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1910

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For the Year 1909.

VOLUME I.

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1910

HIGHMOOR FARM BUILDINGS

THIRTY-FIFTH ANNUAL REPORT

OF THE

Maine Agricultural Experiment Station

ORONO, MAINE.

1909

STATE OF MAINE.
1910.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

ORGANIZATION JANUARY TO JUNE 1909.

THE STATION COUNCIL.

THE STATION STAFF.

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	FRANK M. SURFACE	*Associate*
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HENRY A. MILLETT		*Meteorological Observer and Janitor*

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

ORGANIZATION JULY TO DECEMBER, 1909.

THE STATION COUNCIL.

THE STATION STAFF.

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	JOHN SUMMERS	*Laboratory Assistant*
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ROYDEN L. HAMMOND		*Seed Analyst and Photographer*
HENRY A. MILLETT		*Meteorological Observer and Janitor*

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.

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.

The post-office, railroad station, freight, express and telegraph address is Orono, Maine. Visitors to the Station can take the electric cars at Bangor and Old Town.

The Station is connected by telephone.

MEETING MAINE POMOLOGICAL SOCIETY, HIGHMOOR FARM, OCTOBER 7, 1909

HISTORICAL NOTES FOR 1909.

HIGHMOOR FARM.

The Legislature of 1909 appropriated $10,000 for the purchase of a farm on which the Maine Agricultural Experiment Station shall conduct experiments in orcharding and with corn and other farm crops. The committee on selection have decided upon Highmoor Farm situated in the counties of Kennebec and Androscoggin, and largely in the town of Monmouth, The farm consists of 225 acres, about 200 of which are in orchards, fields and pastures. There are in the neighborhood of 4,000 apple trees upon the place which have been set from 10 to 20 years. The fields that are not in orchard are well adapted to experiments with corn, potatoes and similar general farm crops. The house is two-storied with a large wing and contains about 15 rooms and is well arranged for Experiment Station offices and the home of the farm superintendent. The barn is large; arranged for 32 head of cattle and 6 horses. The buildings are supplied with running water from a never failing spring situated on the farm. The Farmington branch of the Maine Central Railroad bounds the farm on the west and it is expected that a flag station will be made at the farm.

The farm is purchased in the name of the State but by law "the Director of the Maine Agricultural Experiment Station shall have the general management, supervision and control of the said farm and of all investigations thereon."

The property was acquired so late in the season that no investigational work could be undertaken in 1909. It is planned to begin another season studies upon orchard management, corn and oat breeding and potato culture. The farm will be used not merely for practical field experiments in horticulture and agriculture but also for studies of practical problems by the entomologists, plant pathologists and biologists of the Station.

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 are not included in the annual report are issued during each year.

All of 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 published in 1909.

No. 164.	Notes on Plant Diseases, 1908	28 pages
No. 165.	Poultry Notes	20 pages
No. 166.	Inheritance of Fecundity in Poultry	36 pages
No. 167.	Field Experiments in 1906-8	20 pages
No. 168.	The Fertility and Hatching of Eggs	60 pages
No. 169.	Two Epidemics of Potato Blight and Rot.	20 pages
No. 170.	Apple Diseases caused by *Coryneum follicolum* and *Phoma mali*	16 pages
No. 171.	Pine Leaf and Green Winged Chermes	8 pages
No. 172.	Fungus Gnats, Part I	68 pages
No. 173.	Chermes of Maine Conifers	32 pages
No. 174.	Blackleg: A Bacterial Disease of Potatoes	20 pages
No. 175.	Meteorology, Finances, Index	12 pages

MISCELLANEOUS PUBLICATIONS IN 1909.

No. 338.	Fertilizer manufacturers affidavit........	1 page
No. 339.	Official Inspections 7..................	8 pages
No. 340.	Abstract of Bulletin 166................	4 pages
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No. 342.	Official Inspections 9..................	16 pages
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No. 363.	Abstract Bulletin 168..................	8 pages
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No. 368.	Official Inspections 17.................	16 pages
No. 369.	Poultry work of the Station.............	8 pages
No. 370.	Official Inspections 18.................	12 pages

BIOLOGY PUBLICATIONS, 1909.

