as these cells are greatly compressed. Where these granules occur in the rete layer they tend to cluster around the nuclei, and clearly indicate, by their arrangement, the changes in form which have accompanied these cells in their migration toward the surface.

In the corium, and less frequently in the rete layer, what appear to be dense masses of dark colored pigment granules are found. These are in reality definite cellular bodies, the "verästigte" cells of Hanau (3), densely packed with the black-brown granules. These cells correspond to the "trophoplasts" of Heinke (13) observed in man. There is a central body which sends out branches in all directions. In deeply colored specimens these ramifying strands interlace and form a compact network, which in many cases is so thick as to give the impression of a homogeneous mass; in others only isolated cells are present. Here and there occur round or oval pigmented bodies, which Hanau concluded were the starshaped cells with their pseudopod-like appendages contracted. Pigment cells commonly lie around blood vessels clearly indicating their course. They frequently form a fairly compact tube, but more often are limited to fragments which only partly enclose the vessels. According to Hanau, pigment cells often appear as nerve endings. Pigment cells are to be found in several well-defined localities; in the upper portion of the cutis among the closely interwoven strands of connective tissue, in the region bordering the blood-vessels, in proximity to nerves (3), and surrounding fat masses. Isolated cells are frequently scattered at random through the lower sections of the corium. The lower bodies of pigment play little part in the color of the external shank, as they lie far beneath the opaque connective tissue. Melanin pigment granules are always in the corium contained in pigment cells. When found in the Malphigian layer, pigment cells were of an oval form, no outrunners being observed, however it is probable that other specimens would show them, as their presence is mentioned in this region in the dove in Hanau's monograph. In size, these cells, when situated in the epidermis occupy a space similar to that filled by several of the Malphigian cells.

Immediately below the epidermis in all specimens examined a space was found a little less in width than that of a row of columnar cells which was practically devoid of pigment. It was impossible to find a single instance in which the pigment cells of the corium penetrated those of the epidermis, although Kerber (15) observed them in the chick embryo.

Zoomelanin is the name given to black-brown pigment in birds by Bogdanow (1) according to Gadow (2).

THE PIGMENT RELATIONS IN THE VARIOUS SHANK COLORS OBSERVED.

White.—Here both lipochrome and melanin pigments are wanting. Gadow (2) observed regarding the coloring of feathers: "Vollkommene Brechung aller eintretenden Lichtstrahlen, ohne Pigment, verursacht weiss," which would apply equally well to the skin though, of course, in the skin one never finds the ivory white of feathers except in the ear-lobes in certain breeds. Melanin pigment may be present in the corium of white shanked birds, either at considerable depths or in quantities insufficient to make itself noticeable. In old birds of yellow shanked breeds, particularly those which have been heavy layers, the yellow of the epidermis frequently disappears and white consequently results. The white shank in this case has a different appearance, however, from that in hereditarily white shanked birds. The thickness of the scales in pure white shanked birds has little to do with the color.

Yellow.—This color results from the presence of zooxanthin in both layers of the epidermis, or in the corneum alone. It is diffused through all parts of the cells and intercellular substances. In brightly colored shanks both epidermal layers exhibit a rich supply of this oil. In young birds the amount in the Malphigian layer is large; as the chick grows this gradually disappears. Old laying hens carry a very small quantity in the horny layer; the rete appearing white to the naked eye. Old hens which for some cause, pathological or other, have never laid possess a deep orange color in both parts of the epidermis. The intensity of the coloration in such cases would seem to indicate that the original supply of lipochrome pigment had not been used up and also that an additional supply had been deposited. As this fat is present in the scales it is but natural that the intensity of their color should be influenced by their thickness. Consequently when the pigmentation is weak as in old laying hens the scales on the anterior portions of the leg possess the brightest shades. However, in non-laying birds the portion covered by the small lateral scales often appears darker. In this instance the less deeply pigmented thick anterior scales have the effect of diluting the color as a whole. In yellow legged young chicks the pigment is distributed evenly around the shank, since the richly colored Malphigian cells are more influential in determining the resultant color than the incompletely formed and still growing scales.

Blue.—In blue shanked birds zoomelanin is present only in the corium. The blue color is the optical effect resulting when this dark pigment is seen through the semi-translucent Malphigian stratum. As Krukenberg (7) has noted, "Das Blau ist alto hier eine sog. optische Farbe, eine Erscheinung, welche überall da zu Stande kommt, wo das Licht ein trübes Medium durchdringt und von einer schwarzen Unterlage aus alsdann reflectirt wird." As no pigment granules lie in the horny layer the thickness of the scales is scarcely concerned in affecting the depths of color, save where yellow fat occurs. In most of the blue-shanked birds examined the number of pigment cells in the corium was greater than in black legged individuals, and they generally fromed a more compact network, however insufficient observations were made to make this conclusion general. The depth of blue color depends directly upon the number of these cells.

Black.—Black shank color results when melanin pigment lies in the epidermis and only under these circumstances, so far as I have observed. It may be heightened by pigment cells in the upper cutis, but pigment in the outer layer is essential to produce the black color. As has been noted two forms of black pigment occur in the epidermis; granules in both layers and pigment cells in the rete. The granules resemble in size the nuclear elements brought out when the tissues are subjected to nuclear stains. In the more deeply colored birds the epidermis is deeply peppered with these particles, the Malphigian layer contains numerous melanin pigment cells, and underneath in the corium the latter cells lie in an almost unbroken mass. Whenever either kind of pigment was found in the epidermis the corium was also found to be supplied, but there appeared to be no agreement between the quantities in the two layers. The thickness of scales when granules lie in them is of importance in regulating intensity of color. Naturally those scales which are the thickest, everything else being equal, are the darkest.

Lipochrome pigment may be diffused through the epidermis. Where much melanin pigment is present in the epidermis the yellow color of the oil has no effect upon the resultant color, but when the epidermis is sparsely supplied with melanin pigment the black color is modified. This condition will be considered later.

It should be particularly noted that a dense black shank color may be associated with any other underlying dermal or epidermal color. Thus one gets, in different cross-bred birds, as I am informed by Dr. Raymond Pearl, dense black over white, over yellow, over blue, and over green.

Green.—This colored shank is characterized by the presence of lipochrome pigment in the epidermis, and numerous melanin pigment cells in the upper corium. It is an optical color resulting from melanin pigment lying under the semi-transparent yellow epidermis. There is no melanin pigment in the epidermis.

Black over green.—This shank color is similar to that described immediately above with the addition of masses of melanin pigment in the epidermis. In the black portions the melanin pigment occurs as granules in both layers, and often in addition as pigment cells in the Malphigian layer. These black spots seldom cover more than a single scale, and usually are much smaller.

Black over white (dusky white). In this case a thin sprinkling of melanin granules occurs in the epidermal layers, and frequently in addition scattered melanin pigment cells in the Malphigian layer. There are usually melanin pigment cells in the corium but not in sufficient quantity to deepen the shade, else the skin would appear black. There is no lipochrome pigment in either layer.

Black over yellow (dusky yellow). This shank color is similar to that described immediately above with the addition of lipochrome pigment in the epidermal layers.

Black over white (spotted). Here are found black spots in an otherwise white shank. As in the black-over-green color mentioned above, the epidermis in the spotted portion is thickly peppered with black-brown pigment granules in both layers, and frequently supplied with melanin pigment cells in the rete layer. The latter type of pigment is usually found in considerable quantities in that part of the upper corium directly under the spotted region, and to a less degree throughout the corium generally. Lipochrome pigment is lacking.

Black over yellow (spotted). This shank color is due to the same pigmentation as that described immediately above with the addition of orange-yellow pigment in the epidermis.

Black over blue. This type may be identical with the black-over-green color described above with the exception that lipochrome pigment is not present.

Blue under white. This is a white skin mottled with blue blotches or spots. It is nothing more than a white skin and an irregular distribution of melanin pigment cells in the upper dermis.

In all these conditions in which black masses overlie the other colors, the pigment granules are often in much greater numbers than in shanks in which a uniform black color is found. These granules in the epidermis and cells (in the rete layer) are at times so numerous that an intense black color is given the scale without any assistance from the pigment cells in the cutis. Old birds tend to possess these irregular markings more than do young.

Pink.—This color is a modification of white, due probably to an abundance of capillaries in the dermis, and possibly also to thin and unusually transparent scales.

Red.—This color probably results from a congestion of blood in the dermis.

Table showing the nature and location in the skin of the different types of pigment concerned in producing each shank color.

Symbols employed in table:
– = absence of pigment specified.
+ = presence of pigment specified in very small amounts.
++ = presence of pigment specified in average amounts.
+++ = presence of pigment specified in very large amounts.
–+ = pigment specified may be absent or present in varying but generally small, amounts.

Shank Color.	Epidermis.					Corium.			
	Stratum Corneum.		*Stratum Malphigi.*			*Upper Region.*[1]		*Lower Region.*[2]	
				Melanin Pigment.					
	Lipochrome pigment.	Melanin pigment granules.	Lipochrome pigment.	Granules.	Cells.	Lipochrome Pigment.[3]	Melanin pigment cells.	Lipochrome pigment.[3]	Melanin pigment cells.[3]
White	–	–	–	–	–	–+	–	–+	–+
Yellow	+ to +++	–	+ to +++	–	–	–+	–	–+	–+
Blue	–	–	–	–	–	–+	++ to +++	–+	–+
Black	–	++ to +++	–	++ to +++	– to +++	–+	– to +++	–+	–+
Black spot on green	+ to +++	++ to +++	+ to +++	++ to +++	– to +++	–+	++ to +++	–+	–+
Dusky white	–	+	–	+	– to +	–+	– to +	–+	–+
Dusky yellow	+ to +++	+	+ to +++	+	– to +	–+	–+	–+	–+
Black spot on white	–	++ to +++	–	++ to +++	– to +++	–+	– to +++	–+	–+
Black spot on yellow	+ to +++	++ to +++	+ to +++	++ to +++	– to +++	–+	– to +++	–+	–+
Black spot on blue	–	++ to +++	–	++ to +++	– to ++	–+	++ to +++	–+	–+
Blue spot on white	–	–	–	–	–	–+	++ to +++	–+	–+
Green	+ to +++	–	+ to +++	–	–	–+	++ to +++	–+	–+

[1]An arbitrary division, comprising approximately the upper fifth of the corium.
[2]The remaining four-fifths of the corium.
[3]Of little or no effect in determining color.

SUMMARY.

1. Yellow and variations are due to the presence of lipochrome pigment in the epidermis, with the absence of melanin pigment.

2. White results from the lack of pigment.

3. Blue color obtains when melanin pigment lies in the upper dermis, with the absence of this type of pigment in the epidermis.

4. Black and variations depend upon the presence of melanin pigment in the epidermis.

5. Green appears when lipochrome pigment lies in the epidermis, and melanin pigment in the corium only.

6. All shades, with the exception of red and pink are the result of various combinations of these pigments; orange-yellow and black-brown.

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Description of Figures.

All figures were drawn at an approximate magnification of 300 diameters. In reproduction they have been reduced by one-fourth. Drawings were made from unstained free-hand vertical sections through the shank skin of the domestic fowl.

Though lipochrome pigment is frequently found in the corium no effort was made to obtain sections which showed it, as its presence has no bearing on the color of the skin and it is difficult to represent it in small quantities in uncolored drawings.

The following characters have the same significance in all of the drawings:

C.—Portion of the corneum.
M.—Rete of Malphigi.
F.—Flattened cells of the rete of Malphigi.
T.—Transition cells of the rete of Malphigi.
B.—Columnar cells of the rete of Malphigi.
D.—A portion of the corium or demis.
G.—Melanin pigment granules.
P.—Melanin pigment cells.
Y.—Lipochrome pigment diffused through cells.
V.—Melanin pigment bordering blood vessels.

Fig. 77. A vertical section of skin from the shank of a white legged hen. Neither melanin nor lipochrome pigment is present.

Fig. 78. A vertical section of skin from the shank of a yellow legged hen. Lipochrome pigment is diffused through the epidermis. Melanin pigment is wanting.

Fig. 79. A vertical section of skin from the shank of a blue legged hen. Melanin pigment cells are thickly scattered through the upper dermis. The epidermis is free from either type of pigment, and there is no lipochrome pigment in the corium.

Fig. 80. A vertical section of skin from the shank of a black legged hen. Melanin pigment granules are scattered thickly through both layers of the epidermis, and melanin pigment cells in the Malphigian layer and through the upper corium. Lipochrome pigment is wanting.

Fig. 81. A similar section from a green shanked bird. The epidermis contains lipochrome pigment in both layers. The corium possesses large numbers of melanin pigment cells in the upper region. Lipochrome pigment is wanting in the dermis, and melanin pigment in the epidermis.

Fig. 82. This drawing shows a portion of a black spot (upper left hand corner) on a green shanked fowl. Lipochrome pigment is diffused through both layers of the epidermis. Melanin pigments granules are numerous in the epidermis of the spotted region, and there are scattered melanin pigment cells in its Malphigian layer. The unspotted portion of the epidermis is free from melanin pigment. Many melanin pigment cells lie beneath the epidermis. There is no yellow pigment in the dermis.

Fig. 83. A vertical section through the skin of a dusky white shank. Here melanin pigment granules are thinly scattered through the epidermal layers. A single melanin pigment cell lies in the rete layer, and similar cells here and there in the corium. There is no yellow pigment in either dermis or epidermis.

Fig. 84. A similar section from a dusky yellow shank. The epidermis contains lipochrome pigment, and melanin pigment granules in small quantities. Melanin pigment cells are sparsely scattered through the Malphigian layer and the dermis.

Fig. 85. A similar section showing a portion of a black spot on a white shank. The spotted region (the upper right hand corner) of the epidermis is thickly supplied with melanin pigment granules in both layers, and sparsely with melanin pigment cells in the rete layer. The latter are present in the corium, in large numbers in the spotted portion. There is no lipochrome pigment.

Fig. 86. A similar section showing a portion of a black spot on a yellow shank. Lipochrome pigment is diffused through both layers of the epidermis. The spotted region of the epidermis (upper left hand corner) is thickly supplied with melanin pigment granules in both layers, and sparsely with melanin pigment cells in the rete layer. The latter cells are present in the upper corium, in large numbers under the spotted portion. Lipochrome pigment is wanting in the dermis.

Fig. 87. A similar section through a part of a black spot on a blue shank. The spotted region of the epidermis (upper left hand corner) is thickly peppered with melanin pigment granules in both layers, and sparsely with melanin pigment cells in the Malphigian layer. The latter cells are numerous in the upper corium. Lipochrome pigment is wanting.

Fig. 88. A vertical section through a blue spot on a white shank. In the spotted region melanin pigment cells lie thickly in the upper corium. Lipochrome pigment is wanting. The epidermis is unpigmented.

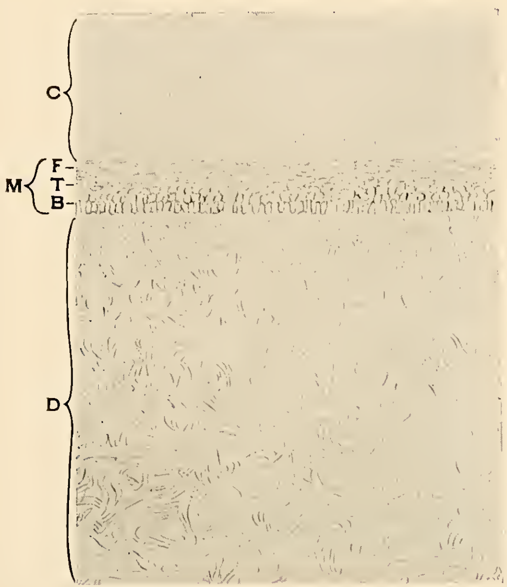

Fig. 77.

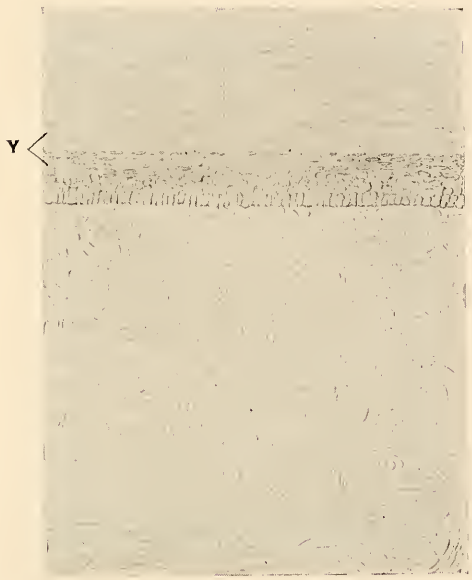

Fig. 78.

Fig. 79.

Fig. 80.

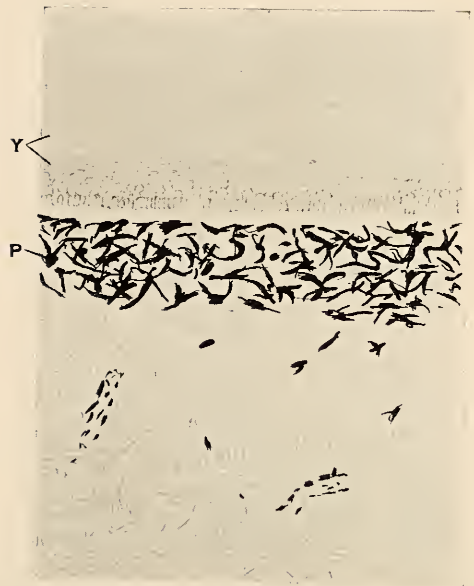

Fig. 81.

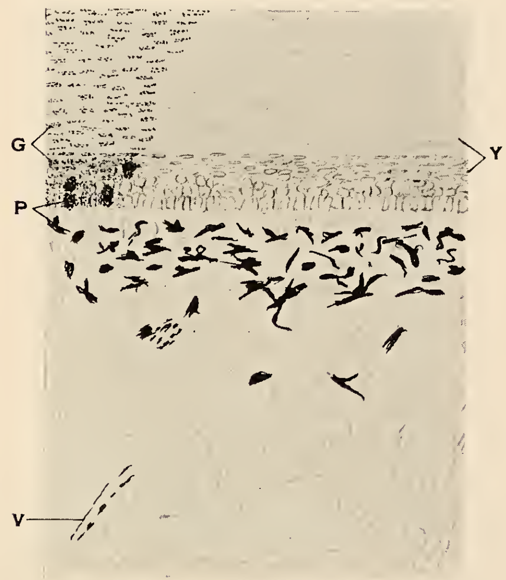

Fig. 82.

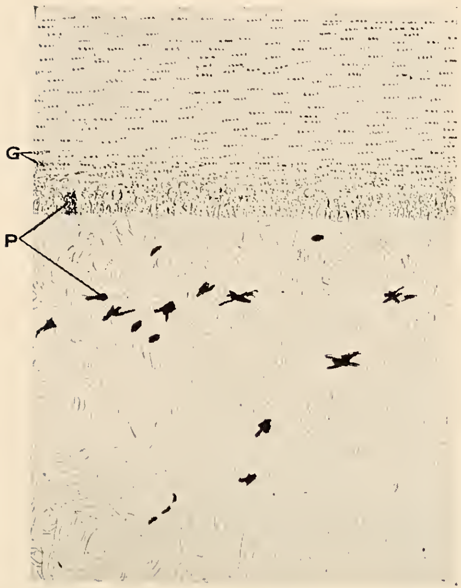

Fig. 83.

Fig. 84.

Fig. 85.

Fig. 86.

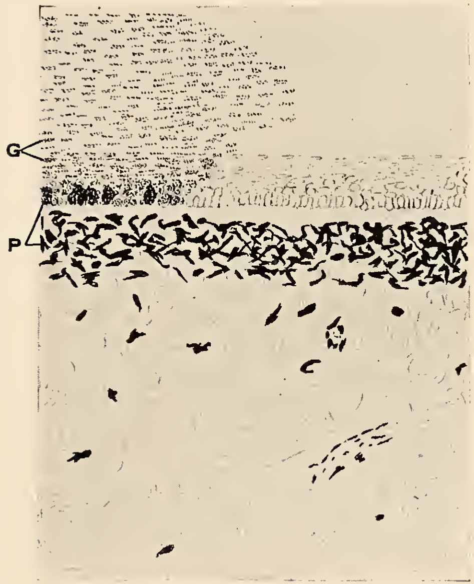

FIG. 87.

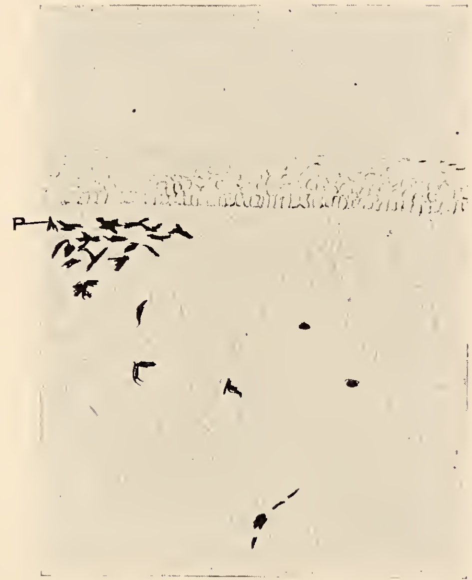

FIG. 88.

BULLETIN 233.

MAINE APHIDS OF THE ROSE FAMILY.*

Edith M. Patch.

It is the purpose of this paper to give descriptive accounts with drawings of those aphids found in Maine upon the members of the rose family. The most serious of the apple aphids have been treated elsewhere and will receive little more than mention here. Our plum aphids, however, have not been worked up before and as some of these are troublesome each year it seems desirable to have them recorded. Also plants, whether weeds or ornamental varieties, which are allied to vegetation of economic importance are suitably included in the same treatment, as certain aphids do not confine themselves to one species of plant but take several closely related species.

AMELANCHIER. Juneberry.

Prociphilus corrugatans Sirrine. Woolly Aphid of Hawthorn Leaf.

(Figure 93, D-E. Figure 95, L.)

A species which I have been considering the insect described by Mr. Sirrine is common in the vicinity of Orono upon both *Crataegus* and *Amelanchier*, inhabiting the ventral surface of the leaf which it distorts into a rolled curl. Professor Gillette (1909) has figured the antenna of this species and recorded it from various parts of the United States. Mr. J. J. Davis (1911) states that both the Colorado and Maine specimens are *alnifoliae* of Williams. Thus unless *alnifoliae* is a synonym of *corrugatans,* the species under consideration should be known

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* Papers from the Maine Agricultural Experiment Station: Entomology No. 77.

as *P. alnifoliae* Williams. Tullgren (1909) has described a species as *Prociphilus crataegi* which is closely allied to the species in this country and may perhaps prove to be the same.

The spring migrants take flight from the primary host from the middle of June to early in July. The summer host is not known.

Stem female. The first generation becomes mature early in June in this vicinity. While immature this form is of a soft greenish color and flocculent. A single individual is found in each infested leaf. Usually by June 5 these stem females begin to produce and the young are pale green and flocculent. When old and wrinkled the stem female becomes dark. The beak reaches the second coxa. The antenna is 5-jointed.

Alate female. Spring migrant. Both my notes and what collections I have would indicate that the entire second generation become winged. A freshly molted individual has a light brown head and prothorax, thorax paler than head, wing veins delicate and abdomen pale olive green. Later the lobes are all purplish black; wings hyaline, with dark slender veins, and stigma conspicuously dark; abdomen rather bright green. The antenna is sometimes with and sometimes without annular sensoria on VI. The relative lengths of IV and V are somewhat variable, V sometimes being decidedly longer than IV and sometimes coequal or even slightly shorter.

Newly molted pupae are yellow, later they are colored much as the freshly molted winged form and flocculent. In this stage the insect is decorated with woolly tufts on head and thorax, the abdomen is flocculent along caudal and lateral margins while along the mid-dorsum the wax appears in little tufts arranged in two rows converging at thorax.

By detaining spring migrants in captivity I have secured third generation nymphs. These in the first instar have a 4-jointed antenna. Their long beaks extend by the length of the two terminal joints beyond the cauda. Where these nymphs develop is not known as we have no clue as to the summer host.

Maine collection numbers 14-06; 27-06; 40-06; 3-07; 29-10; 16-11; 37-13. An Ithaca (New York) collection taken May 19, 1911, had only immature stem females.

CRATAEGUS.

Prociphilus corrugatans Sirrine. Woolly Aphid of Hawthorn Leaf.

This species, just recorded for *Amelanchier* is also common on *Crataegus* leaves in the spring. Maine collection numbers 50-04; 50-06; 67-12; 40-13.

Schizoneura lánigera. Woolly Aphid of the Apple.

This species is discussed for Maine in Bulletin 217 of the Maine Agricultural Experiment Station. The Maine collections from English Hawthorn are *Crataegus oxyacantha* (112-12, 176-12) and native *Crataegus.* (114-06, 67-11, 184-12).

Macrosiphum crataegi Monell.

(Figure 91, I. Figure 95, J.)

This elegant species is not uncommon in the vicinity of Orono on the petioles and ventral surface of leaves and on tender new growth shoots of *Crataegus.*

Alate female. My notes for No. 96-06 record this form as follows: Head yellow with black eyes and conspicuous black ocelli, antenna dark except basal joints, III with numerous sensoria, IV with few or none; prothorax and thorax yellow, legs with yellow femora and dark tibiae and tarsi, wings with rather heavy dark brown veins; abdomen yellow with four vivid green spots in a quadrangle, cornicles cylindrical and dark, cauda light yellow.

The nymphs and apterous viviparous form are also bright yellow with four vivid green spots on abdomen placed as with the winged females. The antenna of the apterous female has III with few sensoria or none.

Maine collection numbers 96-06; 30-11; 31-11; 50-11; 58-11; 144-13.

In a letter dated June 28, 1910, Mr. J. T. Monell sent me some notes on this species which might well be quoted here. He wrote as follows:

"I have never taken any specimens except the apterous ones of the type slide 72° July 4, 1878. The antenna of the largest was measured September 1908 and gave III, .856; IV, .579, V, .585; VI*, .143; VII*, 1.356 mm. Length of body 2.2 mm. The measurements are approximate, being made with camera lucida. In September, 1908, Professor Gillette sent me 707x from Fort Collins, Col., on cultivated *Crataegus*, some half grown apterous specimens which I identified as *crataegi*. He says in his letter 'apterous are not yellowish green but light yellow tinged with green, each louse has upon its dorsum four conspicuous green spots arranged in form of a quadrangle—two near the bases of the cornicles and two near the metathorax. The antennae are not black on joints 3, 4 and 5, but these joints are annulated with black at the distal ends.' September 28, 1908, Professor Gillette sent me alcoholic winged material which I mounted as 722x. Evidently all are males. One antenna measured III .599, IV .514, V .499, VI* .114, VII* .914 mm."

"September 21, 1908, Mr. Davis wrote he had *crataegi* at Chicago saying 'it agrees with description except in antennal coloration, the antennae being entirely pale except at joints 3+4, 4+5 and 5+6. Also legs are brownish'."

Aphis avenae (Fab.) Oat Aphis.

(Figure 90, G-I. Figure 96, D.)

A collection of *avenae* (33-12) made from *Crataegus* at Orono June 14, 1912, is interesting enough to record. Alate viviparous females and pupae were taken. The latter were green with darker green longitudinal median and sub-lateral lines between which ran a row of whitish spots. There were no rusty or orange colored markings near the cornicles. On date of collection 12 of the migrants were caged in the laboratory on young oats. Of the two of these which settled on the grain and produced progeny, one remained alive and active until June 25. The nymphs were very pale green with rusty yellowish places at base of cornicles and connecting them. Two of these had reached maturity and were producing young on June 26. These were both apterous and the rusty orange curve connecting the cornicles was conspicuous in the adult stage. On June 29 one pupa was

* That is basal VI and spur of VI.

noticed and this acquired wings July 1. The first grain generation born of migrants from *Crataegus* is thus seen to comprise both alate and apterous females. Fig. 90, H, is a drawing of the antenna of a spring migrant and Fig. 90, G, that of the next generation reared on oats in confinement, both being done to the same scale.

This species whether found on the winter or summer host is characterized in the winged forms by M branching the second time very near the margin of the wing. In fact M not infrequently runs way to the edge of the wing before branching more than once thus giving a venation such as we find in the genus *Toxoptera,* a 2-branched M.

Maine Collections from *Crataegus,* 33-12, 39-13, 103-14.

APHIS BREVIS Sanderson. The Long-beaked Clover Aphid.

(Figure 94, D. Figure 95, K. Figure 97, B.)

This species which was described by Professor Sanderson from the quince, is very abundant upon hawthorn in Maine. It migrates for the summer to clover and sweet peas and possibly other legumes.

It resembles *bakeri* in having very short caûda and cornicles, but is at once separated from that species by its longer beak which reaches well beyond the second coxa and sometimes to the third. The antenna and the stigma of the wing, further separate this species from *bakeri* as do also the blunter lateral tubercles of the prothorax and abdomen.

On the hawthorn it lives in the leaves causing them in the spring to become distorted into dark purple curls.

APHIS BAKERI Cowen. The Short-beaked Clover Aphid.

(Figure 94, E. Figure 95, I.)

I have made a single fall migrant collection of this species from hawthorn. (104-14). Oct. 1, 1914. The figures show the characters of the antenna and wing. This species is discussed as an apple pest by Gillette and Taylor (1908). Like *brevis,* which it resembles in the shortness of its caûda and cornicles, it migrates to clover for the summer.

FRAGARIA. Strawberry.

Myzus porosus Sanderson.

(Figure 91, J-M. Figure 96, H.)

On September 24, 1912, some wild strawberry vines growing in the Station greenhouse near an open window were found to be heavily infested with pale yellow and pale green apterous oviparous aphids with pale cornicles. Winged males were also present. The plants were colonized on both upper and lower surface of leaves, on the leaf stem and along the runners. Antenna of male has III with 15 or 20 sensoria, IV with 1 to 10, and V with 8 more or less, as shown in the figures. The cornicle is graceful and slender. Maine collection No. 171-12.

PRUNUS. Cherry.

Myzus cerasi (Fab).

(Figure 92, H-K. Figure 95, B.)

A species so distinctive that there is no danger of confusing it with other aphids is rather a relief. *Myzus cerasi* is a glossy black plant louse of world wide distribution and a common pest upon both wild and cultivated cherries, congregating on growing shoots and ventral surface of leaves which become badly deformed. I have taken it in Maine on *Prunus pennsylvanica.* L. and *P. serotina* Ehrh, but have not followed the fortunes of this insect through its seasonal history.

Apterous females of collection 57-06 taken July 3 are recorded as follows:—head and eyes black, antenna black with III and IV pale and with no sensoria except those usual for V and VI; prothorax and thorax, black, leg with femora pale proximally and black distally, tibia pale except distal tip, tarsus black; abdomen, long tapering cornicles, and caûda black.

Alate females of the same collection had head and eyes black, antenna black with about 12 sensoria on III (collections of subsequent years had as many as 18) in a somewhat irregular row, usually none on IV, and with two of the marginal sensoria on VI approximately as large as the terminal sensorium thus giving three large sensoria and several small ones in the group at base of spur; prothorax and thorax black, prothoracic tubercle very small, wing with slender brown veins, leg with femora pale proximally and dark distally, tibia pale except distal point, tarsus black; cornicles long tapering and black, caûda black, abdomen glabrous black.

A collection made Sept. 14 (80-11) comprised sporadic alate females, apparently recently alighted, with young nymphs on leaves of wild cherry. As will be seen by Fig. 92, H, the antenna differs from that of the earlier females in having fewer sensoria on III.

The Maine collection numbers are, 38-14, June 14, apterous females, nymphs and pupae; 1-05, May 31, apterous females and pupae nearly ready for the molt to alate females; 14-05, July 3, alate and apterous females; 21-06, June 12, apterous females and colonies; 38-06, June 21; 57-06, July 3; 127-06, July 6; 9-08, June 16; 107-10 apterous females and pupae, August 30; 80-11, Sept. 14, winged females sporadic on leaves with young nymphs; 42-13, June 8, apterous females and nymphs; 59-13, June 23, apterous and winged females.

Aphis furcata. n. sp.

(Figure 94, F. Figure 95, C.)

A tiny aphid on choke cherry (*Prunus virginiana*) resembles *avenae* in having the second branch of M very near the margin of the wing, but is distinguished by having antennal III with 7 to 12 sensoria in a row, IV and V about equal in length, IV with usually one sensorium (sometimes more, sometimes none) about midway, and total antennal length nearly equal to the body length. The cornicle is straight to tip, without the distal constriction and flange which is conspicuous in *avenae*. The antennal characters of *furcata* are much like *gossypii;* but it can be distinguished by the wing and cornicle, M branching nearer the margin in *furcata* and the cornicle being shorter. In life the color scheme is different.

The head and antenna are dark, the eyes black, the beak extends to second coxa; prothorax dark, membrane lighter, lateral tubercles prominent; thorax greenish with dorsal lobes and ventral shield black; wings with slender dark brown veins; abdomen green, unmarked except 3 lateral dots in a row; cornicles dark brown; cauda light.

I have taken this species but once (99-06) at Orono, August 6, 1906, from the ventral surface of leaf, causing curl.

Myzus persicae Sulzer.

(Figure 90, F. Figure 96, G.)

Fall migrants of this general feeder were taken abundantly on choke cherry, Sept. 27, 1910 at Monmouth (142-10) and Sept. 24, 1912 at Orono (166-12.)

Aphis cerasifoliae Fitch. Choke Cherry Aphid.

(Figure 89, G-J. Figure 95, G. Figure 97, C.)

This well defined species is common upon both the native choke cherry, *Prunus virginiana* and the western *P. demissa* Walp. introduced in a nursery row on our campus.

Apterous female. Head, pale green or water whitish, beak short, extending to 2nd coxa, eyes, antenna with I, II and III concolorous with head, distal half darker to black, III with no sensoria, proportions as shown in the figure; prothorax pale green, lateral tubercles present; thorax green with dark green mid dorsal line, femora and tibiae pale and tarsi black; abdomen pulverulent, pale green with dark green medial line and dark green transverse lines between segments, lateral tubercles present, cornicles pale with dusky tip slender, slightly tapering and approximately twice the tarsus in length, cauda white with dark tip, conical, being broad at base and abruptly tapering.

The nymphs and pupae are also pulverulent and have the dark green mid dorsal and transverse intersegmental lines, though these are not always well defined in the pupa which has two lateral dark green stripes on thorax.

Alate female. Head black, beak short, not reaching second coxa, eyes black, antenna dark, III with from about 12 to 18 large sensoria about the size of the terminal one on V, IV with from none to several sensoria like those of III, proportion of joints as shown in the figure; prothorax green with black transverse band, lateral tubercle present; thorax black, wings iridescent with slender brown veins and large dusky stigma with pointed tip; M commonly though not always with second branch very short, abdomen glabrous, rather bright though not vivid green, median line dark green, sutural lines dark green ending in marginal green dots, cornicles dark, cauda green.

Aphis cerasifoliae is gregarious on the ventral surface of the terminal leaves badly curling and deforming them. A copious amount of honey dew is present, and ants are usually found attending a colony of this species.

Maine collections—3-04; 21-04; 19-06; 11-08; 87-09.

APHIS TUBERCULATA *n. sp.* Red and Black Aphis of Cherry.

(Figure 89, D-F. Figure 95, A. Figure 97, A.)

A striking species was collected August 5, 1913 at Orono in dense red masses on new growth shoots of Black cherry. (*Prunus serotina*). It did not occur on the leaves. The head, caûda, cornicles, legs, prothorax and mesothorax are black with white "bloom" and the rest of the body showy red. My 1914 collection notes give for this species,—the body of *Aphis tuberculata* is a light mahogany red touched with a soft very slight "bloom" of white pulverulence. Genital and anal plates black, lateral margin of abdomen marked with a row of a few indistinct dark dots. Cauda ringed with white pulverulence near base.

Alate female. Antenna with III having 20 or more large sensoria irregularly arranged, IV with about 6 sensoria; V with 4 to 6 sensoria besides the terminal one, relative length of segments shown in the figure; beak extending about second coxa; cornicle about two and one half times the length of tarsus, straight, cylindrical and heavily imbricated; cauda about half the length of cornicles and shaggy; wings with veins all uniformly dark and heavy and all shadowed along their course.

The prothoracic tubercles are broad and blunt and unusually large for the genus. The lateral tubercles of the abdomen are similar in contour but are not so large.

Apterous female. The antenna of this form is shown in D. Figure 89. It is without sensoria except for those usual for V and VI.

PRUNUS. Plum.

APHIS CERASIFOLIAE Fitch.

(Figure 89, G-J. Figure 95, G. Figure 97, C.)

On two occasions I have collected this species on *Prunus nigra* Ait., where it colonies the ventral surface of terminal leaves, curling them as it does those of the choke cherry. 42-10.

APHIS PRUNORUM Dobrowljansky? Black and Brown Aphid of Plum.

(Figure 89, C. Figure 95, D.)

This species is common in Maine in June on the ventral leaves and twigs of the cultivated plum, ordinarily not causing a curl. Specimens of the alate viviparous female from cultivated plum collected at Canton, New York, June 11, 1909, have been sent me.

Alate viviparous female. The head, prothorax, thorax, and cornicles are black; the abdomen is dark brown; the cauda is dark; the wings are somewhat smoky with dark veins. The beak extends to or beyond the second coxa. The lateral tubercles of the prothorax and abdomen are prominent and about ten times as long as broad. Antennal III with about 20 or fewer irregularly placed sensoria scattered the whole length of joint; IV frequently with no sensoria, but also frequently with one or two on the distal half; V with no sensoria except the terminal one; spur of VI not much longer than III; IV and V about equal in length. The fore wings are characterized by a long stigma with pointed tip with Rs joining it somewhere near the middle of the margin, the second branch of M usually, though not always, near the margin of the wing; the hind wing is large, full curved and with the veins nearly as heavy as those of the fore wings. The cornicle is slender, about twice the length of the cauda, constricted slightly near the middle and again just before the tip. The pupal nymph which develops into this form is dull greenish brown with greenish pads. Head and entire body pulverulent both dorsally and ventrally, the powdery dots on the abdomen being arranged in lateral lines and also transversely at the two extremes of the abdomen.

The apterous viviparous parent of the foregoing form is a nearly uniform dark brown with tibiae lighter than rest of the body.

This species has apparently not been recorded previously from America. I had it described as new in manuscript but it so closely resembles *Aphis prunorum* Dobrowljansky that I hesitated to publish it under another name. It does not seem to fall conveniently into either *Aphis, Myzus, Rhopalosiphum* or *Siphocoryne* as ordinarily interpreted. It is, however, closely allied to *Siphocoryne* (?) (*Rhopalosiphum*) *nymphae,* and on the basis of alcoholic material alone I should not be certain that it may not fall as a synonym of that species. This is offered merely as a suggestion for future migration tests.

Maine collection numbers 41-06; 11-09; 20-09 in part; 21-09; 31-09; 36-12; 47-12; 62-12; 169-12 in part.

APHIS CARDUI Linn? (*pruni* Koch) (*prunifoliae* Fitch).

The Long-beaked Plum-Thistle Aphis.

(Figure 92, L-M. Figure 95, F.)

The full cycle for this species has not yet been recorded for America. I have no experimental evidence as yet that the plum-thistle cycle is established for this country. I had, however, noticed that structurally *prunifoliae* Fitch and *cardui* were close and migration tests were planned to ascertain whether they proved to be the same species, when Dobrowljansky (1913) published the fact of the plum-thistle migration for Europe and the synonomy of *cardui* and *pruni* Koch. There seems so little doubt that the species here treated is the same as the European that I am so listing it with the mere precaution of a question mark biding the time of experimental evidence.

There is a very good color description of this species in the third report of Thomas (1879) which accords exactly with Maine material. Both the apterous and alate forms are hard, shiny, and glistening in their black and green.

Among the apterous forms are two color varieties, one conspicuously decorated with a big, shiny black patch on the abdomen which sometimes covers nearly the whole dorsum. Other apterous individuals lack this as recorded by Thomas. These may, perhaps, belong to distinct generations, though they are both present at the same time.

The alate viviparous form has a shiny black head and thorax and a pale green abdomen decorated with lateral black dots, a large dusky spot on the dorsum, black cauda, cornicles, and ventral patch and dashes of black on ventral abdominal segments 4, 5 and 6. The beak extends to or in some cases well beyond the third coxa. The wings are not particularly distinctive but are characterized by a short stigma in the fore wing and the curve in the hind wing sufficient to render the proximal part rather slender. The antenna has 30 more or less sensoria irregular in size and irregularly placed along III, and IV without sensoria; V is shorter than IV and the spur of VI about the length of III. The cornicle is cylindrical and its length in relation to antennal III is shown in the figure.

This species inhabits the new growth twig and ventral surface of terminal leaves causing curl.

Maine collection numbers 16-04; 17-04; 17-06; 18-06; 123-06; 7-09; 25-10; 50-12; 73-12; 169-12 in part.

Aphis avenae and *Aphis brevis*. Fall migrants of these species I have taken together on cultivated plum (169-12), but these have received fuller treatment elsewhere.

PHORODON HUMULI. The Aphid of Plum and Hop.

(Figure 89, A-B. Figure 95, H.)

This is a serious pest on both its food plants in certain parts of the country. As the hop is only incidental in Maine we do not often get complaints of this plant louse on its summer host. It is sometimes injuriously abundant on plum, causing leaf curl. This is not a mealy species.

The apterous forms are very pale green with a median and lateral lines of darker green,—giving three rather conspicuous longitudinal dorsal stripes. The dorsum of the winged form is decorated with black markings and there are lateral black spots. The antennae are shown in Fig. 89. The projection of the head at base of the antenna is the conspicuous distinctive feature of this aphid both in the winged and wingless forms. Maine collection numbers 70-12 on plum, 77-12 on hop.

HYALOPTERUS ARUNDINIS (*Pruni*) Fab. Mealy Aphid of Plum and Arundo.

(Figure 89, K. Figure 95, E.)

A heavy infestation of this species occurred on a variety of large green plum at Orono in 1910 and again in 1912. Late in July the leaves on the ventral surface were so thickly packed that many of the aphids could find resting place only for their beaks, their bodies being pressed out from the leaf and supported by one another. There was no tendency to curl, the foliage remaining even flatter than a normal leaf. The notes taken at the time of this collection (79-10) July 27 are as follows:

Alate viviparous female. Migrant. Head dark green, pulverulent; antenna dark, III with 30 more or less sensoria, IV with row of about 8 sensoria; eyes reddish black; beak pale proximally, dark distally, short and thick not reaching second coxa; prothorax green, pulverulent; thorax green with lobes dusky, venter dusky black, dorsum and venter pulverulent; veins slender, hind wing rather small and weak; femora and tibiae green, tarsi black; abdomen slender, tapering, light green with dark green median streak including cauda and with 1 longitudinal dark green streak on each side, pulverulent; cornicles black, shorter than cauda, constricted at base.

The pupal nymph in last instar previous to winging is colored about as the apterous viviparous, wing pads slightly dusky at margins.

Apterous viviparous female. Head pale green; antenna pellucid with tip dusky, pulverulent; prothorax and thorax light green, pulverulent; femora and tibiae pellucid and pulverulent, tarsi dusky; abdomen slender, tapering, pulverulent, light green with 3 dark green longitudinal markings the mid dorsal one extending so as to include cauda; cornicles dark. Packed unbelievably close on ventral leaf which remains uncurled. Maine collection numbers 79-10; 75-12; 108-12. As the name indicates this species migrates to certain grasses for the summer generations.

PYRUS AMERICANA, P. SITCHENSIS, etc. Mountain Ash.

Schizoneura lanigera. Woolly Aphid of Apple.

This species is as common on *Pyrus americana, P. sitchensis* and other mountain ashes about Orono as it is on the apple. It migrates in Maine to the mountain ash in June as it does to the apple and the return migration takes place in the fall. For a fuller discussion of this species see *Pyrus malus.*

Aphis pomi, The Green Apple Aphis, is common on our native mountain ash. This is discussed under apple.

PYRUS MALUS. Apple.

The most serious aphids which have been recorded for the apple in Maine are discussed in other publications of the Maine Agricultural Experiment Station so that they need only be touched lightly here.

Schizoneura lanigera (*americana* in part of authors). The Woolly Aphid of the Apple.

This species causes terminal leaf cluster or rosette on the elm in the spring and migrates to the apple for the summer generations, fall migrants returning to the elm (*Ulmus americana*) in the fall where the true sexes are developed and the winter egg deposited. The life cycle of this species is further complicated by hibernating nymphs which remain about the apple tree through the winter, and by root forms which are found throughout the year on apple roots. How long, under favorable climatic conditions, the apple can serve as a host for this pest independent of reinfestation from the elm has not been ascertained. In Maine an annual spring and fall migration occurs.

This species can be distinguished from others of the same genus inhabiting the leaves of elm by the antenna and the character of the wax glands.

Aphis avenae *Fab.* The Aphis of Oat and Apple.

(Figure 90, G-I. Figure 96, D.)

This species migrates from the apple and certain other members of the rose family to the oat or other grasses for the summer, so that it is ordinarily found on the apple only in the spring and fall and in the egg stage, during the winter. It is characterized by the short distal branch of wing vein M, the peculiar distal constriction and flange of the cornicle, and the antenna, details which are shown in the figures.

APHIS POMI. The Green Apple Aphis.

This species is by far the most troublesome of the leaf aphids of the apple in Maine. It is not migratory and is, therefore, to be found at all seasons of the year upon the apple in some form or other. Like *avenae* and *sorbi* this aphis passes the winter in the egg stage on the apple tree. At other times it is to be found on the new growth shoots and leaves or even on the fruit itself.

APHIS SORBI. Rosy Aphis of the Apple.

(Figure 90, E. Figure 96, B.)

There is no difficulty in recognizing this species as the dorsal tubercles of the head, prothorax and caudal segments of the abdomen, as well as the antennal characters serve to distinguish it. Professor Sanderson (1901-02) gives a very careful account of this species with good color notes for the different forms. Maine collection numbers 32-09; 39-09.

MYZUS PERSICAE Sulzer.

(Figure 90, F. Figure 96, G.)

The only collection of this general feeder that I have made from apple was in 1911 where winged forms that had developed on chrysanthemums in the greenhouse colonized with their progeny on apple seedlings growing in the same house. Maine collection number 91-11.

PYRUS JAPONICA.

APHIS BREVIS Sanderson. The Long-beaked Clover Aphid.

(Figure 94, D. Figure 95, K. Figure 97, B.)

Specimens of this species were taken on Japanese quince, June 28, 1906, and again July 21, 1906. Maine collection numbers 56-06, 80-06. A discussion of this species is given under *Crataegus*.

ROSA.

Macrosiphum rosae Linn.

(Figure 93, A-C.)

This world-wide species I took on the Maine Campus in 1905 and again in 1914.

The apterous form is striking on account of the contrasting black and green in the coloring. General body color pale green with very pale caûda; the antenna is dark and the long cornicles black; the legs with distal femora, distal tibiae, and tarsi black, the rest green. Antennal III with proximal portion somewhat bulkier than the rest and bearing sensoria as shown in the figure. The distal reticulations of the cornicle are heavily marked and the area they cover is somewhat more slender than the rest of the cornicle.

The alate viviparous female has antennal III crowded with sensoria, none on IV and only the ordinary terminal ones for V and VI. The beak reaches second coxa. There is nothing remarkable about the wings which are an ordinary Macrosiphum type. Maine collection numbers 59-05, 75-14.

Macrosiphum solanifolii Ashmead?

(Figure 90, A-D. Figure 96, A.)

This species has not yet received experimental tests as to its summer host. However, the strongly marked, clear cut, though slender, venation; the antennal characters; the beak length; the pink and green color varieties; the caûda and the cornicles; all are identical for this widespread species on the rose and *Macrosiphum solanifolii* Ashmead as found on the potato in summer. It seems so unlikely that two species could show such a complete resemblance that I am listing this species as *solanifolii* with a question mark, until the matter be given a conclusive experimental test. It is our most common species on Japanese rose bushes on the campus.

Macrosiphum dirhodum (Walker.)

(Figure 92, A-C. Figure 96, E.)

An aphid on Japanese rose on the campus at Orono with the preceding species appears to be *dirhodum* as given by

Theobald (1913). The Maine material is named also with reference to Colorado specimens received from Mr. Maxson who has worked out the host cycle as a migration between rose and grain. It is readily distinguished from the foregoing rose species by its non-reticulated cornicles and the greater number of sensoria on antennal III of the alate viviparous female. There is nothing particularly distinctive about the wing characters.

Myzus rosarum.

(Figure 92, D-C. Figure 96, C.)

For the identification of this species I am indebted to Professor Gillette for named material from Colorado for comparison. The accompanying figures of antennae, cornicles and wings will probably serve to characterize this aphid. Maine collection 14-14 was taken on the Maine Campus by Mr. Geo. Newman June 11, 1914.

RUBUS.

Aphis rubiphila n. sp.

(Figure 91, G-H. Figure 96, F.)

An aphid about the size of *gossypii* and resembling it in wing venation and length of cornicle, I have taken in Maine on wild red raspberry. A good colony was found June 26, 1906, (44-06), inhabiting the stem and ventral leaves.

The alate female had head shiny black, antenna dusky, eyes black, prothorax with pale membrane and prominent lateral tubercles; thorax shiny, wings with slender dark brown veins; abdomen glabrous pale green, lateral tubercles prominent, cornicles nearly concolorous, perhaps a little darker, cauda green and hairy. The sensoria of antennal III are few (4-5) and confined chiefly to the distal two-thirds.

The apterous female is pale green with slightly pulverulent abdomen. Cauda and cornicles lighter than abdomen with the tips of the latter black.

Macrosiphum rubicola Oestlund.

(Figure 94, A-C.)

An alate female with 8 nymphs was collected from the ventral leaf of wild red raspberry, August 1, 1906. This had head bluish black dorsally and ventrally pale green, antenna blackish except proximal III, eyes black; prothorax bluish black dorsally, and ventrally green; marked transversely with pale green at membrane and space cephalad thorax; tubercles distinct; thorax with lobes glistening bluish black, lateral portion pale green with two black patches, ventrally green, wings clouded at apex inclosing distal portion of Rs, stigma very dark; abdomen glabrous medium green, cornicles brownish black, cauda pale green.

The individual described is evidently darker than those Doctor Oestlund saw. Some specimens taken at the same time here ran lighter. These aphids were taken on ventral leaves and on stems. Maine collections; 92-06, 34-08, 158-12.

SPIRAEA,

Aphis spiraecola n.n.

(Figure 91, B-C. Figure 96, J.)

This species is certainly close to *pomi* and may possibly be a variety but it does not seem safe to place it with that species at present. It is recorded by Professor Gillette as *Aphis spiræella* Schouteden (1910). The antenna is practically the same as with *pomi.* The cornicles in the winged form are shorter than any *pomi* I have taken.

Aphis spiraephila n. sp.

(Figure 91, D-F. Figure 96, I.)

The most common and constant species for native *Spiraea salicifolia* is the one I am recording as a new species after collecting it for ten years. It apparently spends its whole cycle on the same food plant, as the colonies have been taken from May to August. A collection made May 31, 1913, contained the stem mother still active and her mature apterous and alate progeny, the latter settling like the former on the Spiraea for their broods. The new growth twig was crowded with a thick black encircling mass.

The apterous viviparous form is a plump, totally huckleberry black with a slight white bloom of wax powder. The nymphs are reddish brown to black. The pupal nymphs (Collection 25-13) were black with wax area of "bloom" on abdomen except central median longitudinal path which was without wax, wing pads and thorax dirty green.

The winged female has head and thorax slate black, abdomen with dorsum reddish black and margin slate black, cauda black and cornicles short and black.

The accompanying figures characterize the wing and antennae, the conspicuous thing about the latter being the shortness of the spur of VI.

Macrosiphum spiraecola n. sp. (97-10.)

(Figure 91, A. Figure 96, K.)

A species which I do not feel justified in ascribing to anything already named, I took on *Spiraea Van Houttei,* on the Maine Campus, August 20, 1910. The apterous females with their nymphs were present, but I have not taken the winged form. The color varieties were vermillion, bright green, yellow green, rose pink, and lemon yellow. The young nymphs had the same range in color.

One of the vermillion specimens chosen for the color description is recorded as follows: head vermillion, antenna with I and II pale, III dark, eyes black, beak with first joint pale and third dusky; prothorax and thorax vermillion; femora and tibiae pale brown, tarsi black; abdomen with the slightest bloom, vermillion with mid-dorsum and lateral margin deeper than the rest; cornicles long, clavate, light brown with tip black; cauda vermillion. The accompanying figures give the antennal structures and the cornicle.

NOTE. The drawings of antennae and cornicles accompanying this paper are all done to the same scale and given the same reduction.

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Figure 89. A-B, *Phorodon humuli*, apterous and alate viviparous; C, *Aphis prunorum*, alate viviparous; D-F, *Aphis tuberculata;* D-E, apterous viviparous; F, alate viviparous; G-J, *Aphis cerasifoliae;* G-H, apterous viviparous; I-J, alate viviparous; K, *Hyalopterous arundinis*, alate viviparous.

Figure 90. A-D, *Macrosiphum solanifolii?* A, alate male; B, apterous viviparous; C-D, alate viviparous; E, *Aphis sorbi*, alate viviparous; F, *Myzus persicae*; G-I, *Aphis avenae*, G, alate viviparous, oat generation progeny of migrant from hawthorn; H-I, alate viviparous migrant from hawthorn.

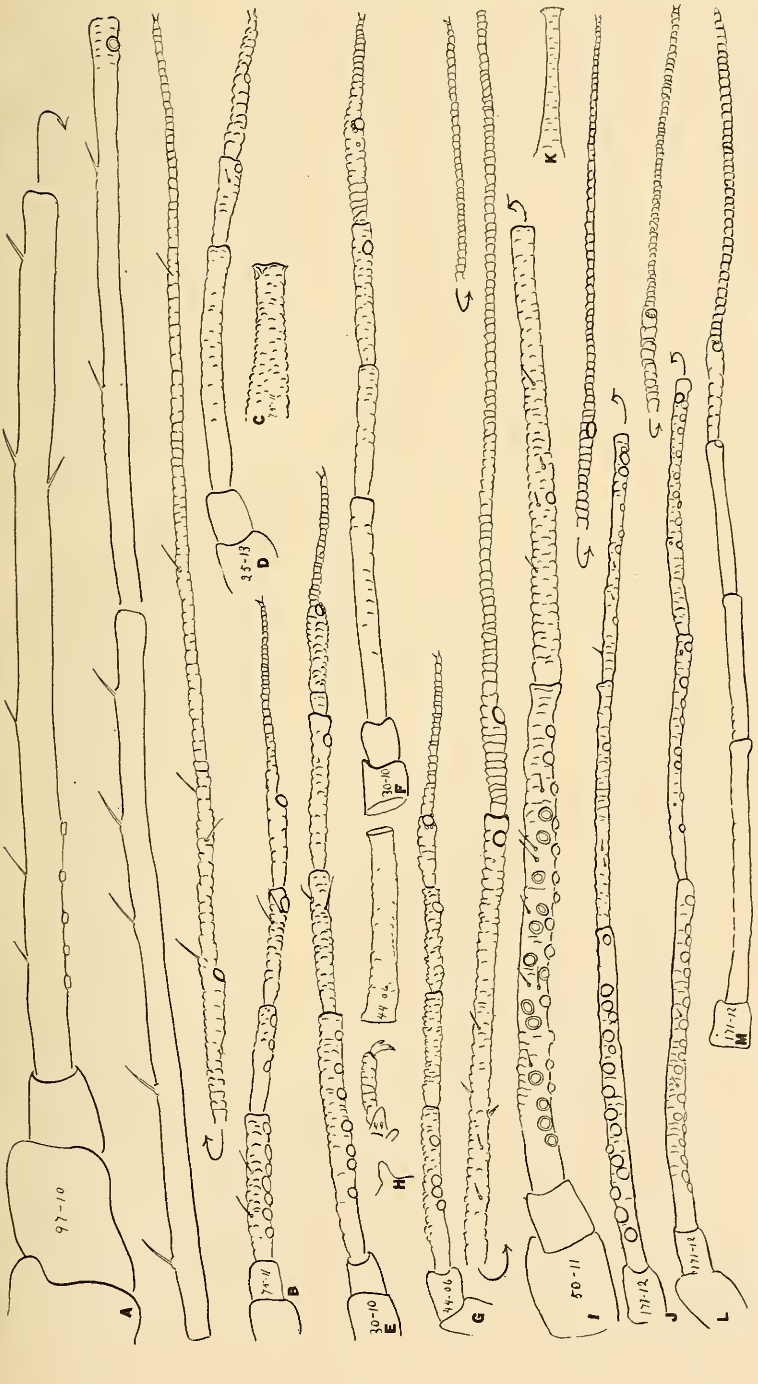

Figure 91. A, *Macrosiphum spiraecola*, apterous viviparous; B-C, *Aphis spiraecola*, alate viviparous; D-F, *Aphis spiraephila*, D, stem female; E, alate viviparous; F, apterous viviparous; G-H, *Aphis rubiphila*, antenna, abdominal tubercle, tarsus, and cornicle of alate viviparous; I, *Macrosiphum crataegi*, alate viviparous; J-M, *Myzus porosus*, J-L, alate male; M, apterous oviparous.

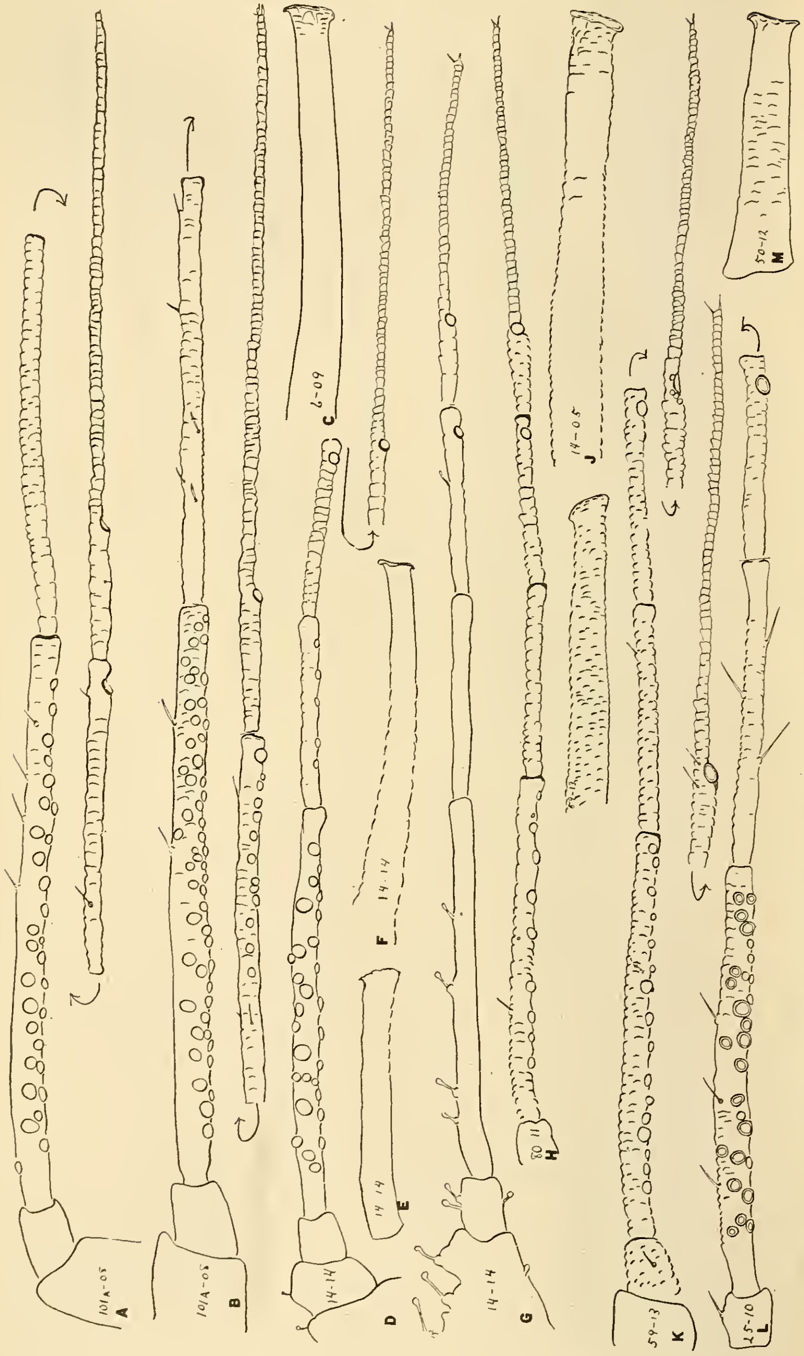

Figure 92. A-C, *Macrosiphum dirhodum*, A and C, alate viviparous; B, alate male; D-G, *Myzus rosarum*, D-E, alate viviparous; F-G, apterous viviparous; H-K, *Myzus cerasi*, H, I, and K, alate viviparous; J, apterous viviparous; L-M, *Aphis cardui (prunifoliae)* alate viviparous.

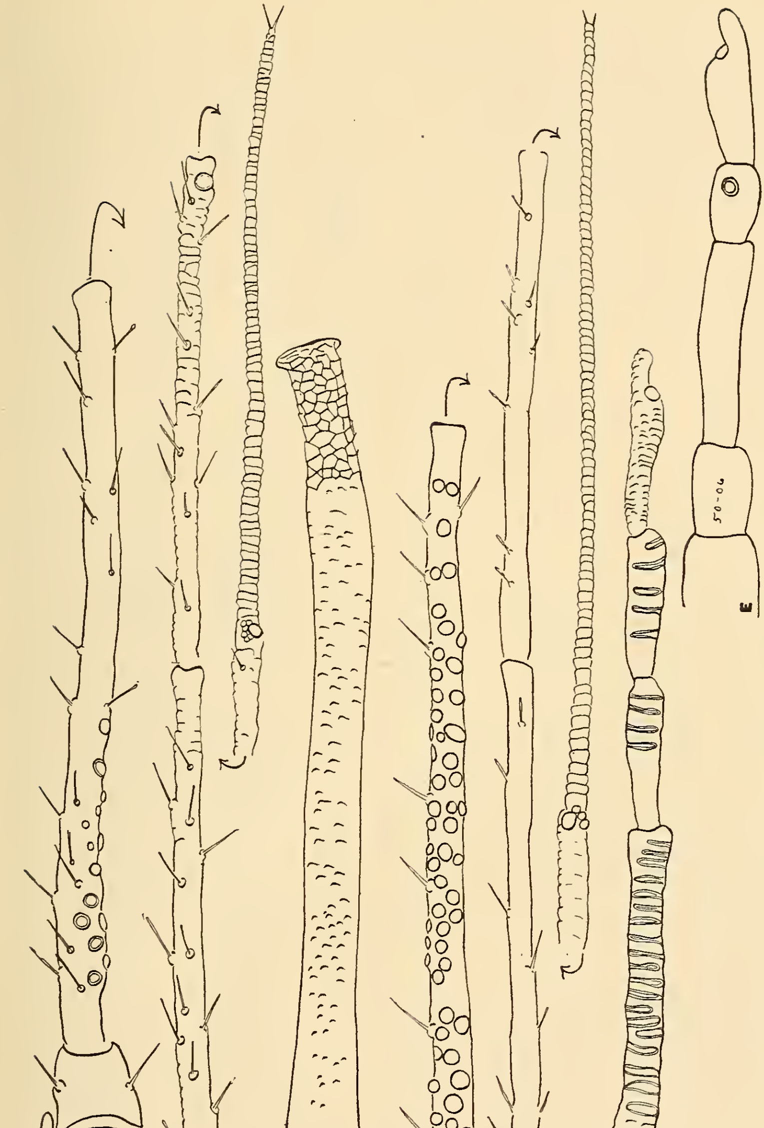

Figure 93. A-C, *Macrosiphum rosae*, A-B, apterous viviparous; C, alate viviparous; D-E, *Prociphilus corrugatans*, alate viviparous and stem female.

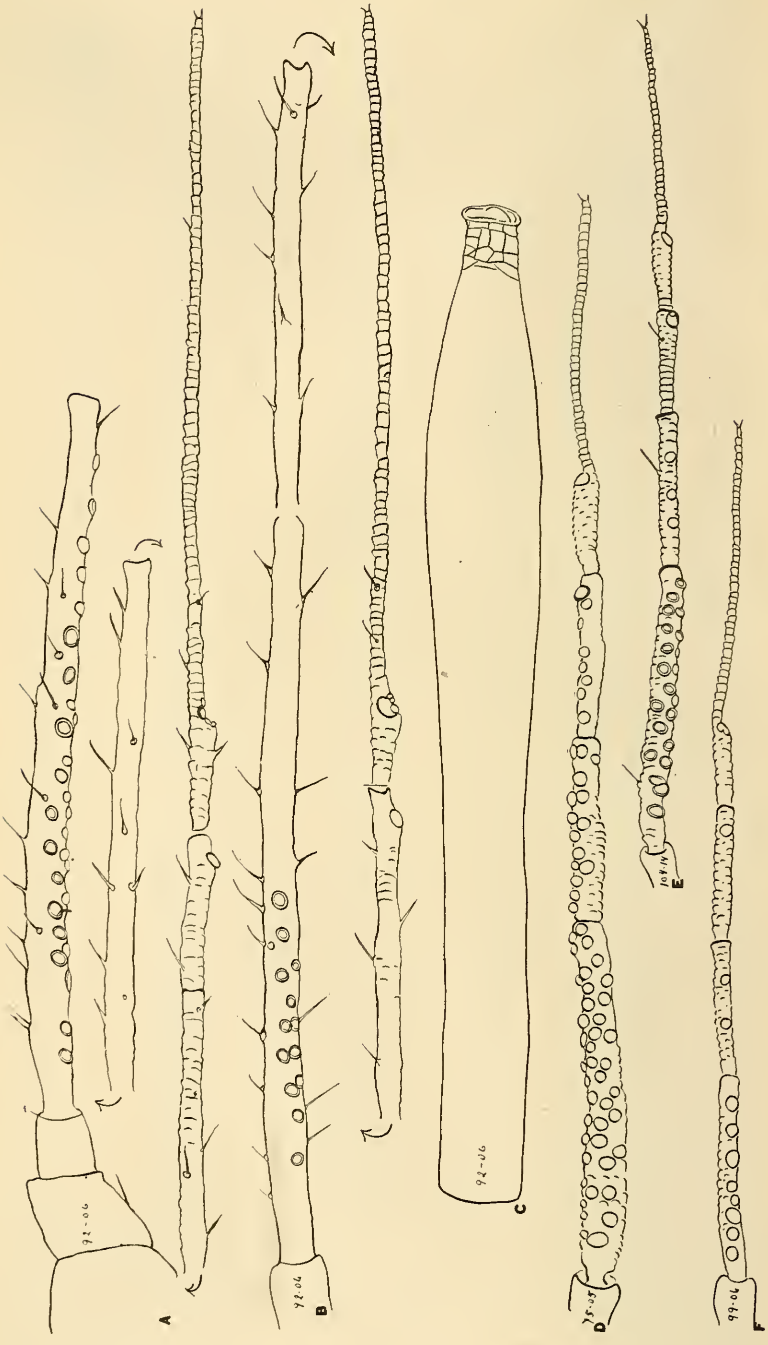

Figure 94. A-C, *Macrosiphum rubicola*, alate and apterous viviparous; D, *Aphis brevis*, fall migrant on hawthorn; E, *Aphis bakeri*, fall migrant on hawthorn; F, *Aphis furcata*, alate viviparous.

Aphid Control.

On account of their small size aphids, or plant lice as they are commonly known, are to a great extent unnoticed; but when conditions are favorable to their increase there are many species of these little creatures that are capable of serious damage to the vegetation which they frequent and staple crops often suffer severely.

These insects occur in winged and wingless forms. Both forms feed by means of a jointed beak which they push into the tissues of the plant in order to suck up the sap which forms their food. Since aphids do not feed on the exposed portion of the leaf, stomach poisons like arsenate of lead are not effective as they are valuable only where caterpillars, or other insects which actually eat up the leaf substance, are concerned. We need, instead, a contact poison which kills the aphid from the outside of its body since we can hardly poison the sap which it sips.

Tobacco sprays will kill these soft-bodied insects and as we know of no injury to the vegetation from their proper use we recommend them for most cases where it is possible to spray at all.

Species inhabiting the trunk or large branches can be destroyed in great numbers by using a brush dipped in any of the spray solutions ordinarily used for aphids.

Tips of branches bearing leaves which have been curled by aphids can be dipped into a pail of tobacco decoction long enough for the solution to penetrate. Such a method as this is of course only applicable for a few treasured plants or small trees.

For many plants underspraying is a necessity, and for this purpose a sprayer should be fitted with an upturned elbow and a nozzle of the Vermorel type so that the under sides of the leaves can be reached.

In recent years tobacco extracts have rapidly taken the place of other sprays for aphids, and well informed apple growers are using them almost to the exclusion of other insecticides. It should be remembered that this is a contact insecticide and kills only the insects actually touched. It is, therefore, necessary to be very thorough in the spraying.

Shade or ornamental trees can be protected frequently from serious aphid attacks by keeping watch from year to year. This is especially desirable while trees are young.

From small or isolated trees the galls of gall forming species can sometimes be collected by hand before the aphids leave them, thus lessening the trouble in that vicinity for another year.

A general account of plant lice, containing a discussion of their habits and of their natural enemies, together with directions for aphid control by remedial measures, is published by this Station under the title of "Aphids" and can be secured free of charge by any resident of Maine who desires it.

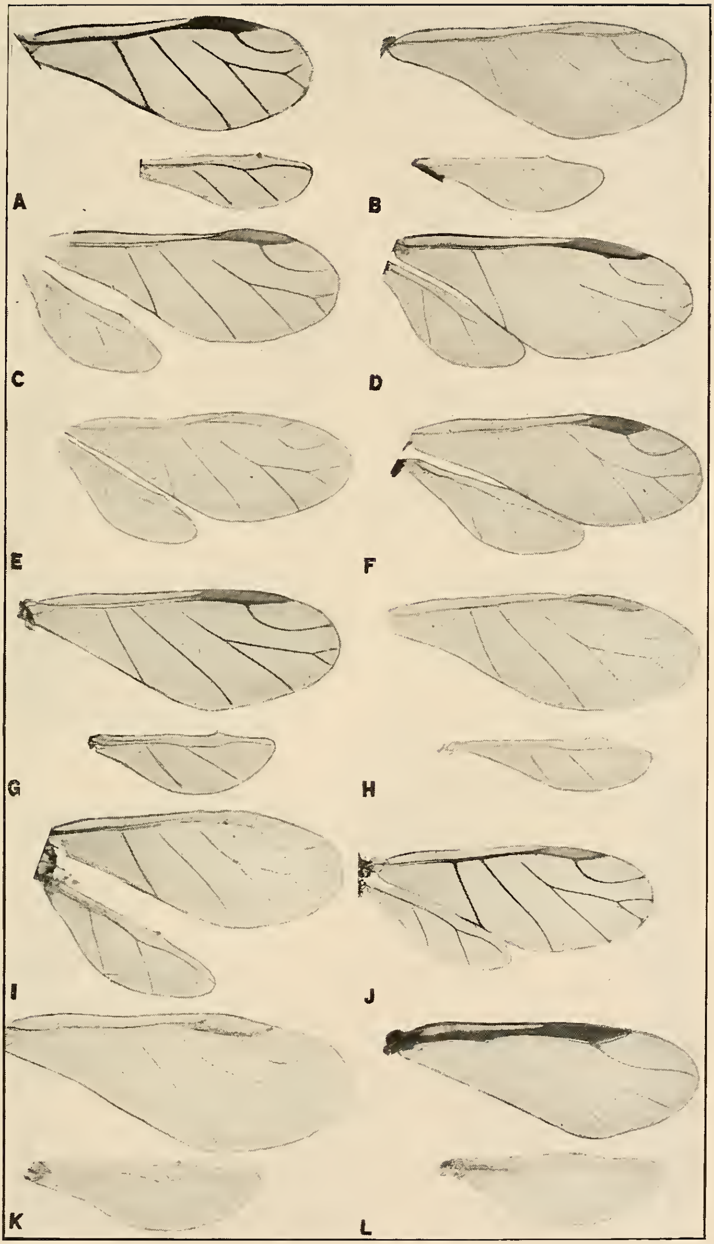

FIGURE 95. A, *Aphis tuberculata*; B, *Myzus cerasi*; C, *Aphis furcata*; D, *Aphis prunorum*; E, *Hyalopterus arundinis*; F, *Aphis cardui* (*prunifoliae*); G, *Aphis cerasifoliae*; H, *Phorodon humuli*; I, *Aphis bakeri*; J, *Macrosiphum crataegi*; K, *Aphis brevis*; L, *Prociphilus corrugatans*.

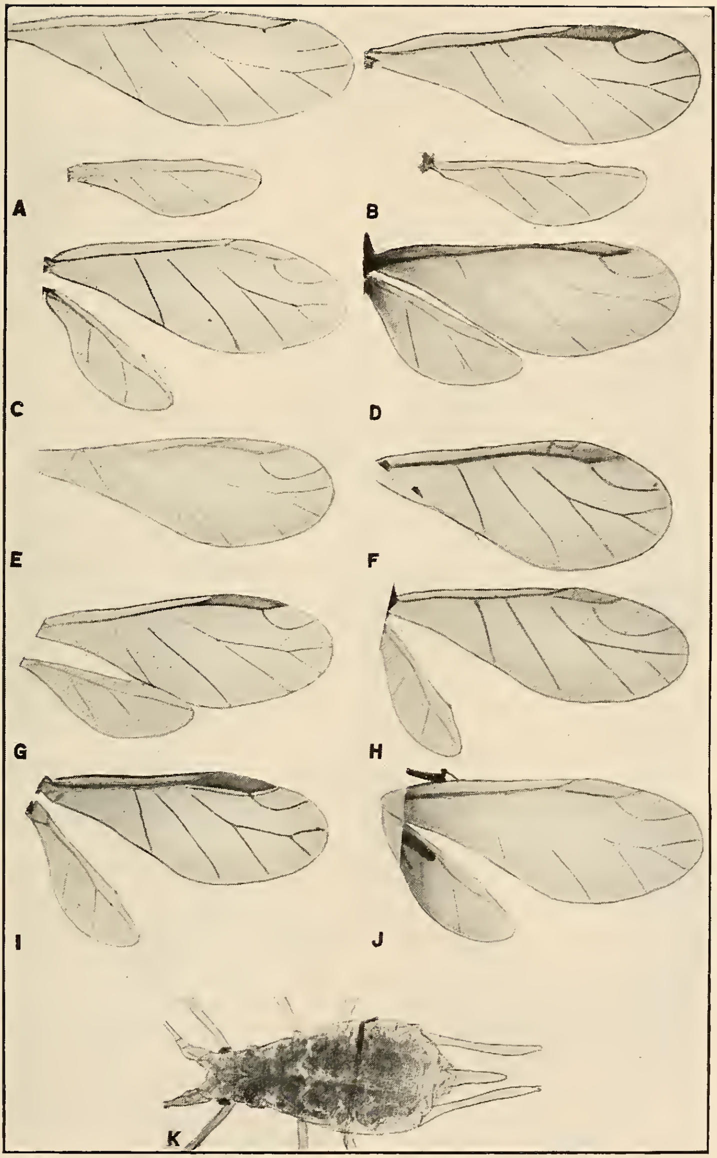

FIGURE 96. A, *Macrosiphum solanifolii?*; B, *Aphis sorbi*; C, *Myzus rosarum*; D, *Aphis avenae*; E, *Macrosiphum dirhodum?*; F, *Aphis rubiphila*; G, *Myzus persicae*; H, *Myzus porosus?*; I, *Aphis spiraephila*; J, *Aphis spiraecola* n. n.; K, *Macrosiphum spiraecola* n. sp.