No. 9. The Use of Atropin Sulphate in Anesthetizing Birds for Surgical Experiments. By R. Pearl and F. M. Surface. Journ. Amer. Med. Assoc. Vol. LII, pp. 382, 383. 1909.

No. 10. Studies on the Physiology of Reproduction in the Domestic Fowl. II. Data on the Inheritance of Fecundity Obtained from the Records of Egg Production of the Daughters of "200-egg" Hens. By R. Pearl and F. M. Surface. Maine Agr. Expt. Station, Bulletin No. 166, pp. 48-84. 1909.

No. 11. Selection Index Numbers and their Use in Breeding. By R. Pearl and F. M. Surface. Amer. Nat. Vol. XLIII, pp. 385-400. 1909.

No. 12. Is there a Cumulative Effect of Selection? Data from the Study of Fecundity in the Domestic Fowl. By R. Pearl and F. M. Surface. Zeitschr. f. Abst.-u. Vererb.-Lehre. (In press).

No. 13. Studies on the Physiology of Reproduction in the Domestic Fowl. III. A Case of Incomplete Hermaphroditism. By R. Pearl and M. R. Curtis. Biol. Bulletin, Vol. XVII, pp. 271-286. Pl. I & II, 1909.

No. 14. Studies on the Physiology of Reproduction in the Domestic Fowl. IV. Data on Certain Factors Influencing the Fertility and Hatching of Eggs. By R. Pearl and F. M. Surface, Maine Agr. Expt. Station, Bulletin 168, pp. 105-164. 1909.

No. 15. A Triple Yolked Egg. By R. Pearl. Zool. Anz. (In press).

ENTOMOLOGY PUBLICATIONS, 1909.

No. 33. Homologies of the Wing Veins of the Aphididæ, Psyllidæ, Aleurodidæ, and Coccidæ. Annals of the Entomological Society of America. Vol. II. No. 2. pp. 101-129. 1909.

No. 34. Pemphigus venafuscus n. sp. Entomol. News. p. 319. 1909.

No. 35. The Desmodium Aphid, *Microparsus variabilis* n. sp. Entomol. News. p. 337. 1909.

No. 36. Downy Psyllid of Alder, *Psylla floccosa* n. sp. Canadian Entomol. p. 301. 1909.

No. 37. The Pine-leaf Chermes. The Green-winged Chermes. Maine Agr. Expt. Sta. Bulletin 171. 1909.

No. 38. The Fungus Gnats of North America. Me. Agr. Expt. Station Bulletin 172.

No. 39. Chermes of Maine Conifers. Me. Agr. Expt. Sta. Bulletin 173.

OFFICIAL INSPECTIONS, 1909.

No. 7. Standards for beverages.

No. 8. Bleached flour, benzoate of soda, sulphur dioxide, ice cream standards, flavoring extracts.

No. 9. Fertilizer Inspection. Analyses of Manufacturers Samples.

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No. 12. Text of the laws regulating the sale of: Agricultural seeds, apples, creamery glassware, feeding stuffs, fertilizers, and foods and drugs.

No. 13. Coffee, gelatine, sweet oil, honey.

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No. 16. Thickeners for ice cream, jams, jellies, preserves, chemicals in food, whiskey, and rice.

No. 17. Seed Inspection, 1909.

No. 18. Analyses of drugs. The druggist and the law.

CHANGES IN STAFF.

June 30, 1909, Prof. F. L. Russell, resigned from the Station Staff to devote his whole time to teaching in the University. Doctor Russell had been a member of the Experiment Station staff since its reorganization and enlargement in 1888.

Frank D. Sterry, Laboratory Assistant in Plant Pathology resigned from the Experiment Station June 1, 1909. Miss Joanna C. Colcord, Assistant Chemist; Miss Annie M. Snow, Clerk and Stenographer to the Director; Mr. R. C. Gellerson, Inspector, resigned from the Experiment Station staff June 30, 1909, and Mr. Joseph F. Merrill, Assistant Chemist, resigned December 6, 1909.

July 1, 1909, Mr. Albert G. Durgin, M. S., was appointed Assistant Chemist; Mr. Harry M. Woods, A. B., Assistant to the Director; Mr. Wellington Sinclair, Superintendent of Highmoor Farm; and Mr. John Summers as Laboratory Assistant in Plant Pathology.

September 1, 1909, Oscar A. Johannsen, Ph.D., came to the Station as Associate Entomologist, and Mr. Walter W. Bonns, B. S., as Associate Horticulturist.

September 1, 1909, Mr. Charles J. Dunn of Orono succeeded Hon. I. K. Stetson of Bangor as Treasurer of the Station.

BULLETIN No. 164.

NOTES ON PLANT DISEASES IN 1908.

W. J. Morse.

In connection with the regular lines of investigation undertaken by the Plant Pathologists of this Station certain minor problems are encountered and studied which of themselves are not of sufficient importance to merit treatment in a separate bulletin. It also seems desirable to record observations upon the yearly prevalence and distribution of the more important plant diseases and any new or unknown troubles which appear, particularly with reference to the apple and potato, around which the major part of the work in this department now centers. This bulletin has to do with certain subjects of this nature, based largely upon the work of the current year. The following topics are considered.

Potato Diseases of the Year.

Leaf Blights. Late blight, *Phytophthora infestans,* did practically no damage in Maine, even on unsprayed fields, during the summer of 1908. This was due to the fact that dry weather conditions prevailed over much of the State during the summer.

However, in the portions of the State where potatoes are the main commercial crop this lack of rain was not enough to reduce the crop, but just sufficient to hold the late blight in check. Early blight, *Alternaria solani,* on the contrary found ideal conditions for development upon the plants already weakened by dry weather, and consequently did much damage on all but the most thoroughly sprayed fields. This was particularly the case in the central and western parts of the State where the drouth was more severe and spraying is less generally practiced.

Stem and Tuber Diseases. Last year the occurrence of a stem and tuber disease new to Maine was noted and the appearance of the affected plants described under the name of Black-leg.*

It was stated that the evidence so far obtained indicates that the disease is of a bacterial nature. During the past summer, cultures of bacteria have been isolated from stems of potatoes attacked by black-leg, which are able to cause a rapid and complete decay of potato tubers and, on inoculation, have produced the characteristic black-leg disease of the stem, thus confirming the diagnosis. The organisms thus secured are now being studied.

Another disease of the stem and tuber which is usually designated as the Fusarium dry rot caused by the fungus *Fusarium oxysporium,* Schlecht. has been found for the first time in Maine during the past summer. It is well known that this disease, and it is probable that black-leg as well, is disseminated by means of seed tubers from infected fields, therefore, tubers from fields showing either of these diseases should not be used for seed. Fortunately neither disease is very widely distributed in Maine, and prompt measures taken at this time will restrict their spread and possibly lead to their eradication.

Both the Fusarium dry rot and black-leg are fully described in a circular issued by the Station, entitled How to Fight Potato Enemies. This circular can be obtained by any potato grower or dealer on request addressed to the Experiment Station.

Maine seed potatoes are probably as free from such diseases as any which are shipped South for planting and the writer believes that for many reasons they are much cleaner in this respect than

* Me. Exp. Sta. Bul. 149, p. 323.

those raised for like purposes in many other parts of the country. However, in order to have these conditions prevail growers and shippers of seed potatoes should at once learn to recognize both of these diseases and not knowingly ship potatoes intended for seed purposes from any fields showing either disease. If any doubt should arise as to whether either disease exists on a given field, specimens of the affected plants should be at once sent to the station.