FIGURE 97. A, *Aphis tuberculata*; B, work of *Aphia brevis* on hawthorn; C, work of *Aphis cerasifoliae* on *Prunus virginiana*

BULLETIN 234.

ABSTRACTS OF PAPERS PUBLISHED BY THE STATION IN 1915 BUT NOT INCLUDED IN THE BULLETINS.

A complete list of all the publications issued by and from the Station in 1914 are given on pages IX to XI of the introduction to this Report. The following pages contain abstracts of the papers issued during the year that are not included in the Bulletins or Official Inspections for the year.

Some Physiological Observations Regarding Plumage Patterns.*

This study was undertaken with the object of carrying the analysis of the genetic factors for color pattern somewhat farther than has hitherto been done. In many forms of domestic poultry the plumage of particular parts of the body displays on each feather a definite and regular pattern. Experimental studies show that these patterns are inherited in a clean-cut Mendelian manner. In the case of the Barred Plymouth Rock color pattern, which has been more thoroughly studied in regard to its inheritance than any other single plumage pattern in birds, extensive investigations in this laboratory and elsewhere indicate that this barred pattern is represented in the gametes by a single Mendelian factor or gene. The manner in which this gene operates physiologically presents a problem of great interest, since it involves an element of morphogenetic localization.

With a view of getting further light on this matter a study has been made of the successive regeneration of feathers, in which special attention has been paid to the comparison of the pattern shown in the regenerates and in the original feather.

*This is an abstract of a paper with the same title by Raymond Pearl and Alice M. Boring published in Science, N. S., Vol. XXXIX, No. 995, pp. 143-144, January 23, 1914.

A few of the more important results which have been obtained from this study, which has now been in progress about a year and a half, may be here set forth, as follows:

1. All feather follicles are not capable of continually producing successive feathers for an indefinite time. In the case of the general body plumage a feather is usually not regenerated more than about three times. The precise number of successive regenerations varies with different birds and different feathers. Wing primaries seem to possess the maximum regenerative capacity. After about the third removal in the case of body feathers the follicle usually remains in a perfectly quiescent condition, taking no steps whatever toward the regeneration of a new feather.

2. This failure to regenerate is, however, very definitely related to the natural moult of the bird, and in the following way. A follicle which has been absolutely inactive for a long period of time (e. g., six months) preceding the natural autumn moult of the bird produces a new feather in connection with the moult, in the same manner as does any other follicle of the body. In other words the process of natural moulting reactivates the follicle which has been brought into a quiescent state by successive feather removal.

3. The precise pattern exhibited by a particular feather is, in the usual course of events, reproduced each time a feather is produced by that follicle with extreme fidelity of detail. If, however, the feather is removed from the follicle as soon as it is fully grown, thus forcing continued regenerative activity of the follicle, the pattern tends progressively to be broken up, and probably will ultimately be entirely lost as a definite pattern. A progressive breaking up of an originally definite pattern is clearly shown in a number of cases. The behavior of the color pattern in successively regenerated feathers suggests, as a working hypothesis, that the pattern factor or gene is possibly represented in each follicle by a strictly limited amount of material, and that when this is used up the pattern is lost.

4. The secondary sexual feathers of the male, such as the saddle hangers, only appear as adult plumage. The same follicles which bear these feathers produce, as juvenile plumage, undifferentiated body feathers. The formation of these secon-

dary sexual feathers is not necessarily dependent upon any normal moult. If the juvenile feather is removed from the follicle the next feather produced by that follicle will be the secondary sexual feather, and not a feather of the juvenile type. After that all further regenerations are of the sexually differentiated feather.

The Measurement of Changes in the Rate of Fecundity of the Individual Fowl.*

The purpose of this note is to call attention to a method of measuring and representing graphically changes in the intensity of ovarian activity, as indicated by rate of ovulation, in the domestic fowl. It has been fully established that if one considers the egg production records from a group or flock of hens as a whole there are observable regular and distinct cycles in the production. Thus, we have distinguished in former publications between winter, spring and summer cycles of flock production. It has not hitherto been possible to observe precisely or to measure any such cyclical changes (either of long or short period) in the egg production of a single individual bird, owing to the fact that the production is in discrete units. Yet while the end products of ovarian activity are discrete units there are very strong reasons for supposing that physiologically the elaboration—or production in the broad sense—of eggs by the ovary is a continuous process of secularly changing rate, rather than a truly discontinuous process.

By a simple statistical expedient it is possible to represent the changes in rate of fecundity in an individual bird as a continuous curve, of which the ordinates represent the rates of egg production on a percentage scale (0 to 100) at the time interval plotted as abscissae. This is done by taking, as the rate of fecundity for any given day Pn, the percentage which the actual number of eggs laid by the bird during the 21 days of which Pn is the central day, is of 21. Put as a formula, if

Rp_n = rate of fecundity (or ovarian activity as indicated by ovulation) on the day P_n

*This is an abstract of a paper by Raymond Pearl having the same title published in Science, N. S., Vol. XL, pp. 383-384.

$\mathbf{1}$ = an egg produced,
and Σ denotes summation between the indicated limits we have

$$Rp_n = 100 \frac{\left(\Sigma_{Pn-10}^{Pn+10}\mathbf{1}\right)}{21}$$

The rates so calculated for each successive day may be plotted as a curve.

Applying this method to records of one, two and three year old hens many interesting and novel points regarding ovarian activity, as expressed in ovulation, may be made out. The long period secular cycles of production appear much more clearly and precisely than in flock mass statistics. The steady diminution in maximum rate of fecundity per unit of time after the first spring cycle in the bird's life is very strikingly shown in the great majority of cases.

Studies on the Physiology of Reproduction in the Domestic Fowl. VII. Data Regarding the Brooding Instinct in Relation to Egg Production.*

This paper presents data regarding variations in the manifestations of the brooding instinct in fowls. It is shown that:

1. Broodiness normally constitutes one element in the cyclical reproductive activities of the female. It recurs with greater or less regularity following periods of laying.

2. The degree of intensity of the brooding instinct, both in respect of its objective manifestations and in respect of its physiological basis, may vary considerably at different times in the life of the same individual.

3. Broodiness in the domestic fowl is not necessarily connected with any particular season. It may occur entirely outside the regular breeding season.

4. While ordinarily broodiness is preceded by the laying of a "clutch" of eggs, this need not necessarily be so. Cases are cited in which well marked broodiness occurs without antecedent laying.

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*This is an abstract of a paper bearing the same title by Raymond Pearl published in the Journal of Animal Behavior, Vol. 4, pp. 266-188.

5. Well marked broodiness behavior may in certain cases disappear very quickly.

6. The manifestations of the brooding instinct are apparently closely connected with the functional activity of the ovary, though the precise nature of the connection has not yet been analyzed.

Studies on the Physiology of Reproduction in the Domestic Fowl. viii. on some Physiological Effects of Ligation, Section or Removal of the Oviduct.*

This paper describes the results of various surgical interferences with the egg-producing mechanism of the fowl, undertaken for the purpose of getting more light on the normal physiology of the organs concerned.

The chief results obtained are:

1. Neither the ligation, section, nor entire removal of the oviduct causes the degeneration or prevents the further growth of the ovary.

2. The pressure of the enclosing funnel is evidently not necessary to ovulation since yolks are ovulated into the body cavity after the *ostium* is sewed or ligated or after the entire duct is removed.

3. Internal pressure due to continued yolk formation is probably the most important factor in the normal rupture of the follicle, since closing the funnel or removing the duct apparently does not greatly delay ovulation.

4. There are cases of unoperated birds with normally functioning ovaries, and oviducts apparently capable of functioning, which do not produce eggs because of some anatomical or physiological condition of the mouth of the oviduct which prevents the entrance of the yolk.

5. The fate of yolks or eggs set free in the body cavity depends apparently upon the physiological vigor of the bird. First, they may cause serious metabolic disturbances which result in the death of the bird; second, they may be absorbed rapidly from the general peritoneal surface; or third, they may be walled off by peritoneum and then absorbed.

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*This is an abstract of a paper bearing the same title by Raymond Pearl and Alice M. Boring, which was published in the Journal of Experimental Zoölogy, Vol. 17, No. 3, pp. 395-424.

6. The material from the resorbed yolks or eggs is apparently utilized in body metabolism since all such birds which were in good health at the time of autopsy were very fat.

7. The removal of the greater portion of an oviduct does not cause the atrophy of any remaining portion.

8. The whole or any remaining part of an oviduct sewed at the funnel, ligated at any level, or with parts removed, passes through growth and cyclic changes coördinated with changes in the ovary exactly as an unoperated duct.

9. The stimulation of the advancing egg is necessary for the discharge of the secretion of the duct, since a duct closed at any level functions only to the point where the passage is interrupted.

10. When any portion of the ventral ligament is removed it is not replaced but all remaining portions develop.

11. The forward portion of the ventral ligament is necessary for the reception of the yolk by the funnel.

12. The muscle bundles which arise from the muscular cord in the ventral ligament along the uterus are probably an important part of the normal apparatus which expels the egg.

Studies on the Physiology of Reproduction in the Domestic Fowl. IX. On the Effect of Corpus Luteum Substance upon Ovulation in the Fowl.*

In this paper it is shown that the dessicated fat-free substance of the corpus luteum of the cow, when injected in suspension, in proper dosage, into an actively laying fowl immediately inhibits ovulation. The duration of this effect varies with different birds from a few days up to two to three weeks. After the bird begins ovulating again the laying goes on unimpaired. The same effect is produced by the injection of extracts of the lutear substance, either intravenously or intra-abdominally. The active substance in producing the inhibition is inactivated by boiling.

Further investigation of the subject is in progress.

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*This is an abstract of a paper bearing the same title by Raymond Pearl and Frank M. Surface and published in the Journal of Biological Chemistry, Vol. XIX, No. 2, pp. 263-278.

Studies on the Physiology of Reproduction in the Domestic Fowl. x. Further Data on Somatic and Genetic Sterility.*

This is a study of certain cases of partial or complete sterility in the fowl, having for its object to get further light on the cause of such sterility.

The chief results may be summarized as follows:

1. Birds which are hereditarily high layers may fail to make good performance records because for some anatomical reason it is impossible for yolks to enter the oviduct.

2. Birds which ovulate, or return partly formed eggs, into the body cavity usually show the nesting instinct.

3. The nesting records show a rhythm similar to egg records of normal birds and it seems probable that they are the normal resultant of the ovulation.

4. Data given in this paper justify the following statements.

A. In case of stoppage of the duct at any level the duct on both sides of the point of stoppage passes through the same cyclic changes coördinated with the cyclic changes in the ovary as a normal unobstructed duct. The duct functions only as far as it receives the stimulus of the advancing egg.

B. Absence of pressure from the funnel does not prevent or apparently greatly retard ovulation. Increased internal pressure may therefore be the most important factor in normal ovulation.

C. Yolks of partly or fully formed eggs may be absorbed rapidly and in large numbers from the peritoneal surface without causing any serious derangement of normal metabolic processes.

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*This is an abstract of a paper bearing the same title by Maynie R. Curtis and Raymond Pearl, now in press in the Journal of Experimental Zoölogy.

Studies on Inbreeding. IV. On a General Formula for the Constitution of the Nth Generation of a Mendelian Population in which all Matings Are of a Brother x Sister.*

In this paper it is shown that if we let

On_{-1} denote the number of *AA* families in the n—1th generation, and

Pn_{-1} denote the number of *AA*+*Aa* families in the n—1th generation, and

Qn_{-1} denote the number of *Aa* families in the n—1th generation, and

Rn_{-1} denote the number of *AA* and 2*Aa* and *aa* families in the n—1th generation, and

Un_{-1} denote the number of *Aa*+*aa* families and

Vn_{-1} denote the number of *aa* families.

Then the families in the nth generation will be given by the following relations of the coefficients.

$$o_n=o_{n-1}+1/4p_{n-1}+1/16r_{n-1},$$
$$p_n=1/2p_{n-1}+1/4r_{n-1},$$
$$q_n=1/8r_{n-1},$$
$$r_n=1/2p_{n-1}+q_{n-1}+1/4r_{n-1},$$
$$u_n=1/2u_{n-1}+1/4r_{n-1}=p_n,$$
$$v_n=v_{n-1}+1/4u_{n-1}+1/16r_{n-1}=o_n.$$

Studies on Inbreeding. V. Inbreeding and Relationship Coefficients.**

The object of this paper is to call attention to the fact that inbreeding of considerable degree may exist in the entire absence of any kinship between the two individuals bred together, and to bring forward a method of separately measuring what proportion of the observed inbreeding in a particular case is due to kinship of the parents, and what to earlier ancestral reduplication. A proposed coefficient of relationship is described, and its application illustrated by concrete cases.

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*This is an abstract of a paper bearing the same title by Raymond Pearl, published in the American Naturalist, Vol. XLVIII pp. 491-494.

**This is an abstract of a paper bearing the same title by Raymond Pearl, published in the American Naturalist, Vol. XLVIII, pp. 513-523.

ON THE LAW RELATING MILK FLOW TO AGE IN DAIRY CATTLE.†

Before the production records of different cows may be critically compared, as in the study of the inheritance of milk flow, for example, it is necessary to make proper corrections for the differing ages of the individuals compared. It has long been a matter of common knowledge that there is a change in amount of milk produced as a cow grows older. Before any proper corrections for this factor can be applied it is essential to determine with precision, and, so far as may be, generality, the quantitative law connecting these two characters milk flow and age. By the associations and individuals who have in charge the Advanced Registry records in all of the dairy breeds of cattle it is generally, and quite erroneously, assumed that the relation between these two variables is a strictly linear one. The essential result of a detailed study of the problem may be stated as follows: *The amount of milk produced by a cow in a given unit of time (7 days, 1 year, etc.) is a logarithmic function of the age of the cow.*

The actual curves which were found to graduate successfully the non-linear regression lines in the case of the different breeds were of the general form

$$Y = a + bX + cX^2 + d \log X$$

where Y denotes the amount of milk produced in a given time, and X denotes the age of the cow. This form of curve is one with which we are already familiar in connection with studies of growth, the change in size of the hen's egg with age, etc.

The law may be stated verbally in the following way: Milk flow increases with increasing age but at a constantly diminishing rate (the increase in any given time being inversely proportional to the total amount of flow already attained) until a maximum flow is reached. After the age of maximum flow is passed the flow diminishes with advancing age and at an increasing rate. The rate of decrease after the maximum is, on the whole, much slower than the rate of increase preceding the maximum.

In general the law above stated applies to the absolute amount of fat produced in a unit of time as well as to the milk.

†This is an abstract of a paper bearing the same title by Raymond Pearl, published in the Proceedings of the Society of Experimental Biology and Medicine, Vol. XII, pp. 18-19.

GROWTH AND VARIATION IN MAIZE.*

This paper gives the results of a study of the growth of the sweet corn plant and the relation of the growth phenomena exhibited to the laws of variation of the plant.

1. Measurements were made at twice-a-week intervals of the height of three series of corn plants. The heights were measured to the tip of the tallest leaf. In addition to these, separate sets of measurements were also made of the tassel height as soon as the tassels appeared.

2. The growth curves obtained by plotting the mean height at each measurement are relatively smooth.

3. After July 3, the time of tasseling, the plants grow in height much faster than before. Growth in height ceases entirely as soon as the tassel blooms.

4. The absolute variability shows a marked increase up to about June 19. From this until the time of tasseling it remains nearly constant but shows a very great increase at the time of tasseling. After all the plants have tasseled the absolute variability decreases somewhat.

5. The relative variability considered for the whole season shows a marked progressive diminution. It thus follows the general growth law of diminishing variability. Considered in detail, however, the relative variability first shows an increase. After June 19 there is a rapid decrease until the time of tasseling. During the period of tasseling there is a very rapid increase in the relative variability. This is followed by an equally rapid decrease. A stable condition is finally reached which is some ten per cent. lower than the variability at the beginning of the season.

6. It is interesting to note that the relation of tasseling to the growth and variability of the height of corn plants is not unlike the relation of puberty to the growth of children. This does not mean that the two processes are necessarily analogous physiologically.

7. From the data presented it appears probable that the corn plant grows in a series of cycles. Each cycle is characterized by the special development of one set of organs. They are,

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*This is an abtsract of a paper with the same title by Raymond Pearl and Frank M. Surface, now in press in Zeitschrift fuer induktive Abstammungs-und Vererbungslehre.

in order, the root cycle, the leaf cycle, the tassel cycle and the ear cycle. The reasons for the postulation of these cycles is given in the text.

8. The observed difference in the manner of growth of individual plants and of groups of plants cannot be explained as the effect of external, environmental factors.

9. These differences are rather to be looked upon as the effect of internal factors.

10. The distribution of the average relative size (mean quintile position) of individual plants is such as to suggest the random distribution of these factors among the plants. The same thing is brought out by the distribution of the relative measurements of plants starting or ending with a given relative size (quintile).

11. The simplest method of explaining these facts is to regard the differences in the manner of growth as due to independent Mendelian factors which are distributed at random in any population of open fertilized maize plants. These factors would occur in the proportions found in a stable Mendelian population mating at random.

12. By assuming the presence of two independent growth factors and weighting each with the proper value, it is possible to obtain a theoretical distribution agreeing very closely with the observed distribution. It is possible that by using more factors even a better fit might be obtained.

13. The interpretation of the growth of these plants by Mendelian factors is strongly supported by the distribution of the standard deviations of the plants with different relative sizes. Thus it has been shown that the extreme plants which would be more nearly homozygous and for this reason less variable are, as a matter of fact, some fifty per cent. less variable than the plants in the middle class after all allowance has been made for the difference in the size of the means.

The Immature Stages of the Tenthredinoidea.*

This study of the immature stages of sawflies was undertaken in the hope that some information might be obtained as to the

*This is an abstract of a paper by Alex. D. MacGillivray with the same title published in the Forty-Fourth Annual Report of the Entomological Society of Ontario, 1913 (1914), pp. 54-75. Plate I with 27 figures.

validity of the species difficult to differentiate from characters of the adults.

The paper begins with a general statement of the classification of the group. The main facts in the development of these insects are then discussed, including the method of reproduction the varied feeding habits of the larvae, the differences in appearance of given species due to molts, and the peculiar preparations of the larvae before pupation.

Descriptions of the larvae of the subfamilies of the group are given, and illustrated by the plate of 27 figures.

A sawfly belongs to the same order of insects as the bees and wasps but instead of having a sting for an ovipositor, its egg laying apparatus is equipped with a small saw with which it cuts a slit in the tissue of the plant and deposits an egg in the opening. The adult or winged sawfly does practically no harm, but the young which hatch from her eggs are as greedy as caterpillars and as completely demolish the foliage they feed upon. These larvae resemble hairless caterpillars somewhat in their appearance as well as in their feeding habits and are frequently mistaken for them.

The eggs are always laid by the female within the tissue or the food plant. Where the larvae are borers, they are laid in holes pierced in the stems of bushy plants or in the limbs or trunks of living or recently dead trees. Where the larvae are leaf-feeders, the eggs are placed in slits sawed by the female from the under surface and located between the two layers of parenchyma. A few species insert their eggs in the petiole of the leaf, some of the gall-making species in the leaf-buds, and one in the blossoms of cherry on the sepals or the upper part of the calyx cup. The eggs are oval in outline, flattened, usually white in color, though sometimes bluish or greenish, and very difficult to locate when first laid. They swell after a short time to twice their original size and push out the surface of the leaf so that it appears to be covered with little mounds.

The manner of feeding is strikingly varied. With many species, the young larvae as soon as they emerge from the egg eat holes through the leaf and continue feeding around the circumference of the hole clinging to the leaf with their thoracic legs and holding the body S-shaped in the hole. Some species are leaf-skeletonizers for the first two or more stages and then either feed from the edge or eat holes in the leaf. The great majority of species are edge feeders.

The larvae of certain genera and subfamilies of the sawflies are entirely different in appearance during their last larval period; white larvae may become spotted, the spotted change to white or green and the spiny lose their spines. Thus the same specimen may be powdery white one afternoon and the next morning yellow with black spots. These changes which take place at time of molting increase the difficulties of studying a species.

The members of one subfamily feed on various species of conifers; they clasp the needles between the thoracic legs and feed until only short stubs are left. Some species will feed only on the needles of the year old growth, others are indiscriminate, feeding either on the new or the old growth. The pines, spruces, and larches especially suffer from the attack of sawfly larvae in Maine.

A Note on Rhagoletis Pomonella in Blueberries.*

In the spring of 1913 the attention of the Maine Agricultural Experiment Station was called to a certain maggot infesting the blueberries in Washington County; and, accordingly certain observations on this insect were made during the summer. Although the work was merely of a preliminary character, the adult was reared, and when bred, the maggot proved to be *Rhagoletis pomonella* Walsh. This appears to be the first record from the blueberry.

When the maggots are small, an infested berry cannot be distinguished by sight from a sound one, but usually when they have attained a fair size the fruit becomes very much shrivelled and shrunken. At all times, even when the larvae are small, an infested berry can easily be distinguished by the touch, for it feels soft and mushy, and this is the surest external indication that it has been attacked. In an infested berry, the pulp becomes red and stringy. Maggots were found at this time in all stages from very small ones to those fully grown. The maggot appears to become full fed in one berry,

*This is an abstract of a paper with the same title by William C. Woods, published in the Journal of Economic Entomology. Vol. 7, pp. 398-399.

which it leaves by an irregularly shaped exit hole through the skin, in order to pupate in the ground.

List of the Hemiptera-Heteroptera of Maine.*

The present list is the first of a series of papers in preparation on the Heteroptera of New England and is offered as a record of the species definitely known to inhabit Maine. In view of the great extent of almost inaccessible territory in the state and the relatively small amount of collecting which has been done, it is to be expected that additional species will be found, but the list is complete enough to be a useful basis for subsequent work, as it includes records of 175 species.

The records have been compiled chiefly from the following sources: An unpublished list of Maine Hemiptera by Mr. O. O. Stover, whose material was determined in part by Uhler, in part by Professor Osborn; the collection of the Maine Agricultural Experiment Station, determined largely by Mr. E. P. Van Duzee; the collection of Mr. F. A. Eddy of Bangor; the collection of the Boston Society of Natural History; and the collection of Mr. Parshley. The dates given are the earliest and latest found on record for the several species.

Where significant data was available, brief notes follow the name of the species listed, as for example:—

"Family COREIDAE.

Anasa Amyot et Serville.

A. tristis De Geer. 22 June—17 Oct. Orono and numerous other localities.

Corynocoris Mayr.

C. typhaeus Fab. 10 May. Orono.

I took twelve specimens of this species as they flew up, one by one, to the dried body of a long dead fowl. Some alighted nearby and others disappeared within the carcass. I was unable to determine whether they came to feed on the juices of the carrion or to prey on other insects, and they may have been attracted merely by the odor. I believe that there are few if any positive records of the frequenting of carrion by Heteroptera."

*This is an abstract of a paper with the same title by H. M. Parshley, published in Psyche, Vol. 21, pp. 139-149.

METEOROLOGICAL OBSERVATIONS.

For many years the meteorological apparatus was located in the Experiment Station building and the observations were made by members of the Station Staff. June 1, 1911, the meteorological apparatus was removed to Wingate Hall and the observations are in charge of Mr. James S. Stevens, professor of physics in the University of Maine.

In September, 1914, the meteorological apparatus was again moved to Aubert Hall, the present headquarters of the physics department.

The instruments used were at Lat. 44° 54′ 2″ N. Lon. 64° 40′ 5″ W. Elevation 135 feet.

The instruments used are the same as those used in preceding years, and include: Wet and dry bulk thermometers; maximum and minimum thermometers; rain gauge; self-recording anemometer; vane; and barometers. The observations at Orono now form an almost unbroken record of forty-six years.

Meteorological Summary for 1914.

Observations Made at the University of Maine.

1914.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Averages.	Totals.
Highest temperature	47	45	50	75	88	88	89	85	91	78	66	62	....	....
Lowest temperature	-22	-24	4	14	27	34	42	38	23	19	6	-17	....	....
Mean temperature	16.3	11.9	30.1	40.0	55.8	60.8	65.8	66.0	60.0	50.9	38.3	24.3	43.35	....
Mean temperature in 46 years	16.51	18.57	28.53	40.95	52.94	62.05	67.17	65.29	57.58	45.66	34.68	22.02	42.66	....
Total precipitation in inches	4.36	2.52	2.71	4.91	1.58	3.82	2.84	3.05	3.03	3.33	1.69	1.20	....	35.04
Mean precipitation in 46 years	4.07	3.51	4.19	2.95	3.53	3.41	3.33	3.44	3.49	3.86	3.56	3.51	42.75	....
Number of days with precipitation of .01 or more	10	7	5	6	3	9	8	7	5	8	6	4	....	78
Snow fall in inches	20.5	22	5	10	....	....	....	....	....	....	4	5	....	66.5
Mean snow fall in 46 years	21.97	21.52	15.36	5.46	0.18	....	....	....	....	0.70	7.03	16.05	88.19	....
Number of clear days	12	20	8	12	15	20	24	19	21	23	12	18	....	204
Number of fair days	4	2	9	4	8	4	2	5	4	4	10	8	....	64
Number of cloudy days	15	6	14	14	8	6	5	7	5	4	8	5	....	97
Total movement of wind in miles	4367	4332	5264	5746	3246	4348	2777	2703	2237	3906	4682	5101	4067.4	48809

REPORT OF THE TREASURER.

The Station is a department of the University and its accounts are kept in the office of the Treasurer of the University. The books, voucher files, etc., are, however, all distinct from those of the other departments of the University. The classification of accounts is that prescribed by the auditors on the part of the Federal Government, and approved by the State Auditor. All of the accounts are audited by the State Auditor and the Hatch Fund and Adams Fund accounts are also audited by the Office of Experiment Stations acting for the United States Secretary of Agriculture in accordance with Federal Law. The tabulated summaries are given in the tables on the two pages that follow.

REPORT OF TREASURER FOR FISCAL YEAR ENDING JUNE 30, 1914.

RECEIPTS.	Hatch fund.	Adams fund.	Animal husbandry investigations.
Balance July 1, 1913	....	....	....
Treasurer of United States	15,000 00	$15,000 00	....
State	....	....	$5,000 00
Sales, etc	....	....	2,500 00
Due from State	....	....	....
Total	$15,000 00	$15,000 00	$7,500 00
DISBURSEMENTS.			
Salaries	$5,196 03	$11,049 58	$5,692 61
Labor	4,888 64	107 86	....
Publications	152 48	....	....
Postage and stationery	525 94	96 85	80 96
Freight and express	226 99	100 78	16 41
Heat, light and power	491 59	105 41	....
Chemical and laboratory supplies	345 88	457 96	132 78
Seeds, plants and sundry supplies	129 27	33 17	....
Fertilizers	60 83	48 00	....
Feeding stuffs	740 18	1,351 95	....
Library	807 11	55 09	41 54
Tools, implements and machinery	452 56	318 37	31 44
Furniture and fixtures	182 14	201 04	82 04
Scientific apparatus	82 45	546 05	437 74
Live stock	8 09	20 45	....
Traveling expenses	249 92	386 90	30 35
Contingent expenses	20 00	....	....
Buildings	439 90	120 54	90 88
Deficit June 30, 1913	....	....	863 25
Total	$15,000 00	$15,000 00	$7,500 00

NOTE: The accounts do not include the expenditures for printing paid in the State treasurer's office. The appropriation is $4,500.00.

REPORT OF TREASURER FOR FISCAL YEAR ENDING JUNE 30, 1914—Concluded.

RECEIPTS.	Aroostook farm.	General account.	Inspection analysis.*
Balance July 1, 1913	....	....	....
Bangor and Aroostook Railroad	$1,250 00	$1,483 88	....
State	....	....	3,837 29
Due from State	....	....	2,764 55
Sales, etc	....	7,051 23	....
Deficit	2,605 84	....	....
Total	$3,855 84	$8,535 11	$6,601 84
DISBURSEMENTS.			
Salaries	$50 00	$2,518 29	$5,551 84
Labor	1,097 04	935 12	....
Publications	....	....	....
Postage and stationery	6 07	126 14	204 77
Freight and express	188 64	139 98	95 74
Heat, light and power	....	328 20	168 23
Chemical and laboratory supplies	33 92	297 26	478 44
Seeds, plants and sundry supplies	783 75	445 03	25
Fertilizers	....	....	....
Feeding stuffs	5 40	26 25	....
Library	....	....	....
Tools, implements and machinery	357 57	75 58	....
Furniture and fixtures	....	....	....
Scientific apparatus	....	19 25	46 19
Live stock	950 00	859 00	....
Traveling expenses	72 15	54 92	17 16
Contingent expenses	73 75	351 26	33 13
Buildings	237 75	1,254 16	6 05
Balance June 30, 1914	....	1,104 67	....
Total	$3,855 84	$8,535 11	$6,601 84

*This account covers the income and expenditures January 1, to June 30, 1914.

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APPENDIX

Official Inspections

56 to 65

SPECIAL REPORT TO COMMISSIONER OF AGRICULTURE
FOR 1913

CONTENTS.

February, 1914.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

ANALYSTS.

James M. Bartlett
Royden L. Hammond
Elmer R. Tobey
Herman H. Hanson
Edward E. Sawyer
Harold P. Vannah

Official Inspections

56

CARBONATED AND OTHER BEVERAGES.

Malt Extract.

Two samples of malt extract were examined, one in the spring and the other in the fall of 1913. "Haskell-Adams Extract. Five per cent alcohol by volume. A compound of malt, hops and other medicinal ingredients. Prepared for Haskell-Adams Co., New England Distributors, Boston, Mass. Guaranteed by the Ebling Brewing Company" was found to carry 4.7 per cent of alcohol by volume.

"Liebigs Malt Tonic, a fermented extract from malt and hops, contains five and a half per cent of alcohol by volume, a pleasant and valuable tonic. This very agreeable preparation combines the nutritive and readily assimilated properties of malted barley with the well known bitter tonic qualities of hops made and guaranteed by the Liebig Malt Extract Co., Jersey City, N. J.," and other healthful claims. This was found to carry 4.65 per cent of alcohol by volume.

Note. All correspondence relative to the inspection laws should be addressed to the Commissioner of Agriculture, Augusta Maine.

"Ale" and "Beer".

It has never been the policy of the executive of the Maine Food Law to mix up with the law prohibiting the sale of spirituous liquors and malt liquors in Maine. Under Governor Cobb's administration, at his request, standards and definitions were fixed for distilled and fermented beverages. At this time there were state and town agencies where liquors could under certain conditions be legally sold. These standards were primarily for the standardization of the quality of the liquors that were dispensed at the public dispensatories.

In the early spring of 1913 all over the State there came to be an unusual activity in the attempts to prohibit the sale of fermented and distilled beverages. It speedily developed that there was a large amount of fraud being perpetrated upon the drinking public by the sale of fermented beverages under false and misleading names. This led to an understanding with the sheriffs whereby when seizures were made fermented beverages that were at all doubtful were sent to the Experiment Station. If they proved to be true to name the goods were condemned and destroyed. If they proved to be untrue to name in many instances cases were brought under the pure food law and the parties concerned fined.

The Maine law prohibits the salt of intoxicating beverages and of malt beverages. Quite a number of years ago it was decided and this decision has been used as a criterion in court cases that a beverage containing less than three per cent of alcohol was not intoxicating. It is, of course, possible to make a malt beverage which carries less than three per cent of alcohol, but the sale of a malt beverage is prohibited. Therefore, there sprung up the special brewing for sale in Maine of fermented beverages which more or less resemble beer which are designed to carry something under three per cent of alcohol. Through the seizures by the sheriffs it was found early in the season of 1913 that many of these imitation beers were carrying labels purposely designed to deceive the purchaser into the belief that he was getting a straight lager beer. This even went so far that many beer bottles were brought into the State and filled with these imitation beers. For instance, a beer carrying only 1.65 per cent of alcohol and without any trace of malt as well as having all the appearance of containing a sugar house by-product, was labeled "Budweiser Lager Bier" and then went on to give the full German label of the Anheuser-Busch Brewing Association of St. Louis. In this particular case the dealer from whom the sheriff seized the goods was fined $25 and costs because "the contents of the package as originally put up had been removed in whole or in part and other contents had been placed in such package". The character of these labels is illustrated by "Excelsior Lager Beer. Extra Quality. Brewed Expressly for Export. Suffolk Brewing Co., Boston;" "Banquet Lager. Brewed by Hanley & Casey, Massachusetts Breweries Co., Boston, Mass."; "Pfaff's Beer. Massachusetts Breweries Co., Boston, Mass."; "Manhattan Style Extra Lager Beer. Bottled expressly for Joseph P. Spang, Boston;" "Export Manhattan Style Lager"; "Imperial Lager Beer, Boston, Mass."; "Philadalphia Style Stock Ale, Specially brewed and bottled"; "Red Star Pale Ale, Boston, Mass."; "Philadelphia Pale Ale. Bottled expressly for hotel and family use"; "Pilsoner's Style Beer. Extra Quality. Brewed expressly for export. Massachusetts Breweries Company."

These fermented beverages analyzed more or less alike, carrying between two and three per cent of alcohol, something less than five per cent of solids and usually quite heavy percentages of glucose or sugar house syrups.

The combined action of the sheriffs and the food executive has probably in no wise diminished the sale of this class of materials. These are, however, at present practically all correctly labeled and are sold for what they are—imitation beer.

Soda Water Bottling Establishments.

During the years 1911 and 1912 a good deal of preliminary work was done in the way of inspection of the soda water bottling establishments in Maine. Many of these were found to be in pretty poor shape. These inspections resulted in a large amount of correspondence and a correction of the most unsanitary conditions.

In the season of 1913 the inspectors were asked to get considerable information in regard to the sanitation problem in connection with the bottlers, including the character of the water supply and its treatment, the treatment of the empty bottles before they were filled, the condition of the premises, whether or not a foam producer was used, whether any sweetener except sugar was used, all data in regard to preservatives used in the goods, and character of the labeling in each case. For the most part these data were completely gathered and reported by the inspectors. Some of the bottlers were visited several times during the summer, but most of them were visited only once. It is believed that the table which accompanies this article includes every bottler in the State.

The first column after the name has to do with the water supply. It is to be noted that most of the water used is the city or town supply and, of course, the water is no better or no worse than that which is used for ordinary domestic purposes in the city. Some times this water is filtered, some of it is strained through cheesecloth or other material. Some of the bottlers are particularly careful as to the quality of the water they use. Some of them, even those that are using spring water, are entirely ignorant of the quality of the water which they are using. At one time there was more or less of a general belief that carbonated beverages did not carry living bacteria, but investigations have shown that the carbonating of water does not kill bacteria.

The next column which includes the treatment of the bottles is perhaps the most important one. It will be noted that in some cases the bottlers claim that they use hot and even boiling water to cleanse the bottles. In one case the claim was made that steam was used to sterilize. In many cases warm to hot water is used. In most cases the bottles are put on a machine which carries a revolving brush, and in almost all cases the bottles are rinsed afterwards usually in cold water. When the conditions under which the empty bottles are returned to the bottlers is considered it would seem as though an efficient system of sterilization ought to be insisted upon. Some of the bottlers have claimed that such a treatment would break a large number of bottles, but that does not seem to be borne out by the facts obtained by the inspectors. Very likely some bottles would be broken by severe treatment, but the health of the public would seem to demand that bottles be thoroughly sterilized. When it is remembered that bacteria cling for a long time to the surfaces of glass and that in many instances the neck of the bottle is put into the mouth and the contents drank directly that way, it is readily apparent that there is large danger of disease producing organisms remaining upon the soda water bottles that go back to the factory for refilling.

The condition of the premises, which is given in the next column, was for the most part found to be very good. In two or three instances the first of the season the conditions in regard to sanitation were very bad indeed, but the worst cases were much improved during the summer, and in general the conditions of bottling establishments, along with other food establishments, were markedly improved throughout the season.

Of the other points collected by the inspectors, the only one that seemed worth while to produce in the report is as to whether foam producers are or are not used. Foam producer is an extract of soap bark. This is poisonous if used in sufficient quantity. The question of soap bark is probably more or less analygous to the question of the disputed preservatives as to whether it is or is not harmful in the small amounts in which it is used in these beverages. It will be noted that quite a large percentage of the bottlers in Maine do not use foam producers.

On the whole the conditions of the bottling establishments and the way in which bottled sodas are produced, while not perfectly satisfactory, are as cleanly and the goods are handled as sanitarily as other food products put up within the State. The conditions certainly average better than the places where the bottled soda is dispensed and the manner in which it is sold and the glasses are rinsed. The whole question of the bottled and unbottled carbonated beverages is a difficult one from the sanitary standpoint. They have the country over been stamping out the common drinking cup, but we are using at public places, the same soda water and other glasses over and over with, in many instances, very little attempt at sanitation. Even under the best conditions there is apparently more or less danger lurking in or rather upon the soda water glass.

Table Showing the Results of Examination of Bottled Carbonated Beverages Purchased in the Summer of 1913. The samples are arranged alphabetically by towns where the goods were made.

Station No.	Name of Town and Maker and Brand.	Color.	Alcohol	Remarks.
	Augusta. Glenwood Spring Co.			
11407	Cherry Phosphate. Artificial flavor and color..............................	Amaranth		
11409	Glenwood Club Peach. Artificial flavor and color..........................	Ponceau 3 R	None	
11406	Glenwood Club Rasport. Artificial flavor and color......................	Amaranth	None	
11408	Glenwood Club Strawberry. Artificial flavor and color....................	Amaranth	None	
	Biddeford. Hanscom Bottling Co.			
11377	Gloria..............................	Probably caramel.	None	
11375	Hanscom's Lemon Sour. Artificial flavor and color......................	Napthol Yellow S		
	Biddeford. York Bottling Works.			
11374	Cherry. Artificial flavor and color....	Amaranth		
11373	Chocolate. Artificial flavor and color	Caramel		
11371	Sparkling Roman Punch. Artificial flavor and color.....	Amaranth	None	
	Caribou. Caribou Bottling Co.			
11427	Raspberry. Artificial flavor and color	Amaranth.		Contains saccharin Adulterated
	Danforth. Chas. Holtz			
11490	Strawberry. Artificial flavor and color	Amaranth		
	Falmouth Foreside. Underwood Spring Corp.			
11381	Underwood Spring Apple Cheer			
11378	Underwood Spring Creme of Mint Soda Artifically colored..................	Light green S F. Yellowish		Mint flavor.
11379	Underwood Spring O................	Caramel		
11380	Vin Fiz. Contains 1-10 of 1 per cent benzoate of soda and added color..			Benzoate of soda 0.084 per cent
	Fort Kent. M. J. Ziter.			
11487	Lemon. Artificial flavor and color			
	Patten. Patten Bottling Co.			
11426	Blood Orange, artificial flavor and color	Amaranth		Contains saccharin. Adulterated
	Portland. Wm. W. Kerrigan.			
11345	Orangeade..........................	Artificial Probably fast yellow. Some fruit color also		

Table Showing the Results of Examination of Bottled Carbonated Beverages Purchased in the Summer of 1913. The samples are arranged alphabetically by towns where the goods were made.

Station No.	Name of Town and Maker and Brand.	Color.	Alcohol	Remarks.
	Portland. Ingalls Bros.			
11317	Fine Blood Orange. Artificially colored and flavored......................	Amaranth		
11316	Fine Sarsaparilla. Sweetener added			
11389	Queen Sherbert. Artifically colored..	Amaranth	None	
11388	Refreshing Miners Fruit Nectar......	Amaranth	None	Color not declared on label.Misbranded
11338	Si-Si der Labetrunk. Alkoholfrei			
	Portland. Murdock & Freeman			
11582	Howel's Grape Julep. Contains 1-20 of 1% benzoate of soda. Artifically colored............................		None	Benzoate of soda 0.037 per cent.
11580	Howel's Orange Julep. Contains 1-50 of 1% benzoate of soda. Artificially colored.........................	Amaranth Orange I	None	Benzoate of soda 0.054 per cent.
	Portland. C. E. Odiorne Bottling Co.			
11385	Orangeade. Artifical flavor and color	Orange I		
11384	Ocherade. Colored with harmless vegetable color.....................	Cudbear	None	
	Portland. Simmons & Hammond.			
10608	Jersey Cream Syrup			
11387	S. & H. Root Beer	....	None	
	Portland. Young Buffalo Bill Wild West Circus.			
11346	Lemonade.........................	....	None	
	Presque Isle. Presaue Isle Bottling Co.			
11424	Sparkling Strawberry Soda. Artifical flavor and color..................	Amaranth		
11423	Superior Quality Imitation Raspberry	Amaranth.		
11422	Superior Quality Lemon Sour. Colored	Napthol Yellow S		
	Van Buren. J. J. Cyr.			
11430	Raspberry. Artifical color and flavor	Amaranth		
11429	Strawberry. Artifical flavor and color	Amaranth		
	Van Buren. Van Buren Bottling Co.			
11428	Blood Orange. Artificial flavor and color...........................	Unidentified Orange		

Table Showing the Reports of the Inspectors of Soda Water Bottling establishments in the summer of 1913.

Bottler.	Water.	Treatment of Bottles.	Condition of Premises.	Foam Producer Used.
Bangor Bottling Co., Front St., Bangor	City supply. Filtered	Washed on machine. Soaked in hot water. Rinsed.	Rooms clean. Not screened.	
Bath Bottling Co., 104 Commercial St., Bath	City supply. Filtered	Washed in cold water. Put on brush. Rinsed	Building old. Fairly clean. Not screened.	No.
Beckett & Co., Calais	City supply from Spring. Filtered	Soaked in hot water. Put on brush. Rinsed.	Clean. Not screened	Yes.
Belfast Candy Co., Belfast	City supply. Filtered	Soaked in hot water with soap powder. Brushed. Rinsed.	Clean. Screened	Yes.
Boggs, E. A., Waldoboro	Spring. Four strainers used	Washed. Soaked. Rinsed.	Clean. Screened	No
Bourgoine, I. B., Fort Kent	Spring. No treatment	Washed in cold water. Brushed. Rinsed	Old building, not very clean. Not screened	Yes
Butterfield, N. L., Old Town	Artesian well. Strained	Washed in boiling water and soap powder. Rinsed in hot water	Temporary location. Light and ventilation poor. Not screened	No
Caribou Bottling Co., Habeeb & Corey, Caribou	City supply. Filtered	Washed in cold water and soap powder. Brushed. Rinsed.	Clean. Screened	Yes
Curtis, Leslie, Dexter	Spring. Filtered	Washed on machine. Soaked in hot water. Rinsed	Clean. Screened	Yes.
Dennis Bros., Cherryfield	Spring. No treatment	Soaked in cold water. Rinsed	Floors dirty. Screened.	Yes
Eastport Bottling Co., Frank Malloch, Eastport	City supply. Filtered	Soaked in hot water. Rinsed	Fairly clean. Screened.	Yes
E. E. Bottling Co., E. E. Epstein, Bangor.				

Table Showing the Reports of the Inspectors of Soda Water Bottling establishments in the summer of 1913.

Bottler.	Water.	Treatment of Bottles.	Condition of Premises.	Foam Producer Used.
Glenwood Spring Co., Augusta	Spring protected by house. Water strained	Washed in hot water. Rinsed.	Very clean	Yes.
Grondin, E. G., Waterville	City supply. Strained	Washed in cold water. Soap powder used. Brushed. Rinsed.	Fairly clean. Untidy. Not screened.	Yes
Hanscom Bottling Co., Biddeford	City supply	Washed in hot water. Brushed. Rinsed	Sanitation improved during summer. Screened in August.	No
Hartleb & Cheltra Co., Bath	City supply. Filtered	Soaked in hot water and soap powder. Brushed. Rinsed.	Clean. Screened.	Yes
Havener, C. E., Rockland	City supply. Filtered	Soaked in cold water and soap powder. Rinsed.	Clean. Not screened.	No
Hewett Bottling Co., Rockland	City supply. Filtered	Soaked in hot water. Brushed. Rinsed	Clean. Not screened.	Yes
Highland Spring Co., Lewiston	Spring protected by house. Water not treated	Washed in hot water. Rinsed.	Clean. Sanitary	Sometimes
Hubbard & Sons, O. J., Wells	Spring	No hot water or steam used in cleansing bottles	Clean. Sanitary.	Yes
Ingalls Bros., 36 Plum St., Portland	Sebago Lake. Filtered. City supply	Washed with caustic soda. Rinsed. Brushed. Rinsed second time.	Clean. Partially. screened.	Yes
Mahew, Gideon, Waterville	City supply. Filtered	Washed with hot water and soap powedr. Brushed. Rinsed.	Clean. Screened.	Yes.
Maine Bottling Co., 218 Lincoln St., Lewiston	Lake Auburn. Untreated. City supply		Conditions improved during summer. Damp. Light and ventilation poor.	Yes

Table Showing the Reports of the Inspectors of Soda Water Bottling establishments in the summer of 1913.

Bottler.	Water.	Treatment of Bottles.	Condition of Premises.	Foam Producer Used.
Maine Jobbing Co., Rockland	City supply Filtered	Soaked. Brushed Rinsed	Fairly clean No screens.	No
Millinocket Bottling Co., Millinocket	City supply Filtered	Soaked in cold water and soap powder Brushed. Rinsed.	Fairly clean Screened.	No
Mineral Spring Soda Co., M. Rudman, Watervile	City supply Filtered	Washed in warm water Brushed. Rinsed	Clean Screened.	Yes
Mitchell, T. G., Lubec	City supply Filtered	Washed. Sterilized with steam and hot water	Clean Screened.	Yes
Mt. Kebo Spring Water Co	Spring. No treatment	Washed in warm water and soap powder Brushed. Rinsed	Clean Screened.	Yes.
Murdock & Freeman, 7 Franklin St., Portland	Sebago Lake City supply	Washed and sterilized	Much improvement during summer. Screened.	Yes
Odiorne, C. E., Bottling Co., 60-62 Cross St., Portland	Sebago Lake City supply	Washed in warm water Brushed. Rinsed	Floors coated with syrup. Cobwebs overhead. Not screened.	Yes
Palmer Bottling Co., Houlton	City supply Filtered	Soaked in cold water Brushed. Rinsed	Fairly clean. Screened	Yes.
Patten Bottling Co., Patten	Spring. No treatment	Washed in hot water Brushed. Rinsed	Clean Screened.	Yes.
Piers, B. F., Old Town	Artesian well Filtered	Washed in hot water, and soap powder Rinsed in boiling water	Clean Screened.	Yes.
Pinecroft Bottling Co., Freeport	Spring. No treatment	Soaked in cold water and soap powder Brushed. Rinsed	Clean No screens.	No.

Table Showing the Reports of the Inspectors of Soda Water Bottling establishments in the summer of 1913.

Bottler.	Water.	Treatment of Bottles.	Condition of Premises.	Foam Producer Used.
Pine Spring Water Co., Brunswick	Spring Filtered	Treated in "20th Century Sterilizer" Washed. Rinsed.	Clean No screens.	No.
Presque Isle Bottling Co., Presque Isle	City supply Filtered	Washed in cold water Rinsed	Fairly clean Screened.	Yes.
Robinson, F. E., 98 Birch St., Bangor	Well Filtered	Washed in machine Soaked in hot water Rinsed.	Floor dirty Screened..	No.
Ross Bottling Works, 559 Main St., Bangor	Spring Filtered	Washed in machine Sterilized in hot water and steam Rinsed.	New building. Clean and sanitary.	
Rumford Bottling Co., Rumford	Spring Strained	Washed in machine Soaked in hot water Rinsed.	Clean. Screened	Yes.
Seekins, Wm. Pittsfield	Well. No treatment	Washed in hot water and soap powder Rinsed	Clean No screens.	No.
Silver Spring Soda Co., Skowhegan	Spring Filtered	Washed in cold water and soap powder Brushed. Rinsed	Clean No screens.	Yes.
Somoar Carbonating Co	Spring	Washed and rinsed in hot water	Clean and sanitary	No.
Spratt, J. L., 116 Kenduskeag Ave., Bangor	Spring Filtered	Washed in hot water and soap powder Rinsed.	Clean. Screened.	
Switzer Water Co., So. Brewer	Distilled	Steamed. Washed Rinsed.	Clean and sanitary	No.

Table Showing the Reports of the Inspectors of Soda Water Bottling establishments in the summer of 1913.

Bottler.	Water.	Treatment of Bottles.	Condition of Premises.	Foam Producer Used.
Underwood Spring Corporation, Falmouth Foreside	Spring	Washed and sterilized	Floor dirty. Cobwebs overhead. No screens.	Yes.
United Bottling Co., 228 Fore St., Portland	Sebago Lake. City supply.	Washed in hot water	Clean. Screens on window.	Yes.
Van Buren Bottling Co., Van Buren	City supply. Filtered.	Soaked in hot water. Brushed. Rinsed.	Clean. Partially screened.	Yes.
Vincent Bottling Co., Auburn	Lake Auburn. City supply. Untreated.	Washed in hot water. Not sterilized.	Clean and sanitary	No.
Virginia Spring Water Co., Rumford	Spring. Filtered.	Washed in cold, then in hot water. Rinsed in cold water	Clean and sanitary. Screened.	Some.
Webber, A., Danforth	City supply. No treatment.	Soaked in cold water. Brushed. Rinsed.	Clean. No screens	Yes.
White Sand Spring Bottling Co., Springvale	Spring	Washed in hot water	Clean and sanitary	No.
Windsor Ginger Ale Co., Lewiston	Spring	Place closed at time of visit	Appeared from outside to be well kept.	
York Bottling Co., 60 Elm St., Biddeford	City supply	Washed in cold water very inefficiently	First of season very dirty and unsanitary and no screens. Later in season considerable improvement and screens put on.	Yes.
Ziter, M. J., Fort Kent	Spring. No treatment.	Washed in cold water. Brushed. Rinsed	Clean. No screens	Yes.

February, 1914.

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Official Inspections

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ICE CREAM.

During the summer of 1913 a large number of samples of ice cream were collected in various parts of the State. An attempt was made to cover the larger towns quite thoroughly. More samples than upon previous years have been examined.

Practically all of the manufacturers that were found in 1912 making ice cream below the standards were visited and samples taken. Whenever an ice cream was found nearly up to the standard or samples were found to run under in the case of makers that had been found all right in previous years second samples were taken before reporting the results of the first examination to the person whose goods were sampled. In the case the cream was within one and one-half percent of the standard the dealers and makers were warned. All cases in which there was a serious falling off in quality hearings were appointed, and the cases fully investigated. These resulted in a number of prosecutions.

NOTE. All correspondence relative to the inspection laws should be addressed to the Commissioner of Agriculture, Augusta Maine.

It is gratifying to report that most of the makers, and particularly the large manufacturers, are putting out a good grade of ice cream. It is doubtful if in any other State the ice cream situation is, on the whole, as satisfactory as it is in Maine.

STANDARDS.

In considering this report it should be kept in mind that the standard for ice cream is as follows:

"Ice cream is a frozen product made from cream and sugar, with or without a natural flavoring, and contains not less than fourteen (14) per cent of milk fat. A limited amount of gelatine, starch, eggs, or other healthful food constituents may be added to ice cream without statement of fact, and such goods may be called ice cream provided the required per cent of milk fat is maintained. If imitation flavoring materials are used, the label must state that fact, as in the case of imitation extracts."

"Fruit ice cream is a frozen product made from cream, sugar, and sound, clean, mature fruits, and contains not less than twelve (12) per cent of milk fat."

"Nut ice cream is a frozen product made from cream, sugar, and sound, nonrancid nuts, and contains not less than twelve (12) per cent of milk fat."

"Imitation ice cream. Frozen products which contain less milk fat than the standards require, cannot be lawfully sold as ice cream and the word *cream* cannot be lawfully used upon the labels or in any way in connection with such goods, unless it is qualified by some such words as 'imitation' or 'substitute.' Thus a frozen product similar to ice cream or fruit or nut ice cream, except that it carries less milk fat than the standards may be lawfully labeled 'Imitation ice cream,' or 'Ice cream substitute.' If an imitation ice cream contains imitation flavoring matter, this fact must be plainly stated on the label."

"At soda fountains, ice cream rooms, etc., if it is desired to sell frozen products that do not conform to the standards for ice cream, conspicuous signs showing exactly what is being served must be displayed and orders for ice cream can not be lawfully filled by serving substitutes without explaining what they are."

"The regulation relative to ice cream and ice cream substitutes applies equally to hotels and restaurants. All statements upon bills of fare, etc., must be in accord with the above."

As in previous years it was found that in some cases low grade ice cream was caused by using low grade cream in its manufacture. People who make ice cream for sale should be careful to obtain a written guaranty from the person from whom they buy their cream certifying that such will be according to a certain strength, for in this way only can the manufacturer be sure of getting a uniform material.

Table showing the results of the examination of samples of ice cream collected in the season of 1913, arranged alphabetically by towns.

Sta. No.	Town and Dealer.	Cream sold as	Per Cent Milk Fat.	
			Standard.	Found.
			Per cent.	Per cent.
11538	Auburn. S. Minolla	Vanilla	14	16.93
11465	Bangor. G. N. Brountas	Vanilla	14	14.36
11519	Bangor. I. B Dean	Vanilla	14	13.22
11577	Bangor. East Side Pharmacy	Vanilla	14	19.04
11522	Bangor. Nicholas Ferris	Vanilla	14	11.23
11526	Bangor. Fifield & Co	Vanilla	14	12.22
11468	Bangor. Fowler Drug Co	Vanilla	14	12.85
11575	Bangor. Fowler Drug Co	Vanilla	14	15.68
11576	Bangor. F. E. Gould	Vanilla	14	17.86
11463	Bangor. L. H. Hamm	Vanilla	14	10.05
11524	Bangor. Solomon Leavitt	Vanilla	14	12.26
11466	Bangor. G. E. Lufkin	Vanilla	14	12.93
11676	Bangor. G. E. Lufkin	Vanilla	14	17.35
11523	Bangor. Paul G. Martini	Vanilla	14	16.41
11525	Bangor. H. K. Priest	Vanilla	41	13.63
11188	Bangor. S. Shiro	Vanilla	14	15.10
11527	Bangor. S. Shiro	Vanilla	14	17.15
11467	Bangor. John Skoufis	Vanilla	14	19.79
11464	Bangor. Caldwell Sweet	Vanilla	14	20.55
11528	Bangor. Waiting Room	Vanilla	14	14.79
11461	Bangor. Harry A. Witham	Vanilla	14	8.86
11545	Bangor. Harry A. Witham	Vanilla	14	13.68
11604	Bangor. Harry A. Witham	Vanilla	14	14.30
11462	Bangor. Fred D. Wyman	Vanilla	14	11.66
11530	Bangor. Fred D. Wyman	Vanilla	14	16.76
11552	Biddeford. G. & A. Boucher	Vanilla	14	14.33
11549	Biddeford. Peter Frediani	Vanilla	14	16.32
11500	Biddeford. F. O. Goldthwaite	Vanilla	14	15.27
11550	Biddeford. H. L. Merrill	Vanilla	14	15.70
11277	Biddeford. John Payheur	Chocolate	12	3.42
11354	Biddeford. John Payheur	Chocolate Sherbert	12	10.14
11551	Biddeford. Geo. X. Vassill	Vanilla	14	16.27
11521	Brewer. Baptist Society (Sold at Fair Grounds)	Vanilla	14	13.73

Table showing the results of the examination of samples of ice cream collected in the season of 1913, arranged alphabetically by towns.

Sta. No.	Town and Dealer.	Cream sold as	Per Cent Milk Fat. Standard.	Found.
			Per cent.	Per cent.
11578	Brewer. Boynton's Pharmacy	Vanilla	14	18.49
11579	Brewer. G. G. Hodgkins	Vanilla	14	17.12
11498	Buxton. A. O. Bourgeois	Vanilla	14	5.90
11586	Buxton. A. O. Bourgeois	Vanilla	14	5.86
11554	Cape Elizabeth. Anderson Bros	Vanilla	14	12.53
11520	East Holden. O. T. Gordon	Vanilla	14	15.03
11516	Fairfield. C. E. Holt	Vanilla	14	13.32
11517	Fairfield. C. W. McClintock	Vanilla	14	14.41
11341	Falmouth Foreside. C. G. Pierce	Vanilla	14	11.02
11342	Falmouth Foreside. Mrs. H. J. Poland	Vanilla	14	15.94
11273	Freeport. H. R. Alden	Vanilla	14	14.40
11272	Freeport. Fogg Drug Store	Vanilla	14	19.30
11391	Gorham. E. F. Caswell	Vanilla	14	10.07
11449	Gorham. E. F. Caswell	Vanilla	14	8.64
11603	Gorham. E. F. Caswell	Vanilla	14	13.61
11392	Gorham. C. G. Pierce	Chocolate	12	10.58
11541	Lewiston. Mike Cyr	Vanilla	14	17.71
10981	Lewiston. E. Gregoraky	Vanilla	14	12.25
11074	Lewiston. E. Gregoraky	Vanilla	14	14.01
11444	North Windham. W. O. Gates	Vanilla	14	9.52
11441	North Yarmouth. L. A. Hamilton	Raspberry	12	2.32
11508	Oakland. Depot Cafe	Vanilla	14	14.18
11515	Oakland. Foster's Drug Store	Vanilla	14	15.73
11509	Oakland. J. E. Morrisette	Vanilla	14	16.23
11336	Old Orchard. E. F. Alkazin Co	Vanilla	14	14.29
11335	Old Orchard. G. W. Armstrong Dining Room & News Co	Vanilla	14	14.02
11332	Old Orchard. I. Kroch	Chocolate	12	13.41
11331	Old Orchard. Sears & Hinchyffe	Vanilla	14	13.84
11333	Old Orchard. Seaside Drug Co	Vanilla	14	14.13
11334	Old Orchard. Wentworth Spa	Vanilla	14	16.30

Table showing the results of the examination of samples of ice cream collected in the season of 1913, arranged alphabetically by towns.

Sta. No.	Town and Dealer.	Cream sold as	Per Cent Milk Fat. Standard.	Found.
			Per cent.	Found.
11480	Old. Town. F. X. Boutin	Vanilla	14	12.29
11484	Old Town. H. M. Burnham	Vanilla	14	17.50
11452	Old Town. H. I. Goldsmith	Vanilla	14	8.36
11482	Old Town. H. I. Goldsmith	Vanilla	14	15.37
11451	Old Town. Jordan Bros	Vanilla	14	10.55
11483	Old Town. Jordan Bros	Vanilla	14	11.85
11459	Old Town. L. E. Leavitt	Walnut	12	15.35
11485	Old Town. Morin Bros	Vanilla	14	14.04
11450	Old Town. W. C. Mutty	Chocolate	12	13.32
11486	Old Town. W. C. Mutty	Vanilla	14	15.71
11481	Old Town. L. Solomon	Chocolate	12	11.42
11456	Orono. P. H. Houlihan	Vanilla	14	9.12
11476	Orono. P. H. Houlihan	Vanilla	14	11.66
11453	Orono. Allie A. King	Vanilla	14	8.57
11477	Orono. George A. King	Chocolate	12	12.47
11478	Orono. George A. King	Vanilla	14	12.75
11601	Orono. George A. King	Vanilla	14	17.49
11455	Orono. Chas. F. Nichols	Vanilla	14	9.79
11475	Orono. Chas. F. Nichols	Vanilla	14	8.79
11600	Orono. Chas. F. Nichols	Vanilla	14	14.58
11566	Peak's Island. E. A. Graham	Vanilla	14	14.48
11057	Portland. John F. Bennett	Vanilla	14	14.14
11285	Portland. Wm. Branz	Vanilla	14	14.01
11556	Portland. Center Drug Store	Vanilla	14	14.27
11555	Portland. Chapman & Wyman	Vanilla	14	16.71
11261	Portland. Thomas Cristo	Vanilla	14	3.99
11278	Portland. Thomas Cristo	Vanilla	14	14.80
11559	Portland. A. Fagone	Vanilla	14	13.91
11529	Portland. B. Feldman	Vanilla	14	14.85
11557	Portland. F. E. Fickett	Vanilla	14	14.03
11560	Portland. W. A. Flaherty	Vanilla	14	13.53
11573	Portland. W. J. Flanagan	Vanilla	14	14.64

Table showing the results of the examination of samples of ice cream collected in the season of 1913, arranged alphabetically by towns.

Sta. No.	Town and Dealer.	Cream sold as	Per Cent Milk Fat. Standard.	Per Cent Milk Fat. Found.
			Per cent.	Per cent.
11431	Portland. Jacob Gitlin	Vanilla	14	9.65
11571	Portland. Jacob Gitlin	Vanilla	14	14.86
11469	Portland. Samuel Gitlin	Vanilla	14	11.21
11572	Portland. Samuel Gitlin	Vanilla	14	15.46
11680	Portland. John H. Hamel	Vanilla	14	14.80
11054	Portland. Hesceltine & Tuttle	Vanilla	14	19.00
11437	Portland. B. Huberman	Vanilla	14	8.80
11264	Portland. K. Johnson	Vanilla	14	11.97
11570	Portland. K. Johnson	Vanilla	14	15.75
11313	Portland. C. A. Miller	Vanilla	14	14.65
11050	Portland. C. C. Pooler	Vanilla	14	14.02
11312	Portland. Ringling Bros. Circus	Vanilla	14	15.17
11314	Portland. Ringling Bros. Circus	Vanilla	14	14.25
11056	Portland. John G. Sawyer	Vanilla	14	14.12
11533	Portland. John G. Sawyer	Vanilla	14	13.53
11055	Portland. Geo. F. Soule	Vanilla	14	13.13
11534	Portland. Geo. F. Soule	Vanilla	14	10.40
11569	Portland. Geo. F. Soule	Vanilla	14	15.45
11681	Portland. Geo. F. Soule	Vanilla	14	14.61
11052	Portland. Smith & Broe	Vanilla	14	13.26
11051	Portland. Arthur G. Spear	Chocolate	12	13.85
11471	Portland. G. L. Stetson	Vanilla	14	11.81
11532	Portland. G. L. Stetson	Vanilla	14	16.55
11470	Portland. H. L. Stimson	Vanilla	14	15.38
11262	Portland. Chas. Thomas	Vanilla	14	13.72
11053	Portland. J. J. Thuss	Strawberry	12	13.80
11558	Portland. Joe Vacchano	Vanilla	14	13.37
11265	Portland. John Zakarian	Vanilla	14	7.50
11286	Portland. John Zakarian	Vanilla	14	12.62
11232	Rockland. Mrs. E. W. Thurlow	Vanilla	14	10.97
11233	Rockland. Mrs. E. W. Thurlow	Vanilla	14	8.63

Table showing the results of the examination of samples of ice cream collected in the season of 1913, arranged alphabetically by towns.

Sta. No.	Town and Deaker.	Cream sold as	Per Cent Milk Fat.	
			Standard.	Found.
			Per cent.	Per cent.
11432	South Portland. W. W. Rich........	Vanilla......	14	7.44
11553	South Portland. W. W. Rich........	Vanilla......	14	11.86
11281	South Windham. A. L. Hoyt........	Vanilla......	14	9.46
11390	South Windham. A. L. Hoyt........	Vanilla......	14	14.03
11562	Waterville. Bowman & Knight......	Vanilla......	14	3.92
11512	Waterville. Lewis Facos............	Vanilla......	14	14.10
11514	Waterville. Hager's Candy Store.....	Vanilla......	14	15.16
11510	Waterville. Wm. C. Hawker & Co....	Vanilla......	14	12.71
11563	Waterville. M. W. Hayden..........	Vanilla......	14	15.84
11565	Waterville. R. H. Jackson..........	Vanilla......	15	13.16
11564	Waterville. Chas. Micque...........	Vanilla......	14	9.31
11511	Waterville. J. D. Parent............	Vanilla......	14	16.12
11513	Waterville. Waterville Drug Store....	Vanilla......	14	14.63
11049	Westbrook. F. D. Anderson.........	Chocolate....	12	14.94
11047	Westbrook. Raymond & Marr.......	Vanilla......	14	11.21
11048	Westbrook. Rexall Drug Store.......	Vanilla......	14	15.52
11046	Westbrook. West End Drug Co......	Chocolate....	12	12.88
11355	Yarmouthville. Coombs Bros........	Vanilla......	14	14.06

CREAM USED IN THE MANUFACTURE OF ICE CREAM.

During the investigation of ice cream the present season the cream used in its manufacture has also been investigated as far as possible. This is particularly true of those cases where the ice cream was found to be below standard. Where possible in such cases the cream itself was sampled and in some cases it was ascertained that the trouble of the manufacturer of ice cream was apparently due to the fact that the cream used was not as rich as it was supposed to be. A special law places the standard for cream at 18 per cent milk fat. As has been repeatedly stated to the trade, a cream of this strength used in connection with the proper amount of sugar, flavoring, and a slight amount of filler, will make an ice cream which carries between 14 and 15 per cent of milk fat.

No attempts at prosecution have been made relative to the samples of cream reported in the following table, although it will be noted that a few are below the standard for cream. In the table the figures given represent the cream which the dealer was supposed to be buying and also the actual strength of the cream determined by analysis.

Tabe showing analyses of samples of cream collected from producers because manufacturers of ice cream attributed the shortage in milk fat to the cream used. The sample was taken at the time the delivery was made by the dairy.

Sta. No.	Town and Dairy.	Per Cent Milk Fat.	
		Claimed.	Found.
		Per cent.	Per cent.
11544	Bangor. L. E. Brown	–	17.8
11295	Portland. Maine Dairy Co	18.0	17.0
11296	Portland. Maine Dairy Co	20.0	18.2
11305	Portland. Maine Dairy Co	18.0	18.3
11284	Portland. Pine Tree Creamery	Light	18.2
11287	Portland. Pine Tree Creamery	18.0	18.1
11568	Portland. Pine Tree Creamery	18.0	18.0
11070	Portland. Portland Creamery	18.0	18.0
11291	Portland. Portland Creamery	Light	17.4
11292	Portland. Portland Creamery	Light	17.4
11302	Portland. Portland Creamery	Light	17.8
11567	Portland. Portland Creamery	18 0	17.9
11304	Portland. Portland Creamery	20.0	21.0
11202	Portland. West End Dairy Co.*	–	15.7
11203	Portland. West End Dairy Co.*	17.0	17.6
11290	Portland. West End Dairy Co.*	18.0	17.0
11329	Portland. West End Dairy Co.*	18.0	18.5

*Samples taken on request of the West End Dairy Company from cream as received from Mohawk Dairy Co., Colebrook, New Hampshire.

March, 1914.

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BUTTER.

During the year 1913 a good many lots of package butter were weighed in different parts of the State. Where the shortage in weight was marked in amount, samples were purchased and in most instances analyzed. The results are reported in the tables that follow.

But little comment is necessary. The figures in the tables are self explanatory. No butter was considered short weight unless the shortage was greater than one-fourth of an ounce. In all instances where samples were obtained and cases commenced analysis was made to find the water and fat content. No prosecutions were begun if the goods contained approximately the weight of milk fat that a pound of butter should carry.

It is such an easy matter to ascertain whether or not butter is full weight that there does not seem to be much excuse for the manufacturer or dealer selling or the purchaser buying short weight packages.

Note. All correspondence relative to the inspection laws should be addressed to the Commissioner of Agriculture, Augusta Maine.

Table giving report of creamery butter weighed by the inspectors at dealers. The samples are arranged alphabetically by the name of makers.

Maker, and Brand, if Any.	Where Found.	Number bricks weighed.	*Number bricks short weight.
Armour & Co., Chicago, Ill. "Butternut Creamery Butter"	D. H. Johnson, Springvale	4	None.
Armour & Co., Chicago, Ill. "Butternut Creamery Butter"	F. W. Stevens, No. Berwick	3	None.
Armour & Co., Chicago, Ill. "Butternut Creamery Butter"	C. L. Baston	3	None.
Armour & Co., Chicago, Ill. "Highest Grade Cloverbloom Creamery Butter"	Buck & Clark, Greenville	7	7
Armour & Co., Chicago, Ill.	Armour & Co., Bangor	20	None.
Armour & Co., Chicago, Ill.	Armour & Co., Bangor	22	None.
Brighton Creamery, Island Pond, Vt.	Clark & Griffin, Long Island	6	3
Brown, L. E., Bangor	Danforth, Marsh Co., Brewer	6	6
Carrabasset Creamery, East New Portland. "Carrabasset Creamery Butter"	W. M. Hogan, Bath	8	None.
Carrabasset Creamery, East New Portland. "Carrabasset Creamery Butter"	O. F. Rullmann, Bath	8	None.
Chapin & Adams, Boston	Parker & Wescott, Castine	9	None.
Fowle, Hibbard Co., Boston	Ben D. Field, Belfast	7	None.
Fowle, Hibbard Co., Boston	H. L. Whitten Co., Belfast	8	None.
Fox River Butter Co., Boston. "Beechwood Creamery Butter"	Pelletier Bros., Springvale	5	None.
Fox River Butter Co., Boston	Rowe & Bartlett, Springvale	4	None.
Pine Tree Creamery, Portland	Patterson Bros.	10	4
Sparkling Spring Creamery, Norridgewock	W. R. Melrose, Bath	10	None.
John P. Squire & Co	John P. Squire & Co., Bangor	15	15
John P. Squire & Co	John P. Squire & Co., Bangor	25	22
John P. Squire & Co., "Arlington Creamery Butter"	Buck & Clark, Greenville	5	4
Sulzberger & Sons Co. of America	Pickard's Market, Bangor	30	10
Swift & Co. "Brookfield Extra Creamery Butter"	Pelletier Bros., Springvale	2	2

* No brick considered short weight unless shortage was more than one-quarter ounce.

Table giving report of creamery butter weighed by the inspectors at dealers.—Concluded.

Maker, and Brand, if Any.	Where Found.	Number bricks weighed.	*Number bricks short weight.
Swift & Co. "Brookfield Extra Creamery Butter"	Ideal Cash Market, Sanford	6	5
Swift & Co. "Brookfield Extra Creamery Butter"	Swift & Co., Bangor	20	None.
Swift & Co. "Brookfield Extra Creamery Butter"	Edward L. Lehar, Kennebunk	21	1
Turner Center Creamery, Auburn	Neil Gregory, Fairfield	8	None.
Vermont Creamery. "Vermont Creamery Butter"	Elliott Trading Co., So. Elliot	2	None.
Yorkshire Creamery Co. "Yorkshire Brand Creamery Butter"	H. P. Webber, Springvale	5	None.
Yorkshire Creamery Co. "Yorkshire Brand Creamery Butter"	Curtis & Roberts, Kennebunk	6	None.
....	H. E. Spinney	4	2

Table giving report of process butter weighed by the inspectors at dealers. The samples are arranged alphabetically by the names of the makers.

Name of Maker and Brand.	Where Found.	Number bricks weighed.	*Number bricks short weight.
John P. Squire. "Ferndale Process Butter"	Sanford's Market, Oakland	9	None.
John P. Squire. "Ferndale Process Butter"	Shenson & Jolvitz, Winslow	3	None.
John P. Squire. "Renovated Butter"	Wm. Seltzer, Fairfield	6	None.
Swift & Co. "Cold Rock Process Butter"	Jules Gamache, Waterville	7	None.
Swift & Co. "Cold Rock Process Butter"	H. P. Webber, Springvale	6	None.

* No brick considered short weight unless shortage was more than one-quarter ounce.

Table giving report of country or dairy butter, source known, weighed by the inspectors at dealers. The samples are arranged alphabetically by the name of the town of the makers.

Town and Name of Maker.	Where Found.	Number bricks weighed.	*Number bricks short weight.
Acton, John Grant	W. C. Remick, Springvale	5	None.
Acton, I. L. Lord	Rowe & Bartlett, Springvale	5	5
Albion, Fred Clark	David King, Fairfield	7	None.
Albion, Fred Littlefield	W. W. Nye & Co., Fairfield	5	None.
Albion, Augustus Rideout	David King, Fairfield	9	1
Albion, J. E. Weston	Frank E. Hammond, Fairfield	7	None.
Albion, Wiggins	Frank E. Hammond, Fairfield	6	1
Alfred, A. M. Burbank	Akers & Fernald, Alfred	4	None.
Alfred, Albion Chadbourn	H. A. Langley, Waterboro	4	None.
Alfred, Mrs. Geo. Chadbourn	Plummer & Nutting, Alfred	4	None.
Alfred, S. B. Cook	A. H. Chadbourn, Ross Corner	3	None.
Alfred, S. D. Emery	Plummer & Nutting, Alfred	3	None.
Alfred, Aldin Gile	H. A. Langley, Waterboro	5	None.
Alfred, Mrs. Lillian Giles	Guy R. Thyng, Ross Corner	6	6
Alfred, Geo. Hobbs	Plummer & Nutting, Alfred	3	None.
Alfred, Mrs. Geo. Libby	Plummer & Nutting, Alfred	4	4
Alfred, Frank Morrill	A. C. Warren, Waterboro	5	None.
Alfred, F. P. Merrill	Akers & Fernald, Alfred	5	None.
Alfred, Marshall Pike	Guy R. Thyng, Ross Corner	3	3
Alfred, Edward Roberts	W. P. Wakefield, E. Waterboro	7	None.
Alfred, James Rowe	Plummer & Nutting, Alfred	3	None.
Alfred, Owen E. Thyng	Guy R. Thyng, Ross Corner	6	None.
Alfred, Pearl Thyng	Guy R. Thyng, Ross Corner	5	None.
Alfred, W. I. Thyng	A. H. Chadbourn, Ross Corner	5	5
Alfred, Wm. I. Thyng	Guy R. Thyng, Ross Corner	7	7
Augusta, James Abbott	Shepard & Cummings, Oakland	5	None.
Bar Mills, Oliver Earl	P. S. Tarbox, Hollis Center	6	None.
Benton, Davis & Boston	E. G. Clark, Fairfield	7	None.
Benton, Lemont McKenney	H. H. Clark, Fairfield	6	4

* No brick sonsidered short weight unless shortage was more than one-quarter ounce.

Table giving report of country or dairy butter, source known, weighed by the inspectors at dealers.—Continued.