ORCHARD DISEASES OF THE YEAR.

On account of the appointment of Dr. Charles E. Lewis as associate pathologist, beginning July 1, it has been possible to commence certain lines of work on orchard diseases which have been under consideration since the Department of Plant Pathology was established two years ago. Comparatively little was known as to the nature and extent of Maine orchard diseases, and preliminary to opening up studies of a more fundamental nature upon the fungi associated with certain apple diseases Doctor Lewis has isolated many cultures from spots on apple leaves, collected by himself and the writer, and representing nearly every part of the State were the apple is grown to any extent. From an equally representative territory cultures have been obtained from decaying apples either on the tree or in storage. The more important results in connection with this work will be given by Doctor Lewis in a later publication.

It is sufficient at this time to say that Maine appears to have in varying degree a relatively large number of the fruit rots which have been described as occurring on the apple in different parts of the United States. Among them may be mentioned those caused by the following fungi:—*Sphaeropsis malorum* Pk. (black rot), *Glomerella rufomaculans* (Berk.) Sp. & von Schr. (bitter rot), *Sclerotinia fructigena* (Pers.) Schrt. (brown rot), *Cepholothecium roseum* Corda. (pink rot), and species of *Penicellium, Botrytis, Rhizopus* and *Alternaria.* In addition at least 4 other apple rots have been encountered, a part of which are caused either by what are apparently undescribed species of fungi or fungi which are not listed as causing apple decay.

Only preliminary work has been done in testing by inocculation of fruit with fungi isolated from leaf spots, but at least 3 of these including *Spaeropsis malorum,* have been found to produce decay of the fruit.

On account of the general lack of spraying, apple scab, caused by *Venturia inaequalis* (Cke.) Alderh., probably does more to reduce the profits from Maine orcharding than any other disease. During the winter of 1907-08 hundreds of barrels of Maine apples which were quite free from scab when placed in storage were found to be in the condition represented by Fig. 1 when taken out after six or eight weeks—quite thoroughly covered with small black specks, usually smaller than those shown in the photograph. This condition was new to the writer and none of the orchardists consulted had experienced a like trouble before.* Microscopic examination and cultures from the diseased spots invariably showed the apple scab fungus and nothing else. This abnormal development of scab was doubtless due to several factors, the principal one being that the entire growing and harvesting season was very wet, and the vegetative development of the fungus continued up to and during the harvest time. The moist apples, covered with spores, were then placed in rather warm cellars, resulting in the infection of the fruit and the formation of the small scab spots in storage.

In view of all that has been written and published on the common diseases of the apple, here mentioned, it hardly seems necessary to remind Maine orchardists that much of the loss resulting from fungi is unnecessary and can be avoided by proper and comparatively inexpensive treatment. To any who request the Station will send a circular on How to Fight Apple Enemies.

The Development of Scab Upon Limed Potato Soils.

In Bulletin No. 149 attention was called to the fact that while liming had proven very beneficial to the clover and grass crops in Aroostook County that it should be applied with caution to potato soils in short rotations on account of its liability to largely increase the amount of potato scab.† The following is a brief summary of an experiment therein reported.

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* Prof. F. C. Sears of the Mass. Agricultural College has lately told the writer that this development of scab in storage is not uncommon on stored apples in Nova Scotia.

† Me. Agr. Exp. Sta., Bul. 149, p. 316 (1907).

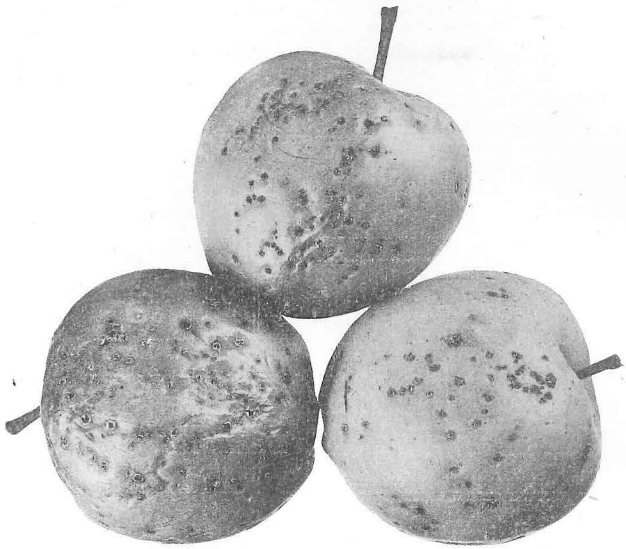

FIG. 1. Apple Scab Produced in Storage.

FIG. 2. Crotch Injury of Apple Trees.

On the John Watson farm in Houlton a series of alternate half-acre plots† were treated by the application of 1000, 500 and no lime per plot respectively, and stocked with clover and oats in the spring of 1905, an untreated check plot lying between each two limed plots. In 1907 a strip sufficiently wide to allow the planting of 5 rows of potatoes was plowed across the middle of these plots and at right angles to them. At maturity the potato crop on these plots was harvested and carefully sorted for scab, care being taken to avoid as far as possible, any cross infection or mixing of soil in the different plots. The results obtained were as follows:—

Treatment	1000 lbs. lime	500 lbs. lime	no lime
Per cent of scab on crop	49	27	11

The above results were so striking that it seemed worth while to continue the experiment for another year by replanting the same and also planting another equal strip, along side, which was in grass last season. Therefore, one series of potato rows running across the lime plots at right angles was on land which since the application of lime had been one year in oats, one year in grass and clover, and one year in potatoes fertilized with 1200 pounds of commercial fertilizer per acre and will be designated as the second year potato crop. The other given below as first year potato crop was on land adjoining and parallel to the first, like it in every way as to soil and treatment except that it had been one year in oats and two years in grass and clover since the lime was applied.

As in 1907, untreated, clean seed tubers were used for planting, and 1,200 pounds of high grade potato fertilizer applied per acre. On digging, the two rows at the junction of the potato plots were rejected as was the crop on all the rows for about 15 feet on either side of the junction of the limed with the check plots in the original grass land. In sorting, all tubers showing plainly marked scab spots were placed in that class. The following is a summary of the result obtained.

† In the previous report the plots were given, through error, as acre plots, thus making the amount of lime per acre one-half what it really was.

SECOND YEAR POTATO CROP.

Treatment	1000 lbs. lime	500 lbs. lime	no lime
Per cent of scab on crop.........	90	48	13.6

FIRST YEAR POTATO CROP.

Treatment	1000 lbs. lime	500 lbs. lime	no lime
Per cent of scab on crop	52	37	6

DISCUSSION OF RESULTS.

As in the previous year the results were quite uniform as well as clean cut and conclusive on the different plots, there being very little variation in plots receiving the same treatment. Taken together the figures obtained during both seasons seem to point to the following definite conclusions with regard to the development of scab on heavily limed Aroostook potato soils.

First, that the effect of the lime on the amount of scab is fully as great at the end of three years in grass as at the end of two years. In fact the amount of scab on the plots receiving 1000 pounds per acre was 10 per cent greater on the land laid down for three years compared with the results obtained in 1907 on similar adjoining land laid down for two years. Adjoining plots receiving 2000 pounds of lime per acre, however, have practically the same results 49 per cent and 52 per cent of scab the first year in potatoes, at the end of two and three years respectively after liming.

Second that, on limed soils, scab is largely increased by planting two successive crops of potatoes. In the present instance where a ton of lime per acre was used the per cent of scab increased from 49 per cent in 1907 to 90 per cent or almost double, in 1908, and where one-half ton of lime was used the per cent of scab increased from 27 per cent the first year to 48 per cent the second year on the same ground.