Town and Name of Maker.	Where Found.	Number bricks weighed.	*Number bricks short weight.
Benton, Leon Monk	David King, Fairfield	6	None.
Benton, W. H. Roundy	David King, Fairfield	4	4
Benton, Mrs. Rude	Ira A. Witham, Clinton	6	6
Benton, Ed. Shorey	Frank Whitten, Shawmut	4	None.
Benton Falls, Geo. Crosby	E. G. Clark, Fairfield	9	None.
Benton Falls, Lucie Reed	A. H. Clark, Fairfield	6	None.
Benton Falls, Geo. Withee	W. W. Nye, Fairfield	6	None.
Benton Station, J. S. Warren	Pillsbury-Jakins Co., Benton Sta.	5	4
Bonny Eagle, H. S. Usher	E. R. Whitehouse, W. Buxton	2	2
Bowdoin, Chester Marshall	E. M. Alexander, Brunswick	6	None.
Buxton, Frank Harmon	G. M. Sawyer, Bar Mills	6	3
Buxton, Frank Leavitt	G. M. Sawyer, Bar Mills	4	1
Buxton, Henry Littlefield	G. M. Sawyer, Bar Mills	7	1
Buxton, Chas. Nichols	G. M. Sawyer, Bar Mills	5	None.
Buxton, F. S. Bradeene	R. A. Bradbury, Buxton Center	6	4
Buxton Center, M. A. Pease	R. A. Bradbury, Buxton Center	5	None.
China, Mrs. Brickett Brann	A. K. Mason, Winslow	6	5
China, Edward Lewis	Jules Gamache, Waterville	10	10
China, G. F. Rowe	Hanna Cook, Waterville	3	3
Clinton, Arthur Adams	W. M. Keene, Clinton	7	7
Clinton, Mrs. A. C. Brown	L. Decker, Jr., Clinton	8	8
Clinton, Wm. Goodritch	W. M. Kenne, Clinton	6	None.
Clinton, Mrs. Harrigan	L. Decker, Jr., Clinton	3	None.
Clinton, H. Leonard	Holt & Filts, Clinton	4	4
Clinton, G. H. Lord	L. Decker, Jr., Clinton	4	None.
Clinton, H. B. Miller	Hayes' Market, Fairfield	7	None.
Clinton, Mrs. Alden Robinson	Davis & Boston, Benton	8	5
Clinton, Carl Stinson	W. M. Kenne, Clinton	6	None.
Coopers Mills, Achorn Bros	M. J. Flaherty, Portland	4	None.
E. Lebanon, Geo. W. Roberts	Libby & Monroe, Sanford	5	5
E. Parsonsfield, S. S. Boothby	Ernest Libby, Limerick	5	None.

* No brick considered short weight unless shortage was more than one-quarter ounce.

Table giving report of country or dairy butter, source known, weighed by the inspectors at dealers.—Continued.

Town and Name of Maker.	Where Found.	Number bricks weighed.	*Number bricks short weight.
E. Parsonfield, David Logee	S. G. Pease, N. Parsonsfield	5	None.
Fairfield, A. B. Goodwin	Hayes' Market, Fairfield	6	None.
Fairfield, F. L. Grant	Frank E. Hammond, Fairfield	5	1
Fairfield, F. L. Grant	David King, Fairfield	6	5
Fairfield, Colley Joy	H. H. Clark, Fairfield	6	None.
Fairfield Center, Thomas O'Neal	A. S. Burke, Shawmut	10	10
Hinckley, L. Decker	A. O. King, Fairfield	15	9
Holden, W. E. Corey	Danforth, Marsh Co., Brewer	4	None.
Hollis Center, T. J. Carll	J. D. Littlefield, Clarks Mills	3	3
Hollis Center, Geo. Harmon	P. S. Tarbox, Hollis Center	6	2
Kezar Falls, Wilson Leavitt	S. G. Pease, N. Parsonsfield	5	None.
Kezar Falls, G. J. Swett	S. G. Pease, N. Parsonsfield	3	None.
Knox, Freeman Cross	Titcomb Bros., Belfast	8	None.
Lebanon, Frank Blanchard	Carroll's Restaurant, Springvale	2	2
Limerick, Mrs. Geo. Garland	W. C. Remick, Springvale	5	1
Limerick, A. W. Lawrence	J. H. Moulton, Newfield	3	1
Limerick, J. W. Lord	Rowe & Bartlett, Springvale	7	7
Limerick, Jessie Pierce	Ernest Libby, Limerick	4	4
Maplewood, B. S. Moulton	J. H. Moulton, Newfield	4	None.
Newfield, Miss Sadie L. Davis	J. H. Moulton, Newfield	4	3
Newfield, Edward Dunnells	C. E. Libby & Sons, Newfield	5	None.
Newfield, H. S. Prescott	C. E. Libby & Sons, Newfield	4	None.
No. Shapleigh, Mrs. Chester Cerry	A. H. Chadbourne, Ross Cor	5	5
No. Shapleigh, C. C. Berry	E. S. Thyng, No. Shapleigh	5	5
No. Vassalboro, G. F. Gowen	Pillsbury-Jakins Co., Benton Sta.	10	10
No. Vassalboro, A. J. Kitredge	E. W. Allen, Winslow	6	6
No. Vassalboro, Arnold Little	W. A. Lord, No. Vassalboro	7	None.
No. Vassalboro, Frank Skillings	G. H. Cates, East Vassalboro	6	None.
No. Vassalboro, John Wallace	Mariner & Knight, No. Vassalboro	9	9
No. Vassalboro, Fred Witham	W. W. Nye, Fairfield	6	None.
No. Waterboro, Joseph Chadbourn	A. C. Warren, Waterboro	2	1

* No brick considered short weight unless shortage was more than one-quarter ounce.

Table giving report of country or dairy butter, source known, weighed by the inspectors at dealers.—Continued.

Town and Name of Maker.	Where Found.	Number bricks weighed.	*Number bricks short weight.
No. Waterboro, Herbert Cook	A. H. Chadbourn, Ross Corner	3	
No. Waterboro, Mark Hill	A. H. Chadbourn, Ross Corner	4	
No. Waterboro, Mark Hill	H. A. Langley, Waterboro	6	6
No. Waterboro, Chas. Pitts	A. H. Chadbourn, Ross Corner	5	5
No. Waterboro, John Synclair	H. A. Langley, Waterboro	6	None.
No. Waterboro, Cyrus Thyng	E. S. Carll, So. Waterboro	4	4
No. Waterboro, Mrs. Annie Welsh	E. S. Carll, Waterboro	4	4
Oakland, Herbert Axtell	Geo. P. Boynton, Oakland	4	4
Oakland, Anson Bickford	Geo. P. Boynton, Oakland	8	None.
Oakland, Chester Bridges	Shepard & Cummings, Oakland	8	2
Oakland, Glen Decker	A. W. Leonard, Oakland	8	2
Oakland, E. M. Ellis	Geo. P. Boynton, Oakland	4	None.
Oakland, Chas. Frost	Shepard & Cummings, Oakland	7	None.
Oakland, Arthur Gleason	A. W. Leonard, Oakland	7	1
Oakland, John S. Gleason	A. W. Leonard, Oakland	4	4
Oakland, John Heatherington	A. W. Leonard, Oakland	4	3
Oakland, John Nichols	Geo. P. Boynton, Oakland	5	None.
Oakland, Geo. Oliver	M. Libby, Oakland	7	6
Oakland, Frank Page	Geo. P. Boynton, Oakland	6	None.
Oakland, Mrs. J. L. Priest	W. W. Nye, Fairfield	6	None.
Oakland, John J. Sawtelle	Sheperd & Cummings, Oakland	7	None.
Oakland, Geo. Shaw	Sheperd & Cummings, Oakland	2	1
Oakland, C. R. Sturdevant	A. W. Leonard, Oakland	6	1
Oakland, Geo. York	Sheperd & Cummings, Oakland	7	2
Palermo, R. E. Nelson	A. P. Marcou, Winslow	1	1
St. Albans, Fred Berry	A. H. Clark, Fairfield	6	None.
Shapleigh, Chas. W. Coffin	Rowe & Bartlett, Springvale	6	None.
Shapleigh, Geo. T. Crediford	J. W. Smith, Springvale	3	3
Shapleigh, W. P. Ferguson	Rowe & Bartlett, Springvale	4	4
Shapleigh, Frank Goodwin	H. Pitts, Springvale	6	None.
Shapleigh, Fred Goodwin	H. P. Webber, Springvale	2	None.

* No brick considered short weight unless shortage was more than one-quarter ounce.

Table giving report of country or dairy butter, source known, weighed by the inspectors at dealers.—Continued.

Town and Name of Maker.	Where Found.	Number bricks weighed.	*Number bricks short weight.
Shapleigh, A. W. Ham	Rowe & Bartlett, Springvale	2	2
Shapleigh, Chas. Ham	D. H. Johnson, Springvale	4	None.
Shapleigh, Mrs. Fannie Knights	Rowe & Bartlett, Springvale	4	None.
Shapleigh, John Mease	J. W. Smith, Springvale	4	None.
Shawmut, A. M. Denney	Wm. Seltzer, Fairfield	6	2
Sidney, Geo. Austins	Sanford's Market, Oakland	8	2
So. Acton, Raymond Goodwin	H. Pitts, Springvale	4	4
So. China, D. B. Cates	Shenson & Jolvitz, Winslow	6	None.
So. China, Chas. Frye	G. H. Cates, E. Vassalboro	7	None.
So. Parsonsfield, Frank T. Benson	J. H. Moulton, Newfield	4	None.
So. Parsonfield, Bennett Moulton	H. C. Moulton, W. Newfield	3	None.
Springvale, D. W. Batchelder	H. P. Webber, Springvale	5	None.
Springvale, Willis Butler	Rowe & Bartlett, Springvale	5	None.
Springvale, Mrs. C. A. Harmon	S. D. Hanson, Springvale	3	3
Springvale, Hobbs Bros	Rowe & Bartlett, Springvale	4	None.
Springvale, I. W. Hooper	J. W. Smith, Springvale	3	3
Springvale, F. W. Smith	Rowe & Bartlett, Springvale	3	3
Springvale, Frank Wentworth	W. C. Remick, Springvale	5	5
Springvale, F. E. Young	Rowe & Bartlett, Springvale	5	5
Vassalboro, James Crosby	G. H. Cates, East Vassalboro	9	3
Vassalboro, Wm. Wentworth	W. A. Lord, No. Vassalboro	5	None.
Waterboro, Mrs. Eugene Blount	A. H. Chadbourn, Ross Corner	3	None.
Waterboro Ctr., Miss Annie Nutter	Chas. H. Rhodes, Waterboro Ctr	3	None.
Waterville, L. S. Bowden	Davis & Boston, Benton	8	None.
Waterville, Hiram Cornforth	Geo. P. Boynton, Oakland	6	None.
Waterville, W. S. Flood	Pillsbury-Jakins Co., Benton Sta	5	3
Waterville, E. Jaquith	Hayes' Market, Fairfield	6	None.
Waterville, Mrs. Lizzie Lord	Geo. E. Withee, Benton Falls	6	None.
Waterville, A. C. Luce	Pillsbury-Jakins Co., Benton Sta	9	None.
Waterville, Miss Susan V. Tarbell	Geo. E. Withee, Benton Falls	7	None.

* No brick sonsidered shoit weight unless shortage was more than one-quarter ounce.

Table giving report of country or dairy butter, source known, weighed by the inspectors at dealers.—Concluded.

Town and Name of Maker.	Where Found.	Number bricks weighed.	*Number bricks short weight.
Waterville, B. L. Taylor	Sheperd & Cummings, Oakland	7	None.
Waterville, Chas. Thomas	Pillsbury-Jakins Co., Benton Sta.	8	None.
West Buxton, Alonzo Bradeene	A. C. Warren, Waterboro	3	3
West Buxton, Warren Haley	E. C. Brown, West Buxton	4	None.
West Buxton, Sam. Hanson	G. M. Sawyer, Bar Mills	7	None.
West Buxton, John Smith	E. R. Whitehouse, W. Buxton	6	None.
West Buxton, Linden Smith	E. C. Brown, W. Buxton	4	None.
West Buxton, E. A. Tarbox	P. S. Tarbox, Hollis Center	6	None.
West Buxton, Geo. H. Tarbox	P. S. Tarbox, Hollis Center	6	None.
West Buxton, R. Waterhouse	E. R. Whitehouse, W. Buxton	6	None.
West Buxton, Mrs. Maria Waterhouse	E. R. Whitehouse, W. Buxton	6	5
W. Newfield, B. J. Garland	H. C. Moulton, W. Newfield	5	None.
W. Newfield, Eugene Gile	Hannaford Bros., W. Newfield	4	None.
W. Newfield, Chas. Hasty	Hannaford Bros., W. Newfield	5	None.
W. Newfield, A. S. Mitchell	H. C. Moulton, W. Newfield	6	2
W. Newfield, T. E. Mitchell	H. P. Webber, Springvale	7	6
W. Newfield, Wm. Sheafe	Hannaford Bros., W. Newfield	4	None.
W. Newfield, W. W. Symms	Hannaford Bros., W. Newfield	2	None.
W. Penobscot, F. H. Clement	Patterson Bros., Castine	5	4
Winslow, W. W. Parker	E. W. Allen, Winslow	6	None.
Winslow, Maurice Prentiss	Wm. Seltzer, Fairfield	12	5
Winslow, Oscar Reynolds	A. K. Mason, Winslow	3	None.
Winslow, Warren Shurtleff	E. W. Allen, Winslow	6	6
Winslow, Geo. H. Simpson	A. P. Marcou, Winslow	12	7

* No brick considered short weight unless shortage was more than one-quarter ounce.

Table giving report of country or dairy butter, source known, weighed by the inspectors at dealers. The samples are arranged alphabetically by the name of the town of the makers. —Concluded.

Town and Name of Dealer.	Number bricks weighed.	*Number bricks short weight.
Alfred, Akers & Fernald	4	None.
Alfred, Plummer & Nutting	4	None.
Bath, W. H. Hogan	14	5
Belfast, Titcomb Bros	17	13
Benton Falls, Geo. E. Withee	21	3
Brunswick, C. A. Pierce & Son	5	None.
Brunswick, Tondreau Bros. Co.	8	None.
Buxton Center, R. A. Bradbury	10	6
Clinton, Ira A. Witham	1	None.
Fairfield, A. H. Clark	6	2
Fairfield, Neil Gregory	6	4
Fairfield, Hayes' Market	3	2
Falmouth Foreside, Dow & Hodsdon	12	5
Hollis Center, W. J. Brown	16	None.
Limerick, G. W. Bennett	4	1
Limerick, Ernest Libby	5	None.
Newfield, C. E. Libby & Sons	8	8
Newfield, J. H. Moulton	4	None.
No. Parsonfield, S. G. Pease	15	None.
No. Vassalboro, W. A. Lord	6	None.
No. Vassalboro, Marriner & Knight	8	None.
Oakland, A. W. Leonard	12	1
Oakland, Sanford's Market	5	1
Sanford, Libby & Monroe	6	6
Shawmut, A. S. Burke	4	None.
Springvale, S. D. Hanson	25	11
Waterboro, A. C. Warren	10	5
Waterville, Philip Baron	7	4
Waterville, Joseph Bizier	6	3
Waterville, Hanna Cook	8	1
West Buxton, E. C. Brown	5	None.
Winslow, E. W. Allen	6	None
Winslow, A. P. Marcou	9	3
Winslow, Ahiro & Cohen	23	3

* No bricks considered short weight unless shortage was more than one-quarter ounce.

Table giving the results of the chemical analysis of butter examined in 1913. The samples are arranged alphabetically by the name of the town and dealer.

Station number.	Town, Dealer, Brand.	"Pound" Package.		Chemical Analysis.				Butter Fat.	
		Price—cents.	Weight—ounces.	Water—per cent.	Fat—per cent.	Casein—per cent.	Salt—per cent.	Found—ounces.	Standard—ounces.
11410	Bangor, Armour & Co. "Armour & Co. Highest Grade Cloverbloom Creamery Butter"	.....	16.7	13.37	82.98	0.90	2.78	13.86	13.2
11241	Bangor, S. E. Rudman	38	14.5	14.25	84.59	1.07	0.07	12.27	13.2
11411	Bangor, John P. Squire Co. "John P. Squire & Co. Arlington Creamery Butter"	.....	15.1	13.17	82.77	0.99	3.07	12.52	13.2
11416	Bangor, Sulsberger & Sons Co. "Clear Brook Creamery Butter"	.....	15.1	16.19	79.68	1.25	2.88	12.03	13.2
11275	Biddeford, John E. Hobbins. Dairy butter	*	13.8	12.24	80.67	1.07	6.00	11.10	13.2
11276	Biddeford, John E. Hobbins. Dairy butter marked "C. S. E."	*	14.7	11.59	83.30	0.98	4.13	12.23	13.2
11189	Brunswick, C. A. Lemieux. Dairy butter	35	13.5	11.85	80.86	1.72	5.53	10.92	13.2
11166	Buxon, H. N. Merrill. Dairy butter	.....	16.8	12.88	77.93	1.48	7.66	13.09	13.2
11251	Buxton, H. N. Merrill. Dairy butter	.....	16.2	12.65	82.61	0.95	3.79	13.38	13.2
11343	Falmouth Foreside, Dow & Hodsdon, R. F. D. 4. Dairy butter	*	15.3	12.77	83.29	1.12	2.83	12.74	13.2
11125	Great Works, W. L. Butterfield. "Hillside Butter, L. E. Brown, Bangor"	40	15.1	12.03	83.82	0.83	3.20	12.67	13.2
11357	Greenville, Buck & Clark. "Arlington Creamery Butter, John P. Squire"	35	14.9	12.28	84.17	2.79	0.75	12.50	13.2
11358	Greenville, Buck & Clark. "Armour & Co. Highest Grade Cloverbloom Butter"	35	14.7	9.95	85.94	3.03	1.06	12.67	13.2
11126	Milford, M. W. Sawyer. "Hillside Butter, L. E. Brown, Bangor"	40	14.6	12 61	80.96	1 32	5.08	11.82	13.2
11130	Oldtown, Lunt's Cash Store. Dairy butter	35	14.8	12.03	81.73	1.16	5.08	12.10	13.2
11131	Oldtown, Lunt's Cash Store. Dairy butter	35	14.8	10 30	74.35	1.32	14.02	11.00	13.2

* Sold for its actual weight and not by the package.

Table giving the results of the chemical analysis of butter examined in 1913—Concluded.

Station number.	Town, Dealer, Brand.	"Pound" Package.		Chemical Analysis.				Butter Fat.	
		Price—cents.	Weight—ounces.	Water—per cent.	Fat—per cent.	Casein—per cent.	Salt—per cent.	Found—ounces.	Standard—ounces.
11167	Orono, Pearl Clark. Dairy butter	38	14.7	9.75	84.70	1.14	4.39	12.45	13.2
11168	Orono, C. G. Hamilton. Dairy butter	35	14.2	8.75	87.59	1.16	2.49	12.44	13.2
11186	Orono, C. G. Hamilton. Dairy butter	36	15.7	10.97	84.74	1.10	3.17	13.30	13.2
11187	Orono, C. G. Hamilton. Dairy butter	34	14.8	8.82	88.42	0.92	1.82	13.10	13.2
11107	Portland, J. H. Charles. Dairy butter	36	13.2	11.50	72.90	1.18	14.39	4.78	6.6
11108	Portland, J. H. Charles. Dairy butter	36	14.7	11.22	76.87	1.20	10.70	11.30	13.2
11113	Portland, B. Cohen. "Sweet butter, Portland Creamery, Portland"	44	15.3	14.43	84.16	1.15	.....	12.88	13.2
11143	Portland, Cummings Bros. "Bridgt'n Creamery Butter"	*	14.7	10.81	85.77	1.27	1.93	12.61	13.2
11072	Portland, Thomas Dyer & Co. Dairy butter	30	15.3	9.48	81.27	.....	.....	12.43	13.2
11140	Portland, J. M. Edwards & Son. Dairy butter	*	14.4	11.00	82.92	1.25	4.84	11.91	13.2
11071	Portland, Greene & Barrett. "Waterford Creamery Co. Pure Creamery Butter"	*	15.1	11.88	83.48	.....	.....	12.61	13.2
11114	Portland, B. S. Johnson. "Produced by H. N. Merrill, Buxton"	*	15.1	15.33	76.34	1.67	6.64	11.53	13.2
11075	Portland, W. A. Johnson. Dairy butter	40	15.1	11.06	83.14	.....	.....	12.55	13.2
11118	Portland, W. S. Jordan & Co. "Bridgton Creamery Print Butter, Island Pond, Vt."	40	14.6	14.28	83.17	0.86	1.67	12.14	13.2
11078	Portland, W. C. Lamb. Dairy butter	*	15.5	12.81	79.59	2.94	4.67	12.34	13.2
11112	Portland, A. D. Lovell. Dairy butter	38	13.8	12.09	82.48	1.06	4.36	11.38	13.2
11109	Portland, John A. Moreshead. Dairy butter	*	13.1	13.64	78.03	1.86	6.42	10.25	13.2
11110	Portland, John A. Moreshead. "Brighton Creamery Print Butter, Island Pond, Vt."	*	14.6	12.16	84.15	1.09	2.58	12.29	13.2
11141	Portland, Geo. C. Shaw Co. "Choice Jersey Butter. F. L. Wescott, Sebago Lake"	*	14.6	9.10	87.20	1.21	2.48	12.70	13.2
11142	Portland, George C. Shaw Co. "Brighton Creamery Print Butter, Island Pond, Vt."	42	14.5	13.50	80.89	0.90	4.69	11.72	13.2
11115	Portland, W. L. Wilson & Co. Dairy butter	35	15.0	10.88	81.16	1.11	6.84	12.18	13.2
11240	Portland, F. L. Daggett. Dairy	*	12.9	11.85	79.99	1.74	6.39	10.32	13.2
11183	Saco, John A. Libby. Dairy butter	*	14.7	13.08	80.91	1.43	4.56	11.97	13.2
11192	Veazie, A. H. Gilman. Dairy butter	35	13.7	13.40	82.72	1.59	2.27	11.33	13.2
11326	Winslow, A. P. Marcou. Dairy butter	33	13.6	10.49	85.13	0.93	3.45	11.56	13.2

* Sold for its actual weight and not by the package.

April, 1914.

MAINE
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Official Inspections

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MOLASSES.

The sweet taste of molasses is due to the cane sugar which it carries. This kind of sugar is called sucrose by chemists and is found in numerous plants. Sugar cane and sugar beets are the common sources of sucrose, but the sap of the maple, the juices of sorghum and of corn and large numbers of other plants, contain more or less sugar in the form of sucrose. The sugar of honey which chemists call levulose, while practically as sweet as sucrose, does not make the clear crystals familiar in the case of sucrose. Dextrose is the name of a sugar that occurs in nature in the grape. It is also made artificially from starch by treating it with acid. The glucose or corn sirup of commerce is a thick sirupy colorless product made by incompletely hydrolyzing starch and decolorizing and evaporating the product. It contains dextrose, maltose, dextrine, ash and water and is standardized within certain limits. The food value of glucose is practically equal to that of sucrose, but it does not have the sweet pleasant taste characteristic of cane sugar.

NOTE. All correspondence relative to the inspection laws should be addressed to the Commissioner of Agriculture, Augusta Maine.

When the juice of any sugar bearing plant, such as the cane, the beet or the maple, is sufficiently evaporated by boiling the resulting material is called sirup. Practically all of the sugar sirup which is on sale is derived from the cane or the maple.

Upon heating a solution of sugar to the boiling point of water in the open air it is slowly changed to what the chemists call invert sugar. Invert sugar is not as sweet as common sugar, but has practically the same food value. Invert sugar, furthermore, will not crystallize out. The rapidity and extent to which sucrose is changed over to invert sugar depends upon the temperature to which it is heated. Consequently, in modern methods of sugar manufacture the boiling necessary to evaporation takes place in a partial vacuum. This evaporation is carried as far as possible and then the sugars are allowed to crystallize out. In the actual process of manufacture it is the purified juice of the sugar plant that is thus evaporated down to a solution of sugar or to a solid or semi-solid consistency. When these evaporated and semi-solid crystalline masses of "raw sugar" are allowed to drain there is separated from them a product called "molasses."

The refiners take the raw sugar from which the molasses has drained and by further treatment refine it until it contains the white crystalline sugars known as "granulated sugar," "loaf sugar," etc. In the process of refining the raw sugar there is also a product formed by inversion which will not crystallize out. This is drained away from the sugar and is known as "refiners sirup" or "treacle."

From the above it will be noted that there are three liquid materials which are made from sugar producing plants that differ not very markedly one from the other—the sirup, which is the evaporated juice of the sugar bearing plants; molasses, which is an uncrystallizable by-product that drains away from the crude sugar; and refiner's sirup or treacle, which is the uncrystallized material that drains away from the refined sugars.

The molasses as found in commerce is ordinarily a viscid, dark colored, uncrystallizable liquor and should, strictly speaking, be limited to that which is obtained in the process of making raw sugar. The name should not be applied to that product which is obtained in the refining process. Usually molasses in the separation from raw sugar is still rich enough to warrant a second boiling, yielding what is called "second molasses." This may be again reboiled yielding a "third molasses." Obviously the first molasses more nearly resembles sirup than either of the other two. The third molasses is so dark in color that it is not used as food for man except as it has glucose added to it. It is utilized for making rum and for feeding stock, and also for food of man by adding glucose. The first molasses has a sweeter taste and better flavor than the other two. Most of the molasses of commerce is second molasses.

STANDARDS AND DEFINITIONS.

While, as explained above, the distinction between sirup, molasses, and refiners sirup, is not sharply marked, the following definitions are in force in Maine for these and allied products:

Sirup is the sound product made by purifying and evaporating the juice of a sugar-producing plant without removing any of the sugar.

Sugar sirup is the product made by dissolving sugar to the consistency of a sirup and contains not more than thirty-five (35) per cent of water.

Sugar-cane sirup is sirup made by the evaporation of the juice of the sugar-cane or by the solution of sugar-cane concrete, and contains not more than thirty-five (35) per cent of water and not more than two and five-tenths (2.5) per cent of ash.

Sorghum sirup is sirup made by the evaporation of sorghum juice or by the solution of sorghum concrete, and contains not more than thirty-five (35) per cent of water and not more than two and five-tenths (2.5) per cent of ash.

Maple sirup is sirup made by the evaporation of maple sap or by the solution of maple concrete and contains not more than thirty-five (35) per cent of water and not less than forty-five hundredths (0.45) per cent of maple sirup ash.

Massecuite, melada, mush sugar, and *concrete* are products made by evaporating the purified juice of a sugar-producing plant, or a solution of sugar, to a solid or semi-solid consistence, and in which the sugar chiefly exists in a crystalline state.

Molasses is the product left after separating the sugar from massecuite, melada, mush sugar, or concrete, and contains not more than twenty-five (25) per cent of water and not more than five (5) per cent of ash.

Refiners' sirup, treacle, is the residual liquid product obtained in the process of refining raw sugars and contains not more than twenty-five (25) per cent of water and not more than eight (8) per cent of ash.

Results of Inspection and Analyses.

When the food law was enacted in 1905 a large part of the molasses being sold in Maine was a compound made from a dark colored molasses and glucose. Of the samples collected by the Experiment Station in 1908 about one-third of the total were found to be mixtures of glucose and molasses. With the enforcement of the law requiring the labeling of retail packages when they are delivered to the consumer it has come about that the demand on the part of the retailer for this adultrated molasses has dropped off. Relative to molasses the inspector always asks the retailer two questions: "Do you sell anything other than pure molasses?" "If so, have you stickers or labels that you put upon the retail packages?" The results of these inquiries show that the retailers for the most part do not carry compounded molasses, and if they do that they have the proper stickers. It is to be noted that out of the large number of samples that were purchased without the inspector making himself known only three were found to be adulterated by the addition of glucose.

It has been reported by one wholesaler that they were finding a very unfair competition in that other wholesalers were adulterating molasses by the addition of sugar house sirup. Sugar house sirup has excellent color and added to molasses makes it appear of a much lighter color than it otherwise would. Sugar house sirups as a rule carry higher ash content than straight molasses. In the few instances in which molasses were found with high ash content the cases were investigated but in no instance was it ascertained beyond a reasonable doubt that the molasses had refiners sirup.

One of the most curious things that developed in this examination of molasses is that in the cities along the Kennebec River (Augusta, Gardiner, Hallowell) molasses retailed from 10 to 13 cents per pint while at other points in the State the price ranged from 5 to 7 cents per pint. It will be noted that the quality of the molasses in the towns which had the higher price was no better than where the prices were lower, and that the same price was charged for molasses carrying only 30 per cent sucrose as for one of the higher grades carrying 45 per cent. There seemed to be, so far as could be judged from this inspection, very little difference in price due to the quality of the molasses.

Table showing the results of analyses of samples of Molasses purchased by inspector without making himself known to dealer. Samples arranged alphabetically by towns where goods were purchased.

Station number.	Town and Dealer.		Price per pint—Cents.	Sucrose—Per cent.	Invert sugar—Per cent.	Water—Per cent.	Ash—Per cent.
11670	Auburn	F. L. Andrews	6	42.1	19.2	25.6	4.38
11658	Auburn	E. A. Bickford	7	44.9	19.8	25.8	4.17
11657	Auburn	C. F. Burleigh	7	39.7	23.6	25.9	4.20
11649	Auburn	Damon & Cole	7	45.2	20.1	24.9	3.24
11665	Auburn	Doe & Goss	7	40.4	24.9	25.8	4.71
11648	Auburn	Dunn & Ross	6	37.1	26.1	21.6	3.01
11667	Auburn	W. W. Farrar	5	33.7	28.1	25.4	6.10
11647	Auburn	O. F. Holmes	7	39.8	25.2	24.1	3.50
11664	Auburn	Warren McFadden	6	34.1	27.6	25.3	6.30
11660	Auburn	Pierre Nadeau	7	36.9	20.7	26.5	5.50
11666	Auburn	O. H. Olfene	7	36.6	25.1	26.0	6.32
11662	Auburn	Perryville Cash Market	8	42.9	22.3	27.0	3.82
11659	Auburn	K. Stemmar	5	29.7	30.1	26.3	4.31
11708	Augusta	A. M. Brown	12	35.8	23.3	24.3	5.69
11704	Augusta	Cassavant & Cloutier	12	30.2	28.0	24.3	6.21
11711	Augusta	B. E. Folsom	10	30.3	27.2	24.8	5.74
11705	Augusta	J. A. Folsom	12	39.3	24.2	24.0	5.80
11714	Augusta	E. Locke	12	38.9	20.9	24.5	5.55
11713	Augusta	Merrill Bros.	13	45.7	23.0	24.7	1.78
11715	Augusta	J. F. Turner	10	38.3	22.8	25.1	5.77
11706	Augusta	G. W. Wadleigh	12	45.9	21.3	24.6	4.62
11710	Augusta	Webber & Hewett	12	45.2	23.6	25.4	1.61
11712	Augusta	L. S. Young	9	32.2	28.7	24.3	6.39
11795	Bangor	A. E. Baker	7	38.9	22.0	25.9	4.16
11718	Bangor	W. L. Clark	5	33.6	26.7	24.4	3.92
11693	Bangor	F. H. Drummond	7	46.3	22.4	24.3	4.22
11691	Bangor	Elmer R. Fox	7	46.4	20.8	24.6	3.79
11694	Bangor	F. L. Frank & Co.	8	42.6	23.9	24.1	3.87
11719	Bangor	Gallagher Bros.	7	43.8	20.8	26.2	2.78
11720	Bangor	Fred T. Hall	7	43.5	21.5	25.6	4.12
11695	Bangor	F. S. Jones & Co.	7	41.7	23.8	24.1	2.12
11696	Bangor	Lord Bros.	7	36.4	26.1	25.9	6.67

Results of analyses of samples of Molasses—Continued.

Station number.	Town and Dealer.		Price per pint—Cents.	Sucrose—Per cent.	Invert sugar—Per cent.	Water—Per cent.	Ash—Per cent.
11689	Bangor	H. E. McDonald........	7	42.8	22.4	24.5	4.21
11716	Bangor	D. J. McGrath.........	7	36.1	25.6	24.8	6.01
11717	Bangor	Staples & Griffin.......	7	42.2	21.1	25.3	4.42
11690	Bangor	E. W. Wilde...........	7	46.1	20.2	24.8	4.02
11789	Gardiner	Boston Provision Co...	13	44.4	20.6	26.3	3.61
11791	Gardiner	Brann's Market Co....	12	41.7	23.8	24.3	4.37
11790	Gardiner	Cash Market Co.......	13	32.3	23.2	25.6	6.60
11788	Gardiner	Clarke's Market.......	13	37.9	21.5	26.5	4.51
11786	Gardiner	A. W. Cunningham....	13	34.1	25.9	23.9	4.54
11792	Gardiner	Gray-Hildreth Co......	13	43.7	20.5	26.5	3.51
11787	Gardiner	Manson's Market......	10	33.8	25.6	24.2	3.83
11781	Hallowell	Cash Market.........	13	44.1	17.9	26.3	4.78
11785	Hallowell	C. A. Cole............	12	24.7	27.8	26.3	5.77
11783	Hallowell	Joseph Grandin.......	10	35.6	24.8	25.9	5.56
11782	Hallowell	Hallowell Market.....	10	32.3	27.5	23.9	4.89
11784	Hallowell	D. C. Skillin..........	10	32.3	26.6	24.0	4.44
11651	Lewiston	John J. Dunn.........	6	32.8	26.8	26.2	5.59
11654	Lewiston	Fogg & Miller.........	7	37.8	24.7	23.1	4.59
11653	Lewiston	F. L. & M. E. Hoxie...	7	38.2	25.9	25.0	4.68
11661	Lewiston	E. Janelle & Co.......	8	44.6	22.3	25.9	3.31
11656	Lewiston	Alphonse LaChance....	8	42.7	21.4	25.0	4.11
11668	Lewiston	Lewiston Cash Market.	7	36.5	25.7	26.0	5.64
11650	Lewiston	D. Mousette & Bro.....	7	37.1	27.1	23.3	6.10
11663	Lewiston	T. Patry & Son.......	10	27.2	28.7	25.1	6.39
11669	Lewiston	Pinette & Auger......	8	28.7	27.4	25.2	6.40
11652	Lewiston	C. Rourke............	7	40.3	25.6	23.6	4.57
11655	Lewiston	Spear & Webster......	7	35.8	26.6	23.7	4.83
11698	Old Town	E. R. Alford.........	7	45.5	19.1	25.5	4.91
11699	Old Town	Beaulieu Bros........	7	43.9	21.9	25.3	3.88
11700	Old Town	F. X. Boutin.........	7	38.7	23.7	25.2	4.54
11702	Old Town	Indian Agency.......	7	43.5	21.8	24.1	3.34
11701	Old Town	Old Town Tea Co.....	8	39.5	21.5	24.3	4 38
11703	Old Town	C. M. Stevens........	7	46.4	20.0	24.8	3.61
11697	Old Town	C. O. Stevens........	7	44.5	19.5	24.3	4.69
11730	Portland	Clarence E. Bangs.....	8	44.2	20.0	25.5	4.98

Results of analyses of samples of Molasses—Continued.

Station number.	Town and Dealer.		Price per pint—Cents.	Sucrose—Per cent.	Invert sugar—Per cent.	Water—Per cent.	Ash—Per cent.
11780	Portland	Carl J. Blom..........	8	47.1	22.0	26.0	1.41
11747	Portland	Butler & Barrowes Co..	10	45.7	20.5	26.7	1.88
11741	Portland	Thomas L. Callan.....	7	40.8	23.2	25.5	3.99
11735	Portland	William P. Carroll.....	6	45.7	19.9	25.9	3.78
11755	Portland	John H. Charles & Co..	6	37.6	26.2	22.3	5.77
11771	Portland	L. B. Chipman........	7	44.4	20.8	25.6	2.94
11745	Portland	John C. Collins........	8	36.6	26.3	24.3	5.42
11765	Portland	D. Colucci............	6	40.3	20.8	25.2	4.55
11723	Portland	John M. Conway......	8	42.4	23.8	24.8	3.82
11776	Portland	John W. Deering & Son	7	38.2	24.5	24.5	4.05
11734	Portland	S Dyro...............	5	30.6	27.9	23.2	6.07
11732	Portland	Fred B. Estes.........	8	43.8	21.2	25.8	3.90
11743	Portland	Green & Barrett.......	7	44.0	19.9	26.4	3.65
11736	Portland	W. C. Haggett & Son..	7	44.8	20.7	24.9	3.89
11753	Portland	George Horner........	7	38.4	23.4	24.3	5.47
11724	Portland	Chas. W. Horton......	8	40.8	22.8	25.4	4.01
11770	Portland	B. Huberman.........	5	36.5	24.8	24.3	5.10
11742	Portland	Burt L. Johnson.......	5	34.5	26.4	24.3	5.27
11727	Portland	John D. Johnson......	6	41.9	21.5	25.6	4.53
11769	Portland	David Josselson.......	10	40.1	22.3	23.5	5.76
11737	Portland	Charles E. Kelly.......	7	40.8	23.7	25.1	3.25
11751	Portland	E. M. Leighton........	7	38.4	26.7	24.3	4.67
11757	Portland	Fred H. Libby........	7	43.1	20.3	26.1	3.42
11756	Portland	M. B. Lougee.........	8	44.4	19.6	26.2	3.47
11729	Portland	Albert D. Lovell.......	7	45.4	19.4	26.0	3.47
11750	Portland	C. E. Mack...........	7	39.6	22.6	25.5	3.59
11772	Portland	L. A. Mercier.........	8	45.4	21.3	25.4	3.26
11754	Portland	Morris B. Miles........	7	39.7	23.1	25.6	4.54
11728	Portland	J. A. Moreshead.......	7	43.0	20.7	25.7	4.35
11774	Portland	Morrill & Ross........	7	40.3	24.2	24.6	3.95
11738	Portland	Henry F. Owen.......	7	35.9	26.7	23.4	5.95
11777	Portland	Ambrose Partridge....	12	35.1	17.9	25.5	6.30
11746	Portland	D. W. Patterson.......	7	39.4	24.7	22.8	4.13
11775	Portland	C. J. Pennell & Co.....	8	37.4	23.1	24.2	5.15

Results of analyses of samples of Molasses—Concluded.

Station number.	Town and Dealer.	Price per pint—Cents.	Sucrose—Per cent.	Invert sugar—Per cent.	Water—Per cent.	Ash—Per cent.
11767	Portland Timothy Reagan......	6	37.5	28.3	23.7	5.22
11768	Portland Mrs. Catherine Reardon	6	44.8	24.5	24.7	4.66
11744	Portland Roscoe R. Reed.......	5	35.1	24.1	23.8	5.69
11731	Portland L. P. Senter & Co.....	8	43.8	24.1	25.9	2.32
11725	Portland Serunian-Amergian Co.	7	39.9	23.8	24.8	5.93
11779	Portland Aram Serunian........	8	37.4	26.0	23.5	4.44
11749	Portland George C. Shaw Co....	7	43.4	23.9	26.3	2.23
11759	Portland Henry L. Starbird.....	5	36.8	21.3	25.9	5.02
11778	Portland C. H. Stowell.........	6	32.6	23.9	24.7	3.95
11766	Portland Mrs. E. A. Thomas....	5	34.9	26.3	24.6	5.31
11752	Portland Joseph Thompson.....	7	37.2	21.7	24.8	3.41
11748	Portland J. L. Waite...........	5	37.6	21.5	25.8	4.80
11773	Portland W. L. Wilson Co......	7	44.6	19.8	27.0	2.86
11733	Portland John Wright..........	6	43.9	23.4	24.2	2.21
11763	So. Portland C. E. Cash.........	7	32.5	27.3	23.5	6.37
11762	So. Portland G. W. Cash Co.....	5	37.1	25.7	24.8	5.36
11739	So. Portland J. A. S. Dyer & Co.	6	24.6	30.0	24.1	5.74
11760	So. Portland M. B. Fuller & Son.	7	43.3	20.2	25.8	3.36
11761	So. Portland W. I. McKenney...	7	38.6	25.3	24.2	4.63
11740	So. Portland Skillin & Knight...	7	40.7	24.0	25.5	3.57
11794	Westbrook R. C. Boothby......	6	40.0	24.0	24.1	4.07
11793	Westbrook A. A. Morrison......	7	43.7	21.0	25.8	3.32

Table showing the results of examination of goods purchased as molasses by the inspector without making himself known, which on examination were found to be adulterated by the addition of glucose.

Station number.	Town and Dealer.	Price per pint—Cents.	Sucrose—Per cent.	Reducing sugar—Per cent.	Water—Per cent.	Commercial glucose—Per cent.
11692	Bangor A. E. Baker..........	7	25.8	25.0	26.5	29.3
11758	Portland M. J. Flaherty......	7	24.1	28.0	25.4	39.6
11764	Portland A. L. Huff..........	6	29.3	26.7	24.6	5.4

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Official Inspections

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Commencing January 1, 1914, the Commissioner of Agriculture is the executive of the law regulating the sale of concentrated commercial feeding stuffs in Maine. It is the duty of the Maine Agricultural Experiment Station to make the analyses of the samples collected by the Commissioner, and it is the duty of the Director to publish the results of the analyses of the samples of commercial feeding stuffs, together with the names of the persons from whom the samples were obtained, the names of the manufacturers thereof and such additional information as may seem advisable.

In the following pages there are given in tabulated form the results of the analyses of the samples of feeding stuffs on sale within the State from April, 1913 to April, 1914.

The results of the analyses seem to call for no special discussion. Whenever the goods have fallen below the guarantees the cases have been investigated by the executive of the law and whenever the blame was found to exist outside of the State interstate cases have been made under the federal law.

NOTE. All correspondence relative to the inspection laws should be addressed to the Commissioner of Agriculture, Augusta Maine.

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
COTTONSEED MEALS.		
American Cotton Oil Co., New York City. Red Tag Cottonseed Meal	D	5139
	D	5140
	D	5171
	D	5172
	D	5199
	D	5206
	D	5210
	D	5211
	D	5215
	D	5240
	D	5268
	D	5305
	O	5328
	D	5343
	D	5472
Blakeslee, Harry J., Little Rock, Ark. Old Reliable Cottonseed Meal	D	4879
	D	4895
Brode & Co., F W., Memphis, Tenn. Dove Brand Cottonseed Meal	D	4866
	D	4884
	D	4897
	D	4905
	D	4908
	D	4909
	D	4924
	D	4925
	O	4946
	O	5118
	D	5157
	D	5221
	D	5277
	O	5284
	D	5295
	D	5296
	D	5298
	D	5306
	D	5364
	D	5470
Brode & Co., F. W., Memphis, Tenn. Owl Brand Cottonseed Meal	D	4856
	D	4869
	D	4874
	D	4882
	D	4888
	D	4904
	D	4906
	D	4907
	D	4914
	D	4926

* Samples marked D are drawn by dealer and those marked O were taken by the inspector.

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	*Weed seeds.
5139	–	–	38.44	38.55	–	7.00	–	11.50	–	0
5140	–	–	39.62	38.55	–	7.00	–	11.50	–	0
5171	–	–	38.75	38.55	–	7.00	–	11.50	–	0
5172	–	–	37.62	38.55	–	7.00	–	11.50	–	0
5199	–	–	41.31	38.55	–	7.00	–	11.50	–	0
5206	–	–	40.37	38.55	–	7.00	–	11.50	–	0
5210	–	–	41.12	38.55	–	7.00	–	11.50	–	0
5211	–	–	41.62	38.55	–	7.00	–	11.50	–	0
5215	–	–	40.31	38.55	–	7.00	–	11.50	–	0
5240	–	–	39.25	38.55	–	7.00	–	11.50	–	0
5268	–	–	41.62	38.55	–	7.00	–	11.50	–	0
5305	–	–	41.75	38.55	–	7.00	–	11.50	–	0
5328	7.46	6.93	41.50	38.55	8.37	7.00	9.23	11.50	26.51	0
5343	–	–	40.18	38.55	–	7.00	–	11.50	–	0
5472	–	–	40.07	38.55	–	7.00	–	11.50	–	0
4879	–	–	41.46	41.00	–	6.00	–	10.50	–	0
4895	–	–	40.62	41.00	–	6.00	–	8.00	–	0
4866	–	–	40.53	38.63	–	6.00	–	10.00	–	0
4884	–	–	41.68	38.63	–	6.00	–	10.00	–	0
4897	–	–	39.09	38.63	–	6.00	–	10.00	–	0
4905	–	–	38.12	38.63	–	6.00	–	10.00	–	0
4908	–	–	38.43	38.63	–	6.00	–	10.00	–	0
4909	–	–	39.37	38.63	–	6.00	–	10.00	–	0
4924	–	–	41.87	38.63	–	6.00	–	10.00	–	0
4925	–	–	40.31	38.63	–	6.00	–	10.00	–	0
4946	7.83	6.02	37.25	38.63	8.53	6.00	12.86	10.00	27.51	0
5118	5.06	5.78	39.00	38.63	8.46	6.00	11.81	10.00	28.89	0
5157	–	–	39.81	38.63	–	6.00	–	10.00	–	0
5221	–	–	37.18	38.63	–	6.00	–	10.00	–	0
5277	–	–	38.19	38.63	–	6.00	–	10.00	–	0
5284	–	–	38.63	38.63	–	6.00	–	10.00	–	0
5295	–	–	38.50	38.62	–	6.00	–	10.00	–	0
5296	–	–	37.50	38.62	–	6.00	–	10.00	–	0
5298	–	–	38.56	38.62	–	6.00	–	10.00	–	0
5306	–	–	37.69	38.62	–	6.00	–	10.00	–	0
5364	–	–	38.50	38.62	–	6.00	–	10.00	–	0
5470	–	–	38.75	38.63	–	6.00	–	10.00	–	0
4856	–	–	36.76	41.00	–	6.00	–	10.00	–	0
4869	–	–	39.74	41.00	–	6.00	–	10.00	–	0
4874	–	–	39.87	41.00	–	6.00	–	10.00	–	0
4882	–	–	33.90	41.00	–	6.00	–	10.00	–	0
4888	–	–	41.34	41.00	–	6.00	–	10.00	–	0
4904	–	–	41.25	41.00	–	6.00	–	10.00	–	0
4906	–	–	40.34	41.00	–	6.00	–	10.00	–	0
4907	–	–	41.71	41.00	–	6.00	–	10.00	–	0
4914	–	–	40.81	41.00	–	6.00	–	10.00	–	0
4926	–	–	45.25	41.00	–	6.00	–	10.00	–	0

* Few means two to eight in a half pint sample; some means eight to fifteen; many not more than seventy-five; and very many means up to two per cent. of weed seeds.

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Owl Brand Cottonseed Meal	D	4928
	D	4929
	D	4938
	D	4959
	D	4962
	D	4966
	D	4972
	D	4974
	D	4976
	D	5013
	D	5029
	O	5043
	D	5046
	D	5075
	D	5079
	D	5096
	D	5097
	D	5115
	O	5116
	D	5133
	D	5135
	D	5143
	D	5156
	D	5158
	D	5170
	D	5173
	D	5175
	D	5183
	D	5187
	D	5188
	O	5191
	D	5195
	D	5201
	D	5202
	D	5204
	D	5207
	D	5213
	D	5216
	D	5217
	D	5218
	D	5222
	D	5224
	O	5227
	O	5231
	O	5233
	D	5234
	D	5235
	D	5243
	D	5244
	D	5246
	D	5252
	D	5264
	D	5267
	D	5276
	D	5278
	O	5292
	D	5294
	D	5299
	D	5302
	D	5319
	D	5320
	O	5332
	D	5342
	O	5380

ANALYSIS OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	*Weed seeds.
4928	–	–	35.83	41.00	–	6.00	–	10.00	–	0
4929	–	–	39.56	41.00	–	6.00	–	10.00	–	0
4938	–	–	40.13	41.00	–	6.00	–	10.00	–	0
4959	–	–	40.88	41.00	–	6.00	–	10.00	–	0
4962	–	–	41.62	41.00	–	6.00	–	10.00	–	0
4966	–	–	41.12	41.00	–	6.00	–	10.00	–	0
4972	–	–	41.00	41.00	–	6.00	–	10.00	–	0
4974	–	–	41.00	41.00	–	6.00	–	10.00	–	0
4976	–	–	38.81	41.00	–	6.00	–	10.00	–	0
5013	–	–	41.44	41.00	–	6.00	–	10.00	–	0
5029	–	–	42.87	41.00	–	6.00	–	10.00	–	0
5043	6.55	5.55	41.25	41.00	7.44	6.00	9.94	10.00	29.27	0
5046	–	–	41.43	41.00	–	6.00	–	10.00	–	0
5075	–	–	36.19	41.00	–	6.00	–	10.00	–	0
5079	–	–	38.75	41.00	–	6.00	–	10.00	–	0
5096	–	–	36.75	41.00	–	6.00	–	10.00	–	0
5097	–	–	41.06	41.00	–	6.00	–	10.00	–	0
5115	–	–	41.43	41.00	–	6.00	–	10.00	–	0
5116	5.36	5.92	38.87	41.00	9.10	6.00	11.10	10.00	29.65	0
5133	–	–	42.00	41.00	–	6.00	–	10.00	–	0
5135	–	–	41.12	41.00	–	6.00	–	10.00	–	0
5143	–	–	41.06	41.00	–	6.00	–	10.00	–	0
5156	–	–	41.75	41.00	–	6.00	–	10.00	–	0
5158	–	–	40.06	41.00	–	6.00	–	10.00	–	0
5170	–	–	43.12	41.00	–	6.00	–	10.00	–	0
5173	–	–	43.68	41.00	–	6.00	–	10.00	–	0
5175	–	–	41.18	41.00	–	6.00	–	10.00	–	0
5183	–	–	41.25	41.00	–	6.00	–	10.00	–	0
5187	–	–	41.18	41.00	–	6.00	–	10.00	–	0
5188	–	–	41.68	41.00	–	6.00	–	10.00	–	0
5191	–	–	41.06	41.00	–	6.00	–	10.00	–	0
5195	–	–	40.31	41.00	–	6.00	–	10.00	–	0
5201	–	–	43.75	41.00	–	6.00	–	10.00	–	0
5202	–	–	44.31	41.00	–	6.00	–	10.00	–	0
5204	–	–	44.18	41.00	–	6.00	–	10.00	–	0
5207	–	–	41.12	41.00	–	6.00	–	10.00	–	0
5213	–	–	42.37	41.00	–	6.00	–	10.00	–	0
5216	–	–	41.81	41.00	–	6.00	–	10.00	–	0
5217	–	–	40.56	41.00	–	6.00	–	10.00	–	0
5218	–	–	40.62	41.00	–	6.00	–	10.00	–	0
5222	–	–	39.93	41.00	–	6.00	–	10.00	–	0
5224	–	–	40.37	41.00	–	6.00	–	10.00	–	0
5227	–	–	42.25	41.00	–	6.00	–	10.00	–	0
5231	–	–	43.25	41.00	–	6.00	–	10.00	–	0
5233	–	–	39.37	41.00	–	6.00	–	10.00	–	0
5234	–	–	39.00	41.00	–	6.00	–	10.00	–	0
5235	–	–	40.06	41.00	–	6.00	–	10.00	–	0
5243	–	–	43.12	41.00	–	6.00	–	10.00	–	0
5244	–	–	39.31	41.00	–	6.00	–	10.70	–	0
5246	–	–	42.25	41.00	–	6.00	–	10.00	–	0
5252	–	–	41.50	41.00	–	6.00	–	10.00	–	0
5264	–	–	41.43	41.00	–	6.00	–	10.00	–	0
5267	–	–	42.37	41.00	–	6.00	–	10.00	–	0
5276	–	–	41.31	41.00	–	6.00	–	10.00	–	0
5278	–	–	41.00	41.00	–	6.00	–	10.00	–	0
5292	–	–	41.13	41.00	–	6.00	–	10.00	–	0
5294	–	–	42.12	41.00	–	6.00	–	10.00	–	0
5299	–	–	40.38	41.00	–	6.00	–	10.00	–	0
5302	–	–	42.13	41.00	–	6.00	–	10.00	–	0
5319	–	–	41.88	41.00	–	6.00	–	10.00	–	0
5320	–	–	44.12	41.00	–	6.00	–	10.00	–	0
5332	–	–	40.25	41.00	–	6.00	–	10.00	–	0
5342	–	–	39.75	41.00	–	6.00	–	10.00	–	0
5380	7.32	6.44	38.50	41.00	8.79	6.00	12.21	10.00	26.74	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Owl Brand Cottonseed Meal	D	5400
	O	5403
	D	5404
	D	5444
	D	5463
	D	5467
	D	5468
	D	5469
	D	5471
Buckeye Cotton Oil Co, Cincinnati, Ohio		
Buckeye Prime Cottonseed Meal	D	4876
	D	4883
	D	4885
	D	4893
	D	4902
	D	4922
	D	4932
	D	4933
	D	4957
	D	4960
	D	4967
	O	5023
	D	5138
	D	5159
	O	5186
	D	5209
	D	5237
	D	5248
	D	5270
	D	5271
	O	5280
Bunch Commission Co., T. H., Little Rock, Ark.		
Acme Brand Pure Cottonseed Meal	D	5273
	D	5274
	O	5291
	O	5424
Bunch Commission Co., T. H., Little Rock, Ark.		
Old Gold Brand Pure Cottonseed Meal	D	4862
	D	4863
	D	4875
	D	4887
	D	4891
	D	4892
Davis, S. P., Little Rock, Ark.		
Good Luck Brand Cottonseed Meal	O	4881
	D	4890
	O	5117
	O	5148
East St. Louis Cotton Oil Co. National Stock Yards, Ill.		
Illinois Brand Cottonseed Meal	D	5130
	D	5181
	D	5194
	D	5205
	D	5263
	O	5356

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	*Weed seeds.
5400	–	–	41.07	41.00	–	6.00	–	10.00	–	0
5403	7.47	5.84	39.63	41.00	8.68	6.00	12.38	10.00	26.00	0
5404	–	–	41.44	41.00	–	6.00	–	10.00	–	0
5444	–	–	41.07	41.00	–	6.00	–	10.00	–	0
5463	–	–	40.88	41.00	–	6.00	–	10.00	–	0
5467	–	–	41.50	41.00	–	6.00	–	10.00	–	0
5468	–	–	38.82	41.00	–	6.00	–	10.00	–	0
5469	–	–	41.13	41.00	–	6.00	–	10.00	–	0
5471	–	–	41.13	41.00	–	6.00	–	10.00	–	0
4876	–	–	38.37	39.00	–	6.50	–	8.00	–	0
4883	–	–	40.00	38.50	–	6.50	–	10.00	–	0
4885	–	–	40.12	38.50	–	6.50	–	10.00	–	0
4893	–	–	39.87	38.50	–	6.50	–	10.00	–	0
4902	–	–	39.30	38.50	–	6.50	–	10.00	–	0
4922	–	–	38.00	38.50	–	6.50	–	10.00	–	0
4932	–	–	39.68	38.50	–	6.50	–	12.00	–	0
4933	–	–	40.81	38.62	–	6.00	–	12.00	–	0
4957	–	–	38.93	38.50	–	6.50	–	10.00	–	0
4960	–	–	38.38	38.62	–	6.00	–	12.00	–	0
4967	–	–	37.19	38.62	–	6.00	–	12.00	–	0
5023	6.41	5.91	38.62	38.62	6.86	6.00	12.84	12.00	29.36	0
5138	–	–	39.12	38.62	–	6.50	–	12.00	–	0
5159	–	–	39.76	38.62	–	6.00	–	12.00	–	0
5186	7.02	5.69	36.37	38.62	6.71	6.00	13.52	12.00	30.69	0
5209	–	–	41.37	38.62	–	6.00	–	12.00	–	0
5237	–	–	37.81	38.62	–	6.00	–	12.00	–	0
5248	–	–	39.00	38.62	–	6.00	–	12.00	–	0
5270	–	–	39.82	38.62	–	6.00	–	12.00	–	0
5271	–	–	39.37	38.62	–	6.00	–	12.00	–	0
5280	–	–	38.38	38.62	–	6.00	–	12.00	–	0
5273	–	–	38.62	38.60	–	7.00	–	8.00	–	0
5274	–	–	39.12	38.60	–	7.00	–	8.00	–	0
5291	5.04	6.80	38.75	38.60	8.53	7.00	10.81	12.00	30.07	0
5424	–	–	38.63	38.60	–	7.00	–	12.00	–	0
4862	–	–	42.93	41.00	–	9.00	–	9.00	–	0
4863	–	–	42.06	41.00	–	9.00	–	9.00	–	0
4875	–	–	44.05	41.00	–	9.00	–	9.00	–	0
4887	–	–	41.00	41.00	–	9.00	–	9.00	–	0
4891	–	–	39.93	41.00	–	6.00	–	10.00	–	0
4892	–	–	39.12	41.00	–	6.00	–	10.00	–	0
4881	–	–	41.81	41.00	–	7.00	–	10.50	–	0
4890	–	–	41.87	41.00	–	6.50	–	10.50	–	0
5117	6.81	6.50	41.75	41.00	7.18	7.00	10.44	10.50	27.32	0
5148	–	–	41.62	41.00	–	7.00	–	10.50	–	0
5130	–	–	41.31	41.50	–	6.50	–	10.00	–	0
5181	–	–	42.12	41.50	–	6.50	–	10.00	–	0
5194	–	–	43.87	41.50	–	6.50	–	8.00	–	0
5205	–	–	44.00	41.50	–	6.50	–	8.00	–	0
5263	–	–	44.25	41.50	–	6.50	–	8.00	–	0
5356	5.27	6.35	41.88	41.50	9.22	6.50	10.97	10.00	26.31	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Humphreys-Godwin Co., Memphis, Tenn.		
Dixie Brand Cottonseed Meal	D	4867
	D	4870
	D	4871
	D	4872
	D	4877
	D	4889
	D	4900
	D	4903
	D	4911
	D	4912
	D	4913
	D	4915
	D	4916
	D	4919
	D	4920
	D	4921
	D	4927
	D	4930
	D	4931
	O	4942
	D	4950
	D	4958
	D	4963
	D	4964
	D	4968
	D	4971
	D	4973
	D	4975
	D	5012
	D	5028
	O	5065
	D	5095
	D	5107
	D	5142
	O	5164
	D	5174
	D	5176
	D	5182
	D	5184
	O	5185
	D	5192
	D	5196
	D	5198
	D	5203
	D	5208
	D	5212
	D	5220
	D	5236
	D	5238
	D	5239
	D	5245
	D	5247
	D	5266
	O	5283
	D	5303
	D	5307
	O	5327
	O	5329
	O	5338
	O	5381
	D	5405

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein.		Fat.		Fiber.		Nitrogen free extract.	*Weed seeds.
			Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.		
4867	–	–	37.62	38.62	–	6.00	–	12.00	–	0
4870	–	–	40.84	38.62	–	6.00	–	8.00	–	0
4871	–	–	40.15	38.62	–	6.00	–	8.00	–	0
4872	–	–	40.62	38.62	–	6.00	–	8.00	–	0
4877	–	–	37.93	38.62	–	6.00	–	8.00	–	0
4889	–	–	41.25	38.62	–	6.00	–	12.00	–	0
4900	–	–	39.15	38.62	–	6.00	–	8.00	–	0
4903	–	–	39.37	38.62	–	6.00	–	8.00	–	0
4911	–	–	40.99	38.62	–	6.00	–	8.00	–	0
4912	–	–	40.93	38.62	–	6.00	–	8.00	–	0
4913	–	–	40.18	38.62	–	6.00	–	8.00	–	0
4915	–	–	39.12	38.62	–	6.00	–	8.00	–	0
4916	–	–	39.87	38.62	–	6.00	–	12.00	–	0
4919	–	–	41.18	38.62	–	6.00	–	12.00	–	0
4920	–	–	39.80	38.62	–	6.00	–	10.00	–	0
4921	–	–	41.13	38.62	–	6.00	–	8.00	–	0
4927	–	–	42.18	38.62	–	6.00	–	8.00	–	0
4930	–	–	37.75	38.62	–	6.00	–	8.00	–	0
4931	–	–	40.66	38.62	–	6.00	–	8.00	–	0
4942	7.77	6.18	38.69	38.62	8.86	6.00	11.92	12.00	26.58	0
4950	–	–	41.22	38.62	–	6.00	–	8.00	–	0
4958	–	–	39.81	38.62	–	6.00	–	8.00	–	0
4963	–	–	39.82	38.62	–	6.00	–	8.00	–	0
4964	–	–	40.00	38.62	–	6.00	–	8.00	–	0
4968	–	–	38.63	38.62	–	6.00	–	12.00	–	0
4971	–	–	39.75	38.62	–	6.00	–	8.00	–	0
4973	–	–	37.38	38.62	–	6.00	–	8.00	–	0
4975	–	–	38.43	38.62	–	6.00	–	12.00	–	0
5012	–	–	37.88	38.62	–	6.00	–	8.00	–	0
5028	–	–	40.87	38.62	–	6.00	–	8.00	–	0
5065	–	–	38.25	38.62	–	6.00	–	12.00	–	0
5095	–	–	38.35	38.62	–	6.00	–	8.00	–	0
5107	–	–	38.37	38.62	–	6.00	–	8.00	–	0
5142	–	–	38.87	38.62	–	6.00	–	12.00	–	0
5164	–	–	39.37	38.62	–	6.00	–	12.00	–	0
5174	–	–	34.25	38.62	–	6.00	–	12.00	–	0
5176	–	–	41.06	38.62	–	6.00	–	12.00	–	0
5182	–	–	38.31	38.62	–	6.00	–	12.00	–	0
5184	–	–	38.63	38.62	–	6.00	–	8.00	–	0
5185	6.92	6.48	35.37	38.62	8.51	6.00	15.65	8.00	27.07	0
5192	–	–	41.37	38.62	–	6.00	–	12.00	–	0
5196	–	–	41.56	38.62	–	6.00	–	8.00	–	0
5198	–	–	36.00	38.62	–	6.00	–	8.00	–	0
5203	–	–	42.18	38.62	–	6.00	–	8.00	–	0
5208	–	–	40.00	38.62	–	6.00		12.00	–	0
5212	–	–	38.87	38.62	–	6.00	–	8.00	–	0
5220	–	–	46.75	38.62	–	6.00	–	12.00	–	0
5236	–	–	40.00	38.62	–	6.00	–	8.00	–	0
5238	–	–	39.94	38.62	–	6.00	–	8.00	–	0
5239	–	–	40.37	38.62	–	6.00	–	8.00	–	0
5245	–	–	41.25	38.62	–	6.00	–	8.00	–	0
5247	–	–	46.88	38.62	–	6.00	–	8.00	–	0
5266	–	–	38.62	38.62	–	6.00	–	8.00	–	0
5283	–	–	48.63	38.62	–	6.00	–	12.00	–	0
5303	–	–	40.00	38.62	–	6.00	–	8.00	–	0
5307	–	–	39.63	38.62	–	6.00	–	8.00	–	0
5327	–	–	41.63	38.62	–	6.00	–	12.00	–	0
5329	–	–	40.00	38.62	–	6.00	–	12.00	–	0
5338	–	–	38.63	38.62	–	6.00	–	12.00	–	0
5381	–	–	39.63	38.62	–	6.00	–	12.00	–	0
5405	–	–	42.25	38.62	–	6.00	–	8.00	–	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Humphreys-Godwin Co., Memphis, Tenn. Forfat Brand Cottonseed Meal	D	4937
	O	4955
	O	5006
	D	5145
	D	5219
	O	5253
	D	5361
Imperial Cotto Milling Co., Memphis, Tenn. Imperial Cotto Brand Cottonseed Meal	D	5141
Soper Co., J. E., Boston, Mass. Pilgrim Brand Cottonseed Meal	D	4939
	O	5004
	D	5074
Soper Co., J E., Boston, Mass. Pioneer Cottonseed Meal	D	4873
	D	4878
	D	4956
	D	4961
	O	4998
	D	5080
	D	5132
	O	5137
	D	5144
	O	5165
	O	5189
	O	5190
	D	5193
	D	5406

COTTONSEED FEED.

Humphreys-Godwin Co., Memphis, Tenn. Creamo Brand Cottonseed Feed	O	5452

GLUTEN FEEDS.

American Maize Products Co., New York City. Cream of Corn Gluten Feed	O	4910
	O	5090
	O	5411
	D	5443
Clinton Sugar Refining Co., Clinton, Iowa. Clinton Corn Gluten Feed	D	4918
	O	4945
	O	5430

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein.		Fat.		Fiber.		Nitrogen free extract.	*Weed seeds.
			Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.		
4937	–	–	39.50	38.62	–	6.00	–	8.00	–	0
4955	–	–	38.63	38.62	–	6.00	–	8.00	–	0
5006	5.78	5.71	41.50	38.62	7.53	6.00	10.46	12.00	29.02	0
5145	–	–	39.43	38.62	–	6.00	–	8.00	–	0
5219	–	–	37.25	38.62	–	6.00	–	8.00	–	0
5253	–	–	39.25	38.62	–	6.00	–	12.00	–	0
5361	–	–	36.75	38.62	–	6.00	–	8.00	–	0
5141	–	–	41.12	41.00	–	8.00	–	9.00	–	0
4939	–	–	41.88	38.50	–	5.00	–	10.00	–	0
5004	6.99	6.48	39.87	38.50	8.82	5.00	10.18	10.00	27.66	0
5074	–	–	39.50	38.50	–	5.00	–	10.00	–	0
4873	–	–	37.87	41.00	–	7.00	–	10.00	–	0
4878	–	–	37.84	41.00	–	7.00	–	10.00	–	0
4956	–	–	43.44	41.00	–	7.00	–	10.00	–	0
4961	–	–	41.50	41.00	–	7.00	–	10.00	–	0
4998	6.27	6.50	42.12	41.00	8.09	7.00	9.63	10.00	27.39	0
5080	–	–	41.25	41.00	–	7.00	–	10.00	–	0
5132	–	–	39.50	41.00	–	7.00	–	10.00	–	0
5137	–	–	38.75	41.00	–	7.00	–	10.00	–	0
5144	–	–	41.12	41.00	–	7.00	–	10.00	–	0
5165	6.52	6.00	36.87	41.00	6.62	7.00	13.93	10.00	30.06	0
5189	6.03	5.94	37.13	41.00	6 64	7.00	13.88	10.00	30.38	0
5190	–	–	42.00	41.00	–	7.00	–	10.00	–	0
5193	–	–	39.41	41.00	–	7.00	–	10.00	–	0
5406	–	–	41.13	41.00	–	7.00	–	10.00	–	0

5452	8.40	4.36	21.88	20.00	5.23	5.00	21.13	22.00	39.00	0

4910	10.80	2.99	24.99	23.00	1.81	2.50	6.85	8.50	52.56	0
5090	7.04	2.17	25.50	23.00	2.79	2.50	6.79	8.50	55.71	0
5411	–	–	25.75	23.00	–	2.50	–	8.50	–	0
5443	–	–	22.00	23.00	–	2.50	–	8.50	–	0
4918	–	–	23.97	20.00	–	3.00	–	8.00	–	0
4945	9.21	2.01	24.88	20.00	3.02	3.00	8.13	8.00	52.75	0
5430	–	–	27.63	23.00	–	3.00	–	8.00	–	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Continental Cereal Co., Peoria, Illinois. Continental Gluten Feed	O	5311
Corn Products Refining Co., New York City, N. Y. Buffalo Corn Gluten Feed	D O O	4936 5009 5413
Douglas & Co., Cedar Rapids, Iowa. Douglas Guten Feed	D	4934
Huron Milling Co., Harbor Beach, Mich. Jenks Gluten Feed	O	4982
Stanley Mfg. Co. A. E., Decatur, Ill. Stanley's Gluten Feed	O O	5055 5412

GLUTEN MEAL.

Corn Products Refining Co., New York City, N. Y. Diamond Gluten Meal	O	5089

LINSEED OIL MEALS.

American Linseed Co., New York City, N. Y. Linseed Oil Meal	O O O	4979 5335 5416
American Linseed Co., New York City, N. Y. Old Process Oil Meal	O	5085
Major Co., Guy G., Toledo, Ohio. Old Process Linseed Oil Meal	O O	5000 5032
Midland Linseed Products Co., Minneapolis, Minnesota. Midland Brand Pure Old Process Ground Linseed Cake	O O	5088 5394

DISTILLERS GRAINS.

Ajax Milling & Feed Co., New York City, N. Y. Ajax Flakes	O	5069

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	*Weed seeds.
5311	5.21	3.82	29.00	29.00	12.58	12.50	8.28	10.50	41.11	0
4936	–	–	24.62	23.00	–	2.00	–	8.50	–	0
5009	8.70	3.91	27.12	23.00	2.85	2.00	7.19	8.50	50.23	0
5413	7.38	4.16	25.50	23.00	2.38	2.00	7.08	8.50	53.50	0
4934	–	–	20.50	20.00	–	2.00	–	8.00	–	0
4982	6.92	2.62	22.38	22.25	4.34	3.00	7.71	8.00	56.03	0
5055	7.73	3.12	24.13	23.00	2.54	2.50	6.95	12.00	55.53	0
5412	–	–	24.38	23.00	–	2.50	–	12.00	–	0
5089	7.00	1.14	43.25	40.00	0.71	1.50	1.80	4.00	46.10	0
4979	7.63	5.63	34.75	36.00	2.75	2.00	10.48	9.00	38.76	0
5335	–	–	36.00	36.00	–	2.00	–	9.00	–	0
5416	7.06	5.47	36.00	36.00	4.04	2.00	9.75	9.00	37.68	0
5085	7.29	5.26	36.87	34.00	5.69	5.00	8.93	8.00	35.96	0
5000	8.48	4.68	31.87	30.00	7.18	5.00	9.78	10.00	38.01	0
5032	6.81	–	31.37	30.00	–	5.00	–	10.00	–	0
5088	7.96	5.30	32.50	32.00	8.28	5.00	8.46	9.50	37.50	0
5394	–	–	34.38	32.00	–	5.00	–	9.50	–	0
5069	5.06	3.06	30.25	30.00	14.13	11.00	12.51	14.00	34.99	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Haltelet Co., The, Milwaukee, Wis. Hector Dried Distillers Grains	O	5377
Larrowe Milling Co., Detroit, Mich. Distillers Corn Grains	D	4965
Ubiko Milling Co., Cincinnati, O. Fourex (XXXX) Distillers Dried Grains	O	5031

WHEAT OFFALS, FEED FLOUR.

Duluth-Superior Milling Co., Duluth, Minn. Red Dog	O	5232
Gwinn Milling Co., Columbus, O. Gwinn's Red Dog	O	5066
Hecker-Jones-Jewell Milling Co., Buffalo, N. Y. Red Dog	O	5127
Pillsbury Flour Mills Co., Minneapolis, Minn. Pillsbury's XX Daisy	O O	4999 5425
Stott David, Detroit, Mich. Stag Flour	O	5309
Washburn-Crosby Co., Minneapolis, Minn. Washburn Crosby Co.'s Adrian (Red Dog)	O	5255

WHEAT OFFALS, MIDDLINGS.