In this connection it is interesting to note that on the unlimed plots there was only a slight increase in the amount of scab the second year in potatoes, and this fully within the limits of experimental error. However, this should not be accepted as conclusive evidence for it is a matter of common observation that the second crop in succession on infected ground is as a rule more scabby than the first crop.

The first year unlimed plots showed quite a marked falling off in the amount of scab as a result of the extra year in grass. The average for these plots was 6 per cent of scabby tubers as compared with 11 per cent in 1907 and 13.6 per cent in 1908 on the adjoining second year plots.

For a discussion as to the methods of handling soil or seed to prevent the introduction of scab and the treatment of land already infested the reader is referred to the following publications of this Station: Bulletins 141 and 149 and the special circular entitled "How to Fight Potato Enemies." The former bulletin is now out of print but the two latter publications will be sent on request.

Another matter was noted in connection with the yields on the two portions of the field which is of practical importance to the potato grower. There was a marked falling off in the yields on the same land growing the second crop of potatoes in succession as compared with that growing the first crop of potatoes, although 1200 pounds of high grade potato fertilizer had been applied for each crop. The former gave slightly less than 83 per cent of a full crop as compared with the latter, or 90 and 109 barrels per acre respectively.

Self-Boiled Lime-Sulphur as a Substitute for Bordeaux Mixture for Apple Scab.

Bordeaux mixture has been found to be the most effective agent as a treatment for and as a preventative of the common leaf and fruit diseases of the apple, but unfortunately it occasionally causes injury to fruit and foliage. This matter of bordeaux injury, or "spray injury" to apple trees as it is commonly called, has been made the subject of quite exhaustive inquiry by Hedrick.* The reader is referred to his report on the subject for a detailed discussion of the nature, causes and prevalence of spray injury. With regard to the continued use of bordeaux mixture on apple trees he summarizes his conclusions as follows:—

"Bordeaux mixture is the best fungicide known to the apple grower. Its use cannot be given up in fighting the apple scab,

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* Hedrick, U. P. Bordeaux Injury, Bulletin 287, N. Y. Agr. Exp. Sta., 1907.

even though it causes some injury, apple scab causes a far greater loss than Bordeaux injury."

At the same time there is need for a fungicide which will protect fruit trees from fungus diseases and yet never injure the fruit and foliage. From the published results of preliminary experiments made by Scott of the U. S. Department of Agriculture, self-boiled lime-sulphur appears to have considerable merit in this respect.† In experiments conducted at Bentonville, Arkansas, the self-boiled lime-sulphur was found to be equally as effective as bordeaux mixture in treating the bitter rot of apple caused by *Glomerella rufomoculans* (Berk.) Sp. and von Schr. It also appeared to be effective in controlling leaf-spot caused by *Sphaeropsis malorum* Pk., and caused no injury to the leaves. Its use on the more tender foliage of the peach at Koshkonong, Missouri, produced no injury and at the same time was very much more effective in controlling peach rot and scab. Bordeaux mixture, applied at the same time, was so injurious to the peach foliage that most of the leaves dropped off after the second application.

In view of the promising results recorded above it seemed advisable to at once make tests of this new fungicide as a preventative of apple scab,—*Venturia inaequalis* (Cke.) Aderh.)

Accordingly in 1908 a small orchard, consisting of about an acre, planted to four or five varieties of apples on land in Orono owned by Director Woods was very kindly set apart for these tests. As originally planned one-half of the orchard was to be sprayed with bordeaux mixture (3-3-50 formula) and one-half with self-boiled lime-sulphur mixture using hot water in preparation. However, after the first application, a letter was received from Mr. Scott advising the comparison of hot and cold water in making the latter preparation.* Therefore, one-half of the lime-sulphur plot on the second and third application was sprayed with a mixture prepared with hot water and one-half with a mixture prepared with cold water.

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† Scott, W. M. Address before the American Pomological Society, Sept., 1907. Circular No. 1. Bureau of Plant Industry, U. S. D. A., April, 1908.