Allen & Wheeler Co, Troy, O. Trojan Middlings	O	5041
Ansted & Burk Co. Springfield, O. William Tell Middlings	O O O	5017 5064 5126
Buffalo Cereal Co., Buffalo, N. Y. Flour Middlings	O	5355
Central Dakota Mill, C.D. M. White Middlings with Ground Screenings not exceeding mill run	O	5441
Christian, Geo. C. Poland Middlings	O	5155

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein.		Fat.		Fiber.		Nitrogen free extract.	*Weed seeds.
			Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.		
5377	9.65	1.54	32.00	30.00	12.23	10.00	13.42	14.00	31.16	0
4965	-	-	25.56	27.00	-	7.00	-	9.00	-	0
5031	5.83	1.86	31.37	31.00	9.76	12.00	14.00	13.00	37.18	0
5232	9.08	2.72	18.13	17.50	4.53	4.50	2.88	3.50	62.66	0
5066	9.54	1.64	16.25	16.19	3.26	4.70	1.66	4.20	67.65	0
5127	9.52	1.82	16.19	18.00	3.90	5.50	1.03	4.00	67.54	0
4999	9.38	3.62	18.38	16.00	5.14	4.50	3.60	4.00	59.88	0
5425	9.24	3.72	17.38	16.00	4.80	4.50	3.71	4.00	61.15	0
5309	9.82	0.73	13.75	15.00	2.28	1.50	0.29	3.00	73.13	0
5255	8.41	3.10	17.00	17.00	5.14	5.00	3.86	4.00	62.49	0
5041	7.87	4.36	16.13	15.00	4.60	4.00	5.89	8.00	61.15	0
5017	9.89	4.59	17.25	14.50	4.76	4.00	6.00	7.50	57.51	0
5064	-	-	15.38	14.50	-	3.50	-	7.00	-	Few
5126	-	-	15.25	14.00	-	3.00	-	11.00	-	Many
5355	8.62	3.96	16.75	-	5.45	-	5.82	-	56.72	0
5441	9.82	4.26	16.88	16.00	5.50	4.50	6.29	6.25	57.25	0
5155	8.78	4.51	17.75	14.00	6.15	4.00	8.04	8.00	54.77	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Christian Breisch & Co., No. Lansing Mich Winter Wheat Middlings	O	5058
Christensen Co., G. S., Madelia, Minn. Flour Middlings	O	5379
Chrystal Milling Co., Choice Middlings	O	5087
Claro Milling Co., Waseca, Minn. Claro Middlings	O	5392
Coombs Milling Co., Wm. A., Coldwater, Mich. Middlings	O	5054
Crescent Milling Co., Crescent Middlings	O	5310
Duluth-Superior Milling Co., Duluth, Minn. (S) Middlings	O O	4947 5060
Everett-Aughenbaugh Co., Waseca, Minn. Eaco Winged Horse Middlings	D O	4868 5093
Federal Milling Co., Lockport, N. Y. Lucky Spring Flour Middlings	O	4986
Federal Milling Co., Lockport, N. Y. Lucky Winter Flour Middlings	O O	5151 5432
Gwinn Milling Co., Columbus, O. Gwinn Wheat Middlings	O	4996
Hale & Sons, J., Lyons, Mich. Acme Middlings	O	5378
Hecker-Jones-Jewell Milling Co., Buffalo, N. Y. Winter Wheat Middlings	O	5375
Hubbard Milling Co., Mankato, Minn. Standard Fine Middlings	O	5039
Huron Milling Co., Harbor Beach, Mich. Jenks Middlings	O O	4983 5456
Kemper Mill & Elevator Co., Kansas City, Mo. Carnation Gray Middlings	O	5150

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	*Weed seeds.
5058	9.11	3.91	16.13	14.96	4.39	5.25	5.50	4.13	60.96	0
5379	10.33	3.92	17.63	14.25	5.64	3.00	5.54	5.35	56.94	0
5087	8.70	5.43	17.63	14.55	4.85	3.95	7.53	9.25	55.86	0
5392	8.97	4.31	17.88	15.00	5.93	3.00	6.94	8.00	55.97	0
5054	7.88	4 93	18.00	15.00	4.89	3.00	6.76	–	57.54	0
5310	8.66	4.45	19.38	17.62	6.51	5.36	6.74	9.78	54.26	Many
4947	2.70	6.20	17.63	17.50	6.64	5.50	7.36	8.50	59.47	0
5060	–	–	18.50	17.50	–	5.00	–	8.00	–	0
4868	–	–	17.68	15.00	–	3.00	–	10.00	–	0
5093	9.05	4.41	17.88	15.00	5.90	3.00	7.09	10.00	55.67	0
4986	8.63	4.16	17.00	17.00	5.95	5.00	5.92	9.00	58.34	0
5151	9.84	4.56	16.38	16.00	4.79	5.00	6.47	7.00	57.96	0
5432	–	–	16.13	16.00	–	5.00	–	7.00	–	0
4996	8.93	4.06	17.38	17.00	6.00	6.00	5.20	6.00	58.43	0
5378	10.40	3.14	17.63	14.60	4.81	3.70	3.58	7.20	60.44	0
5375	9.65	4.53	17.00	15.59	5.17	4.67	7.15	7.13	56.50	0
5039	7.74	5.64	18.38	14.50	6.14	6.10	8.25	10.00	53.85	0
4983	9.89	2.02	13.38	13.00	3.20	2.50	1.95	3.50	69.56	0
5456	–	–	14.38	13.00	–	2.50	–	3.50	–	0
5150	8.95	3.95	18.13	16.00	5.34	4.30	5.58	6.00	58.05	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Lawrenceburg Roller Mills Co., Lawrenceburg, Ind. Snowflake Middlings	O	5019
Liken & Co., J. C., Sebewaing, Mich. Michigan Winter Wheat Middlings	D	5242
Lyon & Greenleaf, Wauseon, O. Waseo Middlings	O	5326
Maple Leaf Milling Co., Toronto, Ont., Can. Fancy Canadian Middlings	O	5334
Maple Leaf Milling Co., Toronto, Ont., Can. Rex Middlings	D O O	5265 5312 5414
Melrose Milling Co., Melrose, Minn. Middlings	O	5325
Morris City Mills, Flour Middlings	O	5460
New Prague Flouring Mill Co., New Prague, Minn. Seal of Minnesota Standard Middlings	O	5417
Niagara Falls Milling Co., Buffalo, N. Y. Niagara Falls Milling Company Middlings	O	5167
Northwestern Milling Co., Minneapolis, Minn. Fancy Country Middlings	O	5083
Pillsbury Flour Mills Co., Minneapolis, Minn. Pillsbury's A Middlings	O O	5293 5448
Pillsbury Flour Mills Co., Minneapolis, Minn. Pillsbury's B Middlings	O	5061
Quaker Oats Co., Chicago, Ill. Bell Cow Middlings	O	5348
Russell-Miller Milling Co., Minneapolis, Minn. Flour Middlings	O O	5102 5419
Russell-Miller Milling Co., Minneapolis, Minn. Standard Middlings	O O	5007 5409

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	*Weed seeds.
5019	8.23	4.10	17.38	16.00	5.24	5.10	5.88	6.00	59.17	0
5242	–	–	16.19	16.00	–	4.50	–	8.00	–	0
5326	10.00	3.75	17.13	18.00	3.69	4.00	5.18	6.00	60.25	0
5334	–	–	16.88	16.00	–	5.50	–	10.00	–	0
5265	–	–	16.63	16.00	–	5.50	–	10.00	–	0
5312	9.22	4.25	16.88	16.00	5.52	5.50	7.06	10.00	57.07	0
5414	–	–	16.13	16.00	–	5.50	–	10.00	–	0
5325	10.12	3.83	17.38	15.00	5.59	3.00	5.26	–	57.82	0
5460	10.40	2.74	17.38	17.00	5.10	5.00	3.41	4.80	60.97	0
5417	8.50	4.34	18.50	17.75	6.25	5.80	5.55	6.75	56.86	0
5167	9.01	4.81	17.25	16.00	6.13	4.00	7.85	10.00	54.95	0
5083	8.92	4.37	17.25	17.00	5.61	4.00	7.89	10.75	55.96	0
5293	6.83	4.47	17.13	15.00	5.23	4.50	6.35	8.00	59.99	0
5448	–	–	16.25	15.00	–	4.50	–	6.00	–	0
5061	7.85	5.45	15.38	15.00	5.43	4.50	9.39	8.00	56.50	0
5348	8.96	3.52	16.88	15.30	5.86	5.50	5.82	7.60	58.96	0
5102	9.06	3.05	17.63	16.00	5.50	5.00	4.11	8.00	60.65	0
5419	9.21	3.45	18.75	18.00	5.13	5.00	4.23	8.00	59.23	0
5007	8.61	6.29	16.00	15.00	6.25	4.00	7.28	9.00	55.57	0
5409	–	–	18.00	15.00	–	4.00	–	9.00	–	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Sleepy Eye Flour Mills Co., Minneapolis, Minn. Pure Wheat Middlings	O	5317
Stock & Sons, F. W., Hillsdale, Mich. Stock's Middlings	O	5048
Stott, David, Detroit, Mich. Climax Middlings	O	5025
Stott, David, Detroit, Mich. Fine White Middlings	O	5026
Stott, David, Detroit, Mich. Pennant Middlings	O	5027
Traders & Producers Supply Co., Buffalo, N. Y. Chippena Fancy Middlings	O	5045
Urban Milling Co., Geo., Buffalo, N. Y. Middlings	O	5098
Urban Milling Co., Geo., Buffalo, N. Y. Wheat Middlings	O	5449
Valley City Milling Co., Grand Rapids, Mich. Farmer's Favorite Middlings	O	5251
Voigt Milling Co., Grand Rapids, Mich. Voigt Pure Middlings	O	5387
Washburn-Crosby Co., Minneapolis, Minn. Flour Middlings	O	5287
Washburn-Crosby Co., Minneapolis, Minn. Standard Middlings	O O	5125 5415
Williams Bros., Kent, O. Fancy Winter Wheat Middlings	O	5359

WHEAT OFFALS, BRAN.

Acme-Evans Co., Indianapolis, Ind. Acme Bran	O	5070
Allen & Wheeler Co., Troy, O. Trojan Bran	O O	5153 5421

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	*Weed seeds.
5317	8.74	4.64	16.25	17.20	5.68	4.30	9.09	9.40	55.60	0
5048	8.58	4.26	17.75	15.00	5.80	4.00	6.00	8.00	57.61	0
5025	9.17	4.17	16.44	17.00	5.35	5.00	5.74	7.00	59.13	0
5026	9.73	3.26	16.38	16.00	4.84	5.00	4.23	6.00	61.56	0
5027	9.67	4.16	17.00	17.00	5.50	6.50	5.76	7.00	57.91	0
5045	7.90	4.67	18.13	16.00	6.03	5.50	7.29	10.00	55.98	0
5098	8.62	4.26	16.63	16.00	5.71	4.50	7.36	8.00	57.42	0
5449	10.07	4.52	16.75	16.00	5.28	4.50	6.84	8.00	56.54	0
5251	8.45	4.75	16.71	15.50	4.88	4.25	6.62	7.00	58.59	0
5387	8.67	4.01	16.38	14.05	5.50	5.50	5.61	5.00	59.83	0
5287	6.76	4.38	19.19	17.00	6.13	6.00	5.88	6.00	57.66	0
5125	8.66	5.28	17.63	15.00	6.05	4.00	8.82	9.00	53.56	0
5415	–	–	17.38	15.00	–	4.00	–	8.00	–	0
5359	9.54	3.93	14.75	10.00	4.72	3.00	4.93	15.00	62.13	0
5070	7.90	6.17	15.19	16.80	4.59	4.00	9.55	10.00	56.60	Few
5153	8.78	6.43	16.00	14.50	4.56	4.00	9.51	8.00	54.72	Few
5421	–	–	16.13	14.50	–	4.00	–	9.50	–	Few

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Alma Roller Mills, Bran and Middlings	O	445
Bay State Milling Co., Winona, Minn. Winona Bran	O	5149
Big Diamond Mill Co., Minneapolis, Minn. Big Diamond Bran	O O	5154 5418
Campbell Milling Co. L. G., Owatonna, Minn. Choice Bran	O	5129
Christian, Geo. C., Jersey Bran	O	5015
Commander Mill Co., Detroit, Mich. Commander Bran	O	5354
Commercial Milling Co., Detroit, Mich. Bran and screenings	O	5353
Coombs Milling Co., Wm. A., Coldwater, Mich. Bran	O	5053
Duluth Superior Milling Co., Duluth, Minn. Duluth Superior Bran	O	5395
Elysian Milling Co., Eclipse Bran	O	5068
Everett-Aughenbaugh & Co., Waseca, Minn. Eaco Winged Horse Bran	O	5101
Federal Milling Co., Lockport, N. Y. Lucky Spring Bran	O	5003
Fergus Flour Mills Co., Spring Wheat Bran	O	5466
Gwinn Milling Co., Columbus, O. Gwinn's Wheat Bran	O O	4995 5446
Hecker-Jones-Jewel Milling Co., Buffalo, N. Y. Choice Bran	O O	5128 5447
Hecker-Jones-Jewell Milling Co., Buffalo, N. Y. Winter Wheat Bran	O	5374
Kemper Mill & Elevator Co., Kansas City, Mo. Anchor Bran	O	4949

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	*Weed seeds.
5445	9.02	5.06	16.63	14.61	5.30	4.01	6.96	–	57.03	Few
5149	8.58	6.40	15.75	15.00	5.38	5.00	10.71	11.00	53.18	Few
5154	7.84	6.79	15.25	14.00	5.11	4.00	10.70	11.07	54.31	Many
5418	–	–	15.13	14.00	–	4.00	–	11.07	–	Many
5129	8.09	6.04	16.38	13.40	5.27	4.50	10.72	12.20	53.50	Few
5015	8.11	6.81	15.88	13.00	5.34	4.00	10.86	11.00	53.00	Few
5354	6.79	6.13	16.63	14.00	5.27	4.00	9.10	11.00	53.42	Many
5353	4.98	5.58	16.00	14.00	4.86	3.00	9.24	14.00	56.78	Few
5053	7.61	6.45	16.13	14.00	4.32	3.00	9.04	–	56.45	Few
5395	8.28	5.93	15.63	15.00	5.88	4.00	10.72	11.25	53.56	Few
5068	7.52	5.97	16.63	15.80	5.68	4.10	9.07	11.80	55.13	Many
5101	8.26	6.22	16.00	14.00	5.50	3.00	9.86	12.00	54.16	Many
5003	8.73	6.51	15.88	15.00	5.38	4.50	10.23	11.00	53.27	Few
5466	10.07	6.02	15.19	16.00	5.24	4.50	10.19	–	53.29	Few
4995	8.64	6.28	15.12	16.78	4.47	4.40	9.52	8.00	55.97	Few
5446	9.24	6.45	15.88	15.78	4.97	4.40	9.47	8.00	53.99	Few
5128	8.41	6.07	16.25	15.00	5.21	4.50	10.54	9.50	53.52	Few
5447	–	–	15.88	15.00	–	4.50	–	9.50	–	Few
5374	9.78	6.62	14.75	15.00	3.82	3.25	9.52	9.50	55.51	Few
4949	10.24	6.78	16.63	14.50	4.42	4.00	8.74	10.00	53.19	Many

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Lawrenceburg Roller Mills Co., Lawrenceburg, Ind. Snowflake Bran	O	5163
Liken & Co., J. C., Sebewaing, Mich. Michigan Winter Wheat Bran	D	5241
Lyon & Greenleaf, Wauseon, O. Waseo Bran	O	5315
Maple Leaf Flour Mills Co., Toronto, Ont., Can. Bran	O	5008
Melrose Milling Co., Melrose, Minn. Fancy Bran	O	5324
New Prague Flouring Mill Co., New Prague, Minn. Seal of Minnesota Bran	O	4977
Northwestern Consolidated Milling Co., Minneapolis, Minn. Pure Wheat Bran	O O	4978 5435
Ogilvie Flour Mills Co., Montreal, Can. Monogram Bran	O	5002
Pillsbury Flour Mills Co., Minneapolis, Minn. Pillsbury's Wheat Bran	O	5067
Russell-Miller Milling Co., Minneapolis, Minn. Bran	O	5082
Saginaw Milling Co., Saginaw, Mich. Samico Winter Bran	O	5230
Sleepy Eye Flour Mills Co., Minneapolis, Minn. Sleepy Eye Bran	O	5134
Stock & Sons, F. W., Hillsdale, Mich. Stock's Bran	O	4980
Stock & Sons, F. W., Hillsdale, Mich. Wheat Bran	D O	5272 5437
Stott, David, Detroit, Mich. Spring Wheat Bran	O	5024
Stott, David, Detroit, Mich. Winter Wheat Bran	O	4940

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	*Weed seeds.
5163	7.93	6.31	15.25	14.20	4.11	3.80	10.30	9.50	56.10	Few
5241	–	–	13.88	14.00	–	3.50	–	12.00	–	0
5315	4.70	6.07	15.00	14.50	4.70	4.00	9.20	9.50	60.33	Many
5008	8.36	5.60	15.63	15.50	5.50	–	10.11	–	54.80	Few
5324	8.16	6.53	14.88	14.00	5.15	3.00	10.91	–	54.37	Few
4977	7.34	7.19	16.00	14.60	5.22	4.75	10.80	11.00	53.45	Few
4978	7.43	6.87	16.13	14.50	5.45	4.00	10.66	11.00	53.46	Many
5435	–	–	15.75	14.50	–	4.00	–	11.00	–	Few
5002	8.22	5.41	15.38	15.00	5.40	4.00	10.49	10.00	55.10	Many
5067	7.71	6.52	15.13	14.50	5.53	4.00	10.72	11.00	54.39	Few
5082	7.37	6.39	16.63	13.00	5.17	4.00	9.65	11.00	54.79	Few
5230	8.76	5.36	15.75	–	4.49	–	8.69	–	56.95	Few
5134	8.15	6.15	16.38	15.30	5.28	4.40	9.80	13.30	54.24	Few
4980	8.41	6.19	17.00	15.50	5.02	3.00	8.76	9.50	54.62	Few
5272	–	–	17.12	14.00	–	3.50	–	11.00	–	0
5437	5.81	6.26	15.25	14.00	4.89	3.00	8.38	10.00	59.41	Few
5024	8.08	5.55	16.00	16.00	5.13	4.00	8.67	10.00	56.57	Few
4940	7.66	6.52	16.13	16.00	4.82	4.00	10.00	10.00	54.87	Few

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Tennant & Hoyt, Pure Wheat Bran	O	5458
Valley City Milling Co., Grand Rapids, Mich. Farmers' Favorite Bran	O	5229
Voigt Milling Co., Grand Rapids, Mich Voigt's Pure Bran	O	5030
Wabasha Roller Mill Co., Wabasha, Minn. Big Jo Bran	O	5033
Washburn-Crosby Co., Minneapolis, Minn. Washburn-Crosby Co.'s Coarse Bran	O O	5051 5084
Western Flour Mills Co., Black Hawk Bran	O	5228
Williams Bros. Co., Kent, O. Pure Ohio Bran	O	5358
Williamson Milling Co., Clay Center, Kans. Bran	O	5282
Williston Mill Co., Bran	O	5461

WHEAT OFFALS, MIXED FEED.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Allen & Wheeler Co., Troy, O. Trojan Mixed Feed	O O	5020 5422
Bay State Milling Co., Winona, Minn. Winona Wheat Mixed Feed and mill run Ground Screenings	O	5369
Blanton Milling Co., Indianapolis, Ind. Blanton Mixed Feed	O O	4923 5180
Blish Milling Co., Seymour, Ind. Bull's Eye Mixed Feed	O	5100
Claro Milling Co., Waseca, Minn. Claro Mixed Feed	O	5462
Commercial Milling Co., Detroit, Mich. Henkel's Mixed Feed	O	5351

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein.		Fat.		Fiber.		Nitrogen free extract.	*Weed seeds.
			Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.		
5458	7.44	5.68	16.38	13.20	6.42	4.90	9.13	13.10	54.95	Few
5229	8.62	5.75	16.13	14.65	4.91	2.80	9.03	10.40	55.56	Few
5030	7.62	5.40	17.00	17.00	4.90	6.50	7.23	7.50	57.85	Few
5033	9.00	6.02	17.50	16.39	5.96	5.15	10.22	9.62	51.30	Few
5051	7.60	6.22	16.00	14.50	6.05	4.00	10.47	11.00	53.66	Few
5084	–	–	15.38	14.50	–	4.00	–	11.00	–	Few
5228	8.16	6.23	16.13	14.60	5.13	4.75	10.80	11.00	53.55	Few
5358	6.82	5.98	15.13	–	4.70	–	8.92	–	58.45	Few
5282	–	–	15.88	15.50	–	3.50	–	12.00	–	0
5461	7.82	5.71	15.13	16.50	5.83	4.60	9.17	10.20	56.34	Few

5020	9.14	5.61	15.63	14.50	4.56	4.00	7.87	8.00	57.19	Few
5422	–	–	16.75	14.50	–	4.00	–	8.00	–	Few
5369	10.07	4.01	16.50	17.00	5.01	5.00	6.20	8.00	58.21	0
4923	–	–	16.13	15.70	–	3.70	–	10.00	–	0
5180	8.54	5.38	15.75	15.70	4.29	3.70	7.44	10.00	58.60	Few
5100	7.45	5.62	16.50	16.00	5.05	4.40	8.59	9.10	56.79	Few
5462	7.64	5.00	17.75	15.00	4.66	3.00	7.61	11.00	57.34	Few
5351	6.32	5.64	16.88	14.50	5.43	4.50	10.12	8.00	52.91	Few

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Coombs Milling Co., Wm. A., Coldwater, Mich. Mixed Feed	O	5044
Duluth-Superior Milling Co., Duluth, Minn. Boston Mixed Feed	O O	5035 5410
Everett-Aughenbaugh & Co., Waseca, Minn. Eaco Winged Horse Mixed Feed	O	5001
Federal Milling Co., Lockport, N. Y. Lucky Spring Mixed Feed	O	5360
Federal Milling Co., Lockport, N. Y. Lucky Winter Mixed Feed	O	5152
Griswold & Mackinnon, St. Johnsbury, Vt. Xtragood Mixed Feed	O O	5382 5442
Hale & Sons, J., Lyons, Mich. Acme Mixed Feed	O	5057
Halliday Milling Co., Cairo, Ill. Halliday's Choice Mixed Feed	O	5391
Hecker-Jones-Jewell Milling Co., Buffalo, N. Y. Mixed Feed	O	5376
Holway Co., Oscar, Auburn, Me. Montana Brand Wheat Mixed Feed with Screenings not exceeding mill run	O	5345
Hunter-Robinson-Wenz Milling Co., St. Louis, Mo. Sunshine Mixed Feed	O O O	4953 5389 5398
Huron Milling Co., Harbor Beach, Mich. Jenks Mixed Feed	O O	4997 5455
Kemper Mill & Elevator Co., Kansas City, Mo. Crescent Mixed Feed	O O	5038 5399
Lawrenceburg Roller Mills Co., Lawrenceburg, Ind. Snowflake Mixed Feed	O	4991
Lyon & Greenleaf, Wauseon, O. Waseo Mixed Feed	O	5323

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	*Weed seeds.
5044	7.79	5.39	17.88	15.00	4.81	3.00	7.85	–	56.28	Few
5035	7.92	5.47	16.88	15.00	6.05	4.00	8.78	9.50	54.90	Few
5410	–	–	16.75	15.00	–	4.00	–	9.50	–	Few
5001	8.90	5.71	16.88	15.00	5.66	3.00	8.74	12.00	54.11	Many
5360	6.63	5.06	17.00	15.00	6.12	4.00	8.91	10.00	56.28	Many
5152	8.45	5.40	15.88	15.00	4.63	4.00	8.01	10.00	57.63	Few
5382	9.71	4.89	16.63	16.00	5.27	4.00	7.19	7.50	56.31	Few
5442	–	–	17.75	16.00	–	4.00	–	7.50	–	Few
5057	10.09	4.84	17.00	14.63	4.38	3.60	7.80	7.40	55.89	Few
5391	7.85	5.36	15.25	14.50	4.21	4.00	8.61	8.00	58.72	Many
5376	9.63	4.90	16.88	14.64	5.59	5.36	7.84	8.83	55.16	Few
5345	6.54	4.74	15.25	14.50	4.43	4.00	8.26	11.00	60.77	Few
4953	8.33	6.56	18.25	14.50	4.66	4.00	8.34	8.00	53.86	Many
5389	–	–	17.25	14.50	–	4.00	–	8.00	–	Many
5398	8.02	4.99	16.25	14.50	4.58	4.00	7.87	8.00	58.29	Many
4997	8.25	5.19	15.00	12.18	4.82	4.60	8.68	5.85	58.06	Few
5455	–	–	15.00	12.18	–	4.60	–	5.85	–	Few
5038	6.44	5.27	17.00	16.00	4.40	4.00	8.04	10.00	58.85	Many
5399	–	–	16.50	16.00	–	4.00	–	10.00	–	Many
4991	7.61	5.42	16.00	15.20	4.69	4.30	7.77	8.00	58.51	Few
5323	7.95	5.55	17.38	15.00	5.39	4.00	7.54	8.00	56.19	Few

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
McLeod Milling Co., A. H., St. Johnsbury, Vt. Brooks' Fancy Mixed Feed	O	5438
Noblesville Milling Co., Noblesville, Ind. N. M. Co.'s Mixed Feed	O	5383
Pillsbury Flour Mills Co., Minneapolis, Minn. Fancy Mixed Feed	O	5226
Portland Milling Co., Portland, Mich. Champion Mixed Feed	O	5034
Sparks Milling Co., Alton, Ill. Try Me Mixed Feed	O O O	4944 5113 5393
Stott, David, Detroit, Mich. Heavy Mixed Feed	O	5108
Stott, David, Detroit, Mich. Honest Mixed Feed	O	4990
Urban Milling Co., Geo., Buffalo, N. Y. Mixed Feed	O	5104
Waggoner-Gates Milling Co., Independence, Mo. Mixed Feed	O	5005
Washburn-Crosby Co., Minneapolis, Minn. Washburn-Crosby Co.'s Mixed Feed	O	5106
Williams Bros. Co., Kent, O. Kent Mixed Feed	O O	5081 5396
Williamson Milling Co., Clay Center, Kans. Mixed Feed	O	5037

ADULTERATED WHEAT OFFAL.

Indiana Milling Co., Terre Haute, Ind. Sterling Feed	O	5040

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein.		Fat.		Fiber.		Nitrogen free extract.	*Weed seeds.
			Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.		
5438	5.85	5.69	16.63	16.00	5.87	4.00	7.72	9.00	58.24	Few
5383	9.34	5.19	16.00	15.00	5.11	4.00	7.43	-	56.93	Few
5226	8.47	4.91	17.63	16.00	5.29	4.50	7.74	8.00	55.96	Few
5034	7.87	5.14	16.63	12.97	4.77	3.25	7.72	7.65	57.87	Few
4944	9.71	6.13	16.38	16.00	4.53	3.50	7.57	8.00	55.68	Few
5113	–	–	17.88	16.00	–	4.50	–	8.00	–	Few
5393	–	–	16.50	16.00	–	3.50	–	8.00	–	Few
5108	7.10	5.09	16.25	16.00	5.11	4.00	7.21	9.00	59.24	Few
4990	8.09	5.62	16.00	16.50	5.14	5.00	7.93	8.00	57.22	Few
5104	8.5[illegible]	5.24	16.63	16.00	5.40	4.00	8.26	10.50	55.95	Many
5005	9.06	5.86	16.13	15.00	4.56	3.00	8.04	9.00	56.35	0
5106	8.01	5.55	17.13	16.00	5.58	4.50	8.67	9.00	55.06	Few
5081	8.74	4.60	16.13	12.00	4.21	2.00	6.62	15.00	59.70	Few
5396	–	–	14.75	12.00	–	2.00	–	15.00	–	Few
5037	6.16	5.10	16.50	16.50	4.77	3.50	7.82	8.00	59.65	Few
5040	6.45	3.85	10.00	9.80	3.07	2.75	17.66	16.00	58.97	Few

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
MISCELLANEOUS COMPOUNDED FEEDS. Protein over 20 per cent.		
Barwell, J. W., Waukegan, Ill. Blatchford's Calf Meal	O	5072
Chapin & Co., Hammond, Ind. Unicorn Dairy Ration	O	4941
Gibbs, B. W., Bridgton, Me. Cow Feed	O	5453
Larrowe Milling Co., Detroit, Mich. Brownie Grains	O	5225
Quaker Oats Co., Chicago, Ill. Blue Ribbon Dairy Feed	O	5056
Ubiko Milling Co., Cincinnati, O. Union Grains, Ubiko. Biles Ready Ration	D	4894
	O	5011
	O	5086
MISCELLANEOUS COMPOUNDED FEEDS. Protein 15-20 per cent.		
Acme-Evans Co., Indianapolis, Ind. Acme Feed	O	5018
American Milling Co., Peoria, Ill. Sucrene Dairy Feed	O	5168
Clover Leaf Milling Co., Buffalo, N. Y. Clover Leaf Dairy Feed	O	5366
Commercial Milling Co., Detroit, Mich. Henkel's Coarse Brown Feed	O	5350
Commercial Milling Co., Detroit, Mich. Henkel's Fine White Feed	O	5352
Cox Co., Chas. M., Boston, Mass. Wirthmore Wheat Feed	O	5427
	O	5465
Dickinson Co., Albert, Chicago, Ill. Alfalfa Meal	O	5124

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	*Weed seeds.
5072	8.46	4.75	25.87	24.00	5.05	5.00	5.84	6.00	50.03	0
4941	7.81	5.19	25.75	26.00	5.60	5.50	11.35	10.00	44.30	Few
5453	8.30	4.31	23.13	–	5.97	–	7.72	–	50.57	0
5225	5.53	4.10	27.12	27.00	11.29	7.00	8.74	9.00	43.22	0
5056	5.01	6.76	26.50	25.00	5.26	4.00	12.21	9.00	44.26	Few
4894	–	–	23.46	24.00	–	7.00	–	9.00	–	0
5011	7.83	5.18	23.25	24.00	6.32	7.00	11.19	9.00	46.23	Few
5086	7.29	5.39	24.00	24.00	7.23	7.00	9.59	9.00	46.50	Few
5018	8.27	5.41	15.81	16.50	5.06	4.00	7.98	9.00	57.47	Few
5168	7.91	7.67	18.13	16.50	5.45	3.50	11.65	12.00	49.19	Few
5366	8.74	11.61	16.75	16.50	5.63	5.50	13.49	12.00	43.78	Many
5350	7.62	4.29	16.50	15.00	5.85	4.00	9.04	8.00	56.70	0
5352	7.90	2.72	17.75	15.00	6.01	3.50	2.10	4.00	60.68	0
5427	8.52	4.44	16.44	16.00	4.91	4.00	7.02	7.00	58.67	Few
5465	–	–	16.38	16.00	–	4.00	–	7.00	–	Few
5124	6.43	8.37	15.13	12.00	2.02	1.00	30.81	35.00	37.24	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Grafton Roller Mill Co., Grafton, N. D. Grafton Wheat Feed	O O	5260 5390
Gwinn Milling Co., Columbus, O. Gwinn Dairy Feed	O	4994
Larrowe Milling Co., Detroit, Mich. Larro Feed	O O O	5022 5362 5426
Noblesville Milling Co., Noblesville, Ind. Goodcatch Feed	O	5279
Northwestern Consolidated Milling Co., Minneapolis, Minn. Planet Feed	O O	5357 5434
Northwestern Consolidated Milling Co., Minneapolis, Minn. XXX Comet	O O	5049 5433
Park & Pollard Co., Boston, Mass. Alfalfa	O	5119
Quaker Oats Co., Chicago, Ill. Buckeye Feed	O	5092
Quaker Oats Co., Chicago, Ill. Daisy Dairy Feed	O	5420
Quaker Oats Co., Chicago, Ill. Quaker Molasses Dairy Feed	O	5021
Quaker Oats Co., Chicago, Ill. Schumacher Calf Meal	O O D	5121 5336 5401
Russell-Miller Milling Co., Minneapolis, Minn. Occident Wheat Feed	O O	4943 5423
Sheffield-King Milling Co., Minneapolis, Minn. Gold Mine Feed	O	5014
Stock & Sons, F. W., Hillsdale, Mich. Monarch	O	5050

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	*Weed seeds.
5260	9.59	3.89	16.50	15.40	5.22	4.50	6.90	9.30	57.90	Few
5390	–	–	16.00	15.00	–	4.50	–	9.20	–	Few
4994	8.44	4.80	16.50	16.39	5.75	4.50	6.76	7.00	57.75	Few
5022	8.37	4.72	19.00	19.00	4.22	3.00	11.70	14.00	51.99	0
5362	5.36	4.91	20.25	19.70	4.65	3.70	12.36	14.00	52.47	0
5426	–	–	19.57	19.00	–	3.00	–	14.00	–	0
5279	5.33	5.59	18.00	15.00	5.18	4.00	8.18	11.00	57.72	Few
5357	7.18	5.02	17.63	15.00	6.01	4.00	6.46	8.00	57.70	Few
5434	–	–	17.75	15.00	–	4.00	–	8.00	–	Few
5049	9.56	3.30	18.00	16.50	5.67	4.00	2.84	3.00	60.63	0
5433	–	–	18.38	16.00	–	4.00	–	3.00	–	0
5119	5.14	9.65	15.75	12.00	2.87	1.50	28.74	30.00	37.85	0
5092	7.98	5.22	17.13	15.50	6.46	4.50	8.23	8.50	54.98	Few
5420	7.98	8.45	16.13	16.00	4.29	3.50	12.43	14.50	50.72	Many
5021	8.85	7.36	16.88	16.00	5.19	3.50	10.39	14.00	51.33	Many
5121	6.50	3.51	16.37	19.00	9.49	8.00	2.46	3.00	61.67	0
5336	–	–	19.88	19.00	–	8.00	–	3.00	–	0
5401	–	–	25.50	19.00	–	8.00	–	3.00	–	0
4943	10.85	5.41	16.69	15.00	5.73	4.50	7.54	10.00	53.78	Few
5423	–	–	17.63	15.00	–	4.50	–	10.00	–	Few
5014	8.82	5.12	16.88	15.90	5.23	4.90	7.75	8.80	56.20	Few
5050	8.46	5.36	17.38	16.00	5.48	4.00	7.70	10.00	55.62	Few

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Stock & Sons, F. W., Hillsdale, Mich. Superior	O O	5047 5436

MISCELLANEOUS COMPOUNDED FEEDS. Protein 10-15 per cent.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
American Hominy Co., Indianapolis, Ind. HOMCO Feed	O	5308
Buffalo Cereal Co., Buffalo, N. Y. Bufceco Horse Feed	O	5368
Clover Leaf Milling Co., Buffalo, N. Y. Ground Corn and Oats	D	4898
Cox Co., Chas. M., Boston, Mass. Wirthmore Hominy Feed	O	5169
Cox Co., Chas. M., Boston, Mass Wirthmore Stock Feed	O	5371
Donahue-Stratton Co., Milwaukee, Wis. Hiquality Pure Hominy Feed	O	5314
Eastern Grain Co., Bangor, Me. Ground Corn and Oats	O	5166
Gray Milling Co., East Gray, Me. G. M. Co. Oat Feed	O	5330
Ham Co., J. B., Lewiston, Me. Corn and Oat Chop	O	5010
Hills Co., Wm. S., Hillsdale, Mich. Trojan Stock Feed	O	5177
Indiana Milling Co., Terre Haute, Ind. Holstein Feed	O	5099
Kimball Bros., Bath, Me. Corn and Oat Chop	O	5347
Krause Milling Co., Chas. A., Milwaukee, Wis. Badger Hominy Feed	O	5290
Miner-Hillard Milling Co., Choice Steam Cooked Hominy Feed	O	5451

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	*Weed seeds.
5047	8.18	4.55	16.50	16.00	5.25	4.50	6.59	7.00	58.93	Few
5436	–	–	16.00	16.00	–	4.50	–	7.00	–	Few
5308	6.86	2.46	10.75	9.50	7.39	7.00	5.35	7.00	67.19	0
5368	9.70	4.64	11.25	10.00	4.71	4.00	10.28	8.00	59.42	Few
4898	–	–	11.09	10.00	–	2.50	–	12.00	–	0
5169	8.61	2.37	10.25	9.50	7.79	7.50	4.90	5.00	66.08	0
5371	8.12	2.99	10.00	9.00	7.35	4.00	6.56	7.00	64.98	Few
5314	7.21	2.92	11.38	10.00	7.38	7.00	6.63	7.00	64.48	0
5166	9.53	2.14	10.38	11.00	4.16	5.00	4.70	6.00	69.09	Few
5330	10.20	2.38	11.00	11.00	5.42	5.00	5.91	7.00	65.09	Few
5010	9.85	2.08	10.50	10.00	4.19	4.00	5.19	5.00	68.19	Few
5177	7.66	4.44	11.38	7.00	6.42	3.00	7.63	12.00	62.47	Many
5099	6.73	4.85	12.00	12.00	3.60	3.00	17.36	16.00	55.46	Few
5347	5.59	2.38	11.88	10.25	4.84	4.77	5.67	5.82	69.60	Few
5290	6.41	3.67	12.38	10.00	8.06	6.00	6.21	5.00	61.29	0
5451	10.60	2.89	10.75	10.00	6.59	5.00	4.13	5.00	65.04	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Quaker Oats Co., Chicago, Ill. Schumacher Stock Feed	O O O	4985 5333 5397
Quaker Oats Co., Chicago, Ill. Yellow Hominy Feed	O O	5337 5344
Stott, David, Detroit, Mich. Winner Chop Feed	O	5052
Valley City Milling Co., Grand Rapids, Mich. Farmers' Favorite Cow Feed	O	5250
Wilson, A. A., Springvale Me. Chop Feed	O	5475

MISCELLANEOUS COMPOUNDED FEEDS. Protein under 10 per cent.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Buffalo Cereal Co., Buffalo, N. Y. Iroquois Chop Feed	O	5162
Commercial Milling Co., Detroit, Mich. Henkel's Chop Feed	O	5349
Grandin Milling Co., D. H., Jamestown, N. Y. Grandin's Stock Feed	D O O	4861 4993 5428
Haskell & Co., W. H., Toledo, O. Haskell's Stock Feed	O O	4984 5439
H-O Co., Buffalo, N. Y. H-O Co.'s De-fi Feed	O	5318
Larrowe Milling Co., Detroit, Mich. Dried Beet Pulp	O O	4948 5408
Marks, E. M., Monmouth, Me. Monmouth Pure Corn & Oat Feed	O	5257
McLeod Milling Co., A. H., St. Johnsbury, Vt. Brooks' Fancy Corn and Oat Stock Feed	O	5431

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	*Weed seeds.
4985	6.37	3.52	10.50	10.00	4.77	3.25	9.96	10.00	64.88	Few
5333	–	–	11.38	10.00	–	3.25	–	10.00	–	Few
5397	–	–	10.50	10.00	–	3.25	–	10.00	–	Few
5337	–	–	11.13	9.00	–	4.00	–	4.00	–	0
5344	8.57	2.28	10.50	9.00	8.16	4.00	4.42	4.00	64.39	0
5052	7.79	3.22	11.25	9.00	6.65	6.00	6.60	10.00	64.49	Few
5250	8.13	5.39	16.63	14.18	5.00	4.25	7.93	7.50	56.92	Few
5475	11.13	1.71	10.13	11.00	4.56	5.00	3.89	6.00	68.58	0
5162	7.64	3.55	9.63	7.00	4.43	3.00	10.42	9.00	64.33	Few
5349	4.50	2.50	9.00	8.00	5.22	5.00	6.34	8.00	72.44	Few
4861	8.13	4.19	7.93	8.50	4.64	3.50	15.26	10.00	59.85	0
4993	6.54	4.27	9.63	8.50	6.12	3.50	9.88	10.00	63.56	Few
5428	–	–	9.63	8.50	–	3.50	–	10.00	–	Few
4984	6.04	3.43	9.75	8.00	6.91	4.00	8.95	8.00	64.92	Few
5439	–	–	9.13	8.00	–	4.00	–	8.00	–	0
5318	4.75	3.76	8.38	8.00	3.42	3.00	15.32	21.00	64.37	0
4948	8.91	3.61	8.13	8.00	0.62	0.50	19.09	20.00	59.64	0
5408	–	–	9.63	8.00	–	0.50	–	20.00	–	0
5257	10.84	1.94	9.62	10.00	4.08	5.00	4.02	8.00	69.50	Few
5431	10.13	2.36	9.38	9.00	3.84	3.00	7.10	8.50	67.19	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Prime Co., L. C., Boston, Mass. Molassine Feeding Meal	O	5042
Robin Hood Milling Co., Moose Jaw, Sask., Can. Oat Feed	O	5386
Robin Hood Milling Co., Moose Jaw, Sask., Can. Reground Oat Feed and Mill Run	O	5459
Waller & Co., A., Henderson, Ky. Blue Grass Feed	O	5016

POULTRY FEEDS.

Bowker Fertilizer Co., Boston, Mass. Bowker's Animal Meal	O	5261
Brastow, F. H., So. Brewer, Me. Monarch Poultry Mash	O	5249
Breck & Sons, Joseph, Boston, Mass. Breck's Ground Beef Scraps	O	5286
Buffalo Cereal Co., Buffalo, N. Y. Bufceco Poultry Mash	O	5109
Buffalo Cereal Co., Buffalo, N. Y. Bufceco Steam Cooked Feed	O	5147
Clark & Co., E. A., Portland, Me. Peerless Baby Chick Feed	O	4987
Clark & Co., E. A., Portland, Me. Peerless Poultry Mash	O O	5373 5454
Clark & Co., E. A., Portland, Me. Peerless Scratch Feed	O	5094
Clark, O. L., Freeport, Me. Yankee Dry Mash	O	4988
Clark, O. L., Freeport, Me. Yankee Growing Feed	O	4981
Clark, O. L., Freeport, Me. Yankee Scratch Feed	O	4989

ANALYSES OF FEEDING STUFFS

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	*Weed seeds.
5042	11.05	6.87	5.81	2.00	2.15	5.00	7.34	–	66.75	0
5386	5.15	6.08	5.13	7.00	3.14	3.00	27.94	30.00	52.56	0
5459	4.97	6.35	5.44	7.00	3.07	3.50	25.54	30.00	54.63	Few
5016	7.44	3.88	9.38	9.00	2.88	3.00	16.54	17.00	59.88	Many
5261	6.16	40.85	40.00	40.00	8.84	5.00	–	15.00	–	0
5249	7.30	8.42	20.19	20.00	5.78	5.50	8.79	7.00	49.52	Few
5286	5.06	27.13	46.38	43.00	16.90	12.00	–	–	–	0
5109	8.08	3.13	15.38	15.00	5.61	4.00	5.31	5.00	62.49	Few
5147	8.02	2.77	10.25	8.00	4.84	4.00	7 77	8.00	66.35	0
4987	9.07	2.03	12.00	12.00	3.87	3.00	3.15	4.00	69.88	Many
5373	9.67	11.01	20.25	20.00	3.95	3.00	7.01	10.00	48.11	0
5454	–	–	20.75	20.00	–	3.00	–	10.00	–	0
5094	9.07	1.60	10.38	10.00	3.17	3.00	3.74	5.00	72.04	Many
4988	7.74	10.05	18.38	16.00	3.73	4.00	5.44	6.50	54.66	Few
4981	6.40	10.01	20.00	19.00	6.57	6.50	5.48	6.00	51.54	0
4989	9.06	1.62	10.50	10.00	3.35	3.50	3.01	4.50	72.46	Few

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of Sample.	Station number.
Cox Co., Chas. M., Boston, Mass. Wirthmore Gritless Chick Feed	O	5367
Cox Co., Chas. M., Boston, Mass. Wirthmore Growing Feed	O	5474
Dickinson Co., Albert, Chicago, Ill. Crescent Chick Feed	O	5321
Dickinson Co., Albert, Chicago, Ill. Globe Scratch Feed with Grit	O	5062
Dickinson Co., Albert, Chicago, Ill. Queen Poultry Mash	O	5063
Dow Co., John C., Boston, Mass. Dow's Beef Scrap	O	5178
Dow Co., John C., Boston, Mass. Dow's Favorite Poultry Meal	O	5179
Greene Chicken Feed Co., Marblehead, Mass. Greene's 5% Meat Mash	O O	5370 5450
Greene Chicken Feed Co., Marblehead, Mass. Greene's Old Fashioned Meat Scraps	O	5105
Greene Chicken Feed Co., Marblehead, Mass. Greene's Scratching Feed for Poultry	O	5103
Hathaway, E. T., Yarmouthville, Me. (H-8) Special Scratch Feed	O	5385
Hathaway, E. T., Yarmouthville, Me. Orono Brand Dry Mash	O	5384
Heneta Bone Co., Newark, N. J. Hen-o-la Dry Mash	O	5365
H-O Co., Buffalo, N. Y. H-O Co.'s Dry Poultry Mash	O	5407
Holway Co., Oscar Auburn, Me. Dirigo Little Chick Feed	O	5123
Holway Co., Oscar, Auburn, Me. Dirigo Scratch Grains	O	5122

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein.		Fat.		Fiber.		Nitrogen free extract.	Weed seeds.
			Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.		
5367	10.95	1.62	13.13	11.00	3.01	3.00	2.96	3.50	68.33	Few
5474	11.20	2.08	11.63	12.00	3.11	4.00	3.44	–	68.54	0
5321	8.51	9.41	10.00	10.00	3.01	2.50	2.58	5.00	66.49	Many
5062	8.36	10.81	11.00	10.00	2.85	2.50	3.19	5.00	63.79	Very many
5063	7.11	5.69	12.00	11.00	4.29	2.50	7.15	10.00	63.76	Few
5178	5.60	28.08	47.37	43.00	12.00	12.00	–	–	–	0
5179	5.87	40.60	30.12	30.00	12.07	10.00	–	–	–	0
5370	7.10	20.80	14.00	12.00	5.34	3.00	6.49	7.00	46.27	Few
5450	–	–	14.13	12.00	–	3.00	–	7.00	–	Few
5105	6.96	39.82	36.00	30.00	11.37	5.00	–	–	–	0
5103	10.48	1.92	11.75	–	3.69	–	3.70	–	–	Very many
5385	9.86	1.77	10.75	10.00	3.72	2.00	4.50	5.00	69.40	Few
5384	7.77	10.60	20.19	22.00	6.70	6.50	7.45	6.50	47.29	0
5365	6.89	26.58	12.38	12.00	3.43	2.00	5.64	4.00	45.08	Few
5407	6.98	4.83	19.00	18.00	3.57	3.50	11.57	9.00	54.05	0
5123	9.70	1.85	12.00	10.00	3.63	2.50	2.68	5.00	70.14	Many
5122	9.59	1.63	10.63	10.00	3.27	2.50	2.77	5.00	72.11	Few

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Hopkins Co., A. R., Bangor, Me. Hopkins Dry Mash	O	5289
Ide, E. T. & H. K., Ideal Scratch Feed No. 2	O	5440
International Glue Co., Boston, Mass. Red Star Brand Fish Scrap	O	5388
Kendall & Whitney, Portland, Me. "K. & W." Red Star Mash Feed	O	5473
Marks, E. M., Monmouth, Me. Monmouth Dry Mash	O	5256
Park & Pollard Co., Boston, Mass. Gritless Chick Feed	O	5146
Park & Pollard Co., Boston, Mass. Growing Feed	O	5071
Park & Pollard Co., Boston, Mass. Intermediate Chick Feed	O	5160
Park & Pollard Co., Boston, Mass. Blue Ribbon Meat Scraps	O	5346
Park & Pollard Co., Boston, Mass. Dry Mash	O	5120
Park & Pollard Co., Boston, Mass. Red Ribbon Scratch Feed	O	5313
Park & Pollard Co., Boston, Mass. Screened Scratch Feed	O	5091
Portland Rendering Co., Portland, Me. Bone Meal for Cattle and Poultry	O	5281
Portland Rendering Co., Portland, Me. Cooked Meat Scraps	O	5112
Portland Rendering Co., Portland, Me. Cracked Bone	O	5161
Portland Rendering Co., Portland, Me. Portland Cooked Meat and Bone Scrap	O	5262
Quaker Oats Co., Chicago, Ill. Schumacher Little Chick Feed	O	5316

ANALYSES OF FEEDING STUFFS.

Station nnmber.	Moisture.	Ash.	Protein.		Fat.		Fiber.		Nitrogen free extract.	Weed seeds.
			Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.		
5289	5.54	8.55	23.13	22.00	5.64	6.50	5.98	8.00	51.16	Few
5440	7.25	1.56	10.38	10.00	4.01	4.00	2.57	-	74.23	Few
5388	5.27	33.32	53.75	45.00	3.68	2.00	-	-	-	0
5473	10.99	3.09	9.50	11.00	3.23	2.50	5.09	10.00	68.10	0
5256	7.81	9.08	19.25	18.00	6.39	5.00	8.89	8.00	48.58	Few
5146	10.42	2.51	14.38	11.00	3.52	3.50	3.09	5.00	66.08	Many
5071	8.64	5.51	14.50	10.00	3.33	3.50	3.23	8.00	64.79	0
5160	10.08	1.87	10.88	10.00	3.19	3.50	3.09	5.00	70.89	Many
5346	4.38	27.53	47.75	45.00	12.90	13.00	–	2.00	4.52	0
5120	7.29	8.83	20.13	18.00	4.01	3.50	8.06	12.00	51.68	0
5313	6.21	1.78	10.75	10.00	3.68	3.50	3.26	5.00	74.32	Few
5091	8.99	1.59	11.25	10.00	3.30	3.50	3.20	5.00	66.67	Many
5281	4.69	56.64	25.50	20.00	5.90	5.00	–	–	–	0
5112	5.67	28.74	45.12	40.00	14.82	9.00	–	–	–	0
5161	5.86	55.97	27.37	10.00	5.41	5.00	–	–	–	0
5262	5.56	32.05	44.75	40.00	12.25	9.00	–	–	–	0
5316	4.65	3.28	11.63	10.00	2.70	2.50	2.00	5.00	75.74	Many

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	* Source of sample.	Station number.
Quaker Oats Co., Chicago, Ill. Schumacher Poultry Mash	O	5457
Quaker Oats Co., Chicago, Ill. Schumacher Scratching Grains	O	5114
Ralston Purina Co., St. Louis, Mo. Purina Chicken Chowder	O	5259
Ralston Purina Co., St. Louis, Mo. Purina Mill Feed, Chick Size	O	5322
Ralston Purina Co., St. Louis, Mo. Purina Mill Feed, Scratch Size	O	5258
Scribner, D. & C. E., Brunswick, Me. Scribner's Laying Mash	O O	5285 5402
Towle & Co., J. N., Bangor, Me. Towle's Balanced Ration	O	5288
Waldron & Son, F. A., Portland, Me. Star Scratch Feed	O	5372
Wentworth Bros., Cornish, Me. Wentworth Bros.' Dry Mash for Laying Hens	O	5429
Whitman & Pratt Rendering Co., Lowell, Mass. Beef Scraps	O	5254

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein.		Fat.		Fiber.		Nitrogen free extract.	Weed seeds.
			Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.		
5457	7.68	4.94	17.88	17.50	6.47	4.00	6.82	10.00	56.21	Few
5114	9.41	1.64	11.13	10.00	3.33	2.50	3.12	5.00	71.37	Many
5259	7.40	7.10	19.25	17.00	5.33	3.00	8.14	9.00	52.78	0
5322	9.55	1.61	11.13	11.00	3.05	3.00	2.26	4.00	72.40	Very many
5258	9.44	1.63	11.38	11.00	3.09	3.00	2.51	4.00	71.95	Many
5285	–	–	12.25	20.00	–	3.00	–	–	–	Few
5402	9.65	5.74	14.07	20.00	3.83	3.00	6.49	9.00	60.22	Few
5288	5.56	5.04	21.69	22.13	5.25	5.72	9.62	9 13	52.84	Many
5372	11.59	1.73	10.63	10.50	3.99	3.50	3.83	4.00	68.23	Many
5429	5.34	10.11	21.88	20.00	6.88	5.50	6.28	8.50	49.51	0
5254	4.54	35.77	41.12	45.00	12.55	10.00	–	–	–	0

Chief Requirements of Feeding Stuff Law.

Kinds of feeding stuffs coming under the law. The law applies to the sale, distribution, transportation, or the offering or exposing for sale, distribution, or transportation of all articles of food used for feeding live stock and poultry, except hays and straws, the whole seeds, and the unmixed meals made directly from the entire grains of wheat, rye, barley, oats, Indian corn, buckwheat, flax seed and broom corn.

The offals from the milling of wheat and the mixed meals, chops, etc., made by grinding two or more kinds of whole grains together come under the requirements of the law.

The Brand. Every lot or package shall be plainly marked with:

The number of net pounds in the package.

The name, brand or trademark under which the article is sold.

The name and principal address of the manufacturer or shipper.

The maximum percentage of crude fiber.

The minimum percentage of crude fat.

The minimum percentage of crude protein.

If the feeding stuff is a compound feed the name of each ingredient contained therein.

If artificially colored, the name of the material used for that purpose.

If the feeding stuff is sold in bulk or put up in packages belonging to the purchaser, the seller, upon the request of the purchaser, shall furnish him with a copy of the statements named above.

All of the foregoing make up the brand and any difference in statement constitutes a distinct brand.

Manufacturer's certificate. Before manufacturing, selling or distributing, a certified copy of the statements named shall be filed with the Commissioner of Agriculture at Augusta.

Registration fee. A registration fee of $10.00 is assessed on any brand offered for sale, distribution or transportation in the State. If the sales of a brand be less than 50 tons, the feeding stuff may be reregistered without payment of fee. The filing of the certificate and the payment of the fee is required of only one person for a given brand.

MAINE
AGRICULTURAL EXPERIMENT STATION
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CHAS. D. WOODS, Director

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Herman H. Hanson
Edward E. Sawyer

Official Inspections

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DRUGS

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NOTE. The Commissioner of Agriculture is the executive of the law regulating the sale of drugs in Maine. It is the duty of the Maine Agricultural Experiment Station to make the analysis of the samples collected under the direction of the Commissioner, and it is the duty of the Director of the Station to publish the results of the analyses together with the names of the persons from whom the samples were obtained, the names of the manufacturers and such additional information as may seem advisable. All correspondence relative to the inspection laws should be addressed to the Commissioner of Agriculture, Augusta, Maine.

Table showing the result of analysis of samples of spirit of gaultheria (wintergreen) purchased in the spring and early summer of 1914. Properly prepared spirit of gaultheria will carry 90 per cent alcohol and 5 per cent oil of gaultheria. The samples are arranged alphabetically by towns.

Station number.	Name and Address of Dealer.	Alcohol found—per cent.	Oil of Gaultheria.	
			Found—per cent.	†Per cent. U. S. P. standard.
12623	Bangor Ara Warren	89.58	4.8	96
11893	Fairfield Fred H. Neal	71.24	6.6	132
11892	Fairfield Wilson Pharmacy	90.56	5.9	118
11891	Oakland Samuel J. Foster	91.28	5.7	114
12354	Portland Chapman & Wyman	*91.30	5.3	106
12355	Portland Deering Drug Co	90.40	5.0	100
12564	Portland Dudley-Weed Drug Co	90.40	4.9	98
12737	Portland Samuel B Gamage	90.40	5.2	104
12392	Portland Fred D. Harvey	91.30	5.3	106
12394	Portland C. E. Hawkins	89.60	4.7	94
12395	Portland Hurlburt Bros	90.40	6.2	124
12788	Portland E. C. McDonough	89.05	3.9	78
12562	Portland John M. Shaw	88.00	5.2	104
12353	Portland John M. Stevens	75.70	2.8	56
12738	Portland Frank L. Winship	*89.60	4.8	96
12393	Portland William S. Wolf	*90 40	5.1	102
11894	Waterville College Ave. Pharmacy	89.08	6.5	130
11887	Waterville Geo. A. Daviau	91.28	6.1	122
11888	Waterville Harry H. Dunbar	89.84	6.2	124
11889	Waterville Ferland's Drug Store	80.96	10.2	204
11886	Waterville Wm. C. Hawker & Co	90.20	6.0	120
11890	Waterville W. R. Jones	88.72	5.4	108
11885	Waterville Larkin Drug Co	*86.76	5.8	116
11896	Waterville E. W. Luques	74.72	3.6	72
11895	Waterville Waterville Drug Store	91.28	5.4	108

* Alcohol not stated on label as required by law.
† In this column 100 means in accord with U. S. P. Goods from 90 to 110 are passed. Outside of these limits hearings were recommended.

Table showing the results of analysis of samples of extract of hamamelis (witch hazel) purchased in the spring of 1914. Properly prepared extract of hamamelis will carry 28.5 per cent of alcohol and some dissolved extract of hamamelis. Hamamelis water will carry 14.3 per cent alcohol and practically no hamamelis. On the labels the names were used interchangeably. Apparently the goods consist of extract of hamamelis made by the formula for preparing hamamelis water. Not being distilled accounts for the odor of hamamelis found. All of the samples carried some hamamelis and were free from formaldehyde. The samples are arranged alphabetically by towns.

Station number.	Name and Address of Dealer.		Alcohol.	
			Claimed—per cent.	Found—per cent.
11964	Auburn	Bumpus & Getchell	*	14.37
11960	Auburn	Ralph F. Burnham	15.0	15.12
11962	Auburn	O. W. Jones	14.3	14.37
11963	Auburn	Claude E. Packard	*	14.37
11951	Auburn	H. C. Packard	15.0	14.37
11952	Auburn	Perryville Drug Store	14.3	14.93
11961	Auburn	Joseph Phenix	15.0	14.37
11925	Lewiston	Aldens Drug Store	15.0	14.93
11927	Lewiston	P. W. Babcock	15.0	14.09
11959	Lewiston	E. Boucher	*	14.56
11940	Lewiston	R. W. Clark	14.3	14.93
11932	Lewiston	Arthur Dussault	*	14.74
11947	Lewiston	Globe Drug Store	15.0	14.74
11937	Lewiston	W. T. Grant Co	15.0	13 90
11958	Lewiston	Great Department Store	15.0	14.74
11934	Lewiston	Harvard Pharmacy	*	13.90
11943	Lewiston	S. S. Kresge	15.0	14.56
11933	Lewiston	Martel's Pharmacy	*	14.74
11931	Lewiston	E. W. Merrill	15.0	14.93
11950	Lewiston	Arthur E. Messier	*	14.37
11935	Lewiston	Louis N. Messier	*	16.89
11929	Lewiston	Charles W. Newell	15.0	14.84
11946	Lewiston	Parlor Drug Store	14.3	14.65
11944	Lewiston	Pharmacie Franco-Americaine	15.0	14.56
11936	Lewiston	Pharmacie Nationale	*	14.93
11938	Lewiston	E. Poucher	*	14.37
11926	Lewiston	Riker-Jaynes	14.2	14.84
11930	Lewiston	Warren Riker	15.0	15.86
11941	Lewiston	Smith's Drug Store	15.0	14.93
11939	Lewiston	W. H. Teague	15.0	14.84
11928	Lewiston	Wakefield Bros	15.0	14.09
11942	Lewiston	F. W. Woolworth Co	15.0	14.65
11956	Lisbon	J. W. Blanchette	15.0	14.09
11954	Lisbon	P. L. Cotton	15.0	14.56
11955	Lisbon	F. E. Jordan	15.0	14.37
11957	Lisbon	W. S. Jordan	15.0	14.56
11953	Sabattus	E. Woodside	15.0	14.18

* Alcohol not stated on label as required by law.

Table showing the results of analysis of samples of spirit of camphor purchased in the spring and early summer of 1914. Properly prepared spirit of camphor will carry 86 per cent alcohol and 10 per cent gum camphor. The samples are arranged alphabetically by towns.

Station number.	Name and Address of Dealer.	Alcohol found— per cent.	Camphor.	
			Found— per cent.	†Per cent. U. S. P. standard.
11858	Bangor C. M Brown	84.68	7.9	79
11863	Bangor Buckley Drug Co	84.58	9.6	96
11865	Bangor B. H. Burke	83.68	9.5	95
11862	Bangor East Side Pharmacy	83.06	10.4	104
11882	Bangor Essex Pharmacy	84.90	9.8	98
11864	Bangor Fifield & Co	84.80	9.1	91
11866	Bangor Fowler's Drug Store	*83.68	9.3	93
11867	Bangor Frawley's Pharmacy	84.46	8.7	87
11869	Bangor Hamm's Drug Store	83.58	9.6	96
11883	Bangor Houlihan's Pharmacy	84.46	9.9	99
11860	Bangor Preble's Pharmacy	84.46	9.0	90
11861	Bangor Priest's Pharmacy	83.38	10.3	103
11868	Bangor Caldwell Sweet Co	84.58	9.3	93
11859	Bangor Ara Warren	87.20	6.5	65
11878	Bangor Fred D. Wyman	83.48	9.8	98
11916	Bath Anderson Pharmacy	84.12	7.9	79
11912	Bath D. T. Dougherty	85.68	8.3	83
11913	Bath A. Hallett & Co	*84.24	9.2	92
11911	Bath L. B. Swett Co	85.90	8.8	88
11917	Bath L. B. Swett	83.16	9.6	96
11915	Bath W. M. Temple Co	82.10	11.4	114
11914	Bath Webber's Drug Store	80.28	7.1	71
12778	Biddeford J. C. Chivierge	*84.12	7.8	78
12748	Biddeford E. A. Fortin	83.16	9.1	91
12690	Biddeford J. W. Mahoney	84.12	8.5	85
12692	Biddeford W. E. McCarthy	83.68	8.5	85
11880	Brewer Barker's Drug Store	71.32	7.3	73
11881	Brewer Boynton's Pharmacy	81.68	7.2	72
11879	Brewer Merrill Drug Co	80.02	14.4	144

* Alcohol not stated on label as required by law.
† In this column 100 means in accord with U. S. P. Goods from 90 to 110 are passed. Outside of these limits hearings were recommended.

Table showing the results of analysis of samples of spirit of camphor—Concluded.

Station number.	Name and Address of Dealer.	Alcohol found—per cent.	Oil of Peppermint.	
			Found—per cent.	†Per cent. U. S. P. standard.
11856	Brunswick Calvin W. Allen	84.12	9.2	92
11853	Brunswick Geo. Drapeau	84.68	9.4	94
11854	Brunswick P. J. Meserve	82.60	9.9	99
11855	Brunswick F. H. Wilson	*87.80	5.1	51
12386	Oakland Samuel J. Foster	80.94	8.7	87
12672	Portland John F. Bennett	85.46	8.2	82
12670	Portland Center Drug Store	80.75	8.8	88
12327	Portland Colcord & Washburn	86.30	6.0	60
12673	Portland Thos. F. Corey	83.68	7.8	78
12326	Portland Dennison Drug Co	*78.50	13.1	131
12324	Portland Wm. J. Flanigan	84.20	9.0	90
12671	Portland Thomas A. Foley	83.58	8.1	81
12317	Portland Samuel B. Gamage	84.60	8.2	82
12675	Portland W. A. Holland & Co	*80.50	9.2	92
12674	Portland Thomas E. Malone	*80.25	9.1	91
12325	Portland Frank D. McCarthy	83.30	9.0	90
12677	Portland Park Drug Store	*86.38	5.6	56
12676	Portland Frank H. Power	83.48	8.7	87
12356	Portland O. J. & F. R. Pride	*80.14	10.3	103
12328	Portland Frank E. Robbins	83.30	7.3	73
12669	Portland James T. State	84.00	8.8	88
12352	Portland Frank L. Winship	82.10	8.3	83
12741	Saco E. J. Bradbury	*83.26	9.8	98
12742	Saco C. H. Sawyer	84.46	8.7	87
11884	South Brewer Seymour's Drug Store	84.34	9.1	91
12330	South Portland Thomas F. Devine	80.90	9.9	99
12390	Waterville College Ave. Pharmacy	83.58	7.2	72
12389	Waterville George A. Daviau	82.64	8.2	82
12388	Waterville John H. DeOrsay	82.52	8.0	80
12387	Waterville Harry H. Dunbar	82.52	8.7	87

* Alcohol not stated on label as required by law.
† In this column 100 means in accord with U. S. P. Goods from 90 to 110 are passed. Outside of these limits hearings were recommended.

Table showing the results of analysis of samples of spirit of peppermint purchased in the spring and early summer of 1914. Properly prepared spirit of peppermint will carry 85.5 per cent alcohol and 10 per cent oil of peppermint. The samples are arranged alphabetically by towns.

Station number.	Name and Address of Dealer.		Alcohol found—per cent.	Camphor. Found—per cent.	Camphor. †Per cent. U. S. P. standard.
11840	Augusta	B. E. Bither	82.44	11.6	116
11843	Augusta	John Coughlin	69.04	6.9	69
11842	Augusta	J. E. Devine	82.44	11.9	119
11841	Augusta	B. E. Getchell	81.32	10.6	106
11845	Augusta	C. B. Murphy	84.76	4.3	43
11847	Augusta	Frank R. Partridge	*73.00	6.8	68
11846	Augusta	W. R. Partridge	85.16	9.2	92
11844	Augusta	Red Cross Pharmacy	80.24	13.0	130
11849	Augusta	Arthur Tetrault	*83.56	9.3	93
11848	Augusta	J. S. Therberge & Co	83.56	9.5	95
12622	Bangor	Ara Warren	84.45	10.7	107
12082	Belfast	Old Corner Drug Store	*85.96	11.9	119
12081	Belfast	Wm. O. Poor & Son	83.96	12.8	128
12779	Biddeford	N. P. Baillargeon	84.24	10.3	103
12691	Biddeford	H. Boynton	85.40	10.1	101
12780	Biddeford	T. F. Cosgrove	87.00	9.8	98
12685	Biddeford	Jeremiah Crowley	83.60	7.5	75
12747	Biddeford	L. Doyon & Co	87.20	7.0	70
12686	Biddeford	Harvard Pharmacy	84.50	0.9	9
12749	Biddeford	Daniel Kerwin	93.70	trace	0
12750	Biddeford	Morin Drug Co	86.30	10.4	104
12746	Biddeford	Wallace F. Percival	*86.30	10.3	10
12687	Biddeford	J. H. Seidel	83.60	10.5	105
12689	Biddeford	A. B. Smith	82.70	8.4	84
12688	Biddeford	Chas. F. Traynor & Co	85.40	10.0	100
12079	Bucksport	Albert A. Page	80.96	14.0	140
12080	Bucksport	R. B. Stover	84.76	12.1	121
12277	Cumberland Mills	L. K. Paine	*78.36	5.0	50

* Alcohol not stated on label as required by law.
† In this column 100 means in accord with U. S. P. Goods from 90 to 110 are passed. Outside of these limits hearings were recommended.

Table showing the results of analysis of samples of spirit of peppermint—Continued.

Station number.	Name and Address of Dealer.	Alcohol found—per cent.	Oil of Peppermint. Found—per cent.	†Per cent. U. S. P. standard.
12278	Cumberland Mills King S. Raymond..........	86.76	2.5	25
12119	Dexter E. A. Brewster & Son..................	83.96	11.9	119
12120	Dexter A. L. Davis.........................	83.96	11.5	115
12122	Dover Elmer E. Cole.........................	84.76	9.5	95
12088	Fairfield Fred H. Neal.......................	79.84	10.4	104
12087	Fairfield Wilson Pharmacy....................	82.44	12.1	121
12121	Foxcroft E. H. Nickerson.....................	84.76	11.8	118
11874	Gardiner Beane's Drug Store..................	83.56	12.8	128
12254	Gardiner Beane's Drug Store..................	84.76	11.3	113
11872	Gardiner Charles J. Burke....................	83.96	11.5	115
11873	Gardiner Jackson Bros......................	82.44	10.0	100
11876	Gardiner Chas. Ward.........................	*84.76	6.6	66
12281	Gorham Edgar F. Caswell.....................	83.20	10.3	103
11877	Hallowell City Drug Store....................	82.08	10.4	104
11875	Hallowell W. D. Spaulding....................	73.00	6.2	62
12092	Oakland Samuel J. Foster.....................	82.08	11.7	117
12693	Old Orchard Seaside Drug Co..................	81.80	11.3	113
12782	Peaks Island Ernest G. Pettingill.............	68.66	2.1	21
11217	Pittsfield Libby's Pharmacy..................	82.44	12.7	127
12118	Pittsfield H. H. Nutter......................	82.08	11.2	112
12309	Portland Asa F. Abbott......................	85.70	7.6	76
12181	Portland Frank J. Bragdon....................	89.08	3.3	33
12199	Portland Dudley-Weed Drug Co..............	82.44	11.9	119
12307	Portland W. A. Flaherty......................	83.68	10.4	104
12180	Portland Edward L. Foss.....................	85.96	6.8	68
12172	Portland Lyman C. Fowler....................	73.44	3.3	33
12184	Portland Franklin Drug Co....................	80.96	10.9	109
12196	Portland George C. Frye......................	82.84	12.0	120
12194	Portland Frank J. Gallagher..................	87.56	5.8	58
12311	Portland C. H. Guppy Co.....................	86.52	5.4	54
12193	Portland Fred D. Harvey.....................	82.44	11.2	112
12190	Portland C. E. Hawkins......................	82.84	11.3	113

* Alcohol not stated on label as required by law.
† In this column 100 means in accord with U. S. P. Goods from 90 to 100 are passed. Outside of these limits hearings were recommended.

Table showing the results of analysis of samples of spirit of peppermint—Continued.

Station number.	Name and Address of Dealer.		Alcohol found—per cent.	Oil of Peppermint.	
				Found—per cent.	†Per cent. U. S. P. standard.
12191	Portland	H. H. Hay's Sons	81.72	5.0	50
12192	Portland	H. H. Hay's Sons	82.44	5.0	50
12312	Portland	John W. Healey	81.34	10.8	108
12173	Portland	Theara Hilton	87.50	4.9	49
12310	Portland	J. H. Hamel	68.22	3.2	32
12179	Portland	Hammond Drug Co	83.56	12.0	120
12171	Portland	Heseltine & Tuttle Co	*82.84	12.6	126
12276	Portland	Francis J. Holland	80.96	13.7	137
12195	Portland	Hurlburt Bros	82.84	8.7	87
12183	Portland	Italian-American Drug Co	80.96	11.7	117
12197	Portland	John D. Keefe	81.32	12.4	124
12275	Portland	L. J. Maguire	78.72	13.1	131
12308	Portland	George W. Merrill	*75.80	10.8	108
12329	Portland	John C. Otis	77.50	6.4	64
12182	Portland	Pearl Street Pharmacy	78.36	11.3	113
12187	Portland	Geo. W. Rankin	82.44	10.6	106
12178	Portland	Riker-Jaynes	82.84	12.5	125
12314	Portland	John M. Shaw	80.68	12.0	120
12188	Portland	Simmons & Hammond	83.56	10.7	107
12189	Portland	Simmons & Hammond	82.08	10.0	100
12176	Portland	Smith & Broe	83.20	12.0	120
12177	Portland	Arthur G. Spear	82.08	12.8	128
12175	Portland	Henry L. Stimson	83.96	7.8	78
12198	Portland	West End Drug Co	77.56	12.4	124
12170	Portland	Charles E. Wheeler	78.72	13.9	139
12114	Rockland	H. J. Fitch	50.82	0.9	9
12115	Rockland	H. J. Fitch	62.31	0.8	8
12646	Rumford	Bower's Pharmacy	*85.40	9.1	91
12648	Rumford	Cote Pharmacy	84.50	9.0	90
12647	Rumford	Chas. E. Fernald	83.60	10.1	101
12755	Rumford	Rumford Drug Co	86.30	10.5	105

* Albohol not stated on label as required by law.
† In this column 100 means in accord with U. S. P. Goods from 90 to 119 are passed Outside of these limits hearings were recommended.

Table showing the results of analysis of samples of spirit of peppermint—Concluded.

Station number.	Name and Address of Dealer.	Alcohol founde—per cent.	Oil of Peppermint. Found—per cent.	†Per cent. U. S. P. standard.
12645	Rumford Waldo St. Pharmacy	85.40	8.8	88
12743	Saco James Z. Beckwith	85.40	9.2	92
12781	Saco H. R. Dennett	80.24	10.0	100
12744	Saco Henry R. Dennett	86.30	10.0	100
12745	Saco H. A. Weymouth	90.40	2.1	21
12273	South Portland Albert E. Thurrell	75.12	12.3	123
12274	South Portland Albion D. Wilson	85.16	6.4	64
12086	Waterville College Avenue Pharmacy	83.56	11.5	115
12090	Waterville Harry H. Dunbar	82.84	11.4	114
12091	Waterville W. C. Hawker	83.96	11.4	114
12089	Waterville Larkin Drug Co.	87.36	4.4	44
12279	Westbrook Charles A. Vallee	82.08	4.9	49
12280	Westbrook West End Drug Co	83.20	10.6	106

* Alcohol not stated on label as required by law.
† In this column 100 means in accord with U. S. P. Goods from 90 to 110 are passed. Outside of these limits hearings were recommended.

Table showing results of analyses of samples of spirit of nitrous ether (sweet spirit of nitre) purchased in the open market. Properly prepared spirit of nitrous ether will carry 92 per cent alcohol and not less than 4 per cent ethyl nitrite. The samples are arranged alphabetically by towns.

No. Sta.	Name and Address of Dealer and Brand.	Per cent. ethyl nitrite.	†Per cent. U. S. P. standard.
11548	Biddeford. Jos. Carrier. "Slade's Sweet Spirit of Niter. D. & L. Slade Co., Boston, Mass. Serial No. 76"	1.56	39.0
11501	Biddeford. H. J. Clark. Purchased of Seidel's Drug Store, Biddeford. "Sweet Spirits of Nitre. Alcohol 92 %. Ethyl Nitrite 4 per cent. Prepared Feb. 10, 1913. Do not use more than 12 weeks after date on this bottle."	2.58	64.5
11502	Biddeford. H. J. Clark, August 22, 1913. "Crompton's Reliable Brand Fruit Flavoring Extracts Nitre. Manufactured by Chas. Crompton & Son, Inc., Lynn, Mass"	3.52	88.0

†In this column 100 means in accord with U. S. P. Goods from 90 to 100 are passed Outside of these limits hearings were recommended.

Table showing results of analyses of samples of spirit of nitrous ether—Continued.

Sta. No.	Name and Address of Dealer and Brand.	Per cent. ethyl nitrate.	†Per cent. U. S. P. standard.
12694	Bradley. Clifford Groteau. "Sweet Spirits of Nitre. Alcohol 92%. Etyl Nitrite 17.5 gms. in oz"	3.30	82.5
11561	Brownfield Center. Thomas Harmon. Aug. 26, 1913. "Baker's Pure Spirits of Nitre. Prepared March 20, 1913. Not guaranteed after three months from date"	3.46	86.5
11494	Buxton. J. E. Leavitt. August 22, 1913. "Forest City Brand Pure Sweet Spirits Nitre. Prepared by Henry W. Goodwin & Co., Springfield, Mass. Date, May 26, 191—"	4.13	103.3
11496	Buxton. G. M. Sawyer. August 22, 1913. "Hay's Sweet Spirits Nitre. Contains 4% Ethyl Nitrite and 92% alcohol. Serial No. 56. Prepared and guaranteed May 23, 1912."	3.43	85.7
11871	Camden. Ames Grocery Co. "Harrington Brand Sweet Spirits of Nitre. Put up by F. Cobb & Co., Rockland Me."	0	0
11439	Cumberland Center. J. L. Dunn. August 15, 1913. "Pure N. S. P. Sweet Spirits of Nitre. Manufactured by Frank E. Harris, Binghampton, N. Y., May 29, 1913."	4.27	106.8
11438	Cumberland Center. A. F. Russell, Aug. 15, 1913. "Forest City Brand Pure Sweet Spirits Nitre. Mar. 19, 1913. We do not guarantee it after three months from date."	3.12	78.0
11446	Gorham. John S. Watson. Aug. 15, 1913. "Forest City Pure Nitre. Alcohol 95 per cent. March 22, 1913. We do not guarantee after three months from date"	2.31	57.8
11499	Kennebunkport. Wilband & Co. Aug. 22, 1913. "Spirit Nitrous Ether, U. S. P. Alcohol not over 90 per cent."	2.82	70.5
11418	Millinocket. M. D. Smart. July 29, 1913. "Hartshorn's Spirits of Nitre. Contains 89% alcohol. E. Hartshorn & Son. Serial No. 2936"	2.81	70.3
11419	Millinocket. M. D. Smart. July 29, 1913. "Foss Pure Sweet Spirit Nitre. 92% alcohol. Date of preparation July 22, 1912. Not to be sold after Nov. 22, 1912. Serial No. 685"	2.10	52.5
12889	Ogunquit. W. F. Cousins. July 11, 1914. "Gem Brand Sweet Spirits Nitre. Prepared by J. E. Goold & Co., Portland, Me"	1.09	27.3
11504	Old Orchard. F. W. Merritt. Aug. 22, 1913. "Brewster's Pure U. S. P Sweet Spirit Nitre. Alcohol 92%. Ethyl nitrite 4% or 17.5 grains per ounce. Prepared by the C. E. Brewster Co., Dover, N. H"	3.65	91.3
11531	Portland. W. A. Bickford. Aug. 27, 1913. "Forest City Brand Pure Sweet Spirits of Nitre. Alcohol 95%. Dec. 21, 1913. We do not guarantee three months from date."	3.16	79.0
11433	Portland. Clark & Griffin. Aug. 12, 1913. "Cumberland Spirits Nitre. Ethyl Nitrite 2½%. Alcohol 62%. 1 oz. above standard	0.57	14.3
11434	Portland. P. W. H. Littlejohn. Aug. 12, 1913. "Cumberland Spirits Nitre. Ethyl Nitrite 2½%. Alcohol 62%, 1 oz. above standard."	1.08	27.0
11435	Portland. Long Island Market, August 12, 1913. "Spirit Nitrous Ether. Alcohol 62%, Ethyl Nitrite 2½%"	0.48	12.0

†In this column 100 means in accord with U. S. P. Goods from 90 to 100 are passed. Outside of these limits hearings were recommended.

Table showing results of analyses of samples of spirit of nitrous ether—Continued.