* This, on account of the fact that he had found that where the lime is exceptionally good, enough sulphur can be brought into solution with hot water to slightly burn the foliage.

The lime-sulphur mixture was prepared as follows:—

15 pounds of fresh stone lime was placed in a 50 gallon barrel and a 3 gallon bucket of boiling water poured over it with constant stirring. As soon as the lime began to slake 10 pounds of sulphur was poured over it and then another bucket of water added with continual stirring with a hoe, being careful not to allow the lime to burn. When the lime appeared to be nearly all slaked but while the mixture was still boiling violently the barrel was covered with several thicknesses of burlap and then with boards, and allowed to remain closed for one hour. The mixture was then diluted, strained† the same as bordeaux mixture, made up to 50 gallons and at once sprayed on the trees. In the letter already referred to Mr. Scott stated that later experiments showed that 10 pounds of lime to 10 pounds of sulphur served the purpose as well as 15 pounds, therefore the smaller amount was used in making the mixture for the two latter sprayings.

The trees were sprayed three times,—May 14, just as the leaves were unfolding, June 10, shortly after the blossoms had fallen and again on July 6. A part of one row of trees in the center of the orchard was left unsprayed for a check. Neither spray produced any visible injury to foliage or fruit. Both adhered well to the trees, the bordeaux somewhat the best. Some of the spray in both cases could be seen on the limbs and leaves when the apples were picked, and with the Bordeaux on some trees it showed so plainly that it was necessary to wipe the fruit.

Unfortunately many of the trees of the varieties susceptible to scab failed to set fruit so that it was impossible to secure apples from several trees illustrating each treatment as was intended. The best that could be done was to select four Fameuse trees, one from each lot, bearing on an average somewhat less than a barrel apiece. The fruit was picked and very carefully sorted by a class of University students under the direction of Professor V. R. Gardner. The per cent of fruit free from scab was as follows:—

Treatment	3-3-50 bordeaux	Self-boiled lime-sulphur, hot water	Self-boiled lime-sulphur, cold water	Unsprayed check
Per cent of fruit free from scab	50	33	16	1

† A strainer with the bottom placed at an acute angle was found particularly well adapted for this purpose.

DISCUSSION OF RESULTS.

Obviously it would be unwise to draw very definite conclusions from the limited data provided above. However, taken in connection with the results obtained by Scott in treating bitter rot and leaf spot of the apple, it seems safe to conclude that self-boiled lime sulphur mixture has considerable value as a preventive of apple scab. It is at least promising enough so that any orchardist who has trouble with bordeaux injury would do well to give the lime-sulphur treatment a thorough trial.* From the comparison of single trees the lime-sulphur mixture prepared with hot water was twice as effective as that prepared with cold water, the former approaching bordeaux mixture in efficiency. Attention should be called to the fact that the percentage of scab free apples was low in all cases—even with the bordeaux mixture much below the average. In that respect the experiment was disappointing. Doubtless a 5-5-50 bordeaux would have produced better results. The large amount of scabby apples, 99%, on the unsprayed trees, indicates that the fungus was very prevalent in the orchard. If the trees had been given two extra sprayings—one early in the spring before the buds started and another about June 20—much better results might have been obtained.

WEATHER RECORDS IN RELATION TO WINTER INJURY OF FRUIT TREES.