Sta. No.	Name and Address of Dealer and Brand.	Per cent. ethyl nitrite.	†Per cent. U. S. P. standard.
11679	Portland. John A. Moreshead. Nov. 20, 1913. "Forest City Pure Sweet Spirits Nitre. Alcohol 90%. Prepared by Henry W. Goodwin & Co"	3.32	83.0
11436	Portland. John W. Perkins Co. Aug. 13, 1913. "Spirit Nitrous Ether. Alcohol 62%, Ethyl Nitrite 2½%. John W. Perkins Co., Portland"	0.65	16.2
11546	Portland. Riker-Jaynes Drug Store. Aug. 30, 1913. "Spt. Nitrous Ether. Alcohol 92%. Put up by Jaynes Drug Co., Boston"	3.69	92.2
11585	Portland. Riker-Jaynes Drug Co., Sept. 12, 1913. "Spirit Nitrous Ether. Alcohol 62%. Ethyl Nitrite 2½%. John W. Perkins Company, Portland, Maine"	4.37	109.2
12322	Portland. Daniel Rubenoff. Apr. 30, 1914. "Spirit Nitrous Ether. Guaranteed by Cook, Everett & Pennell, Portland, Me"	3.32	83.0
11819	So. Portland. Daniel P. Cobb, Jan. 30, 1914. "Forest City Pure Sweet Spirits Nitre. Alcohol 90%. Prepared by Henry W. Goodwin & Co., Springfield, Mass"	3.49	87.2
11239	So. Portland. Tarling Bros. April 1, 1913. "Hay's Pure Full Strength Sweet Spirit Nitre. H. H. Hay Sons, Portland, Me."	3.13	78.2
12868	Sanford. N. G. Brisson. June 30, 1914. "Forest City Nitre Forest City Extract Co., Portland, Me."	0	0
12130	Sanford. O. V. Libby. April 7, 1914. "Foss' Pure Spirit Nitrous Ether. Prepared by Schlotterbeck & Foss, Portoand, Me. Spirit Nitrous Ether deteriorates by age. Put up Sept. 9, 1910"	1.00	25.0
11507	Scarboro. G. W. Knight. August 22, 1913. "Foss Spirit Nitrous Ether prepared by Schlotterbeck & Foss Co., Portland, Me. The contents of this bottle should not be sold or used after July 26, 1913. Put up March 26, 1913"	4.30	107.5
11506	Scarboro. L. W. Leavitt. August 22, 1913. "Baker's Pure Spirits Nitre. Prepared by Baker Extract Co., Springfield, Mass. May 16, 1912. As this preparation loses strength rapidly we do not guarantee it after three months from date"	3.74	93.5
11492	Scarboro. Orra E. Sherman. Aug. 22 1913. "Forest City Pure Sweet Spirits Nitre. Prepared at Cor. Dwight & Bridge Sts., Springfield, Mass. Date Feb. 29, 1912. We do not guarantee three months from date."	1.93	48.2
	Second bottle	2.24	56.0
11493	Scarboro. Orra E. Sherman. Aug. 22, 1913. "Foss Spirit Nitrous Ether. The contents of this bottle should not be sold or used after July 19, 1913. Put up March 19, 1913"	4.49	112.2
12756	South Paris. Percy P. Allen. June 15, 1914. "Foss Pure Sweet Spirit Nitre. 92% alcohol. Prepared by Schlotterbeck & Foss, Portland. Spirit Nitrous Ether deteriorates by age. Put up Sept. 9, 1910"	4.06	101.5
12116	Thorndike. Low's Market. April 2, 1914. "Dill's Sweet Spirits of Nitre. Dill Medicine Co., Norristown, Penna."	3.11	77.8
11311	Westbrook. E. Gagnon. June 3, 1913. "Spirit Nitrous Ether. Guaranteed by Cook, Everett & Pennell under the Food & Drugs Act, June 30, 1906. Serial No. 1058"	1.19	29.8

†In this column 100 means in accord with U. S. P. Goods from 90 to 100 are passed Outside of these limits hearings were recommended.

Table showing results of analyses of samples of spirit of nitrous ether—Concluded.

Sta. No.	Name and Address of Dealer and Brand.	Per cent. ethyl nitrite.	†Per cent. U. S. P. standard.
11308	Westbrook. Ernest LeBel. June 3, 1913. "Sweet Spirit of Nitre. Made by Nathan Wood & Son, Portland, Me."...	0.9	2.3
11309	Westbrook. J. W. Welch. June 3, 1913. "Hall Brand Spirit Nitrous Ether. Below Standard. Prepared at 36 & 38 Brown St., Portland, Me."...	0.02	0.5
11445	White Rock. A. D. Larkin. August 15, 1914. "Hay's Pure Full Strength Sweet Spirit of Nitre. Oct. 12, 1912"......	3.27	81.7
11442	North Windham. H. H. Boody Co. Aug. 15, 1913. "Hall Brand Spirit Nitrous Ether. Prepared at 36 & 38 Brown St., Portland. One-third standard strength"...	0.03	0.7
11443	North Windham. H. H. Boody Co. Aug. 15, 1913. "Baker's Pure Spirits of Nitre. Prepared by Baker Extract Co. Jan. 31, 1913. We do not guarantee it after three months from date"...	2.74	68.5
11279	So. Windham. Wm. Bickford & Co. May 12, 1913. "Solar Brand Sweet Spirits Nitre. Put up by C. A. Weston Co., Portland, Jan. 18, 1912"...	4.02	100.5
11282	South Windham. James A. Magnusson. May 12, 1913. "Forest City Pure Sweet Spirits Nitre. Nov. 20, 1911. Serial No. 1510"...	3.81	95.2
11280	So. Windham. A. G. Peabody & Son. May 12, 1913. "Baker's Pure Spirits of Nitre. April 17, 1912"...	3.72	93.0
11817	Woolwich. Harry P. Hathorne. Jan. 26, 1914. "Stickney & Poor's Sweet Spirits of Nitre. U. S. P. Alcohol 91%. Guaranteed by Stickney & Poor Spice Co., Boston, under the Food & Drugs Act. June 30, 1906"...	3.84	96.0
11356	Yarmouth, W. H. Rowe. July 11, 1913. "Sweet Spirits Nitre. Each fluid ounce contains alcohol 92%, ethyl nitrite 4% or 18 minims. W. H. Rowe, Yarmouth, Me."	1.25	31.2
11440	No. Yarmouth. H. H. York. Aug. 15, 1913. "Cook's Pure Spirits Nitre. Manufactured by Cook, Everett & Pennell, Portland, Me. Manufactured July 2, 1913' ...	3.18	79.5

†In this column 100 means in accord with U. S. P. Goods from 90 to 100 are passed. Outside of these limits hearings were recommended.

Tincture of Iodine.

Two samples of tincture of iodine, put up in packages and sent out by the John W. Perkins Co., Portland were examined.

11205 was found to be 102 U. S. Pharmacopeoia strength.

11505 was found to be 94.6 U. S. P. strength.

11205 was obtained from Blake Brothers, Oakland, and 11505 from F. W. Merritt, Ocean Park, Old Orchard.

Peroxide of Hydrogen.

11252 collected from F. W. Woolworth Co., Sanford was labeled "Star Brand Peroxide of Hydrogen, 3%. Contains 3-16 grains acetanilid in each fluid ounce. Middletown Chemical Company, New York." This was found to contain 2.95 per cent of hydrogen peroxide, and to carry acetanilid as claimed.

11495, collected from R. A. Bradbury, Buxton Center, Maine. Labeled "Peroxide of Hydrogen, 3% H_2O_2. 3-18 grains acetanilid to ounce." Found to carry 3.3 per cent hydrogen peroxide, and acetanilid as claimed.

Sweet Oil. Olive Oil.

11029 was labeled "Pompeian Brand Extra L. Virgin Lucca Olive Oil," and was found true to name.

11497 from J. H. Atkinson, Bar Mills, Buxton, Maine, was labeled "Pure Sweet Oil. Put up by J. E. Goold & Co., Portland, Me." This was found to contain no cottonseed oil, and to be correctly labeled.

Adulterated Sweet Oil.

11299, Angelo Vincella, Center Street, Portland, sold as Sweet Oil. Cottonseed oil. Adulterated and misbranded.

11310, E. Gagnon, Westbrook, Maine. "Leighton's Pure Sweet Oil, Prepared by R. G. Leighton, Portland." Cottonseed oil. Adulterated and misbranded.

11324, B. Cohen, Newbury Street, Portland, Maine Bought for Sweet Oil. Not labeled. Consists of cottonseed oil.

11503, H. J. Clark, Biddeford. "Pure Sweet Oil for general use. New England Supply Company." Cottonseed oil. Adulterated and misbranded.

Witch Hazel Cream.

Three samples of a toilet article, which bore the name "Witch Hazel," but which were not ordinary extracts of witch hazel were examined. These are not U. S. P. preparations.

11945. Labeled "Violet Perfumed Witch Hazel for the Toilet." Obtained from the Parlor Drug Store, 136 Lincoln Street, Lewiston. This did not carry a statement of the alcohol upon the label, had a vivid green color due to coal tar dyes, a strong odor of violet, and no odor of witch hazel. No arsenic was present. It was slightly acid.

11948. Witch Hazel Cream. Arthur E. Messier, Lincoln Street, Lewiston, Maine. This had the consistency of a thick cream; odor was like rose water without odor of witch hazel. Contains gum tragacanth and some glycerine. Also contains small amount of formaldehyde.

11948. Wilson's Witch Hazel Cream. Arthur E. Messier, 203 Lincoln Street, Lewiston, Maine. This had the consistency of cream, the odor of bitter almonds, and no odor of witch hazel. No formaldehyde was present. Contained a small amount of calcium, and was slightly alkaline.

Vurpillat Remedies.

12926. "Vurpillat Relief. For External Use Only. For Relief of Rheumatism, etc." Contains mineral oils, petroleum, camphor and turpentine. Also an aromatic volatile oil which is probably mustard. Therapeutic value would be slight.

12927. "Vurpillat's Special Nerve Tablets for Men and Women. Highly recommended as a tonic, to tone and strengthen certain impaired conditions." Consisted of finely ground drugs in sugar coated chocolate tablets. Drug was mostly cascara with small quantities of other drugs unidentified. Also contained corn starch. No alkaloids were found. Apparently of very little therapeutic value.

12928. "Vurpillat's Catarrh Remedy. For Coughs, Colds, Sore Throat, or Bronchial Trouble." Consists of sodium bicarbonate, borate of soda, and salts. It was colored with a harmless color. Of only slight therapeutic value.

12929. "Vurpillat's New Discovery. A Non-poisonous compound. A Remedy for Stomach, Liver, Kidneys and Blood." Found to carry .7 per cent of alcohol. Fluid extracts of numerous things; resembling castoria in odor and test. The ash contains magnesium sulphate and potassium and sodium salts, probably in the form of Rochelle salts. No alkaloids were found. Doubtful therapeutic value.

Results of the Analyses.

The samples were usually examined within three weeks after they were received from the inspectors. As soon as completed the results of the examination were sent in duplicate to the Chief of the Bureau of Inspection. In case the goods differed essentially from the standard, hearings were recommended.

Although, with the exception of the alcohol content in one sample, there is little reason to think there was intentional fraud on the part of the druggists putting up the adulterated preparations, it is rather startling to find half of the preparations, which are simpler to make than a batch of biscuit, differed more than ten per cent from the standard. In several cases the druggist apparently entirely forgot to put the essential ingredient, to which the preparation owes its name and upon which its medicinal value depends, into the goods. The minor errors of preparation are due to poor graduates and scales, aggravated by unfamiliarity with the metric system of weights and measures that are used in the Pharmacopoeia directions, and accompanied by carelessness. There probably is not a druggist in Maine but what could make any of the preparations here reported upon so that they would be within five per cent of the standard.

STATEMENT BY THE EXECUTIVE OF THE LAW.

A. M. G. Soule, Chief Bureau of Inspections.

Collections and analyses of drugs have been made during the year; an action we are instructed to perform under the statute. For the most part, the articles collected and analyzed have been of the druggist's own manufacture, while in a few instances the samples collected have been purchased from wholesalers.

It has been brought to the attention of the deputies in the nature of a complaint, that the collections of drugs have consisted for the most part of simple compounds. Although it is to be regretted that any complaint or criticism should be made of our methods, it was very gratifying and has brought the feeling that we have not been unreasonable in our request for a product not difficult to manufacture in conformity with the U. S. P. standard.

Along with the publishing of the results of these analyses, no comment seems necessary for individual samples, as the lists in tabular form show those found that have not conformed to the U. S. P. It does, howexer, seem necessary that a general statement should be made relative to the deficiencies. For it is my belief, after careful investigation, that scarcely any wilful or intentional violations of the law have been found. The fact remains, however, that a violation has been committed. And as our duty has been interpreted, it is to remedy the conditions found to exist and give impartial enforcement of the law which it has been found necessary to place on our statute books.

It seems of the utmost importance that any drug, whether recognized by the U. S. P. or not, should possess the proper therapeutic qualities and when administered should produce the desired physiological effect.

The dispensing of drugs which are not in conformity to the above requirements, seems to be unfair to the physician who prescribes them; to the public consuming them and the druggist who with great care is dispensing a standard product. Whenever a sample collected and analyzed has been found to be not conforming to the U. S. P. standard, a hearing has been arranged and an explanation required why the deficiency has occurred.

In general, the druggists have shown a willingness to have samples taken and thus secure an index on the product they are dispensing. It has been gratifying to note their attitude, with few exceptions. On the whole they have been ready to accept suggestions and have shown their intentions to conform closely with the spirit and the letter of the law. The attempt has been made in settlement of all such cases to deal impartially and fairly and to effect a satisfactory settlement; remedy the conditions found to exist; to protect the public and also the dealer, without the disagreeable feature of court proceedings and notoriety, trusting that as much good can be accomplished in this way.

A very few cases are still unsettled and although regretted, it may be necessary to make court cases of some of them.

October, 1914

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

ANALYSTS.

James M. Bartlett
Royden L. Hammond
Elmer R. Tobey
Herman H. Hanson
Edward E. Sawyer
Hoyt D. Lucas

Official Inspections

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FERTILIZER INSPECTION

The Commissioner of Agriculure is the executive of the law regulating the sale of commercial fertilizers in Maine. It is the duty of the Maine Agricultural Experiment Station to make the analyses of the samples collected by the Commissioner, and it is the duty of the Director to publish the results of the analyses of the samples of commercial fertilizers, together with the names of the persons from whom the samples were obtained, the names of the manufacturers thereof and such additional information as may seem advisable.

Outline of the Requirements.

The following are the chief points of the law and the regulations. The full text of the law will be sent on application to the Commissioner of Agriculture, Augusta, Maine

1. *Kind of materials coming under the law.* The law applies to the sale, distribution, transportation, or the offering or exposing for sale, distribution or transportation, any materials

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Note. All correspondence relative to the inspection laws should be addressed to the Commissioner of Agriculture, Augusta, Maine.

used for fertilizing purposes the price of which exceeds $10 per ton, and to lime, marl and wood ashes intended for fertilizing purposes at whatever price they are sold.

For many years the sale of materials other than mixed goods was so small that no notice was taken of it. As time went on, however, with the propagation of the ideas of home mixing, the demand for chemicals increased. For the last few years the most common chemicals such as acid phosphate, ground bone, nitrate of soda and the various potash salts are regularly registered by the companies handling them. In the case chiefly of companies manufacturing in the State it happens that other fertilizing constituents are sold in small amounts and primarily for experimental purposes. While the law is explicit there will until further notice, be no prosecutions made by the Commissioner of Agriculture for the sale without registration of small amounts of these more unusual fertilizing constituents, provided the company can show that these goods were sold in good faith for experimental purposes. As a part of the indication that the goods were thus sold it should be explained to the customer exactly under what conditions the goods are sold; that they are unregistered; that they have not been or are not likely to be analyzed by the Director of the Maine Experiment Station and that the Commissioner of Agriculture holds himself in no way responsible for the quality of these unlicensed goods sold for experimental purposes. Their sale is allowed because the Commissioner of Agriculture does not regard it as the purposes of the law to either hamper ordinary business or hinder experiments on the part of the farmer. Whenever any goods thus offered experimentally come to be sold in considerable amount they must be registered the same as other fertilizing materials.

2. *The Brand.* Every lot or package shall be plainly marked with:

The number of net pounds in the package.

The name or trade mark under which it is sold.

The name and principal address of the manufacturer or shipper.

The minimum percentage of nitrogen, or its equivalent in ammonia, in available form.

The minimum percentage of available phosphoric acid (soluble and reverted).

The minimum percentage of total phosphoric acid.

The minimum percentage of potash soluble in water.

In the case of lime, marl and wood ashes each package shall, in addition to the above be plainly marked with:

The minimum and maximum percentage of total lime (Calcium oxide).

The minimum and maximum percentage of total magnesia (magnesium oxide).

The minimum and maximum percentage of lime combined as carbonate (Calcium carbonate).

The minimum and maximum percentage of magnesium combined as carbonate (magnesium carbonate).

The minimum percentage of lime-sulphur (calcium sulphate) in gypsum or land plaster.

If a fertilizer (including lime, marl and wood ashes) is sold in bulk or put up in packages belonging to the purchaser, upon the request of the purchaser he shall be furnished with a copy of the statements named above.

3. *Manufacturers' certificate.* Before manufacturing, selling or distributing a commercial fertilizer a certified copy of the statements named in 2 shall be filed with the Commissioner of Agriculture.

4. *Manufacturers' samples.* When the Commissioner of Agriculture shall so request, the manufacturer shall furnish a sealed package containing not less than two pounds of the commercial fertilizer.

5. *Registration fee.* A registration fee is assessed on any brand offered for sale, distribution or transportation in the State as follows: $10 for the nitrogen, $10 for the phosphoric acid, $5 for the potash and $10 for the lime contained or said to be contained in the fertilizer. The filing of the certificate and the payment of the fee is required from only one person for a given brand.

6. *Registration may be refused or canceled.* The Commissioner of Agriculture may refuse to register any commercial fertilizer which bears a name that is misleading or deceptive or which would tend to mislead or deceive as to the materials of which it is composed. The Commissioner of Agriculture also

has power to cancel the registration of a fertilizer manufactured, sold, distributed or transported in violation of any of the provisions of the law.

7. *Adulteration.* A fertilizer is adulterated if its weight, composition, quality, strength or purity varies from its fixed guaranty or if it contains any materials deleterious to growing plants.

8. *Misbranding.* A fertilizer is misbranded if: the package or label carries any statement, design or device that is false or misleading in any particular; the container does not carry the statements named in 2; the printed statements attached to the container differ from the statements in the certificate; and if the registration fee has not been paid.

9. *Analysis for correspondents.* A special law provides for the analysis of samples of fertilizers on sale in Maine taken in accordance with the law and the payment of an analysis fee of $10. If the analysis proves to be of public importance the analysis fee will be returned. Otherwise the money will be used in the enforcement of the law. Blanks with full directions will be furnished by the Commissioner of Agriculture on request.

10. *Written guaranty, the dealers' safeguard.* No prosecution will lie against any person handling commercial fertilizers provided he obtains at the time of purchase a written guaranty signed by the person residing in the United States from whom the purchase was made to the effect that the commercial fertilizer is not adulterated or misbranded within the meaning of the Maine law regulating the sale of commercial fertilizers. After a person has been duly notified that an article of commercial fertilizer appears to be adulterated or misbranded the written guaranty will not protect further sales.

11. *Hearing.* The person who is believed to have violated the law regulating the sale of commercial fertilizer will be granted a hearing at which he may appear in person, or by attorney, or by letter. The notice of the hearing will name the time and place of the hearing and a copy of the charge. Failure to appear will not prejudice the case. The hearing will be private and every opportunity will be given for explanation and the establishment of innocence. If the time appointed is not a convenient one, postponement within reasonable limit will be granted.

12. *Penalty.* Violations of the law are punishable by a fine not exceeding one hundred dollars for the first offense and not exceeding two hundred dollars for each subsequent offense.

Valuation of Fertilizers.

For many years this Station has not printed an estimate of the commercial value of the different brands licensed in the State. If any one wishes to calculate the commercial value he can do so by using the trade values adopted for 1914 by the Experiment Stations of Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, Rhode Island and Vermont. These valuations represent the average retail prices at which these ingredients could be purchased during the three months preceding March 1, 1914, in ton lots at tide water in southern New England. On account of the greater distance from the large markets the prices for Maine at tide water would probably be somewhat higher than those quoted.

TRADE VALUES OF FERTILIZING INGREDIENTS FOR 1914.

	Cents per pound.
Nitrogen in nitrates	16½
in ammonia salts	16½
Organic nitrogen in dry and fine ground fish and blood	22½
in cottonseed meal and castor pomace	22½
in fine bone and tankage	21½
in coarse bone and tankage	17½
In mixed fertilizers	19½
Phosphoric acid, water-soluble	4½
citrate-soluble	4
in fine ground bone and tankage	4
in cottonseed meal, castor pomace	4
in coarse bone, tankage and ashes	3½
in mixed fertilizers, if insoluble in ammonium citrate	2
Potash as high grade sulphate and in forms free from muriate (chloride)	5
as muriate	4
in cottonseed meal and castor pomace	5

RULES FOR CALCULATING VALUATION OF FERTILIZERS.

The commercial valuation will be accurate enough as a means of camparison if the following rule is adopted:

Multiply 3.9 by the percentage of nitrogen.

Multiply 0.8 by the percentage of available phosphoric acid.

Multiply 0.4 by the percentage of insoluble phosphoric acid.

Multiply 1.0 by the percentage of potash.

The sum of these 4 products will be the commercial valuation per ton on the basis taken.

Illustration. The table of analyses shows a certain fertilizer to have the following composition: Nitrogen 3.30 per cent; Available phosphoric acid 8.00 per cent; Insoluble phosphoric acid 1.00 per cent; Potash 6.00 per cent. The valuation in this case will be computed thus:

Nitrogen,	3.9×3.30................	$12 87
Available phosphoric acid,	0.8×8.00................	6 40
Insoluble phosphoric acid,	0.4×1.00................	40
Potash,	1.0×6.00................	6 00
		$25 67

POTASH IN 1915 FERTILIZERS.

While there are twenty odd elements that enter into the composition of plants, nitrogen, phosphorus, potasium and calcium are the important ones added in commercial fertilizers. Although an acre of fertile soil contains tons of nitrogen, phosphoric acid and potash they are usually in forms unavailable to plants. Growing plants take up and carry off in the resulting crops a large amount of the available nitrogen, phosphoric acid, potash and lime in a given soil. If the crops are fed upon the farm and the resulting manures are saved a large part of the manurial matter in a good available form will be returned to the land. If, however, the crops are sold from off the farm the farm is depleted by this loss of plant food which must be made good in some way or other. Usually manures are applied to soil for the double purpose of applying plant food in an available form and unlocking the unavailable compounds which are

New England agriculture has been dependent for the last generation upon the purchase of plant food to supplement that already in the soil.

produced upon the farm and replace that sold off in the crops. It has been a matter of great concern to those officially interested in agriculture that New England agriculture is not self maintaining. That is, it has been necessary to look outside of its borders for the supplies of plant food. Phosphoric acid is found in abundance in this country. Various refuses furnish large amounts of organic nitrogen. Mineral nitrogen in the form of ammonia salts is obtained from coke plants and gas works as a by-product. It is also obtained directly from the air by synthesis. All of the nitrogen in the form of nitrate of soda is, however, imported from South America.

While ordinary farm manures carry some potash, and such materials as sea weed and wood ashes contain potash, the world's usable supply of potash has come from the mines of Germany. The fact that war might make the potash of Germany or the nitrate of soda of South America outside of the reach of the American farmer, has been a matter of great concern for years to the leaders in agricultural thought. This fear is realized in this terrible European war now raging which prevents the importation from Europe of the German potash salts. There is probably from a quarter to a third as much potash in the United States as would normally be used in the 1915 fertilizers, and hence the question which confronts the fertilizer manufacturer and the user of fertilizers is how to use this limited supply to the best advantage.

An acre of soil to the depth of one foot in the potato growing districts of Maine carries from 4 to 6 tons of potash salts soluble in strong acid. Gradually by soil action this potash is rendered available to growing plants. With the three and four year rotation fairly common in Maine potato districts the crops remove from 225 to 300 pounds of potash per acre. Three hundred bushels (110 barrels) of potatoes will remove about 90 pounds of potash, 50 bushels of oats about 45 pounds of potash, and two crops of two tons of clover and timothy about 180 pounds. Most of the fertilizer used in these rotations in the potato growing sections is applied for the potato crop. The application will carry from 125 to occasionally 200 pounds of potash per acre. Hence it is evident that in this rotation there is a constant drawing, although small, upon the reserve stock of potash. In field experiments potash has rarely been a determining element in the yield of the potato crop.

While the writer believes it to be important for Maine that as much potash be put in the commercial fertilizers as can be used under the present circumstances, it is more than probable that by more thorough preparation of the soil, the use of liberal quantities of high grade fertilizers carrying equally as much nitrogen as in the past and perhaps rather more phosphoric acid, and with as much potash as can be obtained, there will be no serious shortage in the crops for 1915.

While there are some chemicals, such as lime, gypsum, and chloride and sulphate of sodium, which are supposed to be more or less effective in making soil potash available, they can be only slightly depended upon. When potatoes enter into the rotation lime cannot be used because of the danger of scab. Gypsum (land plaster) and sodium chloride (common salt) are about the only chemical agents that can be economically and safely used. All commercial fertilizers carry as a byproduct in the manufacture of acid phosphate, considerable quantities of gypsum. As land plaster is not an expensive product it probably will be advisable to use it at the rate of perhaps half a ton per acre. It will also be advisable to use a small amount, perhaps 300 pounds per acre, of common salt.

If the present conditions continue we plan to use both at Highmoor Farm and at Aroostook Farm in 1915 a fertilizer carrying about five per cent of nitrogen, eight to ten per cent of available phosphoric acid and all the potash that we can obtain up to seven per cent. One-third of the nitrogen will be in the form of nitrate, one-third in the form of ammonia salts and one-third in the form of high grade organic nitrogen. The amount of phosphoric acid will depend upon the amount of potash that can be had. The more potash the less the phosphoric acid. If the potash falls below five per cent we shall apply broadcast about 1000 pounds of land plaster and 300 pounds of common salt per acre. As the land plaster is quite insoluble it must be finely ground. The common salt is readily soluble in water and it can be safely applied in as coarse form as so-called Liverpool salt.

It is to be remembered that this formula is not based upon the results of definite field experiments, nor is it one that the writer would recommend were sufficient potash available. Although such a formula could not be expected to give results if used year after year the writer believes that by the use of such a mixture there will be no very material reduction in the yields per acre for a single year. It is self evident that 1915 is not a year in which there should be a reduction in the acreage of hoed crops particularly upon moderately heavy soils. It may not be advisable to plant light sandy soils in 1915 unless there is a fair amount of farm manure available. Even with a diminished yield the higher prices that it seems likely will prevail will tend to maintain the net profit.

Farm Manure.

With the introduction of commercial fertilizers there has been an increasing apparent indifference to farm manure as an agricultural resource. Too many of our farmers lose sight of the fact that commercial fertilizers should supplement rather than replace the manurial supply of the farm. It is the purpose to call attention to the value of farm manures in Maine, and particularly to Farmers' Bulletin 192 on Barnyard Manure which is published by the United States Department of Agriculture, a copy of which may be obtained by anyone writing to their Congressman.

According to the State Assessor's report for 1913 there were in the State, in round numbers, 130,000 horses; 250,000 head of neat stock; 40,000 swine; 120,000 sheep and 2,000,000 hens, ducks and geese. If all of the manure was saved from these animals it would amount in a single year to nearly 4,000,000 tons and would carry approximately 19,000 tons of nitrogen, 12,000 tons of phosphoric acid and 18,000 tons of potash. This plant food in the world's market would cost about $10,000,000, or sufficient to buy 300,000 tons of high grade commercial fertilizer. It is doubtful if by present methods of management one-half of this plant food is actually returned to the soil.

The intelligent farmer recognizes that when he sells meat, milk, grain, hay, fruit, vegetables, etc., from his farm or neglects to save and use the manure produced, he removes from his soil a certain amount of potash, phosphoric acid and nitrogen that must be restored sooner or later if production is to be maintained. If the farmer instead of selling off his crops feeds them to live stock on the farm, a large proportion of this fertility is retained on the farm, and if the business of stock feeding is carried to the point where feed is purchased in addition to that grown on the farm a considerable addition may in this way be made to the fertility of the farm at almost a nominal cost. It is this indirect purchase of fertilizers practiced largely in Europe that to quite a degree accounts for the profits of stock raising abroad. Of course these advantages will not be secured unless the manure produced is carefully saved and used.

It seems to be difficult for the average farmer to really grasp the idea that manure should be as carefully preserved from unnecessary losses as any other product of the farm. The large bulk of the material, the insidious losses, the ease with which commercial fertilizers can be had, the expense of properly providing for storage and application of manure to land, and the lack of proper understanding of the value of the manure and of the large losses that prevail under ordinary farm management, are among the reasons that have led to this neglect.

While it is customary to compare farm manures with fertilizers on the basis of their content of nitrogen, phosphoric acid and potash, this comparison is not adequate for determining the relative value, since manures serve certain purposes fertilizers cannot serve. Farm manure is of a very complex composition. It contains more or less of all of the elements contained in the foods given to the animals and in the litter. It is rich in organic matters, being composed chiefly of vegetable substances. Organic matter is the source of humus to the soil and is of much value. Soils need humus and it can only be supplied by the addition of organic matter in farm manure or by plowing under green crops. Commercial fertilizers do not supply humus.

The urine is by far the most valuable part of the excreta of animals. It is not sufficient to save the solid droppings but the liquid should be collected as well. The amount of fertilizing constituents in a manure stands in direct relation to those in the food. The nitrogen in a food exerts a greater influence on the quality of the manure than any other constituent. It is the most costly fertilizing constituent. It undergoes more change in the animal's stomach than the mineral constituents and rapidly escapes from the manure in fermentation. Even if all the manure is saved and proper absorbents are used, barnyard manure is still an unstable product. It rapidly undergoes changes. The deterioration of manure results from fermentation, and from weathering or leaching. Farm manure loss from destructive fermentation may be largely prevented by the use of proper absorbents and by keeping the manure moist and compact. The loss from leaching may be prevented by storage under cover or in water tight bins.

If practicable, manure should be removed and spread on the field at short intervals and in that case the loss of valuable constituents is not very great. When the manure must be stored for some time the difficulties of preservation are greatly increased. These matters are fully discussed in the Farmers' Bulletin referred to at the beginning of this article. Every farmer is urged to get a copy of this bulletin, study it and put its general principles into practice. If the present shortage of potash should lead the Maine farmer to conserve millions of dollars worth of plant food which are now being neglected through lack of care in the collection and handling of farm manures it would largely help to offset the losses that may come in 1915 from a potash shortage.

Results of the Inspection.

The tables giving the analyses of the samples collected by the direction of the Commissioner of Agriculture during the year 1914 follow.

EXPLANATION OF THE TABLES.

Under the head of "Nitrogen" in the tables are found eight columns of figures under the following headings:

1. *The nitrogen from nitrates.* In this column is given the percentage of nitrogen present as nitrate. Nitrate nitrogen is wholly and quickly available.

2. *Nitrogen from ammonia salts.* In this column is given the nitrogen from ammonium salts, chiefly sulphate. Ammonia nitrogen while not usually as quickly available to the growing plant as nitrate nitrogen is completely available.

3. *Water soluble organic nitrogen.* This is the soluble nitrogen from organic materials, such as dried blood, dried fish or meat, tankage, cottonseed meal, etc. It dissolves in water

and is supposed to be quickly and completely available to the plant.

4. *Active water insoluble organic nitrogen.* The nitrogen in this column is that portion of the organic nitrogen which is insoluble in water but is converted into ammonia by the action of the permanganate of potash solution. This is probably quite readily available to plants.

5. *Inactive organic nitrogen.* This is the portion of the organic nitrogen that is not converted into ammonia by the action of the permanganate solution. It is probably only slowly available to plants.

6. *Available or active nitrogen.* In this column is given the sum of the percentages found in the first four columns, viz: nitrate nitrogen, ammonia nitrogen, water soluble organic nitrogen and active water insoluble organic nitrogen.

7. *Total nitrogen found.*

8. *Total nitrogen guaranteed.*

Phosphoric Acid. Under the head of "phosphoric acid" are given the usual columns with the exception that inverted and insoluble phosphoric acids are this year omitted. If it is desired to know what the insoluble phosphoric acid is it may be found by substracting the available from the total as given in the table. If it is desired to know what the reverted phosphoric acid is for a given sample this may be found by subtracting the soluble phosphoric acid from the available.

Potash. No change is made in the arrangement of the potash results. The potash found and that guaranteed by the manufacturer are given.

THE MEANING OF THE RESULTS FOUND FOR NITROGEN.

In order to obtain an idea of the value of the organic nitrogen in any given brand from the figures given in the table, it is necessary to compare the columns of active insoluble and inactive insoluble nitrogen, and also take into consideration the amount of soluble organic nitrogen. That is, the organic nitrogen is valuable in proportion as the percentage of the active is greater than the inactive, and the amount of water soluble is large or small. A fertilizer showing more than twice as much active as inactive insoluble nitrogen would be rated as high grade. Also in one carrying a quite large percentage of water soluble and small amounts of active and inactive water insoluble the nitrogen would be likewise rated as high grade. One showing a small amount of water soluble and a larger amount of inactive than active would be classed as a poor grade of organic nitrogen. The percentage of inactive as compared with the total organic is the measure of the value of the organic nitrogen in the goods. With a fair amount of organic nitrogen soluble in water, a large per cent of active and a small amount of inactive, the organic nitrogen is considered good. If but a small amount is soluble in water and less active than inactive is found the organic nitrogen would be considered low grade.

The column headed "available nitrogen" is somewhat analogous to the available phosphoric acid column which has been used for years. It cannot, however, be relied upon without reference to the other results reported in the table. While as a general rule the nearer the figures in the available column approach to the figures in the total nitrogen column the better the grade of nitrogen in the goods this must be construed in connection with the other preceding figures. The mineral nitrogen is all available and consequently must be taken into consideration in estimating the availability of the organic nitrogen.

Lime.

Two samples of limestone were registered, as follows: "Edison Pulverized Limestone," Edison Portland Cement Co., Stewartsville, N. J., guaranteed to carry carbonate of lime 90 per cent, total carbonate 93 per cent, carbonate of magnesia 3 per cent and calcium oxide 50 per cent. A sample taken from Morison Bros., Bangor was examined as No. 3052, and found to carry carbonate of lime 91.71 per cent, carbonate of magnesia 1.03 per cent, total carbonate 92.74 per cent and calcium oxide 51.36 per cent, and was, therefore, in accord with its guaranty.

"R-R Land Lime," Rockland & Rockport Lime Co., Rockland, Me. Sample obtained from Kendall & Whitney, Portland. This brand was guaranteed by the manufacturers to carry not less than 60 nor more than 65 per cent of calcium oxide, not less than 0.5 and not more than 5 per cent magnesium oxide, not less than 30 and not more than 40 per cent calcium carbonate, no magnesium in the form of carbonate. On examination it was found to carry 63.38 per cent calcium oxide and .78 per cent of magnesium oxide.

Descriptive List of Fertilizer Samples, 1914.

Station number.	Manufacturer, place of business and brand.
	AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK CITY, N. Y.
2692	AA Potato Grower
2703	AA Potato Grower
2644	A. A. C. Co. Aroostook Complete Manure
2804	A. A. C. Co. Aroostook Complete Manure
2651	A. A. C. Co. Aroostook High Grade
2777	A. A. C. Co. Aroostook High Grade
2545	A. A. C. Co. Grass & Oats Fertilizer
2652	A. A. C. Co. Grass & Oats Fertilzier
2643	A. A. C. Co. Northern Maine Potato Special
2748	A. A. C. Co. Northern Maine Potato Special
2646	A. A. C. Co. Peerless Potato Manure
2807	A. A. C. Co. Peerless Potato Manure
2670	A. A. C. Co. Sweet Corn Special
2805	A. A. C. Co. Sweet Corn Special
2923	Bradley's Alkaline Bone with Potash
2941	Bradley's Complete Manure for Corn and Grain
2606	Bradley's Complete Manure for Potatoes and Vegetables
2568	Bradley's Complete Manure with 10% Potash
2604	Bradley's Complete Manure with 10% Potash
2608	Bradley's Corn Phosphate
2678	Bradley's Corn Phosphate
2609	Bradley's Eureka Fertilizer
2675	Bradley's Eureka Fertilizer
2588	Bradley's High Grade Potato and Root Special
2571	Bradley's Niagara Phosphate
2844	Bradley's Niagara Phosphate
2655	Bradley's Potato Fertilizer
2817	Bradley's Potato Manure
2605	Bradley's XL Super-Phosphate of Lime
2607	Bradley's XL Super-phosphate of Lime
2635	Clark's Cove Bay State Fertilizer
2913	Clark's Cove Bay State Fertilizer
2589	Clark's Cove Bay State Fertilizer GG
2911	Clark's Cove Bay State Fertilizer GG
2638	Clark's Cove Great Planet Manure AA
2639	Clark's Cove King Philip Alkaline Guano for All Crops
2938	Clark's Cove King Philip Alkaline Guano for All Crops
2937	Clark's Cove Potato Fertilizer
2629	Clark's Cove Potato Manure
2936	Clark's Cove Potato Manure
3056	Complete Manure with 10% Potash
2683	Crocker's Ammoniated Corn Phosphate
2806	Crocker's Ammoniated Corn Phosphate
2687	Crocker's Aroostook Potato Special
2824	Crocker's New Rival Ammoniated Superphosphate
2689	Crocker's Potato, Hop and Tobacco

Analysis of Fertilizer Samples, 1914.

Station number.	Nitrogen.							Phosphoric Acid.						Potash.	
	As nitrate.	As ammonia.	Organic. As water soluble.	Organic. As active insoluble.	Organic. As inactive insoluble.	Total. Found.	Total. Guaranteed.	Soluble.	Insoluble.	Available. Found.	Available. Guaranteed.	Total. Found.	Total. Guaranteed.	Found.	Guaranteed.
2692	0.95	1.16	0.48	0.82	0.31	3.72	3.70	2.71	1.10	6.87	7.0	7.97	8.0	10.28	10.0
2703	1.16	0.82	1.02	0.87	0.30	4.17	3.70	2.93	2.11	7.49	7.0	9.60	8.0	10.00	10.0
2644	1.37	0.45	0.30	0.29	0.09	2.50	2.47	2.34	1.38	6.20	6.0	7.58	7.0	10.33	10.0
2804	0.50	0.24	1.12	0.45	0.21	2.52	2.47	2.58	2.09	6.03	6.0	8.12	7.0	10.26	10.0
2651	0.85	1.39	0.73	0.89	0.44	4.32	4.12	3.29	1.25	7.46	7.0	8.71	8.0	7.10	7.0
2777	1.70	0.68	0.36	0.95	0.43	4.12	4.12	2.28	1.57	6.95	7.0	8.52	8.0	7.04	7.0
2545	.....	.....	.....	.....	.....	.....	.....	8.15	0.73	10.91	11.0	11.64	12.0	2.18	2.0
2652	.....	.....	.....	.....	.....	.....	.....	4.42	0.74	11.35	11.0	12.09	12.0	2.06	2.0
2643	2.16	0.50	0.36	0.49	0.21	3.72	3.70	2.09	2.05	7.18	7.0	9.23	8.0	10.45	10.0
2748	1.39	0.63	0.46	0.88	0.36	3.72	3.70	2.73	1.65	7.00	7.0	8.65	8.0	10.33	10.0
2646	0.89	1.25	0.48	0.49	0.23	3.34	3.29	4.08	1.72	8.23	8.0	9.95	9.0	7.14	7.0
2807	1.35	0.16	0.93	0.68	0.32	3.42	3.29	3.75	1.63	7.75	8.0	9.38	9.0	7.86	7.0
2670	0.21	0.69	0.72	0.65	0.21	2.48	2.06	4.27	1.66	7.88	8.0	9.54	9.0	6.72	6.0
2805	0.36	0.80	0.29	0.50	0.23	2.18	2.06	3.33	1.72	8.07	8.0	9.79	9.0	6.29	6.0
2923	.....	.....	.....	.....	.....	.....	.....	6.57	0.41	9.96	11.0	10.37	12.0	3.12	2.0
2941	.....	0.95	1.55	0.44	0.35	3.29	3.29	1.71	2.07	7.82	8.0	9.89	9.0	7.05	7.0
2606	0.80	1.45	0.17	0.63	0.33	3.38	3.29	6.51	1.72	8.58	8.0	10.30	9.0	6.88	7.0
2568	1.12	1.26	0.72	0.37	0.15	3.62	3.29	3.48	1.05	5.98	6.0	7.03	7.0	10.01	10.0
2604	0.79	1.41	0.16	0.61	0.21	3.18	3.29	4.23	1.45	6.48	6.0	7.93	7.0	10.07	10.0
2608	0.80	0.42	0.32	0.38	0.14	2.06	2.06	4.59	2.25	8.13	8.0	10.38	9.0	1.68	1.5
2678	0.09	0.73	0.68	0.54	0.22	2.26	2.06	3.51	1.91	7.09	8.0	9.00	9.0	1.70	1.5
2609	0.03	0.11	0.90	0.49	0.03	1.56	1.03	3.11	2.14	7.91	8.0	10.05	9.0	2.60	2.0
2675	0.11	0.10	0.66	0.41	0.17	1.45	1.03	3.30	2.12	7.29	8.0	9.41	9.0	2.47	2.0
2588	0.69	0.40	0.39	.....	.....	1.77	1.65	5.31	1.02	9.09	8.0	10.11	9.0	10.06	10.0
2571	0.18	0.08	0.45	0.39	0.13	1.21	0.82	3.94	1.66	7.75	7.0	9.41	8.0	3.67	1.0
2844	0.08	0.10	0.20	0.30	0.30	0.98	0.82	3.19	2.15	7.00	7.0	9.15	8.0	1.50	1.0
2655	0.54	0.24	0.71	0.36	0.21	2.06	2.06	1.91	2.13	7.38	8.0	9.51	9.0	3.32	3.0
2817	0.78	0.72	0.46	0.31	0.21	2.48	2.47	2.71	1.56	6.86	6.0	8.42	7.0	5.33	5.0
2605	0.84	0.92	0.29	0.32	0.15	2.52	2.47	7.16	1.89	9.21	9.0	11.10	10.0	2.18	2.0
2607	0.65	0.85	0.71	0.40	0.05	2.66	2.47	6.41	1.91	9.19	9.0	11.10	10.0	2.12	2.0
2635	0.08	1.14	0.51	0.52	0.23	2.48	2.47	6.24	1.31	8.67	9.0	9.98	10.0	2.64	2.0
2913	0.66	0.44	0.70	0.42	0.27	2.49	2.47	2.46	2.81	8.96	9.0	11.77	10.0	2.34	2.0
2589	0.23	0.67	0.49	0.49	0.24	2.12	2.06	5.26	1.63	8.31	8.0	9.94	9.0	1.80	1.5
2911	0.51	0.38	0.76	0.31	0.22	2.18	2.06	2.62	2.19	8.24	8.0	10.43	9.0	1.77	1.5
2638	1.36	0.76	0.78	0.36	0.21	3.47	3.29	2.98	1.70	7.79	8.0	9.49	9.0	7.05	7.0
2639	0.44	0.10	0.44	0.34	0.18	1.50	1.03	4.66	1.56	8.46	8.0	10.02	9.0	3.04	2.0
2938	0.04	0.12	0.32	0.39	0.29	1.16	1.03	3.76	1.37	8.12	8.0	9.49	9.0	2.12	2.0
2837	0.64	0.16	0.62	0.38	0.28	2.08	2.06	5.31	0.92	8.33	8.0	9.25	9.0	3.47	3.0
2629	1.18	0.68	0.29	0.31	0.18	2.64	2.47	1.66	1.62	6.58	6.0	8.20	7.0	5.64	5.0
2936	0.58	1.02	0.50	0.53	0.09	2.72	2.47	4.15	1.38	6.59	6.0	7.97	7.0	5.15	5.0
3056	0.80	1.41	0.59	0.57	0.21	3.58	3.29	4.34	1.16	6.46	6.0	7.62	7.0	10.56	10.0
2683	0.23	0.75	0.58	0.56	0.16	2.28	2.06	3.35	1.84	7.31	8.0	9.15	9.0	1.62	1.5
2806	0.10	0.92	0.48	0.38	0.18	2.06	2.06	4.64	1.94	7.88	8.0	9.82	9.0	2.51	1.5
2687	0.98	0.44	0.50	0.18	0.14	2.24	2.06	3.92	1.22	7.93	8.0	9.15	9.0	6.70	6.0
2824	0.02	0.84	0.59	0.32	0.23	2.00	1.03	3.88	1.34	8.07	8.0	9.41	9.0	2.35	2.0
2689	0.74	0.56	0.56	0.37	0.15	2.38	2.06	4.21	1.54	7.58	8.0	9.12	9.0	3.34	3.0

Descriptive List of Fertilizer Samples, 1914.

Station number.	Manufacturer, place of business and brand.
2681	Crocker's Special Potato Manure
2825	Crocker's Special Potato Manure
2815	Darling's Blood, Bone & Potash
2836	Darling's Blood, Bone & Potash
2823	General Crop Grower
3064	Genuine German Kainit
2684	Great Eastern General Fertilizer
2980	Great Eastern General Fertilizer
2669	Great Eastern High Grade Potato Manure
2749	Great Eastern High Grade Potato Manure
2653	Great Eastern Northern Corn Special
2686	Great Eastern Northern Corn Special
2685	Great Eastern Potato Manure
2973	Great Eastern Potato Manure
2837	Great Harvester Potato Manure
3070	Great Harvester Potato Manure
3097	High Grade Dried Blood
2573	High Grade Fertilizer with 10% Potash
2654	High Grade Fertilizer with 10% Potash
2921	High Grade Fertilizer with 10% Potash
2929	High Grade Sulphate of Potash
2570	Lazaretto Aroostook Potato Guano
2578	Lazaretto Corn Guano
2569	Lazaretto High Grade Potato Guano
2821	Lazaretto High Grade Potato Guano
2585	Lazaretto Propeller Potato Guano
3054	Muirate of Potash
2933	Nitrate of Soda
3095	Nitrate of Soda
2734	Otis Potato Fertilizer
2735	Otis Supre-Phosphate
2636	Pacific Dissolved Bone & Potash
2634	Pacific Grass & Grain Fertilizer
2632	Pacific High Grade General Fertilizer
3085	Pacific Nobsque Guano for All Crops
3099	Pacific Nobsque Guano for All Crops
2633	Pacific Potato Special
2910	Pacific Potato Special
3084	Packers Union Animal Corn Fertilizer
3091	Packers Union Animal Corn Fertilizer
2688	Packers Union Gardeners Complete Manure
2691	Packers Union Maine Central Fertilizer
2574	Packers Union Potato Manure
2575	Packers Union Universal Fertilizer
3083	Packers Union Universal Fertilizer
2928	Plain Super-Phosphate

Analysis of Fertilizer Samples, 1914.

Station number.	Nitrogen.							Phosphoric Acid.						Potash.	
			Organic.			Total.				Available.		Total.			
	As nitrate.	As ammonia.	As water soluble.	As active insoluble.	As inactive insoluble.	Found.	Guaranteed.	Soluble.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
2681	0.96	1.32	0.51	0.42	0.15	3.36	3.29	3.29	1.28	6.12	6.0	7.40	7.0	10.06	10.0
2825	0.72	1.42	0.76	0.62	0.06	3.60	3.29	3.60	1.52	6.15	6.0	7.67	7.0	10.45	10.0
2815	1.38	1.42	0.12	0.79	0.43	4.14	4.11	4.35	1.35	7.25	7.0	8.60	8.0	8.08	7.0
2836	1.30	0.72	0.90	0.70	0.50	4.12	4.11	2.74	1.54	7.10	7.0	8.64	8.0	7.62	7.0
2823	0.89	0.47	0.20	0.50	0.26	2.32	1.65	2.01	1.67	7.92	8.0	9.59	9.0	5.94	5.0
3064	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13.99	12.0
2684	0.24	0.24	0.35	0.33	0.21	1.37	0.82	4.04	1.59	7.61	8.0	9.20	9.0	4.62	4.0
2980	0.14	0.12	0.42	0.34	0.20	1.22	0.82	4.27	1.30	8.14	8.0	9.44	9.0	4.93	4.0
2669	0.81	1.33	0.39	0.48	0.27	3.29	3.29	2.97	1.35	6.70	6.0	8.05	7.0	10.00	10.0
2749	1.06	0.22	0.85	0.83	0.38	3.34	3.29	2.79	1.45	6.36	6.0	7.81	7.0	10.00	10.0
2653	0.44	0.58	0.36	0.63	0.25	2.26	2.06	4.04	1.16	8.31	8.0	9.47	9.0	1.80	1.5
2686	0.13	0.73	0.59	0.50	0.27	2.24	2.06	3.45	1.84	7.30	8.0	9.14	9.0	1.86	1.5
2685	0.78	0.48	0.59	0.38	0.13	2.36	2.06	4.75	1.40	8.20	8.0	9.60	9.0	3.15	3.0
2973	0.58	0.72	0.17	0.42	0.28	2.17	2.06	3.92	0.93	8.48	8.0	9.41	9.0	3.22	3.0
2837	0.72	1.27	0.90	0.89	0.50	4.28	4.11	3.89	1.76	7.06	7.0	8.82	8.0	10.56	10.0
3070	1.32	0.80	0.56	1.08	0.36	4.12	4.11	3.00	0.88	7.64	7.0	8.52	8.0	10.68	10.0
3097	.....	.....	2.97	3.86	2.02	8.85	9.87	.....	.....	.....	.....	.....	.....	.....	.....
2573	1.06	0.54	0.47	0.26	0.14	2.47	2.47	1.75	1.30	5.97	6.0	7.27	7.0	10.00	10.0
2654	1.12	0.56	0.42	0.44	0.18	2.72	2.47	2.62	1.40	6.67	6.0	8.07	7.0	10.20	10.0
2921	0.80	0.70	0.32	0.47	0.21	2.50	2.47	2.20	2.16	6.21	6.0	8.37	7.0	10.36	10.0
2929	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	51.48	48.0
2570	0.26	0.04	0.38	0.31	0.13	1.12	0.82	4.08	1.40	7.69	8.0	9.09	9.0	4.98	4.0
2578	0.12	0.58	0.40	0.54	0.18	1.82	1.64	3.27	2.11	7.30	8.0	9.41	9.0	2.47	2.0
2569	1.20	1.30	0.49	0.40	0.14	3.53	3.29	3.43	1.12	6.12	6.0	7.24	7.0	9.77	10.0
2821	0.98	1.02	0.46	0.71	0.29	3.46	3.29	1.88	2.09	6.55	6.0	8.64	7.0	10.25	10.0
2585	0.96	0.54	0.35	.....	.....	2.14	2.06	4.51	1.12	8.16	8.0	9.28	9.0	6.34	6.0
3054	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	54.68	49.0
2933	15.16	.....	.....	.....	.....	15.16	15.00	.....	.....	.....	.....	.....	.....	.....	.....
3095	15.00	.....	.....	.....	.....	15.00	15.00	.....	.....	.....	.....	.....	.....	.....	.....
2734	0.13	0.93	0.42	0.67	0.33	2.48	2.06	3.48	1.05	9.25	8.0	10.30	9.0	3.05	3.0
2735	0.03	0.90	0.47	0.76	0.32	2.48	2.06	3.14	0.87	7.39	8.0	8.26	9.0	1.87	1.5
2636	.....	.....	.....	.....	.....	.....	.....	7.18	0.66	10.35	10.0	11.01	11.0	2.72	2.0
2634	.....	0.06	0.47	0.38	0.17	1.08	0.82	6.59	1.30	9.86	7.0	11.16	8.0	1.74	1.0
2632	1.58	0.78	0.49	0.41	0.18	3.44	3.29	3.03	1.79	7.80	8.0	9.59	9.0	7.56	7.0
3085	.....	0.10	0.38	0.36	0.22	1.06	1.03	2.60	1.68	8.27	8.0	9.95	9.0	2.54	2.0
3099	0.36	0.10	0.15	0.29	0.18	1.08	1.03	4.59	1.28	8.27	8.0	9.55	9.0	2.52	2.0
2633	0.94	0.57	0.37	0.40	0.18	2.46	2.06	4.82	1.47	8.13	8.0	9.60	9.0	4.13	3.0
2910	0.54	0.35	0.61	0.35	0.21	2.06	2.06	2.76	2.45	8.17	8.0	10.62	9.0	3.30	3.0
3084	.....	0.69	0.21	0.56	0.30	1.76	2.47	3.96	1.09	9.21	9.0	10.26	10.0	3.44	2.0
3091	.....	1.26	0.16	0.75	0.35	2.52	2.47	4.43	0.78	9.36	9.0	10.14	10.0	2.75	2.0
2688	1.17	0.52	0.47	0.28	0.14	2.58	2.47	1.82	1.37	6.00	6.0	7.37	7.0	10.69	10.0
2691	1.90	1.12	0.49	0.34	0.15	4.00	3.29	2.98	1.08	5.49	6.0	6.57	7.0	10.63	10.0
2574	1.17	0.70	0.27	.....	.....	2.47	2.06	4.47	1.16	8.03	8.0	9.19	9.0	7.04	6.0
2575	0.27	.....	0.46	0.31	0.12	1.16	0.82	4.39	1.45	7.75	8.0	9.20	9.0	5.14	4.0
3083	.....	0.37	0.18	0.42	0.27	1.24	0.82	3.56	1.34	8.58	8.0	9.92	9.0	4.03	4.0
2928	.....	.....	.....	.....	.....	.....	.....	10.05	0.94	13.29	14.0	14.23	15.0	.....	.....

Descriptive List of Fertilizer Samples, 1914.

Station number.	Manufacturer, place of business and brand.
2904	Quinnipiac Corn Manure
3062	Quinnipiac Market Garden Manure
3059	Quinnipiac Potato Manure
3060	Quinnipiac Potato Phosphate
2577	Read's Farmer's Friend Super-Phosphate
3082	Read's Farmer's Friend Super-Phosphate
2583	Read's High Grade Farmer's Friend Super-Phosphate
2586	Read's Potato Manure
2914	Read's Practical Potato Special Fertilizer
3098	Read's Standard Super-Phosphate
2934	Read's Sure Catch Fertilizer
2637	Read's Vegetable & Vine Fertilizer
2641	Soluble Pacific Guano
2909	Soluble Pacific Guano
3061	Special Grass & Garden Mixture
2581	Standard A Brand
2903	Standard A Brand
2631	Standard Bone & Potash
2584	Standard Complete Manure
3902	Standard Complete Manure
2591	Standard Fertilizer
2901	Standard Fertilizer
3086	Standard Guano for All Crops
2905	Standard Special for Potatoes
2907	Williams & Clark Americus Ammoniated Super-Phosphate
2912	Williams & Clark Americus Corn Phosphate
2906	Williams & Clark Americus High Grade Special for Potatoes & Vegetables
2908	Williams & Clark Americus Potato Manure
2939	Williams & Clark Royal Bone Phosphate for All Crops
	ARMOUR FERTILIZER WORKS, BALTIMORE, MARYLAND.
3010	All Soluble
3024	All Soluble
2718	Bone, Blood & Potash
2766	Bone, Blood & Potash
2854	Complete Potato
2990	Complete Potato
2791	Corn Grower
3029	Corn Grower
2722	Double Value
2848	Double Value
2997	Fruit & Root Crop Special
3025	Fruit & Root Crop Special
3009	High Grade Potato
3028	High Grade Potato
2989	Wheat, Corn & Oats
3027	Wheat, Corn & Oats
	BAUGH & SONS CO., BALTIMORE, MARYLAND.
2725	Baugh's Aroostook 5-8-7
2761	Baugh's Aroostook 5-7-10
2726	Baugh's Aroostook 4-8-7

Analysis of Fertilizer Samples, 1914.

Station number.	Nitrogen.							Phosphoric Acid.						Potash.	
			Organic.			Total.				Available.		Total.			
	As nitrate.	As ammonia.	As water soluble.	As active insoluble.	As inactive insoluble.	Found.	Guaranteed.	Soluble.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
2904	0.46	0.38	0.70	0.33	0.21	2.08	2.06	2.89	2.17	8.23	8.0	10.40	9.0	1.80	1.5
3062	1.38	0.08	0.92	0.78	0.36	3.52	3.29	3.14	1.47	7.68	8.0	9.15	9.0	7.25	7.0
3059	0.16	0.70	1.18	0.55	0.15	2.74	2.47	1.75	1.10	6.95	6.0	8.05	7.0	5.33	5.0
3060	0.66	0.78	0.18	0.48	0.18	2.28	2.06	3.19	0.85	8.75	8.0	9.60	9.0	3.36	3.0
2577	0.68	0.42	0.40	0.41	0.17	2.08	2.06	4.78	1.25	8.14	8.0	9.39	9.0	3.74	3.0
3082	0.47	0.60	0.45	0.36	0.18	2.06	2.06	4.27	1.38	8.29	8.0	8.67	9.0	3.48	3.0
2583	1.04	1.28	0.54	0.39	0.15	3.40	3.29	1.79	1.68	5.96	6.0	7.64	7.0	10.36	10.0
2586	1.06	0.61	0.56	0.30	0.11	2.64	2.47	1.82	1.54	6.05	6.0	7.59	7.0	9.88	10.0
2914	0.14	0.08	0.22	0.32	0.18	0.94	0.82	1.24	1.42	4.96	4.0	6.38	5.0	8.21	8.0
3098	.....	0.05	0.09	0.47	0.24	0.85	0.82	4.23	0.96	8.00	8.0	8.96	9.0	4.11	4.0
2934	.....	.....	.....	.....	.....	.....	.....	7.21	1.14	10.25	10.0	11.39	11.0	3.07	2.0
2637	0.23	0.85	0.46	0.44	0.22	2.20	2.06	5.84	1.00	8.31	8.0	9.31	9.0	7.42	6.0
2641	0.09	0.77	0.86	0.49	0.03	2.24	2.06	5.30	1.70	8.83	8.0	10.53	9.0	2.14	1.5
2909	0.92	0.38	0.17	0.35	0.24	2.06	2.06	2.76	2.35	8.42	8.0	10.77	9.0	1.91	1.5
3061	2.60	2.28	1.15	1.49	0.48	8.00	8.23	3.68	0.27	7.58	7.0	7.85	8.0	8.42	8.0
2581	0.07	0.04	0.36	0.36	0.23	1.06	0.82	6.27	1.62	9.19	7.0	10.81	8.0	2.06	1.0
2903	0.03	0.05	0.35	0.27	0.16	0.86	0.82	3.06	1.45	7.37	7.0	8.82	8.0	1.47	1.0
2631	.....	.....	.....	.....	.....	.....	.....	7.07	0.60	10.00	10.0	10.60	11.0	4.40	2.0
2584	1.54	0.74	0.46	0.43	0.12	3.29	3.29	2.86	1.88	7.80	8.0	9.68	9.0	7.63	7.0
2902	0.78	1.02	0.67	0.47	0.28	3.22	3.29	1.90	2.42	7.66	8.0	10.08	9.0	7.24	7.0
2591	0.11	0.59	0.69	0.61	0.26	2.26	2.06	4.23	1.63	7.68	8.0	9.31	9.0	2.25	1.5
2901	0.96	0.40	0.29	0.44	0.15	2.24	2.06	2.68	2.19	8.29	8.0	10.48	9.0	1.92	1.5
3086	.....	0.10	0.18	0.52	0.28	1.08	1.03	3.22	1.57	8.51	8.0	10.08	9.0	2.38	2.0
2905	0.64	0.44	0.80	0.34	0.26	2.48	2.06	2.78	2.55	8.46	8.0	11.01	9.0	3.17	3.0
2907	0.68	0.42	0.80	0.44	0.23	2.57	2.47	2.39	2.83	8.88	9.0	11.71	10.0	2.33	2.0
2912	0.60	0.38	0.78	0.34	0.15	2.28	2.06	2.39	2.42	7.95	8.0	10.37	9.0	1.96	1.5
2906	1.01	0.96	0.78	0.46	0.32	3.53	3.29	1.87	2.39	7.79	8.0	10.18	9.0	7.04	7.0
2908	0.83	0.42	0.35	0.37	0.21	2.18	2.06	2.57	2.40	8.03	8.0	10.43	9.0	3.52	3.0
2939	.....	0.46	0.01	0.40	0.25	1.12	1.03	0.16	1.21	8.58	8.0	9.79	9.0	2.18	2.0
3010	0.11	0.71	0.79	0.81	0.34	2.76	2.88	4.34	1.08	8.11	8.0	9 19	8 5	4 21	4 0
3024	0.08	0.94	0.82	0.68	0.64	3.16	2.88	4.05	1.51	8.03	8.0	9.54	8.5	4.27	4.0
2718	0.99	0.85	0.50	1.35	0.41	4.10	4.11	0.77	1.17	8.03	8.0	9.20	8.5	7.34	7.0
2766	1.50	0.78	0.81	0.71	0.32	4.12	4.11	0.69	0.79	6.66	8.0	7.45	8.5	7.39	7.0
2854	0.38	1.30	0.64	0.50	0.38	3.20	3.29	5.10	0.61	6.46	6.0	7.07	6.5	10.00	10.0
2990	0.63	1.08	0.73	0.56	0.32	3.32	3.29	3.51	0.88	6.17	6.0	7.05	6.5	10.09	10.0
2791	0.04	.....	0.96	0.53	0.49	2.02	1.65	2.87	2.55	7.13	8.0	9.68	8.5	2.86	2.0
3029	0.30	0.12	0.21	0.46	0.57	1.66	1.65	2.58	1.84	7.67	8.0	9.51	8.5	2.61	2.0
2722	1.00	0.94	0.73	1.08	0.48	4.22	4.11	0.97	1.25	7.04	8.0	8.29	8.5	10.21	10.0
2848	0.58	1.48	0.90	0.72	0.44	4.12	4.11	5.82	1.29	7.77	8.0	9.06	8.5	10.00	10.0
2997	0.15	0.47	0.41	0.41	0.22	1.66	1.65	4.93	1.10	8.15	8.0	9.25	8.5	5.51	5.0
3025	.....	0.42	0.52	0.48	0.38	1.80	1.65	4.90	1.47	8.07	8.0	9.54	8.5	5.51	5.0
3009	0.25	0.26	0.70	0.30	0.16	1.67	1.65	4.82	1.05	8.03	8.0	9.08	8.5	10.17	10.0
3028	0.18	0.28	0.59	0.35	0.26	1.66	1.65	2.84	1.30	8.00	8.0	8.64	8.5	10.23	10.0
2989	.....	0.02	0.51	0.22	0.15	0.90	0.82	4.31	0.91	6.46	7.0	7.37	7.5	1.07	1.0
3027	.....	0.12	0.17	0.52	0.35	1.16	0.82	3.19	1.15	7.37	7.0	8.52	7.5	1.87	1.0
2725	0.63	2.44	0.48	0.43	0.26	4.24	4.12	7.24	1.20	8.21	8.0	9.41	9.0	7.21	7.0
2761	.....	3.11	1.26	.....	.....	4.59	4.12	6.28	1.31	7.65	7.0	8.96	8.0	9.55	10.0
2726	0.68	1.69	0.25	0.27	0.12	3.01	3.30	6.99	1.40	8.65	8.0	10.05	9.0	7.05	7.0

Descriptive List of Fertilizer Samples, 1914.

Station number.	Manufacturer, place of business and brand.
2760	Baugh's Aroostook 4-6-10
2762	Baugh's Aroostook $4\frac{1}{2}$-7-10
	BOWKER FERTILIZER CO., BOSTON, MASS.
2998	Bowker's Acid Phosphate
2743	Bowker's Blood, Bone & Potash
2767	Bowker's Blood, Bone & Potash
2592	Bowker's Bone & Potash Square Brand
2744	Bowker's Bone & Potash Square Brand
2769	Bowker's Complete Manure for Potatoes and Vegetables
2871	Bowker's Complete Manure for Potatoes and Vegetables
2580	Bowker's Corn Phosphate
2618	Bowker's Corn Phosphate
2576	Bowker's Early Potato Manure
2741	Bowker's Early Potato Manure
2888	Bowker's Farm & Garden Phosphate
3001	Bowker's Fresh Ground Bone
2590	Bowker's Hill & Drill Phosphate
2730	Bowker's Hill & Drill Phosphate
2582	Bowker's Market Garden Fertilizer
2740	Bowker's Market Garden Fertilizer
2999	Bowker's Muriate of Potash
3000	Bowker's Nitrate of Soda
2594	Bowker's Potash Bone
2621	Bowker's Potash Bone
2622	Bowker's Potato & Vegetable Fertilizer
2642	Bowker's Potato & Vegetable Fertilizer
2579	Bowker's Potato & Vegetable Phosphate
2620	Bowker's Potato & Vegetable Phosphate
2640	Bowker's Sure Crop Phosphate
2731	Bowker's Sure Crop Phosphate
2593	Stockbridge Manure "A" for Potatoes
2739	Stockbridge Manure "A" for Potaotes
2747	Stockbridge Manure "B" for Potatoes
2572	Stockbridge Special Complete Manure for Corn and All Grain Crops
2832	Stockbridge Special Complete Manure for Corn and All Grain Crops
2746	Stockbridge Special Complete Manure for Potatoes & Vegetables
2795	Stockbridge Special Complete Manure for Potatoes & Vegetables
2628	Stockbridge Special Complete Manure for Seeding Down, Permanent Dressing and Legumes
2887	Stockbridge Special Complete Manure for Seeding Down, Permanent Dressing and Legumes
2630	Stockbridge Special Complete Manure for Top Dressing and Forcing
2890	Stockbridge Special Complete Manure for Top Dressing and Forcing
	CHESAPEAKE CHEMICAL CO., BALTIMORE, MARYLAND.
2971	C-C-Co.'s Granger Special*
2969	C-C-Co.'s Potato Producer Fertilizer
2754	C-C-Co.'s Special Compound
2852	C-C-Co.'s Special Compound

*Not registered in 1914.

Analysis of Fertilizer Samples, 1914.

Station number.	Nitrogen.							Phosphoric Acid.						Potash.	
	As nitrate.	As ammonia.	Organic.			Total.		Soluble.	Insoluble.	Available.		Total.		Found.	Guaranteed.
			As water soluble.	As active insoluble.	As inactive insoluble.	Found.	Guaranteed.			Found.	Guaranteed.	Found.	Guaranteed.		
2760	0.89	1.76	0.97	.....	.....	3.64	3.30	5.53	1.05	6.78	6.0	7.83	7.0	8.84	10.0
2762	1.05	2.19	0.44	.....	.....	3.84	3.70	6.09	1.08	7.76	7.0	8.84	8.0	9.73	10.0
2998	.....	.....	.....	.....	.....	.....	.....	10.10	1.17	13.89	14.0	15.06	15.0	.....	.....
2743	2.04	0.18	0.69	0.93	0.44	4.28	4.11	2.86	1.28	7.14	7.0	8.42	8.0	7.39	7.0
2767	1.14	1.20	0.65	0.94	0.37	4.30	4.11	1.85	1.05	6.89	7.0	7.94	8.0	7.39	7.0
2592	0.17	0.66	0.69	0.59	0.21	2.32	1.65	3.05	1.91	6.67	6.0	8.58	7.0	2.90	2.0
2744	0.30	0.18	0.79	0.51	0.21	1.99	1.65	1.60	1.56	6.19	6.0	7.75	7.0	2.09	2.0
2769	1.47	0.09	0.96	0.90	0.40	3.82	3.29	1.80	1.38	6.04	6.0	7.42	7.0	9.62	10.0
2871	1.25	0.62	0.74	0.71	0.34	3.66	3.29	1.85	1.53	6.00	6.0	7.53	7.0	10.00	10.0
2580	0.05	0.64	0.42	0.43	0.20	1.74	1.65	4.78	1.53	8.04	8.0	9.57	9.0	2.39	2.0
2618	0.02	0.82	0.38	0.36	0.12	1.70	1.65	2.68	1.33	7.86	8.0	9.19	9.0	2.54	2.0
2576	1.38	0.70	0.66	0.39	0.17	3.30	3.29	3.51	1.61	7.98	8.0	9.59	9.0	7.24	7.0
2741	1.72	0.07	0.72	0.68	0.37	3.56	3.29	2.90	1.28	7.91	8.0	9.19	9.0	7.38	7.0
2888	0.56	0.54	0.31	0.35	0.11	1.87	1.65	4.35	1.35	8.68	8.0	10.03	9.0	2.34	2.0
3001	.....	.....	.....	.....	.....	2.57	2.47	.....	.....	.....	.....	28.18	22.9	.....	.....
2590	0.06	1.16	0.57	0.56	0.24	2.59	2.47	6.43	1.67	8.90	9.0	10.57	10.0	2.79	2.0
2730	0.18	1.02	0.54	0.63	0.39	2.76	2.47	5.60	2.49	8.40	9.0	10.89	10.0	2.60	2.0
2582	0.81	0.83	0.40	0.29	0.17	2.50	2.47	2.11	1.44	6.00	6.0	7.44	7.0	10.09	10.0
2740	0.47	0.08	1.02	0.81	0.32	2.70	2.47	1.88	2.02	5.95	6.0	7.97	7.0	10.50	10.0
2999	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	50.36	49.0
3000	15.22	.....	.....	.....	.....	15.22	15.00	.....	.....	.....	.....	.....	.....	.....	.....
2594	0.08	0.08	0.40	0.33	0.13	1.02	0.82	3.92	1.12	6.44	6.0	7.56	7.0	2.62	2.0
2621	0.14	0.28	0.34	.....	.....	1.00	0.82	3.00	0.64	6.30	6.0	6.94	7.0	2.22	2.0
2622	0.91	0.41	0.44	0.61	0.20	2.57	2.47	4.10	1.15	8.23	8.0	9.38	9.0	4.21	4.0
2642	1.20	0.61	0.41	0.23	0.16	2.61	2.47	4.50	1.15	8.99	8.0	10.14	9.0	4.72	4.0
2579	0.40	0.56	0.31	0.36	0.17	1.80	1.65	3.99	1.51	9.26	8.0	10.77	9.0	2.95	2.0
2620	.....	0.74	0.95	0.32	0.13	2.14	1.65	4.93	0.94	8.10	8.0	9.04	9.0	2.42	2.0
2640	0.41	0.14	0.46	0.33	0.16	1.50	0.82	4.55	1.35	8.57	8.0	9.92	9.0	3.16	2.0
2731	.....	0.06	0.51	0.35	0.20	1.12	0.82	4.48	2.09	8.15	8.0	10.24	9.0	2.10	2.0
2593	1.47	0.79	0.74	0.85	0.31	4.16	4.11	2.34	1.58	7.06	7.0	8.64	8.0	9.44	10.0
2739	0.65	1.25	0.99	1.01	0.38	4.28	4.11	3.84	1.74	7.19	7.0	8.93	8.0	10.65	10.0
2747	0.80	1.10	0.37	0.93	0.34	3.54	3.29	3.54	1.99	10.05	10.0	12.04	11.0	7.41	7.0
2572	0.75	1.58	0.16	0.42	0.20	3.11	3.29	6.75	1.53	9.76	10.0	11.29	11.0	7.51	7.0
2832	0.86	0.50	0.60	0.83	0.53	3.32	3.29	4.23	1.07	9.90	10.0	10.97	11.0	7.43	7.0
2746	1.18	0.10	1.03	0.77	0.31	3.39	3.29	1.91	1.48	6.24	6.0	7.72	7.0	10.45	10.0
2795	1.00	1.24	0.44	0.73	0.26	3.64	3.29	2.39	1.95	6.52	6.0	8.47	7.0	10.75	10.0
2628	1.22	0.78	0.10	0.32	0.16	2.58	2.47	7.46	1.10	10.34	10.0	11.44	11.0	8.22	8.0
2887	0.02	0.76	0.62	0.84	0.38	2.62	2.47	7.59	2.42	11.39	10.0	13.81	11.0	7.81	8.0
2630	2.17	0.63	0.45	1.25	0.42	4.92	4.94	1.34	1.19	4.68	4.0	5.87	5.0	6.23	6.0
2890	1.31	2.00	0.40	0.86	0.37	4.94	4.94	1.24	0.19	4.45	4.0	4.64	5.0	6.44	6.0
2971	0.92	1.28	0.47	0.26	0.15	3.08	2.46	4.50	1.03	7.60	6.0	8.63	7.0	10.15	10.0
2969	0.90	1.42	0.28	0.42	0.28	3.30	3.28	0.99	0.94	5.92	6.0	6.86	7.0	10.00	10.0
2754	1.10	1.76	0.63	.....	.....	3.70	3.69	4.26	0.61	7.33	7.0	7.94	8.0	10.20	10.0
2852	0.83	1.56	0.46	0.46	0.27	3.58	3.69	5.30	0.93	6.95	7.0	7.88	8.0	10.72	10.0

Descriptive List of Fertilizer Samples, 1914.

Station number.	Manufacturer, place of business and brand.
	E. D. CHITTENDEN CO., BRIDGEPORT, CONN.
2783	Chittenden's High Grade Potato
2845	Chittenden's High Grade Potato
	COE-MORTIMER CO., NEW YORK CITY, N. Y.
2550	E. Frank Coe's Blood, Bone & Potash
2616	E. Frank Coe's Blood, Bone & Potash
2988	E. Frank Coe's Celebrated Special Potato Fertilizer
2612	E. Frank Coe's Columbian Corn Fertilizer
2626	E. Frank Coe's Columbian Corn Fertilizer
2624	E. Frank Coe's Columbian Potato Fertilizer
2547	E. Frank Coe's Complete Manure with 10% Potash
2615	E. Frank Coe's Complete Manure with 10% Potash
2567	E. Frank Coe's Double Strength Potato Manure
2838	E. Frank Coe's Double Strength Potato Manure
2549	E. Frank Coe's Excelsior Potato Fertilizer
3079	E. Frank Coe's Extra Special Potato Fertilizer & Fruit Grower
2672	E. Frank Coe's Famous Prize Brand Grain & Grass Fertilizer
2617	E. Frank Coe's Gold Brand Corn Manure
2991	E. Frank Coe's Gold Brand Corn Manure
3037	E. Frank Coe's Grass & Grain Special
2546	E. Frank Coe's High Grade Ammoniated Superphosphate
2614	E. Frank Coe's High Grade Ammoniated Superphosphate
3071	E. Frank Coe's High Grade Potato Fertilizer
3092	E. Frank Coe's High Grade Potato Fertilizer
3057	E. Frank Coe's High Grade Soluble Phosphate
2552	E. Frank Coe's Red Brand Excelsior Guano, for Market Gardening
2600	E. Frank Coe's Red Brand Excelsior Guano, for Market Gardening
2613	E. Frank Coe's Standard Potato Fertilizer
2625	E. Frank Coe's Standard Potato Fertilizer
3055	Muriate of Potash
3058	Nitrate of Soda
2599	Thomas Phosphate Powder (Basic Slag Phosphate)
	CONSUMERS CHEMICAL CORPORATION, NEW YORK CITY, N. Y.
2995	Consumers Potato & Vegetable Compound
	DOMINION FERTILIZER CO., ST. STEPHEN, N. B.
2771	Dominion Five-Eight-Seven
3044	Dominion Five-Eight-Seven
2818	Dominion Four-Six-Ten
3043	Dominion Four-Six-Ten
2779	Dominion Four-one-half-Eight-Nine
2968	Dominion Four-one-half-Eight-Nine
3045	Dominion Two-Nine-Five
	ESSEX FERTILIZER CO., BOSTON, MASS.
3004	Essex Complete Manure for Corn, Grain & Grass
2717	Essex Complete Manure for Potatoes, Roots & Vegetables
2880	Essex Complete Manure for Potatoes, Roots & Vegetables
2732	Essex Grain, Grass and Potato Fertilizer
2855	Essex Grass & Top Dressing for Lawns and Meadows*
2720	Essex High Grade Special, with 10% Potash
2879	Essex High Grade Special, with 10% Potash

*Not registered in 1914.

Analysis of Fertilizer Samples, 1914.

Station number.	Nitrogen.							Phosphoric Acid.						Potash.	
			Organic.			Total.				Available.		Total.			
	As nitrate.	As ammonia.	As water soluble.	As active insoluble.	As inactive insoluble.	Found.	Guaranteed.	Soluble.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
2783	0.13	2.79	0.37	0.44	0.41	4.14	4.10	6.00	1.42	8.64	8.0	10.06	9.0	8.99	7.0
2845	0.21	2.80	0.32	0.42	0.37	4.12	4.10	6.60	1.43	9.05	8.0	10.48	9.0	8.08	7.0
2550	1.08	1.20	1.07	0.83	0.12	4.30	4.11	2.41	0.94	7.35	7.0	8.29	8.0	7.06	7.0
2616	1.16	1.30	0.62	0.81	0.43	4.32	4.11	3.73	1.49	7.31	7.0	8.80	8.0	7.07	7.0
2988	0.21	0.50	0.47	0.29	0.29	1.76	1.65	5.28	1.11	8.30	8.0	9.41	9.0	4.36	4.0
2612	0.12	0.08	0.56	0.48	0.19	1.43	1.23	4.31	1.61	8.36	8.5	9.97	9.5	2.61	2.5
2626	0.10	0.06	0.52	0.46	0.19	1.33	1.23	4.40	1.58	8.39	8.5	9.97	9.5	2.78	2.5
2624	0.14	0.08	0.63	0.46	0.19	1.50	1.23	3.62	1.67	8.11	8.5	9.78	9.5	2.85	2.5
2547	0.94	0.04	1.12	0.38	0.20	2.68	2.47	2.65	1.54	6.35	6.0	7.89	7.0	11.17	10.0
2615	0.08	0.70	0.62	0.56	0.12	2.68	2.47	1.55	1.65	6.42	6.0	8.07	7.0	10.61	10.0
2567	0.84	0.84	0.62	0.93	0.47	3.70	3.70	1.87	1.03	7.06	7.0	8.09	8.0	10.21	10.0
2838	1.11	0.99	0.45	0.83	0.48	3.86	3.70	4.48	1.54	7.06	7.0	8.60	8.0	10.37	10.0
2549	0.80	0.80	0.52	.....	.....	2.48	2.47	5.44	0.66	7.68	7.0	8.34	8.0	8.32	8.0
3079	0.42	0.50	0.37	0.36	0.15	1.80	1.65	2.90	1.05	8.33	8.0	9.38	9.0	10.00	10.0
2672	.....	.....	.....	.....	.....	.....	.....	1.45	1.22	10.89	10.0	12.11	11.0	2.03	2.0
2617	1.02	0.62	0.25	0.72	0.21	2.82	2.47	3.45	1.22	8.48	8.0	9.70	9.0	6.25	6.0
2991	1.13	0.43	0.15	0.49	0.32	2.52	2.47	3.43	1.20	8.05	8.0	9.25	9.0	6.00	6.0
3037	0.14	0.23	0.21	0.37	0.11	1.06	0.82	3.08	1.15	8.02	8.0	9.17	9.0	2.39	2.0
2546	0.71	0.12	0.51	0.48	0.26	2.08	1.85	1.93	1.40	8.04	8.0	9.44	9.0	3.26	3.0
2614	0.51	0.09	1.13	.....	.....	1.94	1.85	1.85	1.66	8.02	8.0	9.68	9.0	3.30	3.0
3071	0.91	0.40	0.55	0.65	0.23	2.74	2.47	2.09	0.89	8.81	8.0	9.70	9.0	6.38	6.0
3092	0.92	0.88	0.23	0.62	0.27	2.92	2.47	3.99	1.07	8.50	8.0	9.57	9.0	7.36	6.0
3057	.....	.....	.....	.....	.....	.....	.....	13.57	0.13	17.51	14.0	17.64	15.0	.....	.....
2552	1.11	0.13	1.20	0.75	0.29	3.48	3.29	3.68	1.56	8.17	8.0	9.73	9.0	7.59	7.0
2600	1.08	0.63	0.64	0.76	0.30	3.41	3.29	4.15	1.54	8.14	8.0	9.68	9.0	7.30	7.0
2613	1.01	0.87	0.39	0.97	0.31	3.55	3.29	3.08	1.96	6.57	6.0	8.53	7.0	10.00	10.0
2625	1.43	0.10	0.75	0.89	0.39	3.56	3.29	1.95	1.25	6.39	6.0	7.64	7.0	10.00	10.0
3055	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	54.52	49.0
3058	15.80	.....	.....	.....	.....	15.80	15.00	.....	.....	.....	.....	.....	.....	.....	.....
2599	.....	.....	.....	.....	.....	.....	.....	.....	.....	16.59	15.0	18.09	17.0	.....	.....
2995	0.16	1.94	0.42	0.38	0.91	3.81	3.29	2.33	1.33	5.59	6.0	6.92	7.0	10.00	10.0
2771	1.39	0.71	0.49	0.77	0.44	3.80	4.10	2.78	2.48	7.07	8.0	9.55	9.0	6.85	7.0
3044	1.55	1.16	0.38	0.60	0.45	4.14	4.10	5.76	0.97	8.17	8.0	9.14	9.0	7.12	7.0
2818	0.98	0.24	1.68	0.64	0.46	4.00	3.28	1.12	1.30	5.37	6.0	6.67	7.0	11.09	10,0
3043	1.57	0.10	0.94	0.57	0.54	3.73	3.28	1.37	0.84	5.30	6.0	6.14	7.0	10.23	10.0
2779	1.40	0.38	0.64	0.78	0.54	3.74	3.70	5.76	1.00	8.00	8.0	9.00	9.0	9.00	9.0
2968	0.52	0.84	1.07	0.84	0.61	3.88	3.70	5.95	0.93	8.16	8.0	9.09	9.0	9.00	9.0
3045	0.78	0.08	0.81	0.50	0.26	2.42	1.64	3.06	0.83	8.85	9.0	9.68	10.0	5.87	5.0
3004	0.06	1.00	1.22	0.56	0.27	3.11	3.28	4.24	0.82	6.44	6.0	7.26	7.0	10.00	10.0
2717	.....	1.22	1.13	0.68	0.27	3.30	3.28	4.18	0.92	6.15	6.0	7.07	7.0	10.34	10.0
2880	0.41	1.14	0.91	0.66	0.26	3.38	3.28	4.29	0.93	6.10	6.0	7.03	7.0	10.48	10.0
2732	.....	.....	0.27	0.21	0.64	1.12	0.82	4.78	1.05	7.45	8.0	8.50	9.0	3.73	4.0
2855	0.14	1.88	0.97	0.69	0.45	4.13	4.10	5.50	1.22	6.59	7.0	7.81	8.0	8.63	8.0
2720	.....	1.80	0.84	0.58	0.56	3.78	3.69	5.23	1.45	7.08	7.0	8.23	8.0	10.29	10.0
2879	.....	2.05	0.47	0.76	0.42	3.70	3.69	5.18	1.06	7.07	7.0	8.13	8.0	10.21	10.0

Descriptive List of Fertilizer Samples, 1914.

Station number.	Manufacturer, place of business and brand.
2994	Essex Lawn Dressing*..........
2659	Essex Market Garden and Potato Manure..........
2716	Essex Peerless Potato Manure..........
2738	Essex Peerless Potato Manure..........
3003	Essex Potato Grower, with 10% Potash..........
2830	Essex Special Corn Ferlitizer..........
2733	Essex Special Potato Phosphate, for Potatoes & Roots..........
2658	Essex XXX Fish & Potash, for all crops..........
	GERMAN KALI WORKS, NEW YORK CITY, N. Y.
2983	Muriate of Potash..........
	HUBBARD FERTILIZER CO., BALTIMORE, MARYLAND.
2877	Hubbard's Aroostook Special Fertilizer..........
3042	Hubbard's Aroostook Special Fertilizer..........
2785	Hubbard's Blood, Bone & Potash..........
2947	Hubbard's Blood, Bone & Potash..........
2946	Hubbard's B. & P. 10 & 2..........
2950	Hubbard's Farmers I. X. L. for Grain & Grass..........
2759	Hubbard's Maine Potato Grower Fertilizer..........
2784	Hubbard's Maine Potato Grower Fertilizer..........
2945	Hubbard's New Process Top Dresser*..........
2943	Hubbard's Royal Ensign for Corn & Grain..........
2758	Hubbard's Special Potato Fertilizer..........
2944	Hubbard's Special Potato Fertilizer..........
2949	Hubbard's 10% Potash Guano for Potatoes..........
	INTERNATIONAL AGRICULTURAL CORPORATION, BUFFALO FERTILIZER WORKS, HOULTON, ME.
2707	Buffalo Farmers' Choice(1-8-5)..........
2788	Buffalo Five-Eight-Nine..........
2863	Buffalo Five-Eight-Nine..........
2789	Buffalo Five-Eight-Seven..........
2861	Buffalo Five-Eight-Seven..........
2773	Buffalo Four-Six-Ten..........
2867	Buffalo Four-Six-Ten..........
2772	Buffalo Four½-Eight-Nine..........
2776	Buffalo Four½-Eight-Nine..........
2710	Buffalo Three-Six-Ten..........
2711	Buffalo Top Dresser (7-6-5)..........
2709	Buffalo Two-Eight-Ten..........
2992	Buffalo Two-Eight-Ten..........
2753	Buffalo Two-Eight-Two..........
2993	Buffalo Two-Eight-Two..........
2708	Buffalo Two-Nine-Five..........
2774	Buffalo Two-Nine-Five..........
	LISTERS AGRICULTURAL CHEMICAL WORKS, NEWARK, N. J.
3094	Genuine German Kainit..........
3075	High Grade Sulphate of Potash..........
2930	Listers Bone Meal..........
3073	Listers Bone Meal..........

*Not registered in 1914.

Analysis of Fertilizer Samples, 1914.

Station number.	Nitrogen.							Phosphoric Acid.						Potash.	
			Organic.			Total.				Available.		Total.			
	As nitrate.	As ammonia.	As water soluble.	As active insoluble.	As inactive insoluble.	Found.	Guaranteed.	Soluble.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
2994	.....	3.85	0.02	.....	.....	4.02	4.50	5.34	0.38	7.07	7.0	7.45	8.0	6.03	6.0
2659	0.40	0.46	0.79	0.29	0.10	2.04	2.00	5.95	1.00	8.08	8.0	9.08	9.0	5.01	5.0
2716	.....	1.70	1.00	0.66	0.46	3.82	4.10	5.42	1.22	7.09	7.0	8.31	8.0	8.73	8.0
2738	0.57	1.82	0.64	0.78	0.32	4.13	4.10	5.12	1.15	7.05	7.0	8.20	8.0	8.00	8.0
3003	0.68	0.42	0.60	0.58	0.23	2.51	2.46	4.42	0.48	6.16	6.0	6.64	7.0	10.23	10.0
2830	.....	0.76	0.74	0.38	0.20	2.08	2.00	5.65	1.06	8.19	8.0	9.25	9.0	3.03	3.0
2733	0.05	0.85	0.88	0.46	0.28	2.52	2.46	5.90	0.97	7,93	8.0	8.90	9.0	6.00	6.0
2658	.....	0.70	1.08	0.41	0.17	2.36	2.00	5.74	1.07	8.79	8.0	9.86	9.0	3.00	3.0
2983	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	49.76	48.0
2877	1.22	1.78	0.01	0.50	0.19	3.70	3.69	4.31	0.71	7.09	7.0	7.80	8.0	10.46	10.0
3042	1.24	1.39	0.32	0.42	0.19	3.56	3.69	4.78	0.76	7.42	7.0	8.18	8.0	10.00	10.0
2785	1.62	1.02	0.37	0.32	0.16	3.49	3.28	3.70	0.93	8.00	8.0	8.93	9.0	7.42	7.0
2947	1.26	1.34	0.06	0.40	0.24	3.30	3.28	0.67	0.43	7.29	8.0	7.72	9.0	9.78	7.0
2946	.....	.....	.....	.....	.....	.....	.....	3.16	1.72	11.04	10.0	12.76	11.0	2.12	2.0
2950	0.62	0.10	0.70	0.44	0.38	2.24	1.64	1.47	1.00	7.61	8.0	8.61	9.0	2.66	2.0
2759	1.29	1.93	0.24	0.45	0.21	4.12	4.10	5.50	0.74	8.30	8.0	9.04	9.0	7.48	7.0
2784	0.88	2.16	0.50	0.51	0.21	4.26	4.10	4.59	0.89	8.11	8.0	9.00	9.0	8.47	7.0
2945	7.04	0.06	1.43	0.29	0.20	9.02	7.50	.....	.....	.....	.....	.....	.....	3.68	3.5
2943	0.75	0.60	0.54	0.45	0.34	2.68	2.46	5.61	0.74	7.35	8.0	8.09	9.0	5.19	4.0
2758	1.02	0.92	1.12	.....	.....	3.13	3.28	1.42	0.68	6.64	6.0	7.32	7.0	10.36	10.0
2944	1.02	1.80	0.28	0.35	0.24	3.69	3.28	0.80	0.97	6.32	6.0	7.29	7.0	10.18	10.0
2949	0.60	1.48	0.26	0.31	0.20	2.85	2.46	1.66	1.25	6.72	6.0	7.97	7.0	10.17	10.0
2707	0.26	0.04	0.51	0.45	0.17	1.43	0.82	4.45	1.63	7.94	8.0	9.57	9.0	5.68	5.0
2788	1.86	0.62	0.74	0.66	0.44	4.32	4.10	5.02	1.11	8.00	8.0	9.11	9.0	9.38	9.0
2863	1.69	0.75	0.73	0.73	0.42	4.32	4.10	5.10	1.15	8.05	8.0	9.20	9.0	9.75	9.0
2789	1.26	0.72	0.99	0.84	0.53	4.24	4.10	4.88	1.39	7.41	8.0	8.80	9.0	7.46	7.0
2861	1.55	0.72	0.47	0.91	0.55	4.20	4.10	6.06	0.69	8.10	8.0	8.79	9.0	7.43	7.0
2773	1.47	0.11	0.52	0.65	0.37	3.12	3.29	1.40	1.25	5.32	6.0	6.57	7.0	10.15	10.0
2867	1.60	0.10	0.45	0.70	0.51	3.36	3.28	2.79	1.28	5.48	6.0	6.76	7.0	11.13	10.0
2772	1.62	0.08	0.66	0.66	0.52	3.54	3.70	2.55	1.51	7.23	8.0	8.74	9.0	9.19	9.0
2776	1.42	0.60	0.50	0.80	0.51	3.83	3.70	6.05	0.91	8.18	8.0	9.09	9.0	9.12	9.0
2710	1.11	0.38	0.55	0.69	0.37	3.10	2.47	4.66	1.65	7.06	6.0	8.71	7.0	10.00	10.0
2711	3.06	0.08	1.32	0.83	0.51	5.80	5.76	2.27	1.15	5.74	6.0	6.89	7.0	6.06	5.0
2709	0.84	0.04	0.33	0.48	0.21	1.90	1.64	5.15	0.71	8.43	8.0	9.14	9.0	10.56	10.0
2992	0.28	0.14	0.41	0.50	0.41	1.74	1.64	4.15	1.07	8.20	8.0	9.27	9.0	10.00	10.0
2753	0.98	.....	0.49	0.57	0.27	2.31	1.64	4.61	1.20	7.91	8.0	9.11	9.0	2.80	2.0
2993	0.57	0.01	0.50	0.34	0.30	1.72	1.64	2.27	0.84	7.84	8.0	8.68	9.0	2.16	2.0
2708	0.62	0.07	0.19	0.51	0.31	1.70	1.64	6.67	1.86	8.43	9.0	10.29	10.0	5.49	5.0
2774	0.04	.....	0.83	0.54	0.37	1.78	1.64	3.30	1.52	7.95	9.0	9.47	10.0	5.46	5.0
3094	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13.99	12.0
3075	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	50.80	48.0
2930	.....	.....	.....	.....	.....	3.63	2.67	.....	.....	.....	.....	24.80	22.9	.....	.....
3073	.....	.....	.....	.....	.....	2.01	2.67	.....	.....	.....	.....	21.60	22.9	.....	.....

Descriptive List of Fertilizer Samples, 1914.

Station number.	Manufacturer, place of business and brand.
2899	Listers 5-7-7 Potato Fertilizer
2671	Listers 5-7-10 Fertilizer for Potatoes
2900	Listers 5-7-10 Fertilizer for Potatoes
2602	Listers Grain & Grass Fertilizer
2898	Listers Grain & Grass Fertilizer
2679	Listers High Grade Special for Spring Crops
2813	Listers High Grade Special for Spring Crops
2548	Listers Potato Manure
2814	Listers Potato Manure
2603	Listers Special Corn Fertilizer
2935	Listers Special Corn Fertilizer
2601	Listers Special Potato Fertilizer
2680	Listers Special Potato Fertilizer
2925	Listers Special Potato Fertilizer
2623	Listers Success Fertilizer
2926	Listers Success Fertilizer
2673	Listers 10% Potato Grower
2924	Listers 10% Potato Grower
3074	Muriate of Potash
3076	Nitrate of Soda
	LOWELL FERTILIZER CO., LOWELL, MASS.
2801	Acid Phosphate
2538	Lowell Animal Brand, A Complete Manure for all crops
2972	Lowell Animal Brand, A Complete Manure for all crops
2563	Lowell Bone Fertilizer, For Corn, Grain, Grass & Vegetables
2660	Lowell Bone Fertilizer, For Corn, Grain, Grass & Vegetables
2561	Lowell Corn and Vegetable
2829	Lowell Dissolved Bone and Potash
2827	Lowell Empress Brand, For Corn. Potatoes and Grain
3081	Lowell Market Garden Manure
3080	Lowell Ground Tankage*
2714	Lowell Perfect Potato Brand
2851	Lowell Perfect Potato Brand
2539	Lowell Potato Grower, With 10% Potash
2967	Lowell Potato Grower, With 10% Potash
2557	Lowell Potato Manure
2598	Lowell Potato Manure
2541	Lowell Potato Phosphate
2661	Lowell Potato Phosphate
2850	Lowell Seeding Down Fertilizer
2884	Lowell Special Grass Mixture
2553	Lowell Special Potato Fertilizer, with 10% Potash
3034	Lowell Special Potato Fertilizer, with 10% Potash
2724	Lowell Sterling Phosphate*
2540	Lowell Superior Fertilizer, With 10% Potash
2966	Lowell Superior Fertilizer, With 10% Potash
2802	Nitrate of Soda

*Not registered in 1914.

Analysis of Fertilizer Samples, 1914.

Station number.	Nitrogen.							Phosphoric Acid.						Potash.	
			Organic.			Total.				Available.		Total.			
	As nitrate.	As ammonia.	As water soluble.	As active insoluble.	As inactive insoluble.	Found.	Guaranteed.	Soluble.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
2899	.....	2.54	0.66	0.50	0.42	4.12	4.11	4.43	1.70	6.88	7.0	8.58	8.0	7.31	7.0
2671	1.72	1.33	0.57	0.38	0.22	4.22	4.11	5.39	0.79	7.23	7.0	8.02	8.0	10.56	10.0
2900	0.06	2.86	0.71	0.42	0.13	4.18	4.11	5.42	0.92	7.09	7.0	8.01	8.0	10.65	10.0
2602	.....	.....	.....	.....	.....	.....	.....	8.04	0.64	10.06	10.0	10.70	11.0	2.00	2.0
2898	.....	.....	.....	.....	.....	.....	.....	7.48	0.46	10.11	10.0	10.57	11.0	2.34	2.0
2679	0.05	0.17	0.62	0.56	0.44	1.84	1.65	3.86	2.33	8.23	8.0	10.56	9.0	10.56	10.0
2813	0.16	0.28	0.67	0.53	0.32	1.96	1.65	2.66	2.41	7.08	8.0	9.49	9.0	11.35	10.0
2548	0.03	1.93	0.40	0.58	0.40	3.34	3.29	6.03	1.48	8.41	8.0	9.89	9.0	7.06	7.0
2814	.....	2.04	0.53	0.51	0.32	3.40	3.29	5.85	1.89	8.43	8.0	10.32	9.0	7.33	7.0
2603	0.06	0.12	0.47	0.41	0.22	1.28	1.23	4.98	1.62	8.01	8.0	9.63	9.0	3.73	3.0
2935	.....	0.22	0.40	0.37	0.25	1.24	1.23	5.15	1.74	7.70	8.0	9.44	9.0	3.08	3.0
2601	0.13	0.07	0.76	0.54	0.24	1.74	1.65	5.17	2.02	8.20	8.0	10.22	9.0	3.32	3.0
2680	0.08	0.08	0.73	0.65	0.37	1.91	1.65	4.48	2.18	7.82	8.0	10.00	9.0	3.73	3.0
2925	.....	0.20	0.54	0.60	0.50	1.84	1.65	5.26	2.50	8.19	8.0	10.69	9.0	3.10	3.0
2623	.....	0.15	0.46	0.69	0.03	1.33	1.23	5.25	1.80	10.74	9.0	12.54	10.0	2.23	2.0
2926	.....	0 24	0.41	0.45	0.26	1.36	1.23	4.74	1.66	8.77	9.0	10.43	10.0	2.51	2.0
2673	0.02	1.96	0.68	0.59	0.36	3.61	3.29	4.07	1.79	6.20	6.0	7.99	7.0	10.14	10.0
2924	.....	1.82	0.56	0.50	0.38	3.26	3.29	3.70	1.59	6.02	6.0	7.61	7.0	11.52	10.0
3074	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	49.28	49.0
3076	15.04	.....	.....	.....	15.04	15.00	.....	.....	.....	.....	.....	.....	.....	.....	.....
2801	.....	.....	.....	.....	.....	.....	.....	10.56	0.26	15.63	12.0	15.89	15.0	.....	.....
2538	0.71	0.42	0.75	0.39	0.19	2.46	2.46	6.65	0.84	8.25	8.0	9.09	9.0	4.30	4.0
2972	0.64	0.50	0.80	0.33	0.21	2.48	2.46	6.51	1.12	7.83	8.0	8.95	9.0	4.00	4.0
2563	0.04	0.68	0.48	0.37	0.07	1.64	1.64	5.74	1.30	7.89	8.0	9.19	9.0	3.09	3.0
2660	0.42	0.38	0.69	0.35	0.16	2.00	1.64	6.08	1.17	8.26	8.0	9.43	9.0	3.05	3.0
2561	0.02	1.24	0.83	0.78	0.43	3.30	3.28	5.90	0.92	8.11	8.0	9.03	9.0	7.55	7.0
2829	0.44	0.42	0.33	0.44	0.24	1.86	1.64	7.18	1.15	9.76	9.0	10.91	10.0	2.17	2.0
2827	0.28	0.10	0.58	.....	.....	1.24	1.24	4.64	0.84	6.58	7.0	7.42	8.0	2.07	2.0
3081	0.69	1.24	1.27	0.76	0.44	4.40	4.10	4.90	1.07	7.22	7.0	8.29	8.0	6.76	6.0
3080	.....	.....	3.29	0.98	0.83	5.10	5.00	.....	.....	.....	.....	14.18	14.0	.....	.....
2714	.....	1.84	1.23	0.71	0.42	4.20	4.10	5.18	1.16	7.10	7.0	8.26	8.0	8.16	8.0
2851	0.11	1.87	1.01	0.74	0.42	4.15	4.10	5.17	1.14	7.30	7.0	8.44	8.0	8.54	8.0
2539	.....	1.16	1.25	0.68	0.25	3.34	3.28	4.55	0.64	6.46	6.0	7.10	7.0	10.00	10.0
2967	.....	1.22	1.13	0.60	0.37	3.32	3.28	4.24	0.68	6.35	6.0	7.03	7.0	10.42	10.0
2557	0.04	0.36	0.80	0.42	0.18	1.80	1.64	4.86	0.93	7.38	7.0	8.31	8.0	4.01	4.0
2598	0.09	0.31	0.99	0.41	0.16	1.96	1.64	4.75	0.98	7.35	7.0	8.33	8.0	4.88	4.0
2541	.....	0.98	0.81	0.43	0.30	2.52	2.46	6.84	0.97	8.66	8.0	9.63	9.0	5.95	6.0
2661	.....	0.90	0.88	0.46	0.26	2.50	2.46	6.03	1.05	8.23	8.0	9.28	9.0	6.01	6.0
2850	.....	0.94	0.73	0.50	0.29	2.46	2.46	6.16	1.20	8.18	8.0	9.38	9.0	6.37	6.0
2884	.....	2.10	1.60	0.74	0.40	4.84	4.10	5.26	1.17	7.14	7.0	8.31	8.0	8.07	6.0
2553	0.55	0.42	1.10	0.56	0.23	2.86	2.46	4.78	0.66	6.34	6.0	7.00	7.0	10.01	10.0
3034	0.54	0.44	0.65	0.55	0.25	2.46	2.46	4.08	0.68	6.18	6.0	6.86	7.0	10.32	10.0
2724	0.03	0.01	0.71	0.24	0.09	1.08	0.82	5.50	1.00	8.14	8.0	9.14	9.0	3.91	4.0
2540	.....	1.58	0.88	0.74	0.30	3.50	3.69	5.34	0.85	7.41	7.0	8.26	8.0	10.17	10.0
2966	.....	1.64	1.12	0.61	0.45	3.82	3.69	5.20	1.00	7.20	7.0	8.20	8.0	10.16	10.0
2802	15.04	.....	.....	.....	.....	15.04	15.00	.....	.....	.....	.....	.....	.....	.....	.....

Descriptive List of Fertilizer Samples, 1914.

Station number.	Manufacturer, place of business and brand.
	MERROW BROS. & CO., AUBURN, ME.
3015	Merrow's Bone Meal
	MORISON BROS., BANGOR, ME.
2694	Morison Bros.' "A" Brand Potato Fertilizer
3050	Morison Bros.' "A" Brand Potato Fertilizer
3046	Morison Bros.' Acid Phosphate
2695	Morison Bros.' Bangor Brand Fertilizer for Potatoes & Vegetables
2696	Morison Bros.' "C" Brand Fertilizer for all crops
3047	Morison Bros.' Muriate of Potash
3048	Morison Bros.' Nitrate of Soda
3049	Morison Bros.' Packing House Tankage
2693	Morison Bros.' 3-8-10 Fertilizer
2697	Morison Bros.' "Xtra" High Grade Potato Fertilizer
3051	Morison Bros.' "Xtra" High Grade Potato Fertilizer
	NATIONAL FERTILIZER CO., BOSTON, MASS.
2797	Chittenden's Ammoniated Bone Phosphate
2755	Chittenden's Aroostook Special
2778	Chittenden's Aroostook Special
3072	Chittenden's Complete Root & Grain Fertilizer
3078	Chittenden's Eureka Potato Fertilizer
2765	Chittenden's Excelsior Potato Fertilizer
2796	Chittenden's Excelsior Potato Fertilizer
2756	Chittenden's Extra High Grade Manure
2763	Chittenden's Extra High Grade Manure
2833	Chittenden's Market Garden Special
2757	Chittenden's Premier Potato Manure
2764	Chittenden's Premier Potato Manure
	NEW ENGLAND FERTILIZER CO., BOSTON, MASS.
2702	Acid Phosphate
2705	Dried Blood
3033	New England Aroostook 5-7-8 Brand
2555	New England Complete Manure, With 10% Potash
2701	New England Complete Manure, With 10% Potash
2565	New England Corn and Grain Fertilizer
2700	New England Corn and Grain Fertilizer
2564	New England Corn Phosphate
2977	New England Corn Phosphate
3053	New England High Grade Potato Fertilizer
2542	New England High Grade Special, With 10% Potash
2780	New England High Grade Special, With 10% Potash
2782	New England Market Garden Manure
2803	New England Market Garden Manure
2699	New England Peerless Fertilizer
2562	New England Potato Fertilizer
2698	New England Potato Fertilizer
2554	New England Potato Grower, With 10% Potash
2792	New England Potato Grower, With 10% Potash

*Not registered in 1914.

Analysis of Fertilizer Samples, 1914.

Station number.	Nitrogen.							Phosphoric Acid.						Potash.	
			Organic.			Total.				Available.		Total.			
	As nitrate.	As ammonia.	As water soluble.	As active insoluble.	As inactive insoluble.	Found.	Guaranteed.	Soluble.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
3015	.....	.....	.....	.....	.....	1.98	1.24	.....	.....	.....	.....	29.71	28.0	.....	.....
2694	1.66	.....	0.78	0.52	0.36	3.32	3.00	5.84	0.33	8.03	8.0	8.36	.....	10.69	10.0
3050	1.12	0.14	0.81	0.49	0.48	3.04	3.00	6.30	0.36	8.27	8.00	8.63	.....	10.39	10.0
3046	.....	.....	.....	.....	.....	.....	.....	13.64	0.19	16.56	16.0	16.75	.....	.....	.....
2695	2.02	0.02	0.74	0.47	0.30	3.55	3.29	5.10	0.79	7.94	8.0	8.73	.....	7.37	7.0
2696	0.72	0.02	0.83	0.48	0.15	2.20	2.20	7.05	0.87	9.90	10.0	10.77	.....	6.33	6.0
3047	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	53.00	50.0
3048	15.60	.....	.....	.....	.....	15.60	15.00	.....	.....	.....	.....	.....	.....	.....	.....
3049	.....	.....	3.21	2.08	1.13	6.42	.....	.....	.....	.....	.....	12.07	12.0	.....	.....
2693	0.79	.....	1.49	0.61	0.11	3.00	3.00	5.25	0.74	8.11	8.0	8.85	.....	10.31	10.0
2697	2.28	0.08	1.06	0.74	0.40	4.56	4.12	6.25	0.51	8.05	7.0	8.56	.....	10.42	10.0
3051	1.35	0.04	2.16	0.58	0.37	4.50	4.12	4.88	0.60	7.85	7.0	8.45	.....	11.29	10.0
2797	0.08	0.84	0.44	0.39	0.17	1.93	1.65	4.02	1.22	8.06	8.0	9.28	9.0	2.78	2.0
2755	1.24	1.73	1.05	.....	.....	4.14	4.11	4.15	1.53	7.29	7.0	8.82	8.0	7.06	7.0
2778	1.64	0.86	0.25	0.89	0.48	4.12	4.11	3.03	1.58	7.13	7.0	8.71	8.0	7.06	7.0
3072	1.28	0.90	0.67	0.49	0.21	3.55	3.29	2.50	1.79	8.56	8.0	10.35	9.0	6.41	6.0
3078	0.72	0.76	0.85	.....	.....	2.62	2.47	1.42	1.53	6.44	6.0	7.97	7.0	10.73	10.0
2765	1.25	0.29	0.49	0.78	0.55	3.36	3.29	2.71	1.44	6.29	6.0	7.73	7.0	10.00	10.0
2796	1.31	0.85	0.37	0.56	0.27	3.36	3.29	2.49	1.79	6.41	6.0	8.20	7.0	10.00	10.0
2756	1.20	1.24	0.87	0.82	0.18	4.31	4.11	3.94	1.53	7.07	7.0	8.60	8.0	10.06	10.0
2763	1.17	1.23	0.45	0.93	0.40	4.18	4.11	3.75	1.84	7.19	7.0	9.03	8.0	10.01	10.0
2833	0.54	0.80	0.45	0.47	0.35	2.61	2.47	1.61	1.22	6.63	6.0	7.85	7.0	5.32	5.0
2757	1.14	0.90	0.63	0.78	0.25	3.70	3.70	2.31	2.11	6.50	7.0	8.61	8.0	11.90	10.0
2764	1.35	1.07	0.39	0.83	0.40	4.04	3.70	4.50	1.25	7.20	7.0	8.45	8.0	10.26	10.0
2702	.....	.....	.....	.....	.....	.....	.....	10.45	0.20	15.72	14.0	15.92	15.0	.....	.....
2705	.....	.....	5.65	2.92	1.43	10.00	9.84	0.61	2.18	6.29	.....	8.47	.....	.....	.....
3033	.....	1.78	0.89	0.81	0.56	4.04	4.10	4.72	0.93	7.22	7.0	8.15	8.0	8.00	8.0
2555	.....	1.18	1.12	0.72	0.30	3.32	3.28	4.18	0.82	6.26	6.0	7.08	7.0	10.00	10.0
2701	.....	1.30	0.86	0.73	0.43	3.32	3.28	4.02	0.74	6.64	6.0	7.38	7.0	10.00	10.0
2565	0.36	0.04	0.49	0.31	0.14	1.34	1.23	5.58	0.73	7.24	7.0	7.97	8.0	2.51	2.0
2700	0.55	0.02	0.32	0.26	0.09	1.24	1.23	6.89	0.97	6.70	7.0	7.67	8.0	2.03	2.0
2564	0.06	0.74	0.34	0.38	0.11	1.63	1.64	6.32	1.20	8.10	8.0	9.30	9.0	3.05	3.0
2977	0.40	0.42	0.68	0.30	0.22	2.02	1.64	6.30	1.51	8.38	8.0	9.89	9.0	3.12	3.0
3053	.....	0.96	0.76	0.49	0.27	2.48	2.46	5.82	0.92	8.04	8.0	8.96	9.0	6.08	6.0
2542	.....	1.66	1.04	0.66	0.42	3.78	3.69	5.17	0.98	7.15	7.0	8.13	8.0	10.17	10.0
2780	0.26	1.54	1.07	0.62	0.35	3.84	3.69	5.10	1.08	7.18	7.0	8.26	8.0	9.60	10.0
2782	0.18	1.28	1.16	0.64	0.42	3.68	4.10	4.75	0.98	6.99	7.0	7.97	8.0	8.80	7.0
2803	0.63	1.14	1.43	0.64	0.44	4.28	4.10	4.94	0.83	7.01	7.0	7.84	8.0	7.64	7.0
2699	.....	0.03	0.65	.....	.....	0.90	0.82	4.78	0.98	7.06	7.0	8.04	8.0	1.16	1.0
2562	0.04	0.34	0.78	0.38	0.22	1.76	1.64	4.71	1.05	7.08	7.0	8.13	8.0	4.03	4.0
2698	.....	1.15	.....	0.45	0.08	1.68	1.64	4.12	1.24	7.25	7.0	8.49	8.0	4.05	4.0
2554	0.56	0.42	0.67	0.50	0.22	2.37	2.46	4.50	0.56	6.30	6.0	6.86	7.0	10.13	10.0
2792	0.50	0.36	1.14	0.56	0.18	2.74	2.46	4.31	0.91	6.03	6.0	6.94	7.0	10.00	10.0

Descriptive List of Fertilizer Samples, 1914.

Station number.	Manufacturer, place of business and brand.
2543	New England Superphosphate, For all crops
2810	New England Superphosphate, For all crops
2704	Nitrate of Soda
	NEW MINERAL FERTILIZER CO., BOSTON, MASS.
3111	New Mineral Plant Food*
	NITRATE AGENCIES CO., NEW YORK CITY, N. Y.
2647	Acid Phosphate
2985	Acid Phosphate
3096	Ground Bone
2648	Ground Tankage
2986	Ground Tankage
2650	Muriate of Potash*
2649	Nitrate of Soda
2984	Nitrate of Soda
	PAN AMERICAN FERTILIZER CO., NEW YORK CITY, N. Y.
2872	Vegetable and Potato Special
	PARMENTER & POLSEY FERTILIZER CO., BOSTON, MASS.
2875	P. & P. "A. A." Brand
2566	P. & P. Aroostook Special, with 10% Potash
2719	P. & P. Aroostook Special, with 10% Potash
3006	P. & P. Grain Grower*
2560	P. & P. Maine Potato Fertilizer, With 10% Potash
2551	P. & P. Plymouth Rock Brand Fertilizer—For all crops
3007	P. & P. Plymouth Rock Brand Fertilizer—For all crops
3005	P. & P. Potato Fertilizer
3101	P. & P. Potato Grower, With 10% Potash
2556	P. & P. Special Potato Fertilizer for Potatoes and all Root Crops
	PORTLAND RENDERING CO., PORTLAND, ME.
2965	Portland Ammoniated Bone Flour
2559	Portland Organic Fertilizers Animal Brand
2842	Portland Organic Fertilizers Animal Brand
2841	Portland Organic Fertilizers Cumberland Garden Manure
2962	Portland Organic Fertilizers Cumberland Garden Manure
2558	Portland Organic Fertilizers Potato Grower
2737	Portland Organic Fertilizers Potato Grower
	ROGERS & HUBBARD CO., MIDDLETOWN, CONN.
3021	Hubbard's "Bone Base" All Soils—All Crops Phosphate
3023	Hubbard's "Bone Base" Complete Phosphate
3068	Hubbard's "Bone Base" Complete Phosphate.
3013	Hubbard's "Bone Base' Fertilizer for Oats & Top Dressing
3014	Hubbard's "Bone Base" Fertilizer for Seeding Down and Fruit
3022	Hubbard's "Bone Base" New Market Garden Phosphate
3069	Hubbard's "Bone Base" New Market Garden Phosphate
3011	Hubbard's "Bone Base" Potato Phosphate
3020	Hubbard's "Bone Base" Soluble Potato Manure
3066	Hubbard's "Bone Base" Soluble Potato Manure
3067	Hubbard's "Bone Base" Soluble Tobacco Manure

*Not registered in 1914.

Analysis of Fertilizer Samples, 1914.

Station number.	Nitrogen.							Phosphoric Acid.						Potash.	
			Organic.			Total.				Available.		Total.			
	As nitrate.	As ammonia.	As water soluble.	As active insoluble.	As inactive insoluble.	Found.	Guaranteed.	Soluble.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
2543	0.78	0.44	0.32	0.51	0.25	2.30	2.46	6.60	1.28	8.77	8.0	10.05	9.0	4.30	4.0
2810	0.72	0.46	1.03	0.51	0.23	2.95	2.48	6.60	1.21	8.65	8.0	9.86	9.0	4.33	4.0
2704	15.00	.....	.....	.....	.....	15.00	15.00	.....	.....	.....	.....	.....	.....	.....	.....
3111	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.16	0.23	0.04	.....
2647	.....	.....	.....	.....	.....	.....	.....	14.91	0.33	18.01	14.0	18.34	15.0	.....	.....
2985	.....	.....	.....	.....	.....	.....	.....	12.66	0.63	16.63	14.0	17.26	15.0	.....	.....
3096	.....	.....	.....	.....	.....	2.54	2.46	.....	.....	.....	.....	22.88	22.9	.....	.....
2648	.....	.....	2.05	2.62	1.28	5.95	5.75	.....	.....	.....	.....	15.81	6.9	.....	.....
2986	.....	.....	3.98	2.69	0.43	7.10	5.75	.....	.....	.....	.....	12.27	6.9	.....	.....
2650	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	51.12	50.0
2649	15.36	.....	.....	.....	.....	15.36	15.00	.....	.....	.....	.....	.....	.....	.....	.....
2984	15.52	.....	.....	.....	.....	15.52	15.00	.....	.....	.....	.....	.....	.....	.....	.....
2872	1.34	1.60	0.04	0.38	0.15	3.51	3.28	0.86	1.21	6.11	6.0	7.32	7.0	9.83	10.0
2875	.....	2.05	1.09	0.71	0.45	4.30	4.10	5.30	1.17	6.74	7.0	7.91	8.0	8.40	8.0
2566	0.02	1.58	0.95	0.60	0.54	3.69	3.69	5.17	1.15	7.18	7.0	8.33	8.0	10.00	10.0
2719	.....	1.59	1.07	0.65	0.39	3.70	3.69	5.30	1.05	7.15	7.0	8.20	8.0	10.04	10.0
3006	0.12	0.48	0.74	0.41	0.21	1.96	1.24	4.12	0.60	6.78	7.0	7.38	8.0	2.04	2.0
2560	0.10	1.14	1.01	0.70	0.47	3.42	3.28	4.40	0.70	6.25	6.0	6.95	7.0	10.15	10.0
2551	0.80	0.44	1.06	0.52	0.22	3.04	2.46	6.56	1.40	8.49	8.0	9.89	9.0	4.34	4.0
3007	0.58	0.44	0.98	0.45	0.24	2.69	2.46	6.25	0.96	8.31	8.0	9.27	9.0	4.10	4.0
3005	0.30	0.40	0.65	0.24	0.13	1.72	1.64	4.12	0.79	6.24	6.0	7.03	7.0	6.25	6.0
3101	0.65	0.42	0.65	0.53	0.21	2.46	2.46	4.61	0.63	6.45	6.0	7.08	7.0	10.00	10.0
2556	0.05	1.19	1.09	0.77	0.36	3.46	3.28	6.06	0.92	8.17	8.0	9.09	9.0	7.18	7.0
2965	.....	.....	.....	.....	.....	3.01	3.29	.....	.....	.....	.....	25.60	22.00	.....	.....
2559	0.40	0.70	0.80	0.43	0.19	2.52	2.46	5.81	0.51	9.47	8.0	9.98	9.0	4.61	4.0
2842	0.33	0.74	0.76	0.41	0.22	2.46	2.46	5.90	0.61	9.37	8.0	9.98	9.0	4.42	4.0
2841	0.57	1.15	1.19	0.76	0.47	4.14	4.10	5.45	1.02	8.68	7.0	9.70	8.0	6.82	6.0
2962	0.90	0.96	1.25	0.59	0.42	4.12	4.10	5.77	1.19	8.99	7.0	10.18	8.0	6.37	6.0
2558	0.52	0.78	0.90	0.75	0.35	3.30	3.28	4.78	0.66	7.65	6.0	8.31	7.0	10.60	10.0
2737	0.64	0.96	0.41	0.92	0.52	3.45	3.28	2.87	2.70	8.10	6.0	10.80	7.0	10.40	10.0
3021	1.72	0.08	0.96	0.58	0.26	3.60	3.30	4.47	2.05	8.48	8.0	10.53	9.0	7.16	7.0
3023	0.30	0.06	0.35	0.66	0.37	1.74	1.50	5.04	1.71	8.82	7.0	10.53	8.0	5.23	5.0
3068	0.47	0.10	0.08	0.72	0.31	1.68	1.50	4.56	2.08	8.54	7.0	10.62	8.0	5.65	5.0
3013	5.53	0.01	1.33	0.37	1.03	8.27	8.50	0.16	1.31	7.06	4.5	8.37	8.0	9.40	8.0
3014	0.10	0.04	0.38	1.14	0.44	2.10	2.20	0.21	6.12	12.06	6.5	18.18	16.0	12.80	12.0
3022	0.73	0.04	0.63	0.35	0.20	1.95	2.00	2.84	1.58	6.81	6.0	8.39	7.0	10.87	10.0
3069	0.80	0.04	0.52	0.47	0.17	2.00	2.00	2.79	1.89	7.15	6.0	9.04	7.0	10.00	10.0
3011	0.73	0.04	0.70	0.59	0.27	2.33	2.00	6.41	1.77	9.62	9.0	11.39	10.0	5.00	5.0
3020	2.15	0.27	0.90	1.05	0.38	4.75	5.00	1.63	1.88	9.11	7.0	10.99	10.0	7.12	5.0
3066	2.24	0.28	1.04	0.93	0.40	4.89	5.00	1.56	1.89	9.08	7.0	10.97	10.0	6.61	5.0
3067	2.19	0.19	0.96	1.25	0.45	5.04	5.00	1.02	2.11	8.90	7.0	11.01	10.0	11.19	10.0

Descriptive List of Fertilizer Samples, 1914.

Station number.	Manufacturer, place of business and brand.
	F. S. ROYSTER GUANO CO., BALTIMORE, MD.
3036	Royster's Complete Potato Manure
2834	Royster's Gold Seal Potato & Cabbage Special
3035	Royster's Universal Truck Fertilizer
	SAGADAHOC FERTILIZER CO., BOWDOINHAM, ME.
2955	Acid Phosphate
2954	Muriate of Potash
2953	Nitrate of Soda
2668	Sagadahoc Aroostook Potato Manure
2959	Sagadahoc Aroostook Potato Manure
2663	Sagadahoc Dirigo Fertilizer
2960	Sagadahoc Dirigo Fertilizer
2957	Sagadahoc Fisher Formula
2787	Sagadahoc 5-8-7 Fertilizer
2952	Sagadahoc 5-8-7 Fertilizer
2736	Sagadahoc 4-6 and 10 Fertilizer
2786	Sagadahoc 4-6 and 10 Fertilizer
2666	Sagadahoc High Grade Superphosphate
2961	Sagadahoc 6-6 and 6 Fertilizer
2667	Sagadahoc Special Corn Fertilizer
2958	Sagadahoc Special Corn Fertilizer
2956	Sagadahoc Special Potato Fertilizer
2664	Sagadahoc 3-6 and 10 Fertilizer
2951	Sagadahoc XX Chemical Brand
2665	Sagadahoc Yankee Fertilizer
	J. W. SANBORN, GILMANTON, N. H.
3002	Prof. Sanborn's Fertilizer for Potatoes and Corn
3017	Prof. Sanborn's Fertilizer for Potatoes and Corn
3102	Prof. Sanborn's Fertilizer for Use in the Hill and Drill
3018	Prof. Sanborn's Grass and Grain Fertilizer
	I. P. THOMAS & SON CO., PHILADELPHIA, PA.
2858	Farmers Union of Maine, 5-8-7
3041	Farmers Union of Maine, 5-8-7
2857	Farmers Union of Maine, 4-8-7
3008	Farmers Union of Maine, 4-8-7
2886	Farmers Union of Maine, 4-8-10
2856	Farmers Union of Maine, 4-6-10
3040	Farmers Union of Maine, 4-6-10
	TUSCARORA FERTILIZER WORKS, BALTIMORE, MD.
3032	Aroostook Special
3077	Complete Potato
3090	Complete Potato
3026	Fruit and Potato
2849	Trucker
2978	Trucker
	UNION CHEMICAL WORKS, INC., NORTH WALES, PA.
2706	Johnson Seed Potato Co. Planting Brand Ideal Potato Manure

*Not registered in 1914.

Analysis of Fertilizer Samples, 1914.

Station number.	Nitrogen.							Phosphoric Acid.						Potash.	
			Organic.			Total.				Available.		Total.			
	As nitrate.	As ammonia.	As water soluble.	As active insoluble.	As inactive insoluble.	Found.	Guaranteed.	Soluble.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
3036	.....	1.72	0.29	0.74	0.55	3.30	3.29	3.41	1.26	6.65	6.0	7.91	6.5	10.47	10.0
2834	0.11	0.96	0.23	0.47	0.29	2.06	1.65	3.91	1.66	7.75	8.0	9.41	8.5	10.41	10.0
3035	.....	1.92	0.44	0.86	0.34	3.56	3.29	4.19	1.56	8.25	8.0	9.81	8.5	8.26	7.
2955	.....	.....	.....	.....	.....	.....	.....	14.13	0.38	17.09	16.0	17.47	17.0	.....	.....
2954	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	50.40	50.0
2953	15.12	.....	.....	.....	.....	15.12	15.00	.....	.....	.....	.....	.....	.....	.....	.....
2668	0.80	0.28	0.39	.....	.....	1.69	1.05	1.18	1.43	9.21	8.0	10.64	10.0	5.59	4.5
2959	0.86	0.13	0.45	.....	.....	1.62	1.05	6.08	1.07	10.73	6.0	11.80	7.0	5.04	4.5
2663	0.10	.....	0.32	0.49	0.19	1.10	1.00	0.48	4.89	7.84	5.0	12.73	7.0	4.47	2.0
2960	0.64	0.16	0.16	0.50	0.35	1.81	1.00	6.20	2.08	10.60	5.0	12.69	7.0	5.55	2.0
2957	3.30	3.30	0.15	.....	.....	6.80	6.80	4.05	0.13	5.23	3.0	5.35	4.0	13.69	11.0
2787	1.92	0.86	0.72	.....	.....	3.58	4.12	2.79	1.11	9.58	8.0	10.69	9.0	7.05	7.0
2952	2.33	0.73	0.38	.....	.....	3.66	4.12	2.60	0.84	9.43	8.0	10.27	9.0	8.18	7.0
2736	1.83	0.70	0.67	.....	.....	3.31	3.29	3.65	0.69	9.36	6.0	10.05	7.0	9.57	10.0
2786	1.76	0.78	0.46	.....	.....	3.06	3.29	3.59	0.57	9.10	6.0	9.67	7.0	9.48	10.0
2666	1.54	0.24	0.32	.....	.....	2.14	1.50	9.97	0.46	12.97	7.0	13.43	7.0	4.00	3.0
2961	2.48	1.34	1.07	.....	.....	4.98	4.94	1.44	0.87	9.18	6.0	10.05	7.0	6.44	6.0
2667	0.84	0.51	0.46	.....	.....	1.94	2.20	6.86	3.99	11.72	6.0	15.71	8.0	4.48	4.0
2958	1.05	0.70	0.28	.....	.....	2.28	2.20	7.15	3.50	12.08	8.0	15.58	9.0	4.56	4.0
2956	1.40	0.47	0.28	.....	.....	2.20	2.00	6.64	0.52	10.34	7.0	10.86	8.0	8.19	8.0
2664	1.42	0.60	0.60	.....	.....	2.62	2.47	5.69	0.70	10.46	6.0	11.16	7.0	9.54	10.0
2951	6.92	0.10	0.55	.....	.....	7.76	6.00	0.19	3.96	7.65	3.0	11.61	6.0	8.00	8.0
2665	0.42	0.08	.....	.....	.....	0.52	0.40	11.77	0.43	14.47	6.0	14.90	7.0	3.13	2.0
3002	0.78	0.04	0.94	1.29	0.41	3.46	3.00	4.86	1.44	7.73	7.0	9.17	9.0	8.41	8.0
3017	0.92	0.08	1.11	1.14	0.47	3.72	3.00	5.68	1.17	7.83	7.0	9.00	9.0	9.28	8.0
3102	1.06	0.06	0.34	0.56	0.36	2.38	2.35	4.42	1.97	7.50	7.5	9.47	11.0	4.90	4.0
3018	3.98	0.02	0.83	0.25	0.06	5.14	4.75	3.03	1.19	5.25	5.0	6.44	5.8	6.39	6.0
2858	0.76	2.24	0.45	0.50	0.15	4.10	4.11	5.28	0.90	8.00	8.0	8.90	8.5	7.16	7.0
3041	0.84	1.72	0.27	0.43	0.29	3.55	4.11	6.03	0.46	8.00	8.0	8.46	8.5	7.73	7.0
2857	1.13	1.82	0.28	0.60	0.21	4.04	3.29	5.65	0.94	8.93	8.0	9.87	8.5	7.48	7.0
3008	0.58	1.64	0.61	0.42	0.37	3.62	3.29	6.70	0.52	8.28	8.0	8.80	8.5	7.23	7.0
2886	0.76	1.66	0.18	0.47	0.34	3.41	3.29	6.89	0.76	8.78	8.0	9.54	8.5	9.58	10.0
2856	0.64	1.50	0.41	0.48	0.31	3.34	3.29	4.93	0.46	6.78	6.0	7.24	6.5	9.73	10.0
3040	0.58	1.62	0.33	0.52	0.43	3.48	3.29	4.93	0.38	6.81	6.0	7.19	6.5	10.29	10.0
3032	.....	1.20	0.40	0.49	0.41	2.50	2.47	5.42	0.45	7.54	7.0	7.99	7.5	8.39	8.0
3077	0.29	1.30	0.65	0.56	0.30	3.10	3.29	4.23	0.47	6.45	6.0	6.92	6.5	10.62	10.0
3090	0.52	1.38	0.32	0.48	0.28	2.98	3.28	5.14	0.38	6.54	6.0	6.92	6.5	10.04	10.0
3026	0.01	0.50	0.76	0.40	0.19	1.86	1.65	4.18	1.22	7.84	8.0	9.06	8.5	10.28	10.0
2849	0.60	1.46	0.90	0.65	0.37	3.98	4.11	4.85	1.10	8.10	8.0	9.20	8.5	7.21	7.0
2978	0.58	1.62	1.38	0.42	0.24	4.24	4.11	6.17	0.41	8.28	8.0	8.69	8.5	7.33	7.0
2706	0.25	1.80	0.52	0.63	0.35	3.55	4.00	7.11	0.37	8.72	8.0	9.09	.....	10.00	10.0

Descriptive List of Fertilizer Samples, 1914.

Station number.	Manufacturer, place of business and brand.
	VIRGINIA-CAROLINA CHEMICAL CO., NEW YORK CITY, N. Y.
2820	V. C. C. Co.'s Beef Blood & Bone BBB
2793	V. C. C. Co.'s Champion Corn & Grain Grower
2819	V. C. C. Co.'s General Crop Grower
2794	V. C. C. Co.'s Indian Brand for Potatoes & General Use
2596	V. C. C. Co.'s Star Brand Potato & Vegetable Compound
2982	V. C. C. Co.'s Star Brand Potato & Vegetable Compound
2595	V. C. C. Co's 20th Century Potato Manure
2847	V. C. C. Co.'s 20th Century Potato Manure
	WHITMAN & PRATT RENDERING CO., LOWELL, MASS.
3088	Whitman & Pratt's All Crop
3087	Whitman & Pratt's Potash Special
2892	Whitman & Pratt's Pure Ground Bone
3089	Whitman & Pratt's Vegetable Grower

Analysis of Fertilizer Samples, 1914.

Station number.	Nitrogen.							Phosphoric Acid.						Potash.	
			Organic.			Total.				Available		Total.			
	As nitrate.	As ammonia.	As water soluble.	As active insoluble.	As inactive insoluble.	Found.	Guaranteed.	Soluble.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
2820	0.12	2.02	0.30	0.50	0.40	3.34	3.29	6.24	1.68	8.62	8.0	10 30	9.0	7.59	7.0
2793	0.10	0.94	0.30	0.42	0.16	1.92	1.65	6.97	1.77	10.19	10.0	11.96	11.0	5.12	5.0
2819	0.08	0.38	0.22	0.18	0.14	1.00	0.82	3.11	1.57	8.43	8.0	10.00	9.0	5.22	5.0
2794	0.02	1.12	0.42	0.47	0.32	2.35	2.47	3.52	1.25	6.64	6.0	7.89	7.0	10.55	10.0
2596	0.05	2.11	0.47	0.52	0.47	3.62	3.29	4.29	1.24	6.80	6.0	8.04	7.0	10.06	10.0
2982	0.01	2.25	0.41	0.35	0.64	3.66	3.29	3.54	1.39	6.49	6.0	7.88	7.0	10.74	10.0
2595	0.06	2.68	0.44	0.61	0.35	4.14	4.12	6.73	1.44	9.12	8.0	10.56	9.0	8.00	8.0
2847	0.10	2.98	0.35	0.47	0.36	4.26	4.12	6.30	1.61	8.33	8.0	9.94	9.0	9.16	8.0
3088	1.40	0.02	0.32	0.50	0.36	2.60	2.46	4.78	3.06	8.89	9.0	11.95	11.0	4.00	4.0
3087	0.71	0.07	0.94	0.64	0.54	2.90	2.87	2.34	2.36	6.09	6.0	8 45	8.0	11.45	10.0
2892	.....	.....	.....	.....	.....	2.88	2.46	.....	.....	.....	.....	26.29	22.0	.....	.....
3089	1.32	0.24	0.81	0.48	0.45	3.30	3.29	4.40	1.89	8.22	8.0	10.11	10.0	7.48	7.0

STATEMENT BY THE EXECUTIVE OF THE LAW.

A. M. G. SOULE, CHIEF BUREAU OF INSPECTIONS.

Acting upon the instructions of the statute, collections of samples of fertilizers were made by this department in the spring of 1914. Great care was exercised to have these samples fairly represent the class of goods sold in the open market and in each instance where the lot was of any amount, the sample was tâken from ten bags of the fertilizer and thoroughly mixed.

Most of the fertilizer manufacturers have shown a willingness to comply with the law and protect the dealers handling their products in this state by the necessary registration; their attitude in general has been very fair and businesslike and there have been but few exceptions.

The inspectors found during the season, on their rounds taking samples, eighteen brands not protected by registration. Hearings were then arranged with the dealers with whom these goods were found and explanation requested. As a result of these hearings, it was found in some cases that the goods had been shipped direct from the manufacturer to the consumer and—as the law was interpreted—did not require registration; in other instances it proved to be an oversight on the part of the manufacturers, evidently entirely unintentional.

It will be seen from the tabulations that most of the samples collected by the inspectors and analyzed at the Experiment Station have been found to be true to guaranty. Whenever there have been exceptions, upon receiving a report of the analysis a hearing has been arranged and the parties were not excused until a satisfactory explanation as to the deficiency was given.

During the past season it has been brought to the attention of the department that the New Mineral Fertilizer Company, who have a plant at Rumford, Maine, have been selling goods evidently contrary to the law, no registration having been issued to them from this office. In order to ascertain the volume of business and the amount of the product shipped from Rumford station from January 1st, 1914, to May 9th, 1914, the matter was carefully taken up by one of our deputies and the result of his investigation showed that 224 tons had been shipped out of the state and 52 tons shipped to different points within the state. It was also ascertained from the different people to whom these goods had been shipped that actual sales had taken place; possessed of this evidence, a hearing was arranged with the New Mineral Fertilizer Company and a request made for an explanation as to why registration had not been arranged. At this time a refusal to register their product was made through their attorney. Samples of the goods were obtained throughl several sources and analyses made and the parties to whom the goods had been shipped, the Director of the Experiment Station and the writer, appeared before the Grand Jury in Portland at the September term of court. A true bill was found by the Grand Jury but, owing to the congestion of business at that time, the case was continued and will probably be brought up in the next term of the Superior Court of Cumberland County. After all that has been written warning people concerning the worthlessness of this product for fertilizing purposes, it seems almost incredible that this company were able to dispense 275 tons. The writer only recently received from one of the users of this product a statement that, in his opinion, ordinary road dust would have served better for fertilizing purposes than did this rock dust.

As several inquiries have been received regarding just what the attitude of this department will be towards the fertilizer companies selling goods containing less potash than formerly, or brands with their guaranty changed from what it has been in previous years, it may be well to state that we have replied to all such inquiries to the effect that there will be no interference with any brand when the guaranty on the certificate and on the package as to the amount of potash agree with that found in the analysis. There is nothing in the law that prevents the sale of a fertilizer that contains no potash, and realizing the dearth of potash and the hardship to the manufacturers, it will be the policy of this demartment to assist and coöperate with the manufacturers in every way possible, keeping always within the limits of the law, however.

November, 1914.

MAINE
AGRICULTURAL EXPERIMENT STATION,
ORONO, MAINE.
CHAS. D. WOODS, Director.

ANALYSTS.

James M. Bartlett
Royden L. Hammond
Elmer R. Tobey
Herman H. Hanson
Edward E. Sawyer
Hoyt D. Lucas

Official Inspections

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ICE CREAM.

During the summer of 1914 large numbers of samples of ice cream were collected in various parts of the State. An attempt was made to cover the larger towns quite thoroughly. Practically all of the places that were found in 1913 to be selling ice cream below the standard were visited and samples taken. Whenever a sample of ice cream was found to be nearly up to the standard or samples were found to run under, in the case of makers that had been found all right in previous years second samples were taken before reporting the results of the first examination to the person whose goods were sampled. In the

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NOTE. The Commissioner of Agriculture is the executive of the law regulating the sale of food in Maine. It is the duty of the Maine Agricultural Experiment Station to make the analysis of the samples collected under the direction of the Commissioner, and it is the duty of the Director of the Station to publish the results of the analyses together with the names of the persons from whom the samples were obtained, the names of the manufacturers and such additional information as may seem advisable. All correspondence relative to the inspection laws should be addressed to the Commissioner of Agriculture, Augusta, Maine.

case of the ice creams within one and one-half per cent of the standard it was recommended that the dealers and makers be warned. In the cases in which there was a serious falling off it was recommended that hearings be appointed and the cases fully investigated.

Standards.

In considering this report it should be kept in mind that the standard for ice cream is as follows:

"Ice cream is a frozen product made from cream and sugar, with or without a natural flavoring, and contains not less than fourteen (14) per cent of milk fat. A limited amount of gelatine, starch, eggs, or other healthful food constituents may be added to ice cream without statement of fact, and such goods may be called ice cream provided the required per cent of milk fat is maintained. If imitation flavoring materials are used, the label must state that fact, as in the case of imitation extracts."

"Fruit ice cream is a frozen product made from cream, sugar, and sound, clean, mature fruits, and contains not less than twelve (12) per cent of milk fat."

"Nut ice cream is a frozen product made from cream, sugar, and sound, nonrancid nuts, and contains not less than twelve (12) per cent of milk fat."

"Imitation ice cream. Frozen products which contain less milk fat than the standards require, cannot be lawfully sold as ice cream and the word *cream* cannot be lawfully used upon the labels or in any way in connection with such goods, unless it is qualified by some such words as 'imitation' or 'substitute.' Thus a frozen product similar to ice cream or fruit or nut ice cream, except that it carries less milk fat than the standards may be lawfully labeled 'Imitation ice cream,' or 'Ice cream substitute.' If an imitation ice cream contains imitation flavoring matter, this fact must be plainly stated on the label."

"At soda fountains, ice cream rooms, etc., if it is desired to sell frozen products that do not conform to the standards for ice cream, conspicuous signs showing exactly what is being served must be displayed and orders for ice cream can not be lawfully filled by serving substitutes without explaining what they are."

"The regulation relative to ice cream and ice cream substitutes applies equally to hotels and restaurants. All statements upon bills of fare, etc., must be in accord with the above."

"The standard for cream in the State of Maine is fixed by statute at eighteen per cent of milk fat. It is unlawful to sell any article as cream that carries less than this amount of milk fat."

Table showing the results of the examination of samples of ice cream collected in the season of 1914, arranged alphabetically by towns.

Sta. No.	Town and Dealer.	Cream sold as	Per Cent Milk Fat. Standard.	Found.
			Per cent.	Per cent.
13342	Auburn. A. Baker	Vanilla	14	17.01
13330	Auburn. J. C. Berry	Vanilla	14	14.96
13365	Auburn. A. Borenstein	Vanilla	14	19.76
13361	Auburn. Bumpus & Getchell	Vanilla	14	15.28
13336	Auburn. F. A. Corey	Vanilla	14	15.52
13335	Auburn. E. L. Fowles	Vanilla	14	15.23
13334	Auburn. R. W. Milburn	Vanilla	14	12.66
13333	Auburn. R. A. Minnard	Vanilla	14	16.74
13331	Auburn. G. L. Moore	Vanilla	14	15.45
13344	Auburn. Raymond & Fortin	Chocolate	12	19.79
13328	Auburn. Rounds & Sands	Vanilla	14	23.99
13332	Auburn. F. L. Ruggles	Vanilla	14	21.05
13345	Auburn. B. D. Sullivan	Strawberry	12	16.16
13329	Auburn. L. E. Tarr	Vanilla	14	15.45
13210	Augusta. Augusta Fruit Co	Vanilla	14	16.44
13208	Augusta. Folsom & Son	Vanilla	14	13.49
13207	Augusta. H. Gerstin	Vanilla	14	18.56
13205	Augusta. L. LeVine	Vanilla	14	19.85
13206	Augusta. H. J. Marden	Chocolate	12	15.22
13209	Augusta. E. L. Winslow	Vanilla	14	12.66
13161	Bangor. East Side Pharmacy	Vanilla	14	17.04
13177	Bangor. Fifield & Co	Vanilla	14	13.69
13178	Bangor. G. T. Floros Co	Vanilla	14	19.05
13162	Bangor. N. T. Floros	Vanilla	14	17.79
13166	Bangor. Fowler's Drug Store	Vanilla	14	17.26
13165	Bangor. J. P. Frawley	Vanilla	14	17.68
13159	Bangor. Frank Karam	Vanilla	14	14.52
13160	Bangor. H. K. Priest	Vanilla	14	14.64
13176	Bangor. S. Schiro	Vanilla	14	17.83
13179	Bangor. John Skoufis	Vanilla	14	18.40
13180	Bangor. Caldwell Sweet	Vanilla	14	19.80

Table showing the results of the examination of samples of ice cream collected in the season of 1914, arranged alphabetically by towns—Continued.

Sta. No.	Town and Dealer.	Cream sold as	Per Cent Milk Fat.	
			Standard.	Found.
			Per cent.	Per cent.
13164	Bangor. Allen P. Trask	Vanilla	14	12.18
13163	Bangor. Zoidis Brothers	Vanilla	14	14.72
13087	Bar Harbor. Fred A. Gonya	Vanilla	14	12.97
13085	Bar Harbor. C. B. Higgins	Vanilla	14	12.12
13088	Bar Harbor. C. A. Keucher	Vanilla	14	13.27
13086	Bar Harbor. W. B. Marshall	Vanilla	14	19.13
13089	Bar Harbor. West End Drug Co	Vanilla	14	13.58
13056	Bath. J. F. Clary	Vanilla	14	15.01
13059	Bath. A. Hallett	Vanilla	14	14.76
13055	Bath. Leonard & Mitchell	Vanilla	14	14.00
13058	Bath. W. M. Temple Co	Vanilla	14	18.70
13057	Bath. Webber's Drug Store	Vanilla	14	14.68
13186	Belgrade Lakes. Mrs. Dora W. Hunt	Vanilla	14	14.40
12898	Biddeford. James Adams	Vanilla	14	13.70
13043	Biddeford. James Adams	Vanilla	14	14.32
12901	Biddeford. G. & A. Boucher	Vanilla	14	10.99
12894	Biddeford. Pete Frediani	Vanilla	14	14.39
12900	Biddeford. A. Mantis	Vanilla	14	15.88
12895	Biddeford. H. L. Merrill	Vanilla	14	13.76
12899	Biddeford. Louis Pelletier	Vanilla	14	13.83
12896	Biddeford. George Vassill	Vanilla	14	15.00
13173	Brewer. L. A. Boyrton	Vanilla	14	14.71
13175	Brewer. S. N. Dooey	Vanilla	14	15.80
13172	Brewer. Hinckley's Pharmacy	Vanilla	14	20.26
13174	Brewer. G. G. Hodgkins	Vanilla	14	14.84
13170	Brewer. Merrill Drug Co	Vanilla	14	15.35
13171	Brewer. B. N. Rowe	Vanilla	14	17.84
13169	Brewer. A. B. Yeaton	Vanilla	14	16.32
13060	Brunswick. H. J. Given	Vanilla	14	14.08
13061	Brunswick. F. E. Hall	Vanilla	14	13.04
13192	Burnham. Frank B. Brown	Vanilla	14	14.20

Table showing the results of the examination of samples of ice cream collected in the season of 1914, arranged alphabetically by towns—Continued.

Sta. No.	Town and Dealer.	Cream sold as	Per Cent Milk Fat. Standard.	Found.
			Per cent.	Per cent.
13191	Burnham. L. E. Gerald	Chocolate	12	4.01
13302	Buxton. Louis Bourgeois	Vanilla	14	18.08
13012	Calais. L. Bernardini	Vanilla	14	10.24
13009	Calais. A. R. Checci	Vanilla	14	8.84
13010	Calais. Mrs. Jane Todd	Vanilla	14	7.51
13011	Calais. Tori Brothers	Vanilla	14	11.60
13037	Camden. E. E. Boynton	Vanilla	14	15.07
13047	Camden. Burkett Brothers	Vanilla	14	18.36
13036	Camden. Camden Baking Co	Vanilla	14	17.44
13035	Camden. Geo. Mixer	Vanilla	14	11.82
13272	Canton. Nathan Reynolds	Vanilla	14	14.33
13063	Cherryfield. U. G. Gardner	Vanilla	14	11.60
13062	Cherryfield. W. A. Van Wart	Vanilla	14	10.44
13273	Chisholm. A. Poisson	Vanilla	14	14.36
13051	Damariscotta. Frank Jacobs	Vanilla	14	15.52
13015	Deer Isle. Mrs. H. J. Pickering	Vanilla	14	8.58
12991	Eastport. W. F. Capen	Vanilla	14	15.65
12992	Eastport. A. Conti	Vanilla	14	11.19
12990	Eastport. Gouldings Restaurant	Vanilla	14	7.56
12993	Eastport. Havey & Wilson	Vanilla	14	15.69
12994	Eastport. J. P. Hutchinson	Vanilla	14	15.90
13034	East Machias. F. A. Hall	Vanilla	14	6.82
13095	Ellsworth. Chas. H. Leland	Vanilla	14	23.14
13091	Ellsworth. Mrs. J. Luchini	Vanilla	14	20.12
13094	Ellsworth. E. G. Moore	Vanilla	14	17.64
13090	Ellsworth. H. W. Morang	Vanilla	14	21.07
13093	Ellsworth. Parcher's Pharmacy	Vanilla	14	14.86
13092	Ellsworth. R. H. Smith	Vanilla	14	20.86
13267	Fairfield. Holman & Nelson	Vanilla	14	15.73
13268	Fairfield. C. E. Holt	Vanilla	14	18.86
13266	Fairfield. C. W. McGlintock	Vanilla	14	20.26
12787	Falmouth Foreside. C. G. Pierce	Vanilla	14	15.84

Table showing the results of the examination of samples of ice cream collected in the season of 1914, arranged alphabetically by towns—Continued.

Sta. No.	Town and Dealer.	Cream sold as	Per Cent Milk Fat.	
			Standard.	Found.
			Per cent.	Per cent.
13279	Farmington. Drake's Drug Store.....	Vanilla......	14	15.09
13278	Farmington. C. E. Marr............	Vanilla......	14	16.33
13277	Farmington. J. F. Norton...........	Vanilla......	14	15.78
13198	Gardiner. I. Baitler................	Vanilla......	14	10.07
13200	Gardiner. R. W. Beales Co..........	Vanilla......	14	10.70
13197	Gardiner. Bean's Drug Store........	Vanilla......	14	13.07
13201	Gardiner. F. H. Call................	Vanilla......	14	11.25
13199	Gardiner. C. W. Flint..............	Vanilla......	14	12.22
13304	Gorham. E. F. Caswell.............	Vanilla......	14	16.47
13303	Gorham. C. G. Pierce..............	Vanilla......	14	14.21
13204	Hallowell. C. B. Hobbs.............	Vanilla......	14	15.77
13203	Hallowell. A. H. Randall...........	Vanilla......	14	18.63
13202	Hallowell. Guy K. White...........	Vanilla......	14	17.38
12132	Kennebunk. V. G. Fiske............	Vanilla......	14	16.61
13116	Kennebunk. P. D. Greenleaf........	Vanilla......	14	17.81
13115	Kennebunkport. W. F. Goodwin.....	Vanilla......	14	21.38
13285	Kingfield. Mrs. Bertha Graves.......	Vanilla......	14	11.35
13127	Kittery. Clark & Rogers............	Vanilla......	14	21.89
13354	Lewiston. P. W. Babcock...........	Walnut.....	12	16.08
13364	Lewiston. Louise Beaumont.........	Vanilla.....	14	18.70
13339	Lewiston. C. Bilodeau..............	Vanilla......	14	14.60
13350	Lewiston. Mary Collins.............	Vanilla......	14	9.04
13340	Lewiston. L. Cote..................	Vanilla......	14	17.43
13343	Lewiston. E. Dubois...............	Strawberry..	12	19.19
13369	Lewiston. A. Ducasse..............	Vanilla......	14	15.50
13349	Lewiston. E. Dumont..............	Vanilla......	14	20.02
13355	Lewiston. A. Grant................	Strawberry..	12	15.19
13338	Lewiston. A. E. Harlow............	Vanilla......	14	17.86
13351	Lewiston. F. Huard................	Strawberry..	12	14.48
13353	Lewiston. Lewiston Candy Kitchen..	Strawberry..	12	17.07
13347	Lewiston. C. Morneau..............	Vanilla......	14	16.51
13346	Lewiston. M. C. Murphy............	Vanilla......	14	7.84

Table showing the results of the examination of samples of ice cream collected in the season of 1914, arranged alphabetically by towns—Continued.

Sta. No.	Town and Dealer.	Cream sold as	Per Cent Milk Fat. Standard.	Found.
			Per cent.	Per cent.
13352	Lewiston. C. W. Newell	Vanilla	14	15.38
13367	Lewiston. O. Parent	Strawberry	12	13.07
13357	Lewiston. R. Perkins	Vanilla	14	17.06
13356	Lewiston. Riker-Jaynes Drug Co	Vanilla	14	16.59
13341	Lewiston. G. E. Roberge	Chocolate	12	16.41
13363	Lewiston. T. J. Robinson	Vanilla	14	15.21
13368	Lewiston. George Ross	Vanilla	14	17.16
13366	Lewiston. A. Simard	Vanilla	14	15.14
13348	Lewiston. P. I. Simard	Chocolate	12	16.27
13337	Lewiston. H. F. Walker	Vanilla	14	18.84
13371	Lisbon. P. L. Cotton	Vanilla	14	20.86
13372	Lisbon. A. G. Deschenes	Vanilla	14	18.43
13274	Livermore Falls. E. Edgecomb	Vanilla	14	13.52
13275	Livermore Falls. B. B. Stinchfield	Vanilla	14	18.48
12996	Lubec. C. L. Adams	Vanilla	14	14.94
12995	Lubec. T. G. Mitchell	Vanilla	14	15.12
13046	Machias. R. D. Crane	Vanilla	14	11.66
13044	Machias. D. A. Curtins & Co	Vanilla	14	16.68
13045	Machias. J. P. Farris	Vanilla	14	8.98
13184	Newport. Jones & McKenney	Vanilla	14	16.37
13182	Newport. S. S. Slosberg	Vanilla	14	12.51
13183	Newport. E. W. Withee	Vanilla	14	14.37
13150	North Berwick. C. W. Goodwin	Vanilla	14	15.75
13022	North Haven. Bray & Miller	Vanilla	14	8.28
13024	North Haven. Mrs. F. M. Calderwood	Chocolate	12	7.47
13292	North New Portland. M. Weinberg	Vanilla	14	18.14
13194	North Windham. D. W. Cram	Vanilla	14	10.76
13193	North Windham. W. O. Gates	Vanilla	14	14.56
13270	Oakland. S. J. Foster	Vanilla	14	11.42
13269	Oakland. H. H. Hatfield	Vanilla	14	14.62
13271	Oakland. J. E. Morrisette	Vanilla	14	16.22
13120	Ogunquit. Mrs. Catherine Ayers	Vanilla	14	8.36

Table showing the results of the examination of samples of ice cream collected in the season of 1914, arranged alphabetically by towns—Continued.

Sta. No.	Town and Dealer.	Cream sold as	Per Cent Milk Fat. Standard.	Per Cent Milk Fat. Found.
			Per cent.	Per cent.
13119	Ogunquit. C. S. Littlefield..........	Vanilla......	14	19.70
13118	Ogunquit. Mrs. M. S. Perkins........	Vanilla......	14	10.65
12936	Old Orchard. Sears & Hinckley......	Vanilla......	14	15.64
12937	Old Orchard Vermont Ice Cream Co..	Vanilla......	14	20.83
13156	Orono. A. A. King................	Vanilla......	14	16.24
13155	Orono. George A. King............	Vanilla......	14	14.92
13153	Orono. Nichols Drug Store..........	Vanilla......	14	14.51
13152	Old Town H. I. Goldsmith........	Walnut......	12	16.22
12681	Old Town. Jordan Bros............	Vanilla......	14	15.74
12680	Old Town. Lunt's Cash Store.......	Vanilla......	14	14.53
13154	Old Town. W. C. Mutty...........	Vanilla......	14	17.82
12682	Old Town. Morin Bros.............	Vanilla......	14	17.22
13188	Pittsfield. Charles Baker...........	Vanilla......	14	15.72
13189	Pittsfield. R. N. Berry..............	Vanilla......	14	12.67
13190	Pittsfield. Nutter's Pharmacy.......	Chocolate....	12	15.21
13305	Portland. C. R. Chapman..........	Vanilla......	14	15.69
12984	Portland. Thomas Cristo...........	Vanilla......	14	15.43
12980	Portland. Deering Ice Cream Co.....	Vanilla......	14	17.45
12862	Portland. Jacob Gitlin..............	Vanilla......	14	16.60
12863	Portland. Sam Gitlin...............	Vanilla......	14	15.56
12977	Portland. Heseltine & Tuttle Co.....	Vanilla......	14	15.51
12981	Portland. Thersa Hilton............	Vanilla......	14	13.86
12939	Portland. Krikori Johnson..........	Vanilla......	14	18.39
12938	Portland. Jacob Linderberg.........	Vanilla......	14	13.48
12983	Portland. I. F. Lord & Son.........	Vanilla......	14	14.91
12866	Portland. O. S. Maxell.............	Vanilla......	14	14.00
12565	Portland. Merrill Cafe..............	Vanilla......	14	4.67
12865	Portland. Munjoy Ice Cream Co.....	Vanilla......	14	15.25
12979	Portland. C. C. Pooler.............	Vanilla......	14	23.76
12949	Portland. Riker-Jaynes.............	Vanilla......	14	13.53
12951	Portland. George E. Sawyer.........	Vanilla......	14	18.75
12940	Portland. George F. Soule..........	Vanilla......	14	15.28

Table showing the results of the examination of samples of ice cream collected in the season of 1914, arranged alphabetically by towns—Continued.

Sta. No.	Town and Dealer.	Cream sold as	Per Cent Milk Fat. Standard.	Found.
			Per cent.	Per cent.
12950	Portland. Arthur G. Spear	Vanilla	14	14.98
12978	Portland. H. L. Stimson	Vanilla	14	12.54
12941	Portland. Charles Thomas	Vanilla	14	16.35
12976	Portland. John J. Thuss	Vanilla	14	17.74
12975	Portland. West End Dairy	Vanilla	14	15.45
13196	Richmond. W. A. Bibber	Vanilla	14	17.82
13195	Richmond. F. R. Winslow	Vanilla	14	10.70
13041	Rockland. A. R. Havener	Vanilla	14	12.96
13040	Rockland. J. H. Meservey	Vanilla	14	14.82
13042	Rockland. Miss F. L. Stover	Vanilla	14	17.12
13050	Rockland. F. H. Whitney	Vanilla*	....	9.67*
13362	Sabattus. F. P. Lombard	Vanilla	14	18.67
13310	Saco. Napoleon Tatro	Vanilla	14	15.87
13080	Sanford. Bourisk Brothers	Vanilla	14	14.64
13078	Sanford. Powers & Ackroyd	Vanilla	14	12.62
13079	Sanford. Powers & Ackroyd	Vanilla	14	12.67
13077	Sanford. N. K. Spinney	Vanilla	14	10.89
13128	South Berwick. M. A. Gordon	Vanilla	14	12.53
12982	South Portland. W. W. Rich	Vanilla	14	14.11
13083	Springvale. Nick Augustinos	Vanilla	14	8.47
13082	Springvale. John J. Gibson	Vanilla	14	13.09
13081	Springvale. Charles P. Rowe	Vanilla	14	10.02
13084	Springvale. Nich. Seferlis	Vanilla	14	12.98
13158	Stillwater. H. C. Sibley	Vanilla	14	14.58
13019	Stonington. Mrs. H. Gardner	Vanilla	14	3.66
13018	Stonington. Mrs. Edna E. Merrill	Vanilla	14	2.36

* Sold for ice cream substitute.

Table showing the results of the examination of samples of ice cream collected in the season of 1914, arranged alphabetically by towns—Concluded.

Sta. No.	Town and Dealer.	Cream sold as	Per Cent Milk Fat. Standard.	Per Cent Milk Fat. Found.
			Per cent.	Per cent.
13016	Stonington. Noyes Pharmacal Co....	Vanilla......	14	17.17
13039	Thomaston. G. A. Moore............	Vanilla......	14	10.21
13020	Vinalhaven. H. Y. Carver & Son.....	Vanilla......	14	4.65
13021	Vinalhaven. J. W. P. Turner........	Vanilla*.....	....	4.77*
13023	Vinalhaven. L. A. Williams.........	Vanilla......	14	8.47
13048	Waldoboro. O. E. Ludwig..........	Vanilla......	14	14.16
13049	Waldoboro. C. B. Stahl.............	Vanilla......	14	13.26
13038	Warren. J. C. Munsey..............	Caramel.....	14	13.86
13259	Waterville. J. H. DeOrsay..........	Vanilla......	14	13.84
13263	Waterville. Evangelos & Condas.....	Vanilla......	14	16.96
13261	Waterville. Louis Facos............	Vanilla......	14	14.30
13265	Waterville. Hager's Candy Store.....	Vanilla......	14	15.18
13258	Waterville. Hayden's Candy Store...	Vanilla......	14	14.70
13262	Waterville. Red Cross Pharmacy.....	Vanilla......	14	14.97
13260	Waterville. J. D. Parents...........	Vanilla......	14	16.92
13257	Waterville. Verzoni Brothers........	Vanilla......	14	15.13
13117	Wells Beach. F. C. Bickford.........	Chocolate....	12	16.40
12947	Westbrook. F. D. Anderson.........	Vanilla......	14	17.31
13276	Wilton. E. P. Parlin................	Chocolate....	12	13.79
13052	Wiscasset. A. W. Kierstead.........	Vanilla......	14	16.29
13053	Wiscasset. E. H. Pushor...........	Vanilla......	14	16.99
13054	Woolwich. Mrs. Thomas Savage.....	Walnut......	12	5.33
13123	York Beach. H. Gleekman & Co.....	Chocolate....	12	17.71
13122	York Beach. J. J. Holland..........	Vanilla......	14	10.87
13125	York Beach. E. A. Talpey..........	Vanilla......	14	13.38
13124	York Harbor. Hawke's Pharmacy...	Vanilla......	14	18.97
13126	York Village. J. P. Sanford.........	Vanilla......	14	15.98

* Sold as ice cream substitute.

STATEMENT BY THE EXECUTIVE OF THE LAW.

A. M. G. SOULE, Chief, Bureau of Inspection.

In the collection of samples of ice cream, a wide range of territory was covered. Particular care was taken by the inspectors, along with the inspection work, to bring to the attention of the ice cream manufacturers in an educational way the requirements under the law. We also issued from this department, about the first of August, a regulatory announcement, essentially the same in text as given on page 143—with the addition of the penalty for the violation of the law and a clause of the dairy law informing the ice cream manufacturers of the protection afforded them when purchasing their raw material.

The deputies report a wilingness, with but few exceptions, on the part of the manufacturers to conform to the law and that very little fault has been found with the standard that is required.

As will be seen from the tabulations, some slight deficiencies were found in a few of the samples collected in the cities, but in nearly all these cases the deficiency was not large enough to warrant a hearing and a letter of warning was written which was apparently gratefully received.

Another feature noticed among the city dealers was a spirit of sharp competition and jealous guarding of their formulæ; as this has a tendency to raise the standard even above that required by law, I feel that it should be encouraged.

In some of the coast towns, and on the islands along the coast, where ice cream is made and sold only in mid-summer, particular care was taken to inquire the source of the raw material, the experience in manufacture, the price paid for the materials and the price charged for the frozen product. Among the samples of ice cream obtained from these localities, several were found to be deficient in milk fat. Hearings were arranged for cases of this nature and an explanation for each deficiency requested. In some cases the use of eggs was responsible for the reduction of the milk fat content, but it is gratifying to note that in no instance have we found a case where, to our belief, an intentional violation could have been proven.

In general the results obtained by collecting and analyzing the samples of ice cream have been most encouraging and it is indeed with pride that the statemennt is made that we believe the people of Maine are supplied with ice cream that is not surpassed anywhere. This condition is, perhaps, not due so much to the careful enforcement of the law as to the actual existence of a fair standard, to sharp competition among the producers and the honesty and integrity of the manufacturers.

Having been informed by the dealers whose samples have shown the highest milk fat content that a fair profit is made on a product that will analyze three or four per cent. above standard, and taking into consideration the fact that large quantities of this healthful and valuable food product are being shipped to this state, there seems to be a broad field for added manufacture by our own people, giving an outlet at a market nearer home for dairy products.

December, 1914

MAINE
AGRICULTURAL EXPERIMENT STATION,
ORONO, MAINE.
CHAS. D. WOODS, Director.

ANALYSTS.

James M. Bartlett
Royden L. Hammond
Elmer R. Tobey
Herman H. Hanson
Edward E. Sawyer
Hoyt D. Lucas

Official Inspections

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SEED INSPECTION.

The Commissioner of Agriculture is the executive of the law regulating the sale of agricultural seeds in Maine. It is the duty of the Maine Agricultural Experiment Station to make the analyses of the samples collected by the Commissioner, and it is the duty of the Director to publish the results of the analyses of the samples of agricultural seeds, together with the names of the persons from whom the samples were obtained, the names of the manufacturers thereof and such additional information as may seem advisable.

The first law regulating the sale of seeds was enacted by the Legislature of 1897. This was revised by the Legislature of 1905. This was again revised by the Legislature of 1911 so as to conform with the requirements recommended by the Association of Official Seed Analysts and agreed to by the American Seed Dealers Association. The chief requirements of the law follow. The full text of the law will be sent on request.

NOTE. All correspondence relative to the inspection laws should be addressed to the Commissioner of Agriculture, Augusta, Maine.

The Chief Requirements of the Law.

The following are the chief points of the law and the rules and regulations for carrying out the law regulating the sale of agricultural seeds which, as directed by the law, the Commissioner of Agriculture, has made.

1. *Kind of seeds coming under the law.* The law applies to the sale, distribution, transportation, or the offering or exposing for sale, distribution, or transportation of the seeds of alfalfa, barley, Canadian blue grass, Kentucky blue grass, brome grass, buckwheat, alsike clover, crimson clover, red clover, medium clover, white clover, field corn, Kaffir corn, meadow fescue, flax, hungarian, millet, oats, orchard grass, rape, redtop, rye, sorghum, timothy and wheat for seeding purposes.

2. *The brand.* Each lot or package shall be plainly marked with the name of the seed and its minimum percentage of purity.

3. *Mixtures.* Mixtures must be plainly marked with the name of the seed and the percentage of purity. In case the mixtures contain seeds not included in 1 these need not be named. (e. g., a mixture consisting of half redtop, 90 per cent pure, quarter Kentucky blue grass, 85 per cent pure and the remainder seeds not named in the law, could be marked "Redtop 45 per cent pure, Kentucky blue grass 21 per cent pure." The statement of the remaining constituents may or may not be named.)

4. *Adulteration.* A seed is adulterated if its purity falls below its guaranty or if it contains the seed of any poisonous plant.

5. *Misbranding.* A seed is misbranded if the package or label bears any statement, designed or device which is false or misleading in any particular, or if it does not carry the statements named in 2.

6. *Free analysis.* Free analysis of seeds on sale in Maine will be made of samples taken in accordance with directions furnished by the Commissioner of Agriculture. Sample not so taken may be refused examination. Blanks with full directions will be furnished on request.

7. *Paid analysis.* As an accommodation to residents of Maine samples of seeds not on sale in Maine will be examined

at cost, and the results will not be published. The cost of the analysis of blue grass or redtop is $1.00 per sample and for other seeds 50 cents. Remittance should accompany the sample.

8. *Written guaranty.* No prosecution will lie against any person handling agricultural seeds provided he obtains at the time of purchase a written guaranty signed by the person residing in the United States, from whom the purchase was made, to the effect that the seeds are not adulterated or misbranded within the meaning of the Maine law regulating the sale of agricultural seeds. After a person has been notified by the Commissioner of Agriculture that an article of agricultural seeds appears to be adulterated or misbranded the written guaranty will not protect further sales.

9. *Hearings.* The person who is believed to have violated the law regulating the sale of seeds will be granted a hearing at which he may appear in person or by attorney or by letter. The notice of the hearing will name the time and place of the hearing and a copy of the charge. Failure to appear will not prejudice the case. The hearing will be private and every opportunity will be given for explanation and establishment of innocence. If the time appointed is not a convenient one, postponement within reasonable limit will be granted.

Testing Seeds at Home.

It is important to the user of seeds not only to know their percentage of purity and what kind of weeds they carry, but to also know something of their vitality. In the case of seeds there are at least three ways whereby the user may be injured. A seed which carries foreign matter of any kind, in any considerable amount, is correspondingly lowered in value. But there is another reason which is more important than the money consideration, and that is that the weed seeds which the seeds contain may be pernicious. For example,—clover seed ferquently carries plaintain seed. If this plaintain seed is the door-yard variety which is present practically all over Maine, there would be comparatively little harm from using clover seed which contained it. On the other hand—lance leaved plaintain or rib grass is not abundant in Maine. It is an undesirable plant and using seed carrying it might introduce a weed into land which is at present free from it. It is important that the farmer should know the vitality as well as the purity of the seed that he is to use. No matter how pure a seed may be, if half of it will not sprout it has no more value than if the seed were half chaff.

While it is not easy to make an exact purity test, it is not difficult for a farmer to so acquaint himself with the seeds that he is ordinarily using that by the help of an ordinary reading or magnifying glass he will be able to tell whether the seed in question contains any considerable amount of impurities. If the seed is spread out upon a white plate, a little practice will enable a farmer to see whether a given seed is reasonably pure or not, and he will soon learn to detect the more common foreign seeds.

Vitality of Seeds.

It is much easier for the farmer to test the vitality of seed than to make a purity examination. The following simple instructions for performing germination tests at home without any special apparatus will enable the farmer to learn for himself whether the seed that he is using has good vitality or not. Germination tests may be made in two ways,—the so-called blotting paper methods, and the sand method. In making the germination test with blotting paper, blue blotting paper of common weight, cut into strips about 6 x 19 inches, should be used. This is laid folded twice so as to get a piece of three thicknesses and about six inches square, on an ordinary dinner plate or platter. The seeds if small are placed on the top of the paper and if large between the folds. The paper is kept moist (not soaked) and at a temperature of 70 to 80 degrees F.

If only a vitality test is desired the blotting paper method is preferable, but if it is desired to know how many seeds may be expected to grow, the sand method is in some ways preferable. In this method a thin layer of fine sand is sprinkled on the bottom of a flat dish and the seeds to be tested placed on it under a thin covering of sand. This must be kept moist and well shaded and at a somewhat higher temperature than in the first case.

At the end of every second day in the case of some seeds, and the third day in the case of those germinating more slowly, the sprouted seeds should be removed from the blotters or the sand and counted, the per cent being readily found by referring back to the number of seeds which were taken for the test. If 100 seeds are used, the number that sprout give the vitality per cent.

The Results of Inspection.

For several years the grass seeds on sale in the State have been inspected by the seed analyst. His experience makes it possible to tell by observation in most instances whether a seed is or is not up to its guaranteed purity. In 1914 he visited 328 dealers and examined 1263 samples of seeds. The varieties examined are given in the table which follows. Of all this large number of lots of seeds he found only 8 samples that seemed at all doubtful as to their quality. On examination at the Station all of these were passed as being in substantial accord with the guaranty. All parts of the State were visited. The stock in the hands of dealers, large and small, were generally examined. Out of nearly 1300 samples none were appreciably below the guaranteed percentage of purity. Not only were the seeds practically all up to guaranty but for the most part all of the seeds sold in the State carry a high percentage of purity. The improvement in the quality of seed used in Maine in the past sixteen years is as gratifying as it is marvelous. It is safe to say that no other State is uniformly using as good seed as Maine. In fact the wholesale dealers and cleaners of seed claim that if all the States were as particular in their demands for seed of high quality there would not be enough to go around.

Table showing the result of the inspection of seed in lots at dealers in 1914. These seeds were all examined at the dealers to see if they were in accord with guarantees upon them. In doubtful cases samples were taken to the laboratory.

Names of Seeds and Number of Lots of Each Inspected.												Total number of lots.	Number of dealers visited.
Timothy.	Red clover.	Alsike clover.	Mammoth clover.	Hungarian.	Redtop.	Japanese millet.	Alfalfa.	Barley.	Buckwheat.	Kentucky blue grass.	Miscellaneous.		
365	275	211	39	125	147	65	7	8	5	2	14	1263	328

A list of weed seeds found in seeds examined in 1914.

NOMENCLATURE, GRAY'S MANUAL 17TH EDITION 1908.

Common Name.	Scientific Name.
Barnyard grass	Echinochloa crusgalli (L.) Beauv.
Bird's foot trefoil	Lotus corniculatus L.
Black medick	Medicago lupulina L.
Bladder ketmia	Hibiscus trionum L.
Blue vervain	Verbena hastata L.
Bracted plantain	Plantago aristata Michx.
Canada thistle	Cirsium arvense (L.) Scop.
Catnip	Nepeta cataria L.
Chicory	Cichorium intybus L.
Common chickweed	Stellaria media (L.) Cyrill.
Common mallow	Malva rotundifolia L.
Common nightshade	Solanum nigrum L.
Common speedwell	Veronica officinalis L.
Crabgrass	Digitaria sanguinalis (L.) Scop.
Dock	Rumex sp.
Evening primrose	Oenothera biennis L.
Ergot	†Claviceps purpurea (Fr.) Tul.
False flax	Camelina microcarpa Andrz.
Five finger	Potentilla monspeliensis L.
Fowl-meadow grass	Glyceria nervata (Willd.) Trin.
Goosefoot	Chenopodium album L.
Green foxtail	Setaria viridis (L.) Beauv.
Heal-all	Prunella vulgaris L.
Hedge mustard	Sisymbrium officinale (L.) Scop.
Knot-grass	Polygonum aviculare L.
Lady's thumb	Polygonum persicaria L.
Leaf cup	Polymnia uvedalia L.
Mayweed	Anthemis cotula L.
Mint	Mentha sp.
Moth mullein	Verbascum blatteria L.
Mouse-ear chickweed.	Cerastium vulgatum L.
Mustard	Brassica nigra (L.) Koch.
Night-flowering catchfly	Silene noctiflora L.
Old-witch grass	Panicum capillare L.
Ovoid spike rush	Eleocharis ovata (Roth.) R. & S.
Ox-eye daisy	Chrysanthemum leucanthemum L.
Pale persicaria	Polygonum lapathifolium L.
Pennsylvania persicaria	Polygonum pennsylvanicum L.
Peppergrass	Lepedium virginicum L.
Pigweed	Amaranthus retroflexus L
Pimpernel	Anagallis arvensis L.
Plantain	Plantago major L.
Purslane	Portulaca oleracea L.
Ragweed	Ambrosia artemisiifolia L.
Raspberry	Rubus idaens L.
Ribgrass	Plantago lanceolata L.
Rugel's plantain	Plantago rugelii Done.
Sedge	Carex, unidentified.
Sheep sorrel	Rumex acetosella L
Shepherd's purse	Capsella bura-pastoris (L.) Medic
Slender crabgrass	Digitaria filiformis (L.) Koeler.
Sow thistle	Sonchus asper (L.) Hill.

†Sclerotia of the fungus.

A list of weed seeds found in seeds examined in 1914—Concluded.

NOMENCLATURE, GRAY'S MANUAL 17TH EDITION 1908.

Common Name.	Scientific Name.
Spurge	Euphorbia preslii Guss.
Sucking clover	Trifolium dubium Sibth.
Tumble-weed	Amaranthus graecizans L.
Virginia three-seeded mercury	Acalypha virginica L.
White vervain	Verbena urticaefolia L.
Wild buckwheat	Polygonum convolvulus L.
Wild carrot	Daucus carota L.
Wild madder	Galium mollugo L.
Wild radish	Raphanus raphanistrum L.
Wormseed mustard	Erysimum cherianthoides L.
Yarrow	Achillea millefolium L.
Yellow daisy	Rudbeckia hirta L.
Yellow foxtail	Setaria glauca (L.) Beauv.
Yellow rocket	Barbarea vulgris R. Br.

Table showing the kind of seed, name and location of dealer, and the results of analysis of official samples taken in 1914.

Station number.	Kind of Seed, Name and Town of Dealer Special Marks.	Purity. Guaranteed.	Purity. Found.	Impurities. Inert matter.	Impurities. Harmless—Foreign.	Impurities. Noxious—Foreign.
	ALFALFA.					
	Judkins & Gilman Co., Newport.					
7281	Pan American Alfalfa	99.5	99.7	0.3	–	–
	JAPANESE MILLET.					
	Gray-Hildreth Co., Gardiner.					
7371	Japanese Millet, Whitney-Eckstein Seed Co	98.0	95.9	0.7	–	3.4
	E. W. Wallace, Pittsfield.					
7372	Japanese Millet, Whitney-Eckstein Seed Co	98.0	95.4	0.9	–	3.7
	BARLEY.					
	Judkins & Gilman Co., Newport.					
7338	Chevalier Barley, Whitney-Eckstein Seed Co	96.0	95.4	1.8	2.8	–

* Sample taken from consumer.

Table showing the kind of seed, name and location of dealer, and the results of analysis of official samples taken in 1914—Continued.

Station number.	Kind of Seed, Name and Town of Dealer Special Marks.	Purity.		Impurities.		
		Guaranteed.	Found.	Inert matter.	Harmless—Foreign.	Noxious—Foreign.
	ALSIKE CLOVER.					
	C. M. Conant Co., Bangor.					
7367	Anchor Alsike Clover	99.25	98.9	0.2	0.5	0.4
7368	Blue Jay Alsike Clover	98.75	98.2	0.2	0.9	0.7
7369	Bell Alsike Clover	97.75	96.8	1.1	1.4	0.7
	Dexter Grange Store, Dexter.					
7393	Fancy Alsike	97.0	97.9	0.3	1.4	0.4
	J. E. Gray, Corinna.					
7388	Export Alsike Clover	97.0	98.3	0.4	0.9	0.4
	Judkins & Gilman Co., Newport.					
7291	Export Alsike Clover	97.0	95.9	0.4	1.8	1.9
	Palmer Bros., Hinckley.					
7335	Alsike	97.0	98.3	0.3	1.1	0.3
	L. L. Sanford, Skowhegan.					
7375*	Alsike, N. Wertheimer & Sons, Ligonier, Ind.	-	96.5	0.8	1.9	0.8
	John Watson & Co., Houlton.					
7314	Globe Alsyke 86967	97.7	98.0	0.2	1.2	0.6
7322	Stark Globe Alsyke 86966	97.7	98.1	0.2	1.4	0.3
7323	Boott Ace Alsyke 86987	95.0	96.9	0.5	1.6	1.0
	Frank S. Wingate, Hallowell.					
7404	No. 4 Alsyke, Whitney-Eckstein Seed Co., Buffalo, N. Y.	97.0	97.1	0.6	1.5	0.8
	RED CLOVER.					
	Dexter Grange Store, Dexter.					
7392	Eureka Medium Clover	99.25	99.6	0.3	-	0.1
	R. E. Gould, Harmony.					
7399	Ace Red Clover, C 79300	98.0	99.0	0.5	0.2	0.3
	Oscar Holway Co., Auburn.					
7302	Red Clover Mark, 308427	99.0	99.3	0.4	0.1	0.2
	Judkins & Gilman Co., Newport.					
7279	Pan American Clover	98.5	98.8	0.5	0.6	0.1
	L. L. Sanford, Skowhegan.					
7374*	Red Clover, N. Wertheimer & Sons, Ligonier, Ind.	-	99.0	0.2	0.1	0.7
	John Watson & Co., Houlton.					
7316	Globe Clover, 79118	99.0	99.4	0.3	0.1	0.2
7317	Globe Clover, 79118	99.0	99.4	0.2	0.2	0.2

* Sample taken from consumer.

Table showing the kind of seed, name and location of dealer, and the results of analysis of official samples taken in 1914—Continued.

Station number.	Kind of Seed, Name and Town of Dealer Special Marks.	Purity. Guaradteed.	Purity. Found.	Impurities. Inert matter.	Impurities. Harmless—Foreign.	Impurities. Noxious—Foreign.
7324	Globe Clover, 79120 A	99.0	99.5	0.2	–	0.3
7327	Ace Medium Clover, 79201	98.0	98.6	0.8	0.3	0.3
	Frank S. Wingate, Hallowell.					
7402	No. 2 Clover, Whitney-Eckstein Seed Co., Buffalo, N. Y	98.0	97.9	0.4	0.9	0.8
	HUNGARIAN.					
	Dexter Grange Store, Dexter.					
7394	Hungarian	99.0	99.0	0.3	0.1	0.6
	Oscar Holway Co., Auburn.					
7299	Hungarian, Mark ''McCullough''	98.0	98.3	0.7	0.1	0.9
	Judkins & Gilman Co., Newport.					
7339	Fancy Hungarian, Whitney-Eckstein Seed Co.	98.5	99.1	0.6	–	0.3
	Frank S. Wingate, Hallowell.					
7403	No. 3 Hungarian, Whitney-Eckstein Seed Co.	98.0	98.4	0.8	–	0.8
	REDTOP.					
	Dexter Grange Store, Dexter.					
7395	Fancy Redtop	88.0	88.5	11.2	–	0.3
	J. E. Gray, Corinna.					
7389	Choice Redtop, Whitney-Eckstein Seed Co	–	89.4	10.2	0.1	0.3
	Oscar Holway Co., Auburn.					
7303	Redtop ''A and J''	90.0	90.6	9.0	–	0.4
	Judkins & Gilman Co., Newport.					
7282	Choice Redtop	87.0	89.1	10.5	–	0.4
	Palmer Bros., Hinckley.					
7337	Redtop	92.0	90.3	9.2	0.1	0.4
	L. L. Sanford, Skowhegan.					
7376*	Redtop, N. Wertheimer & Sons	–	95.4	3.1	0.8	0.7
	TIMOTHY.					
	B. D. Coombs, Lisbon Falls.					
7347	Pan American Timothy	99.5	99.5	0.3	0.1	0.1
	Dexter Grange Store, Dexter.					
7391	Pan American Timothy	99.5	99.4	0.3	0.2	0.1
	J. E. Gray, Corinna.					
7386	Pan American Timothy	99.5	99.3	0.4	0.2	0.1

* Sample taken from consumer.

Table showing the kind of seed, name and location of dealer, and the results of analysis of official samples taken in 1914—Concluded.

Station number.	Kind of Seed, Name and Town of Dealer Special Marks.	Purity. Guaranteed.	Purity. Found.	Impurities. Inert matter.	Impurities. Harmless—Foreign.	Impurities. Noxious—Foreign.
	R. E. Gould, Harmony.					
7400	Pine Tree Timothy, 65614	99.5	99.6	0.2	0.1	0.1
	E. P. Ham, Lewiston.					
7295	Pan American Timothy	99.5	99.6	0.2	0.1	0.1
	Haskell Implement & Seed Co., Lewiston.					
7265	XXXX Timothy, No. 65288, Purity Brand	99.7	99.7	0.2	-	0.1
7311	"Fern" Timothy	99.0	98.3	0.6	0.6	0.5
	Oscar Holway Co., Auburn.					
7301	Timothy, Blue Jay Brand	99.0	99.5	0.3	0.1	0.1
	Judkins & Gilman Co., Newport.					
7280	Pan American Timothy	99.5	99.3	0.6	-	0.1
	Palmer Bros., Hinckley.					
7336	Timothy	99.5	99.7	0.2	0.1	-
	L. L. Sanford, Skowhegan.					
7373*	Timothy, N. Wertheimer & Sons	-	98.8	0.6	0.4	0.2
	John Watson & Co., Houlton.					
7315	Pine Tree Timothy, 65476	99.5	99.5	0.3	0.1	0.1
7319	Pine Tree Timothy, 65476	99.5	99.6	0.2	0.1	0.1
7320	B. H. Globe Timothy, 65348	99.7	99.8	0.1	0.1	-
7325	Pine Tree Timothy, 65400	99.5	99.6	0.2	0.1	0.1
	Frank S. Wingate, Hallowell.					
7401	Timothy, Whitney-Eckstein Seed Co.	99.5	99.5	0.3	0.1	0.1
	MAMMOTH CLOVER.					
	Dexter Grange Store, Dexter.					
7390	Eureka Mammoth Clover	99.0	99.2	0.4	0.2	0.2
	J. E. Gray, Corinna.					
7387	Pan American Mammoth Clover	98.0	98.8	0.1	0.5	0.6
	Oscar Holway Co., Auburn.					
7300	Mammoth Red Clover, "Peavine"	99.0	99.3	0.3	0.2	0.2
	John Watson & Co., Houlton.					
7318	Globe Boott Mammoth Clover, 79127 A	99.0	99.4	0.3	0.1	0.2
7321	Boott Globe Mammoth Clover B	99.0	99.4	0.4	0.1	0.1
7326	Boott Globe Mammoth Clover, 79128	99.0	99.6	0.3	-	0.1

* Sample taken from consumer.

Table showing results of examination of samples of seed in 1914.

Names of Weeds.	Kind of Seed and Number of Samples.								
	Red clover.	Alsike clover.	Mammoth clover.	Timothy.	Redtop.	Kentucky blue grass.	Japanese millet.	Hungarian.	Oats.
Number of samples examined..	34	47	11	37	9	1	4	13	1
Barnyard grass..............	4	–	–	–	–	–	–	8	–
Bird's foot trefoil...........	2	–	–	–	–	–	–	–	–
Black medick................	10	45	2	–	–	–	–	–	–
Bladder ketmia..............	–	–	–	–	–	–	–	1	–
Blue vervain.................	–	–	–	3	–	–	–	1	–
Bracted plantain............	1	–	–	–	–	–	–	–	–
Canada thistle..............	–	3	1	–	–	–	–	–	–
Catnip......................	1	1	–	1	–	–	–	–	–
Chicory.....................	1	–	1	–	–	–	–	–	–
Common chickweed..........	–	1	–	–	–	–	–	–	–
Common mallow.............	1	–	1	–	–	–	–	–	–
Common nightshade.........	–	–	–	–	–	–	–	5	–
Common speedwell..........	–	–	–	–	1	–	–	–	–
Crabgrass..................	–	–	–	–	–	–	–	4	–
Dock.......................	10	23	8	1	–	1	–	–	–
Evening primrose...........	–	–	–	12	–	–	–	–	–
Ergot......................	1	–	–	13	8	–	–	–	–
False flax..................	–	14	–	–	–	–	–	–	–
Five finger.................	–	6	–	21	3	–	–	–	–
Fowl-meadow grass..........	–	–	–	1	–	–	–	–	–
Goosefoot..................	10	14	2	12	–	–	1	9	–
Green foxtail...............	27	5	3	5	–	–	2	12	–
Heal-all....................	2	3	1	2	–	–	–	–	–
Hedge mustard.............	–	–	–	3	–	–	–	–	–
Knot-grass.................	–	1	–	–	–	–	–	2	–
Lady's thumb..............	10	–	–	1	–	–	3	12	–
Leafcup....................	–	–	–	–	–	–	–	–	1
Mayweed...................	1	8	–	6	–	–	–	–	–

Table showing results of examination of samples of seed in 1914 —Concluded.

Names of Weeds.	Kind of Seed and Number of Samples.								
	Red clover.	Alsike clover.	Mammoth clover.	Timothy.	Redtop.	Kentucky blue grass.	Japanese millet.	Hungarian.	Oats.
Mint	1	–	–	4	7	–	–	–	–
Moth mullen	–	1	–	2	1	–	–	–	–
Mouse-ear chickweed	–	15	–	2	6	–	–	–	–
Mustard	–	1	–	–	–	–	–	4	–
Night flowering catchfly	3	43	2	2	–	–	–	–	–
Old-witch grass	2	1	–	7	2	–	–	6	–
Ovoid spike rush	–	1	–	–	–	–	–	–	–
Ox-eye daisy	–	2	–	1	–	–	–	–	–
Pale persicaria	–	–	–	–	–	–	–	2	–
Pennsylvania persicaria	–	–	–	–	–	–	1	–	–
Peppergrass	–	3	–	25	–	–	–	–	–
Pigweed	1	–	–	2	–	–	–	4	–
Pimpernel	–	1	–	–	–	–	–	–	–
Plantain	–	7	–	7	8	–	–	–	–
Purslane	–	1	–	5	–	–	–	–	–
Ragweed	2	–	–	–	–	–	4	7	–
Raspberry	–	1	–	–	–	–	–	–	–
Ribgrass	23	12	6	3	–	–	–	–	–
Rugel's plantain	14	4	5	16	–	–	–	–	–
Sedge	–	–	–	16	9	1	–	–	–
Sheep sorrel	10	34	6	19	1	–	–	–	–
Shepherd's purse	–	–	–	2	–	–	–	–	–
Slender crabgrass	3	–	1	–	–	–	–	7	–
Sow thistle	–	1	–	1	–	–	–	–	–
Spurge	2	–	–	–	–	–	–	–	–
Sucking clover	–	2	–	–	–	–	–	–	–
Tumble-weed	1	–	1	1	–	–	–	1	–
Virginia three-seeded mercury	2	–	–	–	–	–	–	–	–
White vervain	–	–	–	1	–	–	–	–	–
Wild buckwheat	–	–	–	–	–	–	1	–	–
Wild carrot	7	–	1	–	–	–	–	–	–
Wild madder	–	1	–	1	–	–	–	–	–
Wild radish	–	–	–	–	–	–	–	–	1
Wormseed mustard	–	2	–	5	–	–	–	–	–
Yarrow	–	–	–	2	9	–	–	–	–
Yellow daisy	–	–	–	15	4	–	–	–	–
Yellow foxtail	1	–	1	–	–	–	4	11	–
Yellow rocket	–	6	–	2	–	–	–	–	–

December, 1914

MAINE
AGRICULTURAL EXPERIMENT STATION,
ORONO, MAINE.
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Official Inspections

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MISCELLANEOUS FOOD MATERIALS.

The Commissioner of Agriculture is the executive of the law regulating the sale of foods in Maine. It is the duty of the Maine Agricultural Experiment Station to make the analyses of the samples collected by the Commissioner, and it is the duty of the Director to publish the results of the analyses of the samples of foods, together with the names of the persons from whom the samples were obtained, the names of the manufacturers thereof and such additional information as may seem advisable.

The examination of samples of *maple sugar and syrup, canned milk, pickles, rice, jams and preserves, salt, sausage, tapioca, tea, sweet oil and confectionery* are given in this number of Official Inspections. For the most part the samples were taken for special reasons and are not representative of the whole State.

Maple Sugar.

Two samples of maple sugar, one purchased from E. Janelle & Co., Lisbon St., Lewiston, and the other from Emile Dumont, 500 Lisbon St., Lewiston, were examined and found to be pure maple sugar.

Maple Sirup.

A few samples of bulk maple sirup were purchased by the inspectors. Two of these, No. 10598 and No. 12313, were adulterated by not being sufficiently evaporated,—that is, they were pure maple goods, but contained too much water and much less sugar than they should have had.

Samples 12621 and 12306 were straight adulterations. They were sold openly as pure maple sirup and contained no maple. Apparently the dealers were aware of exactly what they were selling.

The results of the examination are given in the table which follows.

Table showing the results of analyses of samples of maple sirup purchased in the spring of 1914. Samples arranged alphabetically by towns in which purchased. Maple Sirup should contain not more than 35 per cent of water.

Station Number.	Name and Address of Dealer.	Price per pint.—Cents.	Maple—Per cent.	Water—Per cent.	Remarks.
10597	Farmington. F. L. Butler	15	100	26.9	Passed.
10596	Farmington. Lowell & Whitten	15	100	33.6	Passed.
10598	Farmington. W. W. Small Co	16	100	36.2	Too much water.
10595	Oakland. H. D. Sanford	18	100	29.9	Passed.
12313	Portland. John W. Deering & Son	23	100	43.2	Adulterated with water.
12304	Sidney. George A. Tilton	20	100	31.0	Passed.
12621	Waterville. Alex Quirion	18	None.	33.0	Mixture of water and sugar artificially colored and flavored to imitate maple syrup.
12305	Waterville. Clayton G. Weeks	20	100	30.1	Passed.
12306	Winslow. Joseph Quinn	13	Trace.	30.5	Mixture of water and cane sugar artificially colored and flavored to imitate maple syrup.

Table showing results of analyses of samples of maple and compound sirups purchased in the spring of 1914. Samples arranged alphabetically by towns in which purchased.

Sta. No.	Maker and Brand.	Name and Address of Dealer.	Remarks.
	Package Syrup Sold as Branded		
11909	C. A. Weston Co., Portland, Me. "Trumpet Brand High Grade Sugar Syrup. A compound of cane and maple sugar syrups."..	J. A. Bernier, Bath...	Not much maple. Contained too much water.
11910	Rigney & Co., Buffalo, N. Y...... "Park Brand Syrup. A blend of Rock Candy Drips and Maple Syrup."	Lowell's Market, Bath	Not much maple. Mostly drips.
11908	Bay State Maple Syrup Co., Boston, Mass. "Mt. Mansfield Brand Fancy Sugar Syrup. A compound of cane and maple sugar syrups."	G. W. Temple, Bath	As claimed.
9745	Bay State Maple Syrup Co., Boston, Mass. "Mt. Washington Brand Maple Sap Syrup. Choisest Quality. Absolutely Pure."	R. J. Kimball, Bridgewater.	Maple syrup but contained too much water.
11902	Vesper Preserve Co., Ayer, Mass. "Golden Beauty Compound Table Syrup. Made from corn syrup, cane and maple sugar. Artificially colored and flavored."	C. A. Lemieux, Brunswick.	As claimed.
11906	Chas. E. Moody & Co., Boston, Mass. "Matchless Brand Maple Syrup.".	Wm. F. McFadden, Brunswick.	As claimed.
11907	Chas. E. Moody & Co., Boston, Mass. "Fearless Brand Table Syrup. ¼ maple, ¾ cane."	Wm. F. McFadden, Brunswick.	About as claimed.
11905	S. S. Pierce Co., Boston, Mass.... "24 fl. oz. pure maple syrup. From Vermont sugar orchards.	H. T. Nason, Brunswick.	As claimed.
11903	New England Maple Syrup Co., Boston, Mass. "Golden Tree Granulated and Maple Sugar Syrup."	M. Parent, Brunswick.	As claimed.
11904	Towle Maple Products Co., St. Paul, Minn. "Towle's Log Cabin Brand Syrup. Made of pure cane sugar and maple sugar."	M. Parent, Brunswick.	Less than one-fourth maple.
11857	New England Maple Sugar Co., Boston. "Golden Tree Syrup. Made from granulated and maple sugars."	Small & Hatch, Brunswick.	As claimed.
12378	C. A. Weston Co., Portland, Me. "Trumpet Brand High Grade Sugar Syrup. A compound of cane and maple sugar syrups."	C. A. Weston Co., Portland.	As claimed.

Table showing maker and brand of samples of canned milk, and dealer and town from whom they were purchased. Arranged alphabetically by makers.

Sta. No.	Maker and Brand.	Dealer and Town.
	Evaporated Milk (Unsweetened.)	
10619	Borden Condensed Milk Co., New York........ "Borden's Peerless Brand."	L. R. Giles Co., E. Brownfield.
11267	Boston Condensed Milk Co., Bellows Falls, Vt. "Quality Brand."	Milliken-Tomlinson Co., Portland
10625	Conant, Patrick & Co., Portland, Me......... "Yours Truly Evaporated Milk."	F. I. Dwinal, Mechanic Falls.
11268	Eastern Importing & Mfg. Co., Boston....... "Eastern Star Brand."	Milliken-Tomlinson Co., Portland
10633	Indiana Condensed Milk Co., Sheridan, Ind.... "Wilson's Evaporated Milk."	Chas. F. Ridlon, Norway.
10815	Mohawk Condensed Milk Co., Rochester, N. Y. "Gold Cross Milk Unsweetened."	Hart & Holbrook, Rockland.
10644	St. Charles Canning Co., St. Charles, Ill...... "St. Charles Evaporated Milk."	H. E. Burnell, Portland.
10624	Van Camp Packing Co., Indianapolis, Ind..... "Van Camp's Evaporated Milk."	A. A. Woodsum, Mechanic Falls.
	Condensed (Sweetened) Milk.	
10620	Borden Condensed Milk Co., N. Y.......... "Baby Brand."	Chas. A. Vallee, Westbrook.
10623	Borden Condensed Milk Co., N. Y.......... "Challenge Brand."	A. A. Woodsum, Mechanic Falls.
10810	Borden Condensed Milk Co., N. Y........... "Defiance Brand."	Willis I. Ayer, Rockland.
10621	Borden Condensed Milk Co., N. Y........... "Gail Borden Eagle Brand."	Chas. A. Vallee, Westbrook.
10643	Boston Dairy Co., Bellows Falls, Vt.......... "Golden Gate Brand"	Sullivan & Osgood, Portland.
10809	Boston Dairy Co., Boston, Mass............. "Trumpet Brand."	W. I. Ayer, Rockland.
10814	Emery Food Co., Chicago, Ill................. "Rubie Brand."	Hart & Holbrook, Rockland.
10642	Mohawk Condensed Milk Co., Providence, R. I. "Blue Cross Brand."	C. A. Rounds, Portland.
10618	Vermont Condensed Milk Co., Richmond, Vt. "Ruby Brand."	L. R. Giles Co., E. Brownfield.

Table showing results of analyses of canned milks. Description of samples on opposite page. None of the samples were found adulterated or misbranded and were all passed.

Station number.	Price—Cents.	Weight. Claimed—Ounces.	Weight. Found—Ounces.	Total solids—Per cent.	Ash—Per cent.	Fat—Per cent.	Protein—Per cent.	Lactose—Per cent.	Sucrose—Per cent.
			Evaporated Milk (Unsweetened).						
10619	10	16	16.2	27.0	1.6	8.7	7.1	9.3	......
11267	....	16	....	25.9	......	8.1	......	......	......
10625	10	16	15.9	26.6	1.5	8.7	7.1	9.0	......
11268	....	....	....	26.4	......	7.9	......	......	......
10633	10	....	16.4	27.4	1.5	8.5	6.8	9.0	......
1081 5	5	....	....	26.0	1.4	7.8	7.5	9.4	......
10644	10	....	16.2	26.8	1.5	7.8	6.6	9.4	......
10624	5	6	5.8	27.3	1.6	8.1	7.3	10.0	......
			Condensed Milk (Sweetened).						
10620	25	....	12.3	73.7	1.7	9.2	7.6	11.5	43.7
10623	12	....	12.2	73.6	1.7	9.3	8.0	14.7	39.8
10810	10	....	....	74.0	1.6	8.3	7.7	12.5	43.9
10621	19	15.5	15.5	73.2	1.6	8.6	7.4	11.2	44.4
10643	10	....	12.5	73.3	1.8	8.2	8.1	12.3	42.9
10809	10	....	....	72.7	1.7	8.6	7.6	11.9	42.8
10814	10	11.5	....	76.7	1.7	9.1	8.0	12.8	45.1
10642	10	....	11.6	76.0	1.9	9.7	8.1	12.6	43.7
10618	10	....	13.3	73.9	1.7	9.2	7.4	11.4	44.2

Pickles.

Under the law a food is misbranded if "it fails to bear a statement on the label of the quantity or proportion of each and any added coloring matter, preservative, chemical or drug contained therein." Under the food regulations benzoate of soda is at present permitted to be used in foods provided its presence and amount are plainly stated on the label. Alum may be used in limited amount in pickles provided its presence and amount are plainly stated on the label.

List of dealers who sold the inspectors pickles that did not contain copper or alum. Arranged alphabetically by towns.

Bangor.	M. C. Baker.	Portland.	Carl P. Christianson.
Bangor.	W. W. Doane.	Portland.	J. T. Dougherty.
Bangor.	Eureka Market.	Portland.	B. Huberman.
Bangor.	C. W. Griffin.	Portland.	M. W. Jensen.
Bangor.	Leighton Market.	Portland.	H. Leighton.
Bangor.	Wentworth's Market.	Portland.	A. D. Lovell.
Biddeford.	Desrosiers & Beaudette.	Portland.	Lewis Olsen.
Fort Fairfield.	Boyd Bros.	Portland.	Serunian-Amergian Co.
Old Town.	Beaulieu Bros.	Portland.	F. H. Verrill.
Old Town.	Lunt Cash Store.		

Dealers who sold the inspectors pickles that did not contain copper and did contain alum, but the package was labeled so as to disclose that fact.

Biddeford.	Bellerose & Beaudette.	Biddeford.	J. H. Holman & Co.
Biddeford.	Desrosiers & Beaudette.		

Dealer who sold the inspector pickles that did not contain alum or copper, but did contain benzoate of soda and not labeled to show that fact.

Portland. E. F. Hillman.

List of dealers who sold the inspectors pickles that did not contain copper but were misbranded in that they contained alum and were not labeled to show that fact. Hearings were appointed and all cases either have been or are in the way of being prosecuted. Arranged alphabetically by towns.

Biddeford.	Desrosiers & Beaudette.	South Portland.	D. P. Cobb.
Lewiston.	Walker Brothers.	South Portland.	A. C. Sailer.
Old Town.	Old Town Tea Co.		

Rice.

In 1908 there was practically not a pound of rice produced in or imported into the United States that was not coated with glucose and talc. This is adulteration for the only reason for thus treating rice is to make it appear better than it is, or in other words to conceal inferiority. It is however, permitted under the food law to practice adulterations of this kind provided the truth is clearly and plainly stated on the label.

Publicity speedily remedied this evil so that in a few months it was possible to buy rice neither coated with glucose and talc nor artificially colored. A good deal of the rice sold is still coated so as to make it appear of better color than it is. This is, however, for the most part properly labeled. A few samples for special reasons were purchased by the inspectors. The results of the examinations follow:

List of dealers who sold the inspectors rice that was not coated with glucose arranged alphabetically by towns.

Kennebunkport.	Tobey's Cash Market	Oakland.	Edward O'Neal
		Portland.	John B. Morgan Co.

List of dealers who sold the inspectors rice that was coated with glucose and not labeled to show that fact. Hearings were appointed and all cases either have been or are in the way of being prosecuted. Arranged alphabetically by towns.

Portland.	Paul Blumenthal	Portland.	Chas. Hatzkelson
Portland.	Mrs. Jennie Branz	Portland.	Benj. Huberman
Portland.	John W. Charles & Co	Portland.	John A. Morshead
Portland.	Nellie G. Collins	Portland.	W. H. Pullen
Portland.	Angelo Giso	Portland.	E. A. Thomes.

Jams and Preserves.

Two samples of Marmo Brand, manufactured by the Corn Products Company have been collected and examined.

"Marmo Jam, Blackberry," No. 11035, according to the label contained approximately 45 per cent corn sirup, 35 per cent fruit and juice from apple trimmings and 20 per cent granulated sugar. "Contains added phosphoric acid. Blackberry." The net weight of the contents of the jar, which cost ten cents, was 10.65 ounces. It contained 70.73 per cent of total solids, 0.59 per cent ash, 10.16 per cent sucrose, 51.46 per cent glucose, 0.16 per cent phosphoric acid. The goods were, therefore, apparently in accord with label.

"Marmo Preserves," No. 11036, made with approximately 40 per cent corn sirup, 38 per cent granulated sugar, 22 per cent fruit juice from apple trimmings. "Contains added phosphoric acid." Claimed net weight 14 ounces. Price paid was 45 cents for three jars. The average net weight was 15 ounces. The total solids were 71.46 per cent, ash 0.4 per cent, sucrose 12.83 per cent, glucose 36 per cent. The reducing sugars were 32.48 per cent, which accounts for the difference between the granulated sugar claimed and the sucrose found. It contained 0.15 per cent phosphoric acid. The goods were practically in accord with label.

Salt.

At several different times in the past eight years the salt used for table and dairy purposes has been examined and for the most part has been found to be well within the standards. Complaint was made by Croswell Brothers, Farmington, regarding "coarse fine" salt bought of T. R. Savage Company, Bangor, part of which was short weight and part of which was very wet. This was labeled "Crystal Spring C. F. Salt." The lot in question was shipped direct from the makers to Croswell Brothers on the order of the Savage Company, and was, of course, not seen by this last named company. The drier bags weighed around 51 pounds instead of the 56 claimed. The wet bags over-weighed. The wet bags contained considerable higher percentages of magnesium sulphate which takes up water from the air. The water in the drier lots was about four per cent and nearly seven in the wet salt. Apparently the whole lot was short weight though the wet salt had absorbed water enough from the air to make it over-weigh. The results were reported to the executive of the law and the case is being further investigated.

Pork Sausage.

The gist of the regulations as regards the sale of pure and adulterated sausage is summed up in the following:—Pork sausage should be composed of minced, fresh pork to which salt, spices, and nothing else has been added. It should contain no larger amount of water than the meat from which it is made. Pork sausage true to name can be lawfully sold without labels. Pork sausage to which cereal, water, or anything else has been added needs to be labeled to show exactly what it is.

In the case of the manufacture of sausage it seems to be a fairly common practice to add more or less water. Some manufacturers state that they only add as much water as is necessary in order to make the sausage in such condition that they can be worked and put in the cases. While the addition of water softens the sausage, it is perfectly possible to make sausage from pure meat, salt and spices without the addition of water. Cereals, such as flour, are frequently added to pork sausage. Some of the spice mixtures sold for sausage flavoring are adulterated with cereal. It seems that cereal is added chiefly so that the sausage may hold more water. Thus it is possible to take 50 pounds of meat and 5 pounds of flour and add water enough to make 100 pounds of sausage. While it is doubtful if such an extreme adulteration is actually practiced, many cases have been found where large amounts of water are added. Most manufacturers who are using both cereal and water are labeling their sausage "cereal added." That, however, is not enough. Correct labeling of pork sausage to which cereal has been added and which contains more water than the meat from which the sausage is made is "Pork sausage, cereal and water added."

The food value of sausage depends upon the protein and fat. Both of these constituents have a direct relation to the water, and because of this mutual relation between fat, protein, and water it is easy to tell with considerable degree of accuracy whether or not sausage has been adulterated by the addition of water. Adulteration by the addition of cereal can be directly learned by the presence of starch which all cereals carry and which meat does not contain.

The results of analyses of samples collected in the spring of 1914 are given on the following page:

Table showing the results of examination of sausages purchased by the inspectors in the spring of 1914. Samples are arranged alphabetically by towns.

Station number.	Town, Dealer, Brand.	Price per pound.—Cents.	Weight sold for one pound.—Ounces.	Water.—Per cent.	Fat.—Per cent.	Protein.—Per cent.	Cereal.	Remarks.
11230	Augusta. Geo. D. Haskell & Sor	15	18.9	47.2	35.9	11.4	Present. Not stated on label	Adulterated.
11229	Augusta. Webber & Hewett	18	16.8	32.5	58.5	6.8	None	Passed.
11274	Biddeford. Desrosiers & Beaudette	15	....	....	....	....	None	Passed.
11225	Gardiner. A. A. Brann	15	17.6	32.9	54.3	8.4	Present. Not stated on label	Adulterated.
11226	Gardiner. F. L. Clark	15	16.1	39.1	47.6	10.7	None	Passed.
11227	Hallowell. Bucknam & Stickney	....	14.7	50.6	27.7	11.3	Present	"Cereal and water added" on label.
11228	Hallowell. J. C. Purinton	14	17.7	46.1	35.8	11.3	Present	"Cereal and water added" on label.
12106	Rockland. Willis Ayer	18	16.0	31.9	57.7	8.2	None	Passed.
12109	Rockland. Ferrand, Spear & Co	18	15.3	35.3	53.0	8.4	None	Passed.
12110	Rockland. H. J. Fitch	16	16.5	40.0	47.1	9.9	None	Passed.
12108	Rockland. J. H. Flint & Son	18	16.3	36.8	51.1	9.1	None	Passed.
12111	Rockland. F. G. French & Son	17	15.9	39.9	47.8	10.0	None	Passed.
12107	Rockland. Jameson & Beverage Co.	17	16.6	33.0	56.4	8.3	None	Passed.
12112	Rockland. Larrabee Bros	20	15.7	45.1	40.3	12.6	None	Passed.
12113	Rockland. H. G. Tibbetts. "Our Knox County Sausage. Made by W. C. French, Rockland, Me."	22	15.6	49.3	32.0	14.2	Present. Not stated on label.	Adulterated.
11340	Rumford Falls. Cooperative Store	16	....	46.7	36.6	11.8	Present. Not stated on label	Adulterated.
12567	Rumford Falls. J. A. Garneau & Co	18	....	34.8	52.6	9.6	None	Passed.
12257	Rumford Falls. Gauthier Bros	18	15.6	46.4	39.4	9.5	Present. Not stated on label	Adulterated.
12255	Rumford Falls. Hubbard & Henry	18	14.9	47.5	40.2	9.5	None	Passed.
12256	Rumford Falls. Oxford Co. Coop. Assoc	18	15.3	45.5	40.2	10.3	Present	"Cereal added" on label.
12258	Rumford Falls. J. Harold Poor	15	15.8	68.1	13.0	12.6	Present. Not stated on label	Adulterated.
12568	Rumford Falls. E. J. Roderick & Co	....	....	55.9	28.8	12.1	None	Passed.

Tapioca.

Complaint was made to the Station relative to tapioca that it was colored blue. This led to the purchase of several samples of tapioca as sold in the State. Six samples of "Minute Tapioca," prepared by the Minute Tapioca Co., Orange, Massachusetts, were collected. One of these was colored blue very decidedly, the color being readily seen with the unassisted eye. It also had high ash content. It was impracticable to obtain interstate papers so this case was not reported to the Federal authorities for prosecution. The Maine dealer was, of course. innocent in the matter. One other sample of Minute Tapioca contained a trace of blue color only visible under the microscope. The ash content was about normal. The other four samples of Minute Tapioca were uncolored.

"Slade's Quick Cooking Tapioca" and "Slade's Pearl Tapioca," made by the D. & L. Slade Company, Boston; and "Pearl Tapioca," made by the Stickney & Poor Spice Co., Boston, Mass., were all found to be free from coloring matter.

Tea.

A sample of tea was obtained from Scott & Co., Corner of Main and Sea Streets, Rockland, on the complaint of a purchaser. It was an Oolong tea, sold at 60 cents a pound. The sample was No. 13014. The pound package weighed 16.2 ounces net. The odor was poor. Tea made in the usual way was weak and poor. Microscopic examination showed no foreign leaves, some sticks and stems were present. It was a very poor quality of tea, composed of the large bottom leaves of the tea plant.

Sweet Oil (Olive Oil).

A few samples of olive oil were tested. Three samples sent in by dealers were found to be straight olive oil. A sample No. 12323, purchased as olive oil from C. Delooke, 41 India St., Portland, Me., was found to be cottonseed oil. The same was true of a sample of sweet oil, No. 13385, purchased from Abraham Rappaport, 152 Newbury St., Portland. The last two were adulterated and misbranded and it was recommended that hearings be appointed and the cases investigated.

Confectionery.

Various samples of cordials were examined for alcohol and found to contain practically none. Goods that were sold as "brandy drops" were found to be practically free from alcohol.

Silver coated candies were found to contain considerable metallic silver, particularly a sample of "Silver Dragees" from the Geo. C. Shaw Co., Portland, Me. These were said to have come from Schall & Co., New York.

The coloring matters found in candies were the permitted colors, were harmless, and were passed.

Not at all thorough examination was made of the confectionery on sale in Maine. It is gratifying to find that in practically all cases the cheap candies were free from objectionable materials. The coatings on the cheap colored candies all carried shellac, but were free from arsenic which is common in some cheap grades of shellac. Commercial glucose entered largely into the manufacture of these cheap candies, but glucose is as healthful a food as sucrose.

There was found to be frequent shortage in weight in package goods. The net weight law did not become effective until the latter part of September and these incorrect short weights will doubtless be corrected as time goes on. In the case of one large department store it was found that their candies as sold by weight were invariably short weight. Investigation showed that a dial scale was used and that the scale was so placed as regards the saleswoman that when the hand was actually at 15½ it appeared to her to be at 16 ounces. It was not possible to learn whether this was an accidental or an intentional arrangement. As soon as the manager's attention was called to this and the resulting short weight, the trouble was corrected.

The candies in some of the more congested streets in the poorer parts of cities were occasionally found to be dirty. Those exposed to the dust of the street were found by microscopical examination to carry mineral matters and bacteria. No prosecutions were brought in these cases, but the practices were discontinued so that the goods were protected from dust, filth, flies, etc.

492-4-14

MAINE
AGRICULTURAL EXPERIMENT STATION,
ORONO, MAINE.
CHAS. D. WOODS, Director.

SPECIAL REPORT

OF THE

Maine Agricultural Experiment Station

FOR THE

COMMISSIONER OF AGRICULTURE

For the Year 1913

Reprint from the report of the Commissioner of Agriculture for 1913.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE

Organization July to December, 1913.

THE STATION COUNCIL.

THE STATION STAFF.

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THE WORK OF THE MAINE AGRICULTURAL EXPERIMENT STATION IN 1913

Director Chas. D. Woods.

The year 1913 was the twenty-ninth year of the Maine Agricultural Experiment Station. It began its work April 1, 1885. In the following pages is given a brief outline of some of the more important lines of investigation that have been taken up during the year, and particularly matters which have an immediate practical agricultural significance. The full report of the operations of the Experiment Station will be found in its bulletins and annual report for the year 1913.

Government of the Station.

The development and management of the Station is in charge of a Station Council made up of the President of the College, the Director of the Station, the heads of the various departments of the Station, the Dean of the College of Agriculture, three members of the Board of Trustees, and a representative from each of the state-wide agricultural organizations.

The Station Council meets once a year. At this meeting the Director and other members of the Station staff outline the work which has been undertaken in the past year and make recommendations for the following year. Such of these as commend themselves to the Station Council as well as suggestions from that body are approved and the Director is instructed to carry them out in detail. The appointment of members of the staff is made by the Trustees, and the recommendations of the Council are subject to their approval.

The Director is the executive officer of the Station and passes upon all matters of business. The members of the staff have charge of the lines of work which naturally come under their departments.

Income of the Station.

For the year which ended December 31, 1913, the income of the Station in round figures was: From the United States Government, Hatch Fund, $15,000; Adams Fund, $15,000; from the State of Maine, investigations in animal husbandry $5,000; printing bulletins and reports $4,500. In addition to this there were about $20,000 in appropriation and fees from the State for carrying out the work of inspection and about $11,000 from the sale of farm and poultry products.

Relation of the Station to the University of Maine.

The Station is by act of legislature a department of the University of Maine and in the organization of the University is co-ordinate with the different colleges. The function of the colleges is to teach. It is by the Act of Congress establishing the Station "The object and duty of said experiment stations to conduct original researches or verify experiments .... bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective States or Territories." None of the funds received by the Station can lawfully be used for teaching, for demonstration, for exhibition purposes or for any purpose whatever outside of research into agricultural problems.

Organization of the Station.

The Maine Agricultural Experiment Station was first established as a fertilizer control, but in 1888, when the Hatch Act became effective, the purpose of the Station was changed by that Act so that its work is that of the investigation of agricultural problems. However, the fertilizer control was left in the hands of the Director of the Maine Agricultural Experiment Station, and as various other inspection laws regulating the sale of commercial feeding stuffs, agricultural seeds, drugs, foods, fungicides, insecticides, and other materials, were enacted they were also placed in the hands of the Director of the Experiment Station. The execution of the laws which had to do directly with the agricultural products were not particularly taxing, but with the large duties which were required particularly under the food and drug law, it came about that the time of the Director of the Experiment Station and much of the office force was diverted from the strict purpose of investigation to that of police duties. Recognizing that it was the function of an experiment station to conduct original experiments and investigations in agriculture, and that the function of the State Department of Agriculture is executive, the Legislature of 1913 so changed the laws regulating the sale of agricultural seeds, commercial fertilizers, commercial feeding stuffs, drugs, foods, fungicides and insecticides, that the purely executive part of the work is, beginning with January 1, 1914, in the hands of the Commissioner of Agriculture. The analytical work, including the publication of the results of the examinations, will be conducted at the Experiment Station, as in the past. This probably is the most important legislation, from the standpoint of the integrity and concentration of the work of the Experiment Station, that has recently occurred.

Dissemination of Information.

It is not the function of the Station to disseminate general agricultural or other information. That is for the College through its extension department. It is, however, the distinct duty of the Station to publish the results of its investigations. Although the correspondence that bears upon general agriculture is referred as far as practicable to the correspondence department of the University, the Station receives and answers many thousand letters each year.

The Station publishes: (a) Bulletins which contain the results of investigation; (b) Official Inspections which give the results of the work of inspection; (c) Miscellaneous Publications; and (d) a series of publicity letters that are issued Wednesdays of each week and sent to a limited number of papers to be released for publication on the following Wednesday. The bulletins, the Official Inspections and the chief miscellaneous publications are bound together at the close of the year and make up the Annual Report of the Station. During 1913 there were issued 14 bulletins containing about 350 pages; 10 Official Inspections containing about 350 pages; 28 miscellaneous publications and 53 publicity letters.

Some of the investigations of the Experiment Station which are necessary for the solution of the problems which the Station is investigating are of a technical nature, and so far as possible these are printed in other places, such as scientific magazines published in this country and in Europe, and the bulletins of the United States Department of Agriculture. Something more than 200 printed pages were thus published in 1913.

The following are the principal publications, although there were numerous circulars not here listed as well as more pretentious papers that were printed in scientific periodicals, both American and foreign.

LIST OF PRINCAPAL PUBLICATIONS IN 1913.

Work of Investigation (Bulletins).

209 New Mineral Fertilizer.
210 Spruce Bud Worm and Spruce Leaf Miners.
211 Potato Flea Beetle.
212 Orchard Spraying Experiments in 1912.
213 Aphid Pests of Maine. II. Willow Family.
214 The Biology of Poultry Keeping.
215 The Measurement of the Intensity of Inbreeding.
216 Poultry Notes, 1911-13.
217 Woolly Aphid of the Apple.
218 Tables for Calculating Coefficients of Inbreeding.
219 Comparative Studies of Certain Disease Producing Species of Fusarium.
220 Woolly Aphids of the Elm.
221 Variations of Fat in Milk. Pedigree System Applied to Guinea Pigs. Aluminum in Chick Feeds.
222 Meteorology, Finances and Index.

Work of Inspection (Official Inspections).

46 Seed Inspection.
47 Fungicide and Insecticide Inspection.
48 Drugs.
49 Protection of Food Offered for Sale.
50 Feeding Stuff Inspection.
51 Weight of Butter.
52 Seed Inspection.
53 Fertilizer Inspection.
54 Insecticide and Fungicide Inspection.
55 Clams, Oysters and Scallops.

Among the more important miscellaneous publications are:

467 The Potato Flea Beetle.

468 Preparation and Use of Lime-Sulphur in Orchard Spraying.
471 Methods of Poultry Management at the Maine Agricultural Experiment Station.
485 Special Report of the Maine Agricultural Experiment Station for the Commissioner of Agriculture for the Year 1912.
488 Summaries of Station Work. I. Apple Studies.

A complete list of the Station publications for 1913 is given in Bulletin 222.

All publications of the Station are distributed free to residents of Maine. The demand for the Station bulletins outside of the State has made such inroads upon the printing fund that a price is put upon them to non-residents with the exception of exchanges, scientific investigators and libraries.

Equipment of the Station.

The Station is well equipped in laboratories and apparatus, particularly in the lines of chemistry, entomology, horticulture, pomology, plant pathology and poultry investigations. Its poultry plant is probably the most complete for the purpose of investigation of that of any experiment station in the country. While the Station carries on some coöperative work such as orcharding, and field experiments with farmers in different parts of the State, most of the work is conducted in its own laboratories and poultry plant at Orono, and upon Highmoor Farm, situated in the town of Monmouth.

Its offices and laboratories are chiefly located in Holmes Hall (named in honor of Dr. Ezekiel Holmes, the first Secretary of the Board of Agriculture) on the University of Maine campus, Orono. It is a two story brick building, 81x48 feet. The poultry plant is also situated on the University of Maine campus.

Aroostook Farm.

More than 70 years ago, Dr. Ezekiel Holmes, the first secretary of the Board of Agriculture, and who was in many ways a pioneer in Maine in the application of science to agriculture, urged the necessity for an experimental farm in Aroostook County. This idea conceived so long ago came to partial fulfillment by the act of Legislature of 1913 providing an appropriation for the purchase of a farm for experimental purposes in agriculture in Aroostook County. The appropriation for the purchase of this farm was $10,000. To the committee this seemed inadequate to obtain such a farm as was needed for the purpose of an experimental and seed farm. In order that a better farm than could be obtained for $10,000 might be purchased, they sought the coöperation of Aroostook citizens. As a result, a farm was purchased in Presque Isle for which the State has paid $10,000 and the citizens of Presque Isle have provided for the payment of the other $10,000 to complete the original cost of the farm and $3,000 for putting up a suitable house.

The farm is well situated two miles south of Presque Isle village. The Bangor and Aroostook Railroad crosses the farm. There was a siding at the point where the direct road from Presque Isle to Houlton crosses the Bangor and Aroostook Railroad, and a flag station has been established there under the name of "Aroostook Farm."

The house and barn upon the farm were destroyed several years ago. One of the best barns in Aroostook County was erected, to replace the one burned, by the last owner. It has a high cement constructed basement, part of which is fitted for admirable potato storage. The farm contains about 275 acres, about one-half of which is cleared. It has several types of soil characteristic of Aroostook County, and it is believed to be in every way suited to experimental work. The house for a farm superintendent will be constructed in the early spring from funds provided by citizens of Presque Isle.

The State made no appropriation for the carrying out of experimental work on this farm in 1913 and 1914. Through the liberality of the management of the Bangor and Aroostook Railroad in contributing $2,500 to the carrying out of investigations in the year 1914 there is made possible the beginnings of experimental work on this farm in 1914. The Directors have given this support clearly recognizing that the railroad will obtain no direct returns therefrom, but believing that the road in common with the County will receive so much indirect benefit that the beginnings of the studies should not be postponed until the meeting of the legislature in 1915. This gift is made with the distinct understanding that it will not be duplicated and is to tide over the existing lack of funds.

As Aroostook Farm was turned over to the Experiment Station there were about 55 acres plowed, ready for the potato crop for 1914. There were about 25 acres in potatoes in 1913 that it was planned by the former owner to seed to oats in 1914.

Among the experiments which it is hoped to begin at Aroostook Farm in 1914, the following may be cited:

Experiment with Oats.

Experiment to test the profitable amount of oat seed per acre for a maximum crop. There is a great diversity of opinion in the county and in the state as to the amount of oat seed that is best used per acre. While this would naturally vary with the different varieties, it is believed that many people in Aroostook County are not merely wasting seed but are decreasing the crop by over-seeding. This will be given as thorough a try-out as is possible in a single season on ten acres, using the Prosperity oats which have been cleanly grown at Highmoor Farm for three years. Fifteen or more varieties of the most promising of the oats which have been grown at Highmoor Farm for the past three years will be tested out in acre plots at Aroostook Farm in 1914.

Experiments with Potatoes.

The hill selection Cobblers which have been made during the past three years at Highmoor Farm will be taken to Aroostook Farm and the testing out continued. Experiments upon the different methods of applying fertilizer to the potato crop will also be as thoroughly tested as is practicable in a single season.

The United States Department of Agriculture will use 12 acres in continuing the testing out of the seedlings and other single tuber tests which they are carrying out at four different sections in the country. For the two preceding years these were conducted on the John Watson farm at Houlton. The study of the chemical effects of potato diseases will be continued by the Department of Agriculture in 1914. A few other minor experiments are planned by the Experiment Station which are not here given.

Highmoor Farm.

The State Legislature of 1909 purchased a farm upon which the Maine Experiment Station "shall conduct scientific investigations in orcharding, corn and other farm crops." The farm is situated in the counties of Kennebec and Androscoggin and largely in the town of Monmouth. It is on the Farmington branch of the Maine Central Railroad two miles from Leeds Junction. A flag station called Highmoor is on the farm.

The farm consists of 225 acres, about 200 of which are in orchards, fields and pastures. There are in the neighborhood of 3,000 apple trees upon the place which at time of purchase had been set from 15 to 25 years. The fields that are not in orchards are well adapted to experiments with corn, potatoes, and similar general farm crops. The house is two story with a large wing, and contains about 15 rooms, well arranged for the Experiment Station offices and for the home of the farm superintendent. The barn is large, affording storage for hay and grain. The basements of the building afford a moderate amount of storage for apples, potatoes and roots.

Highmoor farm is used as a laboratory by the different departments of the Station and part of the work in progress there is described in other parts of this report. Anyone interested can obtain a full list of the field experiments at Highmoor Farm in 1913 on request to the Director of the Station. A similar list for 1914 will be published.

Work of Inspection.

The inspections entrusted to the Maine Agricultural Experiment Station include agricultural seeds, commercial feeding stuffs, commercial fertilizers, creamery glassware, drugs, foods, fungicides and insecticides. In the course of the year this work leads the deputies to visit practically every town of importance in the State at least once and many of them several times.

The work of inspection comprises much more than the actual collection of the samples. The deputy has constantly to be on the watch for goods which are not registered in the case of fertilizers, feeding stuffs, fungicides and insecticides; labels and tags have to be constantly examined in order to see that the statements thereon are apparently in accord with truth. Weighings are often made in order to see that the net weight actually contained in the package does not fall below the guaranteed weight; and there must be constant watch for old, shop-worn and damaged goods.

The fertilizer inspection must of necessity be carried on almost entirely during the early spring months just before that commodity is used by the farmers. While a large amount of fertilizer comes into the state during the fall and winter and is stored in large warehouses, more and more is being shipped into the state by rail and directly to the points of consumption so that the collection of samples of the various brands becomes more and more difficult and involves a larger expenditure of time and money each year.

The feeding stuffs inspection comes naturally during the fall and winter months when commercial feeding stuffs are most in use. This work also increases year by year as the consumption of commercial cattle feeds increases. The importance of this inspection becomes more and more apparent as the number of compounded feeding stuffs on sale increases. The tendency to use waste and inferior materials, screenings, chaff, oat clippings, hulls, cob meal, and other low grade materials, is ever increasing and the importance of having such compounds marked plainly so that the consumer may know exactly what he is getting is, of course, apparent.

The inspection of agricultural seeds also comes during the spring months just before the seed is placed in the ground. A comparatively few samples of seeds are actually analyzed, because the seed analyst himself does the actual work of inspection and no samples are taken unless the appearance of the goods indicates that the guarantees accompanying it may be too high, or for some other reason there is cause for suspicion.

The insecticides and fungicides inspected include all classes of materials which are used to destroy, repel, or mitigate in any way insect and fungus pests. The requirements of the insecticide and fungicide law are more recent than the other inspection laws of the State, but the importance of the work is already evident.

The inspection of foods and drugs goes on constantly throughout the year, and the number of samples collected does not represent in the least either the importance of the work or the scope of the ground covered by the deputies.

The importance of manufacturing, storing and dispensing food materials under sanitary conditions is just being realized by the public. Just how much disease is spread because flies carry with them and deposit upon exposed foods the germs of dangerous diseases, or the dust of the streets containing dangerous disease germs is scattered upon food materials, or the spray from human mouths contaminate food products, can never be ascertained. That diseases are spread by these means, however, is indisputable. In like manner it can never be ascertained of just what value various inspection laws are to the commonwealth, but by comparing the reports of many other states with our own we can feel certain that at the present time the old statement that Maine is the dumping ground for inferior materials can no longer hold true. The character of the various materials offered for sale in the State, which come under the requirements of the various inspection laws, is constantly improving.

The actual work of inspection in the field is accomplished by means of several deputies. The collection of samples of fertilizers, feeding stuffs and seeds is done, as noted above, at certain short definite periods of the year and is usually done by special deputies who search for these particular materials only. The remainder of the inspection work is at the present time done principally by local inspectors appointed to look after some limited locality in which they reside.

By this means the larger towns and cities are at present being constantly inspected and the sanitary conditions of food displays are being constantly improved.

As stated above, with the close of the present year the Director of the Experiment Station is relieved from the executive work under these various laws, which will be enforced by the Commissioner of Agriculture. There will be no radical changes in the enforcement of these various acts. The chemical analyses will be made at the Maine Agricultural Experiment Stations and the results of the examination published by the Station, as in the past.

Biology.

The Department of Biology is chiefly engaged in the study of plant and animal breeding. The final goal of this work is to find out how the common farm crops and live stock may be improved in quality and productivity by breeding. On the animal side the work is largely with poultry and cattle, while on the plant side corn, oats and beans have been the crops chiefly studied.

WORK WITH POULTRY.

During nearly the whole existence of the Maine Agricultural Experiment Station it has carried on work with poultry along one line or another. Two phases of the poultry work of this Station have attracted wide attention, namely its experiments in breeding for increased egg production, on the one hand, and in poultry management on the other hand. In recent years an increasing amount of attention has been paid to the former line of work. This is warranted by the great practical importance to agriculture of the subject of breeding for performance in general. Not only is a working out of the fundamental principles upon which successful breeding for egg production depends proving useful and valuable to the poultryman, but also to the breeder of any kind of live stock who is seeking to improve utility qualities. Poultry probably furnishes more favorable material for working out the laws of inheritance and breeding than any other of the domestic animals.

Another line of work has to do with the physiology of egg production. In this connection a study has been published during the past year of the mode of formation of the white of the egg.

How the White of the Egg Is Made.

The oviduct or egg tube of a laying hen is divided into five main parts, readily distinguishable by gross observation. Beginning at the anterior end of the organ these parts, in order, are: (a) the infundibulum, or funnel, (b) the albumen secreting portion, (c) the isthmus, (d) the uterus or "shell gland" and (e) the vagina.

Each of these parts is generally supposed to play a particular and exclusive role in the formation of the protective and nutritive envelopes which surround the yolk in the complete egg as laid. Thus the funnel grasps the ovule at the time of ovulation; the glands of the albumen region secrete the different sorts of albumen or "white" (thick and thin) found in the egg; the shell membranes are secreted in the isthmus; and finally the glands of the uterine wall secrete the calcareous shell. This is in brief, the classical picture of the physiology of the oviduct.

For some years past experiments and observations have been systematically carried on in the Biological Laboratory of the Maine Station with the object of acquiring a more extended and precise knowledge of the physiology of the hen's oviduct than is to be gained from the literature.

Putting all the evidence together, the following account of the processes by which the hen's egg acquires its white and shell summarizes the results of this study.

1. After entering the funnel the yolk remains in the so-called albumen portion of the egg tube about three hours and in this time acquires only about 40-50 per cent by weight of its total "white", and not all of it as has hitherto been supposed.

2. During its sojourn in the funnel and albumen portions of the duct the egg acquires its chalazæ and chalaziferous layer, and the "thick" albumen layer.

3. Upon entering the isthmus, in passing through which portion of the duct something under an hour's time is occupied instead of three hours as has been previously maintained, the egg receives its shell membrane by a process of discrete deposition.

4. At the same time, and during the sojourn of the egg in the uterus or shell gland it receives its outer layer of fluid, or "thin" albumen which is by weight 50-60 per cent of the total "white."

5. This "thin" albumen is taken in as a dilute fluid by osmosis through the shell membranes already formed. The fluid albumen added in this way diffuses into the dense albumen already present, dissolves some of the latter and so brings about its dilution in some degree. At the same time the fluid albumen is made more dense in this process of diffusion, and comes to have the consistency of the thin layer of the normal laid egg. The fluid albumen taken into the egg by osmosis is a definite secretion of glands of the isthmus and uterus.

6. The addition of albumen to the egg is completed only after it has been in the uterus from 5 to 7 hours.

7. Before the acquisition of albumen by the egg is completed a fairly considerable amount of shell substance has been deposited on the shell membrane.

8. For the completion of the shell and the laying of the egg from 12 to 16, or exceptionally even more, hours are required.

Poultry Management.

At all times efforts are being made to improve the methods of management of poultry on the Station plant. During the past year the Station has issued Circular 471 entitled "Methods of Poultry Management at the Maine Agricultural Experiment Station." This is a revision, with much additional matter, of Farmers' Bulletin 357; it brings the account of the Station methods up to date.

"Dead in Shell."

Careful analysis of the matter leads to the conclusion that there can be but two general classes of causes concerned in the death of chicks in the shell during incubation. The first of these classes of causes must be those which are inherent in the egg which one has attempted to hatch. The other class of causes must include those which are involved in the method of incubation practiced in hatching the eggs. The causes of mortality during incubation which are inherent in the egg itself may be considered first. The developing chick embryo derives the nourishment which it needs for its proper development from the yolk and white of the egg. All the time that it is growing and developing it feeds on these substances. It is, of course, obvious from general experience that if a young growing animal does not get the right kind of food for its proper nourishment it does not make good growth or develop in strength. Improper nourishment means that the young animal will weaken and may finally die. The same reasoning applies exactly to the development of the chick in the egg. It cannot make a proper growth unless it has nourishment of the right kind. Now the yolk and white of the egg are formed in the body of the mother hen which laid the egg. Experience has demonstrated that if this hen is not in good, strong, vigorous physical condition and is not fed the proper sort of food while she is laying eggs, then in turn the yolk and albumen within these eggs which is to serve as food for the embryo during incubation will not be of the sort which will produce strong healthy chicks.

Here then is the clue to the primary factor in the control of death of chicks in the shell during incubation. The first step to take towards preventing mortality in the shell is to see that the breeding birds from which the eggs come are in a strong, healthy, vigorous condition, and that they are fed a proper ration for breeding birds. In the experience of the Maine Agricultural Experiment Station the most important factor in feeding breeding birds is to see first of all that they get a minimum amount of animal food of any kind in their ration. By animal food is meant any food substance of animal origin, such as beef scrap, blood meal, fish scrap, milk, green cut bone, etc. Furthermore it is necessary that the breeding birds have an abundance of fresh succulent green food. During the season of the year when hatching is done the climatic conditions in Maine are such that green food from out of doors cannot be obtained. Under these conditions the most satisfactory source of green food which has been found at the Station is green sprouted oats. These should be fed to the breeding birds in liberal quantities. To give good results the oats should be quickly grown and should be about 6 inches tall above the root at the time when they are fed. This material may furthermore be supplemented to great advantage by feeding cut clover or cut alfalfa which has been steamed. The birds relish this and it has a valuable influence on the quality of the hatching eggs. Attention to these points in the feeding of breeding birds will go a long way in the reduction of mortality in the shell during incubation.

Turning now to the second class of causes, those having to do with the operation of the incubator itself, it is probable that the greatest single factor in incubation causing mortality in the shell is a lack of sufficient moisture. In making this statement it is of course assumed that the operator of the machine is skilled in that work and that he understands how to run the incubator at an even temperature. By improper temperatures chicks may be killed in the shell very easily, but there should be no difficulty in this direction with any good standard incubator, provided the directions furnished by the manufacturers are carefully followed. The need for a continuous and copious supply of added moisture during incubation however is very often overlooked. This necessary added moisture may be supplied in various ways. Some incubators on the market are made with automatic arrangements to supply this water. On the other hand most of the hot air incubators, which are very widely used, lack any such arrangement. In these cases the most satisfactory way of supplying added moisture is by sprinkling the eggs each time they are taken out of the machine for turning, with water warmed to a temperature of from 108-110 degrees: This water may be sprinkled on the eggs by hand as in sprinkling clothes for ironing, or a hand spray-pump may be used for the purpose. The eggs should be put back into the machine when wet. There should be no sprinkling of the eggs after the 18th day of incubation. From this time on the eggs should be left undisturbed until the chicks hatch.

The Value, Method of Preservation, and Economical Use of Hen Manure.

One of the most valuable by-products of any live-stock industry is the manure. Its proper care and use is one of the distinguishing features of a successful stock farm. The high nitrogen content of poultry droppings makes them in certain respects the most valuable of farm manures. At the same time this quality necessitates special treatment to preserve the nitrogen and utilize it economically.

According to experiments carried on at this Station some years ago the night droppings average 30 pounds per hen per year. They contain .8 pound of organic nitrogen, .5 pound of phosphoric acid and .25 pound of potash. At the present price of fertilizers this material would be worth 20 cents. No data are available on the amount of day-voided dung. Since the hens spend less than one-half of their time on the roosts, and since more dung is voided while the birds are exercising than when at roost, it is estimated that during a year probably 45 pounds of dung are voided by each bird while off the roost. Allowing that more than one-half of the fertilizing elements of the day dung are necessarily lost, the value of the total droppings, if properly cared for, should be at least 30 cents per bird per year.

The poultryman or farmer who properly cares for the droppings can add a neat further profit to his business. For example the droppings from 1000 birds, if preserved without needless loss, will be worth at least $300.

Poultry manure contains more nitrogen than other farm manure, because in birds the excretion of the kidneys is voided in solid form (uric acid), with undigested portions of the food. This form of nitrogen is easily available to plants. Unfortunately, however, it is not stable. Putrefactive processes easily change it to ammonia compounds, and unless special care is taken of the droppings one-third to one-half of the nitrogen passes off as ammonia gas.

The mechanical condition of poultry manure is poor. It is apt to be sticky when fresh and lumpy when dry. On this account, if used untreated, it can only be successfully applied to the land by hand, as it does not work well in drills or spreaders. Hen manure used alone is very wasteful of nitrogen as it carries this element in too large a proportion to its phosphorus and potassium.

In the experiments referred to above the attempt was made to find a method of treatment of hen manure which would first prevent the loss of nitrogen, second, add sufficient phosphorus and potassium in forms available for plant food to make a balanced fertilizer; and, third, so improve the mechanical condition of the dung that it can be applied to the land with a manure spreader. Seven different methods of treatment were tested. Summarized the results were as follows: By itself, hen dung is a one-sided nitrogenous fertilizer. As usually managed, one-half or more of its nitrogen is lost, so that as ordinarily used it does not carry so great an excess of nitrogen. Because of its excess of nitrogen it will be much more economically used in connection with manures carrying prosphoric acid and potash. As both acid phosphate and kainit prevent the loss of nitrogen, it is possible to use them in connection with sawdust or some other dry material as an absorbent (good dry loam or peat will answer nicely) so as to make a well balanced fertilizer. For example, a mixture of 30 pounds of hen manure, 10 pounds of sawdust, 16 pounds of acid phosphate, and 8 pounds of kainit would carry about .25 per cent nitrogen, 4.5 per cent phosphoric acid, and 2 per cent potash, which, used at the rate of 2 tons per acre, would furnish 50 pounds nitrogen, 185 pounds phosphoric acid and 80 pounds potash.

At the present price of fertilizing ingredients this mixture is worth about $10.00 per ton. It is a well balanced, stable fertilizer which, while still not fine enough to work well in drills, can be successfully applied with a manure spreader.

The kind of absorbent used should be the one which can be obtained at least cost, since the amount of plant food added by any one of those suggested is negligible, and since they are about equally effective as dryers (the slight acidity of peat gives it some advantage as it helps a little to preserve the nitrogen). It is probable that one of the three can be obtained by any poultryman or farmer at little or no expense.

The absorbent and the acid phosphate and kainit should be kept conveniently at hand and each day when the droppings are collected they should be treated. It may be best to weigh the ingredients a few times, after which it will be possible to make sufficiently close estimates by measure.

The treated droppings should be well sheltered until time to apply them to the land, i. e., shortly before plowing. Any form of shelter may be used. For a temporary plant, or for a small farm, a small wooden building or a bin in a larger building will probably be the best place practicable; but for a large, permanent poultry plant a cement manure shed or tank is advisable. A general farmer also will find such an equipment for the storage of all farm manure a paying investment. A portion of this shed can be partitioned off for hen manure.

A properly constructed cement building will not have to be constantly repaired and frequently replaced like a wooden structure, which rots out quickly when used for the storage of manure. The cement building is water tight, preventing the entrance of water from without and the escape of any unabsorbed liquid manure. It is, in fact, a perfect permanent shelter.

WORK WITH DAIRY CATTLE.

At the last session of the legislature an act was passed providing for the conducting by the Station of investigations in animal husbandry. An annual appropriation was made for this purpose. Work on this line has been well started during the past year. The main lines of study involved are:

(1) The study of existing records of milk production for the different pure breeds of dairy cattle.

(2) The carrying out of definite and controlled matings, both within the pure breeds and in crosses of high and low producing breeds, in order to discover whether this character milk production is inherited in a similar way to the character egg production, which has been studied in fowls.

It is of course obvious that experimental work in this line will take a considerable number of years to produce results. The dairy cow is a slow growing animal and the character milk production is one which does not come into expression until full adult life is reached. However, the milk records now in existence will make it possible to make some beginning at once on an analysis of the inheritance of this character before the results of experimental investigation come into hand.

Collateral lines of investigation in connection with the cattle breeding project include the study of sex determination, of inbreeding and other topics.

Influencing the Sex Ratio in Cattle.

To control the sex of offspring is a thing which the breeder of live stock would very much like to be able to do. Sex control, however, can never be hoped for until the laws of sex determination are known. The search for these laws has engaged the attention of students for centuries past. Many theories regarding the matter have been propounded, but only within comparatively recent years have careful experimental and statistical investigations on sex-determination been made.

Some years ago the Maine Agricultural Experiment Station undertook the collection of statistics in regard to cattle breeding operations in order to find out whether the time of service in relation to the period of heat had any relation to the sex of the resulting calf. About 1860 it was suggested by a European investigator named Thury that if cows were served at the very beginning of heat there would be a tendency towards a preponderance of heifer calves in the resulting offspring. On the other hand if the cows were served relatively late in heat there would tend to be more male calves born. Thury produced practically no concrete evidence in support of his theory and after a few experimental tests of it on a small scale the matter dropped out of notice and has been practically forgotten. Within the last few years, however, experimental studies on sex determination in lower animals like the frog and the toad have tended to show that in its essentials Thury's idea was probably right. In these lower animals it has in some cases been possible to control sex absolutely, that is, to produce all the offspring of one sex.

The statistics regarding sex determination in cattle collected at the Maine Agricultural Experiment Station are the most extensive which have yet been available to test this matter. Putting together all the authentic evidence which has been collected at the Maine Station and at several experiment stations in Germany the relations are as shown in the following table:

Time of Service.	Sex of Calf.		Number of Male Calves to every 100 Female Calves.
Early in heat	134 male	178 female	75.3
Middle of heat	67 male	58 female	115.5
Late in heat	77 male	44 female	175.0
Totals	278	280	

These figures comprise 558 distinct breeding operations to test the matter. They show that when the service was early in the heat there were 133 heifers to every 100 bull calves (or put the other way about there were 75 bull calves to every 100 heifers). When the service was late in the heat this relation was reversed. There were then 175 bulls born to every 100 heifers. These figures have been subjected to the most refined mathematical tests, applied to determine whether they are to be regarded as accidental or as representing a real and definite law of sex determination. The results point with a high degree of probability to the latter conclusion.

The position of the Experiment Station in regard to the results set forth above should be clearly understood. It is not contended or supposed that the time of service in relation to the period of heat absolutely controls the sex of the subsequent offspring. It is believed, however, that the facts show, with a considerable degree of probability, that the sex ratio in cattle can be to some extent modified by controlling the time of service. But the amount of such observed modification is not so great that the matter can be tested with a few individuals.

There is every reason to believe that any effect would only appear in fairly comprehensive statistics. The matter is one of much practical consequence to the stock breeder. Because this is so we would caution the reader against misinterpreting these results. A trial of a half dozen individuals will not in any sense whatever adequately test the accuracy of the results set forth above.

The probability that the sex ratio can be changed by careful attention to this matter of time of service is sufficiently great, in our judgment, to warrant any man in modifying his breeding practice in accordance with it, particularly since in so doing he will be incurring no added risk of any kind. In the every day affairs of life in regard to business, investment of funds, and the like, practical men every day undertake courses of action on the basis of probabilities much smaller than that in favor of getting an increased number of males if cows are served late in heat. The practical cattle breeder in most cases would like, if he could get it, an excess of female calves. All the evidence at hand warrants the belief that by taking care that cows are served as soon as possible after the onset of heat there will be some reduction in the proportion of male calves born. In short, the facts warrant the breeder in paying attention to the time of service in his cattle breeding operations, but he must not suppose that by so doing he can absolutely control the sex of the offspring, or even approach measurably close to absolute control. He can at best merely modify, over a period of years, the sex ratios in greater or less degree, in the direction which he desires.

The Fear of Inbreeding.

A careful study of the history of the best improved strains of live stock of all sorts leaves no room for doubt that the attainment of the highest degree of excellence has always been associated with the practice of a very considerable amount of inbreeding, of rather close degree. It is a curious paradox of animal husbandry in general that while, as a matter of fact, every successful breeder of high grade stock practices inbreeding to a greater or lesser extent, a great many of these men are violent, even fanatical, opponents to inbreeding in theory. Most of them will deny stoutly that they ever practice inbreeding. They contend that they practice "line breeding," but never "inbreeding."

The distinction here is obviously verbal and not biological. The essential and important biological point is that what is actually done is to *purify* the stock in respect to all characters to as great a degree as possible. What the successful breeder aims to do is to get his stock into such condition that he has only one kind of "blood" in it. Expressed more precisely, though unfortunately more technically, it may be said that the breeder endeavors to get his stock homozygous with reference to all important characters or qualities. The quickest way, indeed the only way, practically to obtain this result is by the practice of some degree of inbreeding. Sometimes a great stride towards the desired end may be made by mating brother and sister or parent and offspring together.

That a mating of such close relatives will surely result in disaster is one of the carefully nursed superstitions of breeding, which has often been exploded, but will doubtless always be with us. It may be said that all the evidence which may be gleaned from the experience of stock breeders indicates that the results which follow inbreeding depend entirely upon the nature of the individuals inbred. If one inbreeds weak animals, lacking in constitutional vigor, and carrying the determinants of undesirable qualities in their germ cells, the offspring resulting from such a mating will undoubtedly be more nearly worthless than were their parents. If, on the other hand, one inbreeds in the same way strong and vigorous animals, high in vitality, and carrying the germinal determiners of desirable qualities there may be expected a corresponding intensification of these qualities in the offspring. The time has come when a vigorous protest should be made against the indiscriminating condemnation of inbreeding. It should be clearly recognized that if the experience of stock breeders extending throughout the world, and as far back as trustworthy data are available, means anything at all it plainly indicates that some degree of inbreeding* is an *essential* to the attainment of the highest degree of success in the breeding of animals.

This contention receives full support from the results of modern exact studies in genetics. Such studies show that the personal bodily characters of the parents have no causal rela-

* Of course if the term "inbreeding" makes too violent a strain upon anyone's prejudices, there is no objection to his using for the practice the term "line-breeding," or some other even milder designation.

tion to the personal characters of the progeny. What the progeny shall be like is determined by the constitution of the germ cells of the parents. When by a proper system of selective breeding the point is reached where these germ cells are pure with reference to a particular character, or degree of a character, then that character will unfailingly appear in the offspring, in the degree of perfection in which it is represented in the germ cells. This is the highest goal of the practical breeder. But in a sexually reproducing organism, like the domestic fowl or cattle, purity of the germ cells with respect to the determiners of any character is only to be obtained, in the hands of a practical breeder without special scientific training, by the practice of inbreeding.

It should not be understood that indiscriminate inbreeding without definite purpose or reason is advised, or advocated as a panacea for all the difficulties which beset the breeder's path. All successful breeding is the working out of carefully made plans. In those plans inbreeding has a place.

WORK WITH PLANTS.

Beans.

The experience of the past two years has shown that it is impossible to grow several varieties of beans in adjoining plots without the varieties mixing. The general impression has prevailed that the bean flower was so constructed as practically to ensure self-fertilization and to prevent cross fertilization by insects. The pistil and stamens are entirely enveloped in a sheath or tube-like structure. Generally the pollen will have ripened and the ovule will have been fertilized before the bud fully opens. Without the intervention of insects, self-fertilization would always take place in the bean blossoms.

Last year humble bees were observed working among the blossoms of the bean plants in the Station's variety tests. Humble bees were seen to light on the lower petals of blossoms, which were borne down by the weight of the bee, and served as levers, throwing the stigma and antlers out of the sheath into full view. The bee brushed its body against the exposed stigma and antlers and then flew to other blossoms, again alighting on the lower petals and repeating the operation described above. Hence, it seems justifiable to conclude that the humble bee may be an agent in the crossing of beans.

The crop of beans harvested in the fall of 1912 presented marked differences in size, color, shape and type within the same variety. Even the descendants of single plants supposedly self-fertilized also showed a wide variation in color and shape. Some exhibited an entire lack of uniformity. This was conclusive evidence that the beans propagated in the variety tests of 1911 had been crossed and observations of the bees lead one to believe that the beans were again crossed in 1912. In view of this hybridization it became necessary to devise ways and means of protecting bean plants to prevent crossing by humble bees, especially if one desires to study the inheritance of characters in beans and to originate new pure strains. To accomplish this a screened cage was planned wherein it would be possible to propagate 500 to 600 plants to form the basis of pure lines.

From the experience reported above growers of seed beans will realize that it is advisable to cultivate only one variety of beans at a time. If more than one variety is grown there is bound to result a mixture of types through the agency of humble bees in crossing.

While the Station's work with beans to date has not progressed far enough to enable one to draw many conclusions, some promising types have been separated out which are breeding true. Among these types that have been found to breed true is one strain which produced white beans. In 1911 out of a variety of beans which each year developed many types was selected one plant characterized by long runners, spreading habit of growth, white blossoms and many pods enveloping all white beans. The seed of this plant has been planted separately during the past two years and each season has produced a high yield of white beans.

Another interesting pure line is one of the Old Fashioned Yellow Eye beans. A plant of this type,—short, erect growing, with white blossoms bearing many pods and yielding beans white in all parts except around the eye, was selected in 1911. This plant also has bred true to type each season. The Old Fashioned Yellow Eye bean is familiar to all in Maine. However, of the three varieties sold in the state by dealers for seed, none is pure. Each will produce many widely varying types. The fixation of the color pattern and shape of bean, and also high yield, seems to have been accomplished in the line developed from the one plant just mentioned. The color present in the Old Fashioned Yellow Eye bean is generally a hue of yellow. However, we have found this same pattern also carrying red, black or brown pigment. In what way each of these is produced is another interesting phase of the work yet to be studied.

In addition to these strains of beans there are many others that have been propagated from single plants. Some produce black beans, others all yellow, brown or mottled beans. Some of these may prove to be superior strains for snap beans if not for marketing as dried beans. All in all the bean breeding work at Highmoor is developing many interesting types of beans, some of which promise to be of superior value as a crop.

Oats.

Two lines of work with oats have been carried on at Highmoor for several years. These are (a) variety tests and (b) breeding work.

(a) *Variety Tests.*

The object of the variety tests of oats is first to find out which varieties already on the market are best suited to Maine conditions and second to furnish material for the breeding work. These variety tests were begun at Highmoor in 1910 and have been carried on for four seasons. In all from 20 to 30 varieties have been tested each year. The more promising varieties have been continued in the test from year to year. Those varieties which failed to do as well as expected have been discarded and new varieties substituted in their place.

Seed for these tests was obtained from dealers and growers in the United States and from members of the Canadian Seed Growers Association in Canada. These varieties represented the most productive strains grown in the regions from which they were obtained. All varieties were sown in drills 6 inches apart and at the rate of two bushels by weight of seed per acre. In the earlier tests each variety was grown in a 1-10 acre plot. During the past season a new method has been adopted which is very satisfactory. Instead of having one 1-10 acre plot there were four 1-40 acre plots for each variety. These four plots were scattered over the field so that each variety was tested in a wide range of soil conditions. In calculating the yield per acre the average yield of the four 1-40 acre plots was used as a basis. This is much more satisfactory than the use of a single large plot.

During the past season 21 varieties of oats were tested at Highmoor. Of these, 11 varieties have been tested for four seasons, 8 for two seasons, one for three seasons and one for one season. The average yield both of grain and straw for the four seasons for the 11 varieties tested is given in the following table.

Yield of the Most Promising Varieties of Oats on the Basis of an Average of Four Successive Years Test.

Name of Variety.	Average Yield for Four Years.	
	Bushels of grain per acre.	Pounds of straw per acre.
Irish Victor	63.7	2794
Lincoln	63.0	2879
Imported Scotch	63.0	2793
Prosperity	62.2	2766
Banner	60.5	2820
President	59.3	2722
Silver Mine	59.0	2710
Reg. Swedish Select	57.6	2684
Victor (a black oat)	57.6	2614
Kherson (an early oat)	57.6	2471
Senator (Horse mane oat)	49.25	2985

Among the varieties tested four seasons there are some very interesting types. First among the early varieties of oats is the Kherson. With short, fine, stiff straw supporting a small open head, characterized by short delicate drooping branches, the Kherson often surprises one in its cropping ability. The grain is long, slender, yellow in color and not particularly attractive to the average farmer because of its small size. Nevertheless, this oat is one worthy of attention. Seeded May 1 to 5 it is generally thoroughly ripe by August 1. At Highmoor this variety yielded from 48 to 69 bushels per acre during the past four seasons, giving an average yield of 57 1-2 bushels per acre. The average yield of straw during the same period was 2,466 pounds per acre. In the season of 1913 this oat yielded 61 bushels per acre.

Among the medium late varieties are the Imported Scotch and Irish Victor. These mature generally about a week later than the Kherson. These varieties have a taller straw and larger, more plump, white grains. The Imported Scotch has yielded from 60 to 71 bushels of grain per acre during the past four seasons, the average yield for the four seasons being 63 bushels per acre. The yield of straw averaged 2,793 pounds per acre. The straw of each of these varieties is a little weak. In 1913 the yield of these varieties was as follows:

Imported Scotch, grain 68 bu. per acre, straw 2,635 lbs.
Irish Victor " 67 " " " " 3,003 "

Of the late varieties of oats which mature 10 days to three weeks later than the Kherson there were several types in these tests. Only a few of these will be mentioned owing to the lack of space.

An oat which always attracts attention by its long head of the "Horse Mane" type, and tall stiff stout straw bearing very broad leaves, is the Senator. However, this oat has never yielded very satisfactorily. The heads carry many spikelets but the percentage of barren grains is very high so that this promising variety always fails to yield as high as one would estimate from its appearance. The grain is very large, the kernel being enclosed in a thick hull. Often the kernel of a mother oat does not develop, in which case the pin oat is generally enclosed within the hull of the mother oat. The yield of grain ranged from 38 to 63 bushels per acre, giving an average yield of 52 bushels per acre in the four years test. The yield of straw amounted to 3,000 pounds.

The Banner Oat with a yield of 46 to 71 bushels per acre is one of the best late oats tried out in these tests. The plants are tall, leafy, possessing stiff straw, and carrying open heads with stiff upright branches. This oat produced on the average 61 bushels of grain per acre and 2820 pounds of straw during the past four seasons. The grain is medium to large in size, plump and white. It does best on strong moist soil. The President oat is late like the Banner and similar in appearance excepting that the branches of its open head are longer and droop more. Yield of grain 50 to 68 bushels per acre. Straw (4 year average) 2,722 pounds. The grain of this variety is large, plump and white.

The Prosperity oat is also a late variety producing tall leafy plants having stiff straw. The heads are open, spreading with long branches, the grain is white, short and plump. During the four years test the yield of grain ranged from 53 to 73 bushels per acre, averaging 62.5 bushels. Average amount of straw produced was 2,768 pounds.

A black oat, the Victor, is an interesting type. The straw is coarse, tall, stiff, and bears an open head with very long branches. This variety yielded 55 to 60 bushels of grain per acre.

The Lincoln oat resembles the President in general appearance except that it does not grow as tall. The grain is short, very plump and white. During the past four seasons this variety has yielded from 48 to 70 bushels of grain per acre and an average of 2,900 lbs. of straw.

Of varieties introduced since 1910 the Early Pearl, a medium to late variety, is very promising, judging from its performance in these tests. This oat has been grown for several years by Mr. R. L. Copeland of Brewer, Maine. It seems that this variety originated from a single plant found on the roadside and later propagated by Mr. Copeland. It has a uniform appearance and is very productive on fertile soils. In 1912 this variety produced 64 bushels of grain per acre and in 1913 70 bushels per acre. These figures are the means of yields from two plots in 1912 and four plots in 1913. The straw of this variety is tall, stiff, medium size, the heads open, erect. The grain is white, long, medium size, and well filled.

Other late varieties, the Siberian, Abundance and Silver Mine, resemble in general the Banner and President varieties in appearance. The yield has not been as great as that of these two varieties.

These tests will be continued in following seasons in order that each variety may be tested more than two years at least and preferably during five years. In such a period it may be possible to judge of the effects of certain seasonal changes on the cropping ability of these different varieties.

(b) *Breeding Work.*

The work of producing new varieties of oats which would be better suited to Maine conditions was started in 1910. Two lines of work have been carried on. One of these has been the attempt to cross varieties which possess desirable characters and then to isolate from the progeny strains which will possess the good qualities of both parents. Last year about 300 hybrid oat plants were grown. It is too early to make any statement regarding new varieties secured in this way. It will be several years before we can be certain that any new varieties secured in this way are breeding true or that they are better than varieties already existing.

The second line of work has been the selection of individual plants and the propagation of new strains from these. Each year we have gone through the plots and selected out individual plants which appeared to be better than their neighbors. The seed of each plant was kept separate and sown in a single row by itself. Hence all plants in a row were the descendants of one plant. Throughout the growing season notes were made as to the characters and general behavior of the plants in these rows. The plants of each row were weighed and threshed together so the progeny of the original selections were kept free from admixtures. Being self pollinated the oat plant generally breeds true from season to season. To those self-fertilized plants which breed true Johannsen of the University of Copenhagen has given the name "pure line." The culture of the progeny of single oat plants in rows affords a good basis for the study of the characters of the plants and also forms a basis of measuring the value of the selections in respect to the yield of grain and straw. Individual plants, all the progeny of which the test of two years showed to be uniform in type and possessing the ability to transmit the character of high yield, were propagated the following season in plots of two-thousandth acre in area. These small plots were necessary because of the small amount of seed available. The test in plots of this area showed some of the pure lines to be worthy of further trial. These promising lines were propagated the following year in fortieth acre plots. During the past season at Highmoor there were 49 of these plots representing the descendants of 33 plants selected in the season of 1910. Some of these appear very promising. These 33 pure lines represent all the plants, out of 300 originally selected, that were deemed worthy of further propagation. Some of these 33 lines will be taken out of the test this year because they are no better than strains already on the market.

One of the most productive pure lines is worthy of mention here. This new variety, Maine 357, represents an oat characterized by tall stiff straw averaging four feet in height, carrying open spreading heads. The grain is white, fairly long, plump and well filled. On two fortieth acre plots during the past season this oat yielded at the rate of 81 1-2 bushels per acre.

Besides this new variety known as Maine 357 there are six varieties of equal importance whose yields in 1913 ranged from 71 to 75 bushels per acre. All of these varieties originated by the Station are characterized by stiff straw, spreading heads and white plump grain. In 1913 these seven new varieties produced an average yield of 74 bushels of grain per acre. Twenty-one commercial varieties representing the best oats obtainable in the seed markets of this country were also tested at Highmoor last season. These yielded an average of 62 bushels of grain per acre as compared with 74 bushels produced by the seven varieties originated by the Station. This represents an average increase of nearly 20 per cent. in yield as a result of the breeding work over the *best* commercial seed.

Before a final decision is made in regard to these lines it will be necessary to continue the test during another season. At present, suffice it to say, there is a great deal worthy of confidence in the strains of oats that have been developed from single plants at Highmoor.

Corn.

The work with sweet corn and with field corn (yellow dent) has been continued. The field corn of the Cornforth strain has been bred up to a point where it appears to be a desirable sort for the Maine farmer. The past season was an extremely hard one for corn on account of the cold weather during June. However, a fair proportion of this corn matured in good season and was ready for harvest in the latter part of September.

The work with sweet corn suffered more severely from the cold spring. This was chiefly owing to the fact that the plots were on a cold piece of ground.

The new variety of sweet corn originated by the Station was given a further extended test this year. This variety promises to be superior to any corn now grown in the state for canning purposes. It is believed that the work of the past season has brought about a still further improvement in this corn. Owing to the unsatisfactory season this year it is desired to test this corn another year before it is put in the hands of the farmers.

Winter Wheat.

The possibility of winter wheat becoming a grain crop in Maine has often been discussed, and a few records of experiments with this cereal in this state have been found. Another winter grain, namely winter rye, is used much more extensively now than a few years ago as a green food for stock and also as a crop for plowing under to increase the humus content of the soil. In order to determine the behavior of winter wheat under the climatic conditions of this region a small amount of each of two varieties, one the World's Champion, the other Garton's Selected Turkey Red, were tested. These are said to be among the best winter wheats grown in the West.

On September 5, 1912, these two varieties were sown at Highmoor on separate plots. The seed was dropped in drills at the rate of 1 1-2 bushels per acre, and fertilizer, 4-8-7 grade, was broadcasted at the rate of 500 lbs. per acre. The growth of winter wheat is similar to that of winter rye. The leaves spread out upon the ground forming a thick covering before snow falls. By September 27 the plants of the World's Champion and the Selected Turkey Red varieties had developed leaves about 6 inches long. Throughout the winter the plants remained green. The plots on which these varieties grew were situated on a slope where very little snow collected. During the greater part of the winter these plants were unprotected and laid fully exposed to the frequent changes from freezing to thawing temperatures. All in all the environmental factors formed a severe test of the hardiness of these varieties. In the spring growth started at an early date and the plants grew rapidly, attaining maturity by the last of July. On August 1 the crop of each variety was harvested. The grain was well developed, red in color and hard, the straw was stiff, free from rust and of bright appearance. The yield of the two varieties tried out was as follows: The World's Champion yielded at the rate of 30 1-2 bushels of grain and 2,745 lbs. of straw; the

Selected Turkey Red produced 27 1-2 bushels of grain and 2,385 lbs. of straw per acre.

Considering these yields of grain in pounds per acre it is seen that 30 1-2 bushels of wheat are equivalent in pounds to a yield of 57 bushels of oats per acre; 27 1-2 bushels of wheat to 51 1-2 bushels of oats. It should be said that more experiments should be conducted to determine the time of planting in its relation to yield of grain and straw. However, in our judgment the time of sowing winter wheat should not be later than September 5 to get the best results.

Yield of Apples from Individual Trees.

It has been felt for some time that in one respect the records of the individual apple trees at Highmoor were not complete. The yield of apples from each tree has in the past been estimated and not accurately determined. Since in different years such estimates are made by various people they are not suitable for comparative purposes. After all it is the yield of apples that is the important thing to know about a tree. This fact was fully appreciated at the beginning of the experiments. The reason for not attempting to measure the yield has been that it was thought likely to involve too great a loss of labor at a very busy season. With a good crop of apples there are twenty to twenty-five pickers employed at Highmoor. If each man should lose five minutes on each bag of apples it would mean a great loss of time for the season.

However, the necessity of having some accurate measure of the yield of fruit from each tree has been becoming more urgent each year. It was decided that this year we should try out some methods for doing this. With a relatively light crop of apples this year it was possible to work out the details without causing much loss of time.

The method finally adopted was as follows: Large tripods were constructed with the legs about twelve feet long. From the center of such a tripod there was suspended a rod upon which a pair of 60-pound spring balances hung. Such a tripod was placed between the rows of trees to be picked. The pickers all use bags which fasten over the shoulder. Each picker brought his bag of apples to the tripod, hung it on the scales and taking another bag returned to the tree. A man at the tripod recorded the weight of the apples to the proper tree and emptied the bag.

By such methods there is practically no loss of time by the pickers. It is, of course, necessary to have an extra man for weighing and emptying the bags. One man can weigh, record and empty the apples from nine or ten pickers.

Such records continued for several years will give the Station a very valuable set of data. In the first place it furnishes the best measure of the success or failure of most experiments. Thus a fertilizer or cultivation experiment must, if it is successful, show an increased yield of fruit over that given by the control trees. Estimates are not reliable especially in years where the differences are small. Besides such estimates may be unconsciously biased by the observer.

Aside from this the data will furnish many interesting biological facts. Thus it will be of interest to know whether certain trees which yield well in a poor year will also yield well in a good year. Are there trees which are uniformly better yielders than other trees of the same age, size, etc.? If so, is it possible to propagate this high yielding quality by grafting or budding? It is hoped that in the course of time these and other questions may be solved from these data.

Chemistry.

The work of this department for the past year has been devoted almost entirely to inspections and may be considered under the following heads:

Fertilizer Inspection,
Feeding Stuff Inspection,
Food and Drug Inspection,
Fungicide and Insecticide Inspection,
Creamery Glassware Inspection.

The work of the department has been interrupted somewhat by quite extensive repairs on the laboratories. However, the addition of two new rooms and considerable new chemical apparatus will greatly facilitate the work in the future.

FERTILIZER INSPECTION.

Four hundred and eighty-seven samples of fertilizing materials were received and analyzed in the last inspection. Nearly all of these were mixed fertilizer, only 19 samples of chemicals being received. These consisted of 6 samples of nitrate of soda, 5 samples of acid phosphate, and 7 samples of muriate and sulphate of potash.

In addition to the regular determinations of nitrogen, phosphoric acid and potash the quality of the nitrogen in the mixed fertilizers was determined. This work involved four extra determinations of nitrogen and increased the work of analyzing a fertilizer about one-third. It is of value, however, in detecting low grade forms of nitrogen which are often used in low grade fertilizers.

The mineral nitrogen, particularly that in the form of nitrate, is very important to Maine farmers, especially those growing potatoes, and the nitrate content should be considered as much as the total nitrogen.

Manufacturers are still in some instances using very different sources of nitrogen in the same brand of fertilizer. It certainly does not seem to be unreasonable to insist that a high priced and high grade brand of fertilizer be as uniform in the forms of nitrogen that it carries as in its total nitrogen. For instance, it is believed to be necessary in this climate for the best results that a potato fertilizer contain about one-third of its nitrogen as nitrate. If much more is present it is liable to loss from leaching. If much less is present the plant will not have enough immediately available nitrogen. Most of the manufacturers do not appear to attach sufficient importance to this feature. They frequently substitute ammonium sulphate or organic nitrogen for nitrate nitrogen, seeming to have only the total nitrogen in mind.

Even a cursory examination of the tables in Official Inspections 53 will show figures that bear out the above statement. This is as true of the high as of the low priced brands of fertilizers sold in the state. And also it seems to apply to a large number of the makers. It would seem that one should have the right to expect that the goods would be uniformly made and mixed. The variations in character of the nitrogen content seem to indicate that too little importance is attached by the manufacturer to the forms of nitrogen in a definite brand.

It is believed that quite heavy losses in crops in this state have occurred in some seasons from lack of sufficient nitrate nitrogen to give the crop an early start. Every farmer who buys fertilizer for potato growing should know whether it contains the required amount of nitrogen in this form and the manufacturers should be required to furnish such guaranty.

As a rule the results of the analyses show that all the fertilizers sold in the state correspond reasonably close to their guarantee in total fertilizing elements.

FEEDING STUFF INSPECTION.

The feeding stuff inspection is made during the months when the most feeds are used and consequently covers a part of two calendar years. The results of the last completed inspection were published in May as Official Inspections 50. Five hundred and ninety-three samples were collected and analyzed, complete analyses being made of one sample of each brand and protein on all samples. At the present time less than half the inspection samples have been collected. Many samples of cottonseed meals, however, have been sent in by dealers and early in the season many samples were found to be below guaranty in protein,—so much so that several were reported for prosecution. This inferiority did not seem to be confined to any particular brand but even those brands which can nearly always be relied upon to be up to guaranty fell below. The manufacturers claimed that the inferiority was due to bad weather conditions in the cotton growing states when the seed was harvested, which always impairs the quality of the meal it makes. The samples which have been received recently are of better quality and are well up to their guarantees.

Other classes of feeds which have been examined correspond well with the guarantees, and very few adulterated feeds have been received.

FOOD AND DRUG INSPECTION.

A smaller number (726) of food and drug samples have been handled the past season than usual, owing to quite extensive repairs to the laboratories going on, and a smaller chemical force than usual for the last five months of the year. The principal materials examined have been oysters and clams, tested for water content and preservatives; ice creams, tested for butter fat content; rice, tested for glucose and talc coatings; pickles, tested for alum and preservatives; sweet spirits of nitre, which deteriorates quite rapidly, tested for percentage of ethyl nitrite; butter tested for fat, water, salt and casein; molasses tested for sucrose, invert sugar, glucose and water.

FUNGICIDE AND INSECTICIDE INSPECTION.

One hundred and sixty samples of fungicides and insecticides were collected and examined. They comprised almost all kinds of materials used as disinfectants or insect repellents or destroyers. Many of these were examined only sufficiently to determine if their labels were in conformity with the law. All materials suspected of carrying arsenic were tested and those with printed guarantees were analyzed. This included 13 samples of Paris green, 10 of lead arsenate, 9 of poison fly paper, 5 of arsenite of soda, 3 of bordeaux mixture and lead arsenate, 1 prepared bordeaux, one of zinc arsenite, one Rough on Rats, and 4 lime-sulphur solutions.

CREAMERY GLASSWARE.

Under the state law requiring that the glassware used by creameries for testing milk and cream by the Babcock test shall be tested for accuracy, about the usual number (1,500 to 2,000) of pieces have been received.

ENTOMOLOGY.

The work of the Department of Entomology has been confined chiefly to five lines of investigation during 1913. These are ecological and life history studies of aphids; a survey of Maine to ascertain the distribution of leaf hoppers, with special attention to those species which give promise of most economic significance; morphological, ecological and life history studies of the larvæ of the sawflies; a study of seasonal distribution and ecology of Maine crane flies; and field studies of our blueberry insects.

APHID INVESTIGATIONS.

In the report for 1912 a general statement of the purpose and significance was given of our aphid investigations which have been under way for several years. The discovery there recorded of the annual migration of the woolly aphid of the apple from the elm leaf to apple and the resulting knowledge that the elm generations are an essential part of the life cycle of this insect put a new significance upon the economic status of the elm aphids and incited the entomologist of the Station to concentrate attention during the past season chiefly upon the woolly aphids of the elm and two bulletins just issued (No. 217 and No. 220) give the results of this investigation. As a brief summary of the case it may be stated that in New England there are five distinct though closely allied species on the elm. Of these, the most important to us as an orchard state is the species previously discussed which migrates to the apple from the leaves of the American elm. A second species common on the English elm in Maine, and probably introduced into this country with the tree, is a leaf curling aphid which migrates to the roots of currant and gooseberry where it is a serious pest. We do not yet know the full life cycle of the third species, which deserts the curled leaf of the American elm in the spring to pass its summer in some place still remaining to be discovered. The fourth species forms a large gall something the size and shape of a fig on the elm twig in the spring, but we do not know its summer haunts. The fifth species apparently confines itself to the elm alone where it is common, especially on young trees, in woolly clusters on the bark.

A key is given here to aid in distinguishing the woolly aphid of the apple from the other elm species with which it may easily be confused in the spring of the year.

A. Conspicuous woolly colonies on bark of *Ulmus americana.* Throughout the summer on young elms. No alternate host known. Widely distributed in America .... *S. rileyi*

AA. Spring generations in elm leaves, causing various types of deformation.

B. Large baggy gall on *Ulmus campestris.* Alternate host unknown. European species. Taken in Connecticut in 1913 ....*S. lanuginosa*

BB. Terminal leaf cluster or rosette on *Ulmus americana.* Spring migration to apple, mountain ash, and hawthorn. Maine to Colorado ....*S. lanigera* (*americana* in part, of authors)

BBB. Leaf curl or roll type of deformation.

C. Leaf roll. Wax glands of apterous generations and antennæ of winged generations apparently the same as those of the rosette dweller. Spring migration to apple. Recorded as yet only from the south ......*S. lanigera* (*americana* in part, of authors)

CC. Leaf roll of *Ulmus scabra* and *U. campestris.* Antenna of winged generations with V and VI without annulations. Spring migration to gooseberry and currant. European species. In America found in California, Oregon and Maine (1913) ....*S. ulmi* (*fodiens*)

CCC. Leaf roll of *Ulmus americana.* Second apterous spring generation with wax glands distinctly unlike those of *lanigera.* Spring migrant with antenna typically with III not longer than IV+V+VI. Alternate host unknown. Maine to California...........*S. americana* in part, of authors

LEAF HOPPER INVESTIGATIONS.

The insects known as leaf hoppers belong to the same order of insects as the aphids or plant-lice and like them feed by piercing the plant tissue with a sharp beak and sucking the sap. As their name implies, however, they are not stationary like the aphids but hop actively from place to place so that often the damage done by them is hard to trace to its source. Especially is this the case when as often happens fungous troubles find entrance into the plant tissue at the wounds caused by the insects.

Closely allied to the leaf hoppers and included with them to a certain extent in this account are the "frog hoppers" or "spittle insects" known by the blobs of froth, common in meadows and on trees in which the young live.

Most of the species are very inconspicuous both on account of their small size and their close color resemblance to the objects around them. They jump so quickly when disturbed that they are caught with difficulty except by sweeping with a net, and when on the wing they are easily mistaken for other insects except by a person especially trained to recognize them. For these reasons the leaf hoppers themselves though abounding nearly everywhere are almost unknown to the ordinary observer, though their cast skins are frequently found in the wake of their injuries and are more familiar objects than the live insects which discarded them.

The principal economic importance rests on their attacks upon such farm crops as oats, timothy, wheat and the various other cereal and forage crops, on fruits of different kinds and upon forest and shade trees, their occurrence in this connection being very general indeed.

No comprehensive study of the Maine species of this group having previously been made and the situation in regard to them evidently needing the attention of a specialist, the Maine Agricultural Experiment Station invited Prof. Herbert Osborn, head of the Department of Zoölogy and Entomology at the Ohio State University, to undertake this important work for us. As Professor Osborn is the best American authority on these insects and has studied them in various parts of the United States as special agent of the Bureau of Entomology, it need not be stated that he was prepared to give us the most valuable information as a result of his summer's investigations in this state.

Reporting very briefly some of the results of the season's work on the leaf hoppers of Maine it may be said that Professor Osborn's collections show in general the species to be found in the state and for many of them a considerable amount of data as to distribution over the state and through the season.

At Highmoor Farm some of the species were found to be doing very apparent damage on oats, one species was found working on beans and two or three particularly on the potatoes. The *Cicadula 6-notata* was abundant on oats and grasses at Orono, North Harpswell, Portland, Highmoor, Houlton, Fort Fairfield and Fort Kent. *Empoasca mali* was found on apple and was also plentiful on beans and potatoes at Highmoor and Houlton. Several of the grass feeding species were abundant in the meadows and pastures and a few notably numerous in the salt marsh grasses near Portland. In 1908 *Aphrophora parallela* attacked the new growth pine shoots in the southern part of the State to such an extent that the sap dripped down from the wounded tips like rain-drops from branches after a shower.

The leaf hoppers affecting the cereal and forage crops constitute a very constant factor and the extent of the drain on such crops is doubtless very much greater than is generally appreciated. In some estimates made by Professor Osborn in other parts of the country these insects were taken in grass land at the rate of one and a half to two millions to the acre and in many instances grain fields have been very badly injured (see Bulletin 108, Bur. Ent. U. S. Dept. Agr.). It may be stated that no such serious devastations were found this season in Maine, but meadows and grass lands have shown the presence in large numbers of certain species which are injurious to an extent that makes them an economic factor of importance.

In all approximately 150 Maine species were studied by Professor Osborn which will be discussed in a forthcoming report on the investigations for the season with especial attention to such as are most important from the economic standpoint.

SAWFLY INVESTIGATIONS.

A sawfly belongs to the same order of insects as the bees and wasps but instead of having a sting for an ovipositor, its egg laying apparatus is equipped with a little saw with which it cuts a slit in the tissue of the leaf and deposits an egg in the opening. The adult or winged sawfly does practically no harm, but the young which hatch from her eggs are as greedy as caterpillars and as completely demolish the foliage they feed upon. The larvæ resemble hairless caterpillars somewhat in their appearance as well as in their feeding habits and are frequently mistaken for them.

Certain species like the currant and gooseberry "worm" the pear and rose "slugs" and the larch sawfly are familiar pests to all who are interested in these plants, and it frequently happens that pine and spruce growths over large areas are devastated by sawfly larvæ.

But in spite of their destructiveness, the larvæ of sawflies have not been given very much attention, only about 150 species for the whole United States having been previously reared and studied.

In order that our Maine species might be adequately handled, this Station invited Dr. A. D. MacGillivray of the University of Illinois to work on the group in this state this summer. As Doctor MacGillivray has made a special study of adult sawflies, his systematic knowledge of the family put him in a position to work up the earlier stages of these insects as only a specialist could.

The task is not a simple one as these larvæ present certain difficulties. Some species for instance are powdery white during one stage and after molting become yellow with black spots. As several molts occur during the growth of the larvæ and as closely related species resemble each other, the precautions necessary in rearing large collections of these insects are evident.

However, about 150 species of larvæ have been taken and recorded, between 40 and 50 species have been reared to the adult stage and others are in their cocoons to emerge next spring. These 150 species have been collected from and reared on the leaves of 36 kinds of trees, shrubs, and plants of economic value either for their products or as ornamental vegetation or because they are so closely related to plants of economic value that their pests should be known.

As a result of this season's work the Maine Agricultural Experiment Station is in possession of an exceedingly fine reference collection of sawfly larvæ and their respective records.

From time to time it is proposed to publish bulletins on such species as are of most significance in the state. On account of their prevalence and the constant inquiries concerning them, the first to be treated will be the sawfly infesting conifers. The spruces, pines and larches in Maine have suffered severely over large areas from the depredations of these insects.

CRANEFLY INVESTIGATIONS.

This family of insects had been almost entirely neglected in Maine, nor had they anywhere received the economic attention which seems their due. There was reason to think that Maine possesses a very extensive fauna in this family and as the larvæ of many species feed upon the roots of grasses their status in relation to corn, oats, wheat, and other grains as well as the native meadow grasses is a matter that could well bear investigation.

Mr. Chas. P. Alexander, of Cornell University, world authority on *Tipulidæ,* undertook for this Station a study of seasonal distribution and ecology of Maine craneflies during the summer of 1913. The outcome of this work was most gratifying, for of the 150 or more species studied none were found which would indicate that these numerous and common insects are a present menace to plants of economic value in Maine, our species being mostly confined to swamplands.

BLUEBERRY INSECT INVESTIGATIONS.

The field observations as to the insect status of the blueberry were supplemented by rearings under control conditions. Among the most common pests bred from the fruit were a fly, a weevil, and two moths. Parasites of the moths were abundant. The results of one season's observations indicate that the situation is well worth following up and this work is to be continued through another season. It might be said that the practice of burning over the blueberry barrens as is the custom is highly to be commended as a means of keeping certain very serious pests in check.

PLANT PATHOLOGY.

The work in this department has been carried on during 1913 upon much the same lines as in the past. While the diseases of other economic plants have been by no means ignored the attention of the plant pathologists has been largely centered upon those which attack the apple and the potato. In addition to the regular lines of investigation much valuable data is accumulated each year relative to the prevalence and distribution of plant diseases within the State. This work is greatly facilitated by the hearty coöperation of the office of the State horticulturist and the directors of extension work in the College of Agriculture. It is also made much more effective through coöperation with the United States Department of Agriculture in connection with the plant disease survey carried on by the Bureau of Plant Industry. The Station pathologist is supplied with printing shipping tags which will carry packages of diseased plants without prepayment of postage and which can be furnished to those who will send specimens.

OCCURRENCE OF PLANT DISEASES IN 1913 WITH RECOMMENDATIONS FOR THEIR CONTROL.

An accurate record is kept of all specimens received giving date and place of the collection, and the name of the collector. The following discussion is based upon the observations made by the pathologists during the season, and upon specimens received from various sources. No attempt is made, however, to include all plant diseases recorded during the season, but simply to mention certain of those which for a particular reason are considered worthy of special consideration.

Diseases of orchard trees and fruits.

Apple scab on the fruit and leaves while quite prevalent was not so common nor so destructive as in 1912. This was without doubt due to differences in seasonal climatic conditions. Mention was made in the previous report of the occurrence of scab on the limbs of some varieties of apples which resulted in more or less killing back of the twigs of the current year's growth. Many more specimens of this form of the disease were collected or received from correspondents during the winter and spring months of 1913. The results of certain studies on this and of spraying experiments on apples are given under a separate heading.

Fewer specimens of crown-gall upon nursery stock were received than for the past two or three years. So far this has all come from trees shipped in from outside the State, no specimens having been received which were reported as coming from Maine nurseries. Apple trees affected by crown-gall should not be set.

Apple rust, which is common and destructive in some states was sent in for the second time since the present record was started some 7 years ago. Both specimens have come from the southwestern part of the state, as apple rust is only found in the vicinity of the red cedar. It is one of the diseases which require the presence of two different or alternate hosts for the development of the fungus which produces it. This fact is the key to the situation with respect to the method of control. If red cedars are removed it is easily eliminated as it is absolutely essential that the fungus pass one stage of its life history upon this tree to be able to re-infect the apple. Recently it has been found, particularly in Wisconsin and West Virginia that lime-sulphur is quite effective in controlling apple rust if applied at the proper time in the spring. However, unless it is impossible to eradicate the red cedar trees in the vicinity of the orchard lime-sulphur should not be relied on wholly in controlling the disease. Also from what has already been said it is evident that apple rust need not be feared in those sections of Maine where the red cedar does not occur.

The quince is also attacked with the same disease, and in Maine appears to be far more susceptible to it than the apple. In fact quince rust is a disease which appears to occur in Maine with a frequency which is far out of proportion to the extent that its host plant is cultivated in the state. Several specimens were sent in during the past season. It attacks the leaves, the limbs, and the fruit of the quince, but it is on the last two that it does the most damage. The affected limbs show swollen or enlarged sections an inch or more in length, not unlike the black knot of plums in shape, but quite different in color. These enlarged portions of the small limbs and twigs are covered with small pustules, and the latter often show feathery projections around the openings. They are quite noticeable when the spores begin to form as the liberation of the latter gives the surface a bright salmon color. Most of the specimens of diseased fruits which have been received by this Station were quite severely attacked by the fungus. They were frequently distorted in shape, and usually covered with the fruiting pustules which showed many of the feathery cylindrical projections which when broken have a fimbriate margin. On account of the liberation of millions of bright colored spores upon the surface of such fruit the diseased portion is of a salmon or even orange color.

Early in the spring, almost before the growing season has begun, the other stage of the quince or apple rust occurs on the red cedar in the form of little swellings of the limbs known as "cedar apples." After the first warm rains come these swell up and become gelatinous and also somewhat orange tinted. It is then that the spores are formed and matured which infect the quince and apple. These spores are not able to re-infect the red cedar. To produce the disease of the latter the other form of the spores must come back from the quince or apple or some closely related fruit.

Where spraying is attempted the quince or apple trees should be sprayed with a bordeaux mixture or lime-sulphur just before the cedar apples on the red cedar become gelatinous, repeating this twice at the intervals of a week or ten days.

Much injury from russeting of apple fruits was observed during the past season which was directly traceable to weather conditions which existed during the earlier part of the season, although this was in some instances incorrectly attributed to spraying. When the fruit was setting, and shortly thereafter, weather conditions were very unfavorable, with late frosts and heavy rains associated with strong, cold winds. Warm weather previous to this, or late in April, forced the flower buds to early opening. These circumstances combined, resulted in almost a total failure of the apple crop. Such fruit as did set was more or less injured. Nearly 32 per cent of the crop of the unsprayed trees at Highmoor Farm were russeted at harvest time, and this could only be accounted for as the result of the conditions mentioned above. Early in the season frost injury was plainly evident on apple leaves in many instances. It is possible that some form of orchard heating such as is practiced in the far West might be effective in preventing disasters of this kind, although unfavorable weather conditions in the spring of 1913 were so prolonged as to make the expense for heating prohibitive.

The usual amount of brown rot and black knot on plums as well as plum pockets was received. The recommendations for control are given on pages 295 and 296 of the Report of the Commissioner for 1912, and need not be repeated here. One specimen of peach leaf curl was received in 1913. While this is a very serious disease in some localities it is of little economic importance in Maine since here the peach is grown in a very limited area. An application of strong lime-sulphur just before the buds open, the same as is used for scale insects, will control it. Bordeaux mixture or even a solution of 2 pounds of copper sulphate dissolved in 50 gallons of water, and used as a spray at the same time will also act as a preventive.

Diseases of Field and Garden Crops.

Certain diseases of field and garden crops observed last year are worthy of special mention. The leaf spot of the beet seems to be very common and widespread in the State, and no doubt does much damage. One case was noted at Orono where the same disease was quite injurious to Swiss chard, although it is claimed by those who have studied the subject that this plant is seldom affected to a serious extent.

On beet leaves the spots are at first very small brown specks with reddish purple borders. When the spots reach a diameter of one-eighth inch or more they turn ashen gray at the center but the border remains purple as long as the blade continues green. After a time the leaves blacken and dry up gradually from tip to base. These leaves stand more nearly upright than the healthy ones and are somewhat curled or rolled. The older and more mature leaves are attacked and killed first.

Leaf-spot of the beet can be controlled by bordeaux mixture, but to do so it is important to begin spraying early.

Late blight of celery is a relatively new disease in the United States, and has very recently made its appearance in Maine. It has not been considered a serious malady in Europe, but judging from an outbreak in an Orono market garden in the summer of 1913 it may prove serious here, for it ruined the crop in this instance.

The attacked plants are covered by irregular rusty brown spots more or less in the center of which, after the spots begin to turn brown, may be seen little dark colored bodies imbedded in the diseased tissues. These are the fruiting organs of the fungus. No experiments have been tried at this Station for the control of this disease, but it is claimed that in the field early spraying with bordeaux mixture or ammoniacal copper carbonate is the most effective means of combatting it. There is much danger in placing an affected crop in storage, and where this is done the cellar must be well ventilated and not too moist.

Two diseases of the pea which have been reported in Wisconsin as doing much damage to the crop in those sections where peas are largely grown for canning purposes have been found to a certain extent in Maine. One of these produces spots on the stems and leaves, and these spots have ashen white centers with dark borders. In severe cases the lesions on the stems run together and girdle the stalk. The other disease attacks the base of the stem causing a wilt and early death of the plant.

For control measures it is recommended to use clean seed,—that is from a field where the disease does not occur, and practice a crop rotation of several years before growing peas on the same land again. Thorough drainage and avoiding the use of manure on the surface of soil around the base of the plants is also helpful. In severe cases it is best to gather and burn all vines after harvesting the crop.

Partly on account of the failure of late blight of the potato to appear in 1912, and partly on account of the scarcity of potato bugs, not making it necessary to spray for them, many potato growers neglected last season to spray sufficiently to control late blight and rot. Consequently more loss resulted from this disease in 1913 than was necessary. Otherwise about the usual amount of the common potato diseases were observed.

Several new types of potato diseases are beginning to manifest themselves in this country, and Maine potato growers should be on the alert to prevent their getting a foothold here. Powdery Scab has been found to be quite abundant in certain restricted, neighboring portions of Canada. As yet there have been but three reports of the occurrence of this disease in the United States, and these are not serious outbreaks.

A new disease known as silvery scurf has recently been introduced into this country from Europe, and apparently is by no means uncommon in Maine. In our cool storage cellars it apparently does not develop sufficiently to attract attention, but when sent South into a warmer climate quite characteristic spots may develop on the surface of tubers. These are dark areas on the skin of the tuber which when carefully examined seem to be covered with fine black spots. The disease only attacks the skin, and does not produce a decay, but the tubers on which it occurs are apt to dry up and shrivel rapidly, particularly if the conditions of storage are warm. So far ordinary methods of seed disinfection have not proven successful in its control.

There are several obscure leaf diseases of the potato which have recently been recognized in Europe, and which are known under the names of leaf roll, potato rosette, curly dwarf, mosaic disease, etc., which have appeared to a limited extent in this country. The names indicate more or less the character of the foliage of the affected plants. Potato fields, particularly those intended for the production of seed should be watched carefully, and all plants which show abnormal or unhealthy foliage should be removed. There is reason to believe that some if not all of the diseases of this type are of a physiological nature, and are more or less closely associated with poor seed. There is also evidence that at least a part of them are carried with the seed, and if tubers from affected plants are used for this purpose that the crop will rapidly deteriorate.

Diseases of the Cereals and Forage Crops.

Three rather interesting diseases of this nature have been under observation during the past year. One is a stripe disease of barley, which has been reported as doing more or less damage in some of the western states, particularly Wisconsin, and the same malady has been reported as very injurious in certain parts of Russia. It is of a fungous nature, and appears as yellow-brown stripes on the leaves. Since the disease may be carried by the seed the hot water or formaldehyde treatment the same as for smut is advised.

A new leaf spot disease of timothy was found in Orono last summer. The fungus which caused it had been previously reported on orchard grass in Vermont, but so far as determined this is the first case recorded on timothy. It appears in the form of light yellow spots with reddish borders, and having many small black dots scattered upon them. These latter are the fruiting bodies of the fungus. No method of treatment can be advised at the present.

An anthracnose disease of clover has been observed in Maine for the past two or three years. This appears similar if not identical with one previously reported from Tennessee. This appears as brownish spots and streaks on the stems and leaves of red clover which eventually result in premature ripening and dying. There is no doubt that this disease has done considerable damage in Maine. The only remedy yet obtained is the selection and growing of resistant strains of clover.

APPLE SCAB ON THE LIMBS A SOURCE OF SPRING INFECTION.

From a financial standpoint apple scab is probably the most important disease with which the Maine orchardist has to contend. Anything which tends to increase the amount of knowledge which we have regarding the life-history of such a parasite simplifies the problem of its control. During the past year the Station pathologists have made a discovery regarding one of the means by which the apple scab fungus passes the winter in condition to start new centers of infection the following spring which is of considerable local significance.

It has been generally taught, and often asserted with considerable assurance by writers on this subject in this country that apple scab lives over winter only in one way, namely upon the fallen leaves of the season before where it produces an entirely different form of spore—the so-called perfect stage of the fungus. Last year's report mentioned the fact that specimens of apple branches had been obtained which showed the growth of the current season badly attacked and in some cases killed back by apple scab.

Cases of limb infection were followed through the winter and it was found that the fungus was alive upon these limbs in the spring, that the summer stage spores thereon were still viable as spring approached and were capable of infecting the leaves as soon as the latter were put forth. A small orchard of McIntosh trees badly affected in this way in 1912 developed a severe attack of scab on the leaves early in the season of 1913, although they had been sprayed in the usual way with summer dilution lime-sulphur. On the other hand adjoining trees which showed equally bad cases of limb infection, but which were sprayed with a strong, or dormant spray of lime-sulphur just before the leaf buds opened were practically free from scab on the foliage during the summer of 1913. It would seem then that to control this form of the disease requires a dormant spray, just before the leaf buds open.

It is not claimed that the spores of the perfect stage of the apple scab fungus, formed on the leaves of the season before, which have lain on the ground under the trees during the winter, are not the source of a large amount, and usually all of the spring infection. It is maintained, however, that with certain varieties limb infection is an important and serious factor in carrying the disease over winter and that this form requires a special treatment with a dormant spray if it is to be effectually controlled.

The data regarding varieties of apple trees which are affected in this way are incomplete, but while this form of the disease has been recorded before in this country it must be remembered that this is the first case where it has been definitely proven in America that apple scab remains alive over winter on infected limbs. It is to be expected that those varieties which are most susceptible to leaf and fruit infection will be more likely to have the limbs attacked. Observations so far made indicate that this supposition is correct. In an orchard containing 7 varieties, McIntosh and Fameuse were the worst attacked. Milden and Westfield ranked next in order of susceptibility. Only an occasional twig was found affected on the Northern Spy trees and these but slightly, while Oldenburg and Tolman trees were entirely free from injury.

THE EUROPEAN APPLE CANKER IN MAINE.

Observations made during the past season show that the European apple canker is not only present in Maine but that in some localities it is quite common. In one young orchard the cankers were found on the trunks of several trees while in older orchards they appeared more abundant on branches an inch or two in diameter. Several were found in crotches, suggesting that they might have followed winter injury. The larger part of them, however, showed the remains of a dead twig in the center indicating that the fungus may have gained entrance thereby.

The fungus associated with the cankers was easily isolated and while it is too early to make definite conclusions it appears to be capable of producing the disease upon inoculation to healthy limbs and twigs. These cankers as they occur in nature are illustrated in Bulletin 223 of this Station.

ORCHARD SPRAYING EXPERIMENTS IN 1913.

The fourth series of experiments in orchard spraying were carried out at Highmoor Farm during the summer of 1913. While the crop was very short on account of unfavorable weather conditions at blossoming time and apple scab was not so severe as was the case the previous season, some very interesting results were secured.

Perhaps the most important result from a practical standpoint was from the use of arsenate of lead as a fungicide. This is a well known and effective insecticide but its fungicidal properties either have been overlooked or have not been fully appreciated. The use of 4 pounds of arsenate of lead paste to 50 gallons of water in 1912 resulted in fruit as free from scab as where lime-sulphur was applied with 2 pounds of arsenate of lead paste to each 50 gallons. These results were fully confirmed in 1913 with 2 pounds of dry, powdered arsenate of lead instead of 4 pounds of the paste. Even one pound of dry arsenate of lead to 50 gallons proved to be two-thirds as efficient in controlling apple scab as lime-sulphur combined with the same amount of poison.

Arsenite of zinc used with lime-sulphur in 1912 resulted in no injury but in 1913 the same lot of material caused severe leaf-spotting and considerable defoliation. The same effects were obtained with 2 pounds of "Soluble Sulphur Compound" and one pound of dry arsenate of lead in 50 gallons of water. This last combination appeared to be quite efficient in scab control, however. "Atomic Sulphur," another proprietary compound, also gave satisfactory results as a preventative of scab, but caused no injury to fruit or foliage.

The results secured in 1913 strengthened the conclusions suggested by the work of the previous year that a dilution of lime-sulphur 20 per cent stronger than standard could be used on Ben Davis trees with little more danger of injuring the leaves or russeting the fruit and the increased efficiency in scab control would more than pay the added cost, particularly where the lime-sulphur concentrate is prepared at home.

"LITTLE POTATO" OR RHIZOCTONIA DISEASE.

Every New England housewife is familiar with the little brownish or almost black patches or nodules of what is generally supposed to be dirt, very frequently found closely adhering to the surface of potato tubers. Unless these are numerous or large they are not usually noticed till an attempt is made to wash the tubers. The notion that these bodies are simply particles of closely adhering, black soil is farther strengthened by the fact that they may be, with some difficulty, removed by means of a stiff brush or the thumb nail, leaving the skin of the potato smooth and uninjured. As a matter of fact they are a mass of closely woven threads or the resting stage of a fungus which has long been known under the name of Rhizoctonia. It was classed among the so-called sterile fungi till it was discovered that in the summer it grew up around the base of growing potato stalks and there produced spores of a definite type.

Rhizoctonia is an almost universal inhabitant of potato soils all over New England and doubtless the same thing is true for all potato growing sections of the country. While it has been known for years as capable of attacking the below-ground parts of the stems of a considerable variety of unrelated plants it has not in the past been generally recognized or accepted as a serious cause of potato disease, except in a very few localities.

It appears to have been the cause of a partial failure of the crop on one field in Maine for the past two years, and evidence is being accumulated which shows that it does more or less damage in some other sections, particularly on Irish Cobblers. It may be that this fungus is one of the factors responsible for imperfect germination some seasons.

It is possible to give only a preliminary report on the occurrence of the disease in this state at the present time. Nothing is known as to what conditions or kinds of soil are favorable or unfavorable to it. The fungus is so common in all kinds of soils that disinfection of the seed will be of little help unless new land is being used for planting. If disinfection is attempted, corrosive sublimate should be used as formaldehyde is not entirely effective upon it.

The injury is all below ground and the plants may be attacked at any time after the sprouts begin to start from the seed pieces. The sprouts which are attacked first or most severely, either never reach the surface of the ground or come up much more slowly than the healthy plants. The diseased stems show brownish patches or areas of varying size, situated anywhere on the parts below the surface of the soil. These lesions start at the surface, are not so black as those produced by blackleg, and do not invariably start from the base and work upward as is the case with the latter disease. Badly affected plants are either cut off and killed or have a stunted appearance, frequently showing leaf-roll or rosette characteristics. Sometimes a stalk will be cut off and then throw out new branches from below.

Fields attacked with Rhizoctonia are quite sure to prove deceptive in the matter of yields. While the plants may be considerably affected by the fungus the majority will appear strong and thrifty till a few weeks before normal maturity. Then, especially if a period of dry weather comes on, they will suddenly wither and die. When the crop is dug the yield falls far short of what it should be and consists of an abnormally large number of small tubers, many of them not much bigger than marbles—hence the name "Little potato disease." The little potatoes result from the fungus cutting off the tuber-bearing stolons as fast or nearly as fast as they are produced.

POTATO SCAB.

The work upon potato scab which has been going on for several years has been continued. Much of that which has been done during the past year has been along the line of laboratory studies of the organism which causes the disease, which while important and necessary are not of general interest except where the facts discovered admit of practical application.

Comparative studies of a large number of cultures of organisms isolated from scabby tubers checked up by inoculation tests, showed that potato scab obtained from many parts of Maine, from several different states and from Canada and Russia is the result of the attack of the same parasite. This of course refers only to the common type of potato scab.

Laboratory experiments showed that the common potato scab organism is extremely susceptible to the effects of direct sunlight. Fifteen minutes exposure was sufficient to kill all of the germs of the disease when spread out in a thin layer in a culture dish. This explains why sunning potato seed for several days before planting tends to reduce the amount of scab on the crop. It was also determined that the organism is very readily killed by drying and that it is destroyed by much weaker dilutions of formaldehyde and corrosive sublimate than are usually employed for disinfecting purposes. However these stronger solutions are necessary for disinfection on account of the fact that the scab organism is fairly well protected by the corky tissues covering the diseased spot.

In an experiment to test how long potato scab would remain alive in the soil without the presence of any crop, the details of which it is not necessary to give here, it has been found that the organisms causing the disease were able to persist in the soil kept entirely free from vegetation and outside contamination for at least 3 years. This work will be continued for several years. A part of the same experiment has also to do with the question of what effect growing various grains, grasses and clovers on scab infected ground has upon the continuance of the germs in the soil.

A TWO-WHEELED POWER SPRAYER FOR POTATOES.

The ideal potato sprayer is one which will cover all parts of each and every potato hill thoroughly. This means that by the use of such a sprayer the lower leaves and the under sides of all leaves are as well coated and protected from fungous attacks as the upper sides of the outer leaves of the hill. Bordeaux mixture is a preventative and not a cure and it must be on the leaves before the spores of the parasitic fungus which causes the blight. Any application of a spray which only partially or slightly meets these requirements must not be expected to give complete protection from disease.

One nozzle to the row and 50 gallons of bordeaux mixture to the acre should never be expected to give complete protection, and should never be used except when the plants are small. As the plants increase in size the number of nozzles should be increased, using 2, 3 or 4 to each row as required and so arranged that they will cover each row thoroughly, but so directed toward the row that the cones of spray will each strike it independently and not interfere with each other. This is the ideal but so far it has not been possible in the past to entirely realize it.

Some very efficient traction sprayers have been developed but to haul a 100 gallon tank of spray and supply pressure for 4 nozzles to each of 4 rows or 16 nozzles in all requires a combination of a most efficient pair of horses and an equally efficient pump. In an attempt to solve some of these difficulties an experimental two-wheeled, gasoline-power sprayer was constructed at Highmoor Farm and used there during the summer of 1913. This machine was by no means perfect but it is felt that it does point the way toward the next step in the improvement of potato sprayers.

This sprayer was mounted on a pair of extra heavy wheels with an equally strong axle. For power the engine and pump from one of the orchard sprayers was used. To save expense as this was an experiment which might prove impractical a 50 gallon barrel was used for a tank. A 100 gallon tank would be necessary in practical work and this full, with the combined weight of it and the engine, would have hauled easier than a traction power sprayer carrying the same size tank.

A special spray boom was constructed and when the plants were large 4 nozzles were used to each row, 2 on top and 2 between the rows. Those above the row were placed 6 inches apart or 3 inches each side of the center, one being directed forward and downward and the other backward and downward. In this way the cones of spray did not interfere with each other, the whole top of the row was covered, the spray striking the row in a slanting direction instead of directly downward, thus securing greater penetration to the interior of the hill and partially forcing the surface leaves upward and hitting the undersides. The nozzles between the rows were of the 45° type. They were attached to a T at the end of a 3 foot pipe which nearly reached the ground between the rows. This T was placed parallel to the rows to avoid catching the vines as much as possible and to permit the adjustment of the nozzles in the proper direction. By rotating the 45° nozzles on the axis of the T they could be adjusted so as to direct the spray forward and upward against the underside of one row and in a like manner backward against the opposite row.

SPRAYING FOR BEAN ANTHRACNOSE.

Bean anthracnose, commonly known as rust, is frequently a very serious and destructive disease in Maine. Rather contradictory results have been secured in attempting to control it by spraying. Based on the assumption that failures in the past might be due to beginning too late and not spraying thoroughly enough some experiments were planned and carried out at Highmoor Farm last season.

The field was planted with seed from a crop where much injury from anthracnose was recorded the season before, and this seed showed plenty of evidence of anthracnose upon it when planted. The field was divided into 3 equal parts, one-third to be sprayed with bordeaux mixture, another with lime-sulphur diluted the same as for summer spraying of apple trees, while the remainder was left as an unsprayed check. The first application was made soon after the first foliage leaves formed and this was repeated every week or ten days till the pods were all set and some of them had attained considerable size.

Unfortunately weather conditions apparently were not favorable for the best development of anthracnose, for less than 5 per cent of the pods were affected on the unsprayed check. The disease was almost entirely controlled where the bordeaux mixture and lime-sulphur were used, there being less than two-tenths of one per cent of the pods affected on the sprayed plots. It is important to note however that heavy applications of bordeaux mixture at the same strength as used for potatoes and equally thorough applications of lime-sulphur diluted as for use on apple trees in foliage produced no detrimental effects whatever on the bean plants.

COMPARATIVE STUDIES OF THE GENUS FUSARIUM.

A preliminary account of these studies was given in this report for last year, with special emphasis upon the practical significance of the results obtained. That part of the work which has to do with the relationship of the organisms and a large amount of data concerning their cultural characters and their ability to attack different host plants, as shown by inoculation tests, has been written up and published in Bulletin 219. While some very important immediate practical results have been secured this was primarily a research problem involving several factors of a broad and fundamental nature. The collection of the published data required much painstaking and careful labor on the part of Doctor Lewis, the author of the bulletin.

As has been suggested above, this study has been carried on for some years, Dr. Lewis paying especial attention to the pathogenicity of the various species isolated from different hosts. His conclusions regarding relationships were based largely upon the behavior of the different organisms in culture. About 2 years ago a full set of these cultures was turned over to Dr. H. W. Wollenweber of the Bureau of Plant Industry at Washington who was making a special study of the relationships of the members of the genus Fusarium. The determinations made by the latter, based on the size and shape of the spores, etc., were accepted and the names which he gave to the strains obtained from different hosts were adopted. It may be said that his conclusions were largely in accord with those obtained by Doctor Lewis working independently and based upon the cultural characters of the organisms.

In all 46 different strains of Fusarium were studied, all but 3 of which were isolated in this laboratory from diseased plants. The following list gives an idea of the wide range of hosts involved; Apple fruit, china aster, dent corn, flint corn, sweet corn, cucumber, fowl meadow grass, June grass, quack grass, redtop, timothy, pea, potato, summer squash, winter squash, sunflower, tomato and wheat.

Definite conclusions were reached as to the identity of 32 of the 46 strains of organisms under consideration or practically all of those which were carefully studied. In all it was found that only 11 species were represented in the entire collection. Ten of these proved to be species already described, although 2 of the 10 were classed as new varieties and one had been previously described as belonging to an entirely different genus. This last, *F. poæ*, is of particular interest as it appears to be of considerable economic importance in Maine, being associated with "silver top" of various grasses. It was isolated from dent, flint, and sweet corn, fowl meadow grass, June grass, quack grass, redtop, timothy and potato tuber. This same fungus has been credited with being the cause of a decay of carnation buds in Nebraska and New York. In this connection an important fact was discovered. It was found that the strains from June grass, quack grass, redtop and timothy were capable of causing the carnation disease while the remaining strains of the same species did not do this, but so far as discovered were identical with the first mentioned in every other respect.

The final studies have shown that neither of the species which are commonly associated with decay of apples in Maine are identical with that which produces a similar apple rot of Europe. This work represents the first record of an apple disease caused by any representative of the genus Fusarium in America. This is somewhat remarkable as all of the strains tested were more or less pathogenic to apple fruits, and at least one more in addition to the 2 mentioned produced a rapid and complete decay.

It is also interesting to note that 5 species of Fusarium were isolated from decaying potatoes and 2 of these are also the cause of apple decay. Numerous other facts of a similar nature were brought out with reference to other, unrelated host plants, all going to show, as has been proven with certain other plant diseases, especially the powdery mildews, that the old notion that a different host means a different species of the parasite is by no means correct. At the same time, as has been pointed out in connection with *F. poœ* strains which to all appearances are of the same species may differ biologically in their ability to attack a given host.