It is well known that there is a wide variation in the ability of various plants to withstand low temperatures. Certain tropical plants have been known to die of cold at temperatures of from +35° F. to +45° F., while some arctic plants have been known to withstand cold to the extent of —76° F. With fruit trees, particularly apples, we know that there is also considerable variation in hardiness in different varieties of the same species. It is admitted that such factors as the condition of the

* Sulphur can be purchased of wholesale druggists in Bangor for 5c. per pound in 25 pound lots and 4c. per pound in 100 pound lots, therefore aside from the extra labor involved in preparation self-boiled lime sulphur mixture should cost but little more if any than bordeaux mixture.

soil, whether moist or dry, frozen or thawed, the amount of water in the tissues at the time low temperatures occur, the abruptness of temperature changes, the rapidity of thawing, the direction and character of preaviling winds, e. g. as influencing the rate of evaporation and conseuqent drying of the tissues, all enter into the question of winter-killing. It is true that these factors along with the intense cold doubtless more often cause the death of trees through stoppage of the upward water current and through its removal from the cells, or cell walls, thus bringing about conditions simulating those of drouth in summer, yet we cannot get away from the fact that: "The capacity of withstanding intense cold is a specific property of the protoplasm of certain plants*****."* There is than a certain minimum temperature below which a given variety of apples, pears, or plums, cannot be expected to endure. Therefore it is a matter of fundamental importance to the fruit grower, first to know as closely as possible the approximate zero point of a certain variety and, secondly, the probable lowest range of temperature of the region in which he wishes to plant, based upon recorded observations extending over as many years as possible. Unfortunately very little data of this nature is available, therefore it is hoped that the following article will be of some value in this respect.

Maine being on the northern limit of commercial apple growing not infrequently the orchards suffer from severe low temperatures and abrupt changes of winter weather. Prof. W. M. Munson notes that in the winters of 1903-04 and 1904-05 the orchards of the State experienced greater injury from conditions of this kind than during the twenty years immediately preceding.† With only one year for recovery this was followed by the most disastrous winter in the history of Maine orcharding, that of 1906-07. The amount of this injury is indicated by the following, quoted from a report of a census of the injured orchards carried out under the direction of Prof. E. F. Hitchings, State Entomologist and undertaken at the instance of Hon. A. W. Gilman, Commissioner of Agriculture:—

* Schimper, Dr. A. F. W., Plant-Geography upon a Physiological Basis, English Translation, p. 41. Clarendon Press, Oxford, (1903).

† Me. Agr. Exp. Sta., Bul. 128, p. 73, 1906.

"******* there were 950 orchards inspected with a total of 443,184 trees. The number killed outright was 24,613 or about 5.5 per cent. A safe estimate of the number injured would be at least 25,000 more. So that 11 per cent of the whole number of trees were killed or injured in 950 orchards." † Farther than this many of the trees which were injured did not recover sufficiently, partly on account of a heavy bearing year, following, so that they were able to withstand the following winter of 1907-08, therefore, it is probable that if the census had been taken again in the summer of 1908 the percentage of trees killed directly or indirectly by the winter of 1906-07 would have been found to be much greater than above quoted.

The writer has elsewhere discussed in some detail the causes which led to the large amount of winter killing in a single season*.. It is sufficient for our present purpose to state that after a careful inspection of the weather records at Orono throughout the fall, winter and spring of 1906-7 it seemed that conditions which preaviled for a single week near the middle of January were responsible for the injury, although it was doubtless increased by the low temperature of —28° F and —25° F recorded on Feby. 24, and March 1, respectively. Figure 3 shows graphically the daily maximum and minimum fluctuations in temperature in degrees Fahrenheit during the last 23 days of this month. The observations were made at 2 P. M., using official instruments. As a rule the minimum record is the temperature of the early morning and the maximum that at about or a little earlier than the hour of observation.

Particular attention should be called to the fact that the two lowest records of the season —40° F. and —35° F., are only 7 days apart and midway between them come two consecutive days with records of +45° F. and +47° F. Moreover these changes were quite abrupt, particularly on the 21st when from 2 P. M. to sometime before sunrise the next morning there was a fall in temperature of 60° F., or in other words a change from 15° F. *above* the freezing point to 45° F. *below* the freezing point in 12 or 15 hours. Following this in 48 hours is the sec-

† Sixth Annual Report of the Commissioner of Agriculture, p. 282, (Augusta, 1907).

* Proceedings of the Maine Pomological Society. pp. 36-46. 1907-8.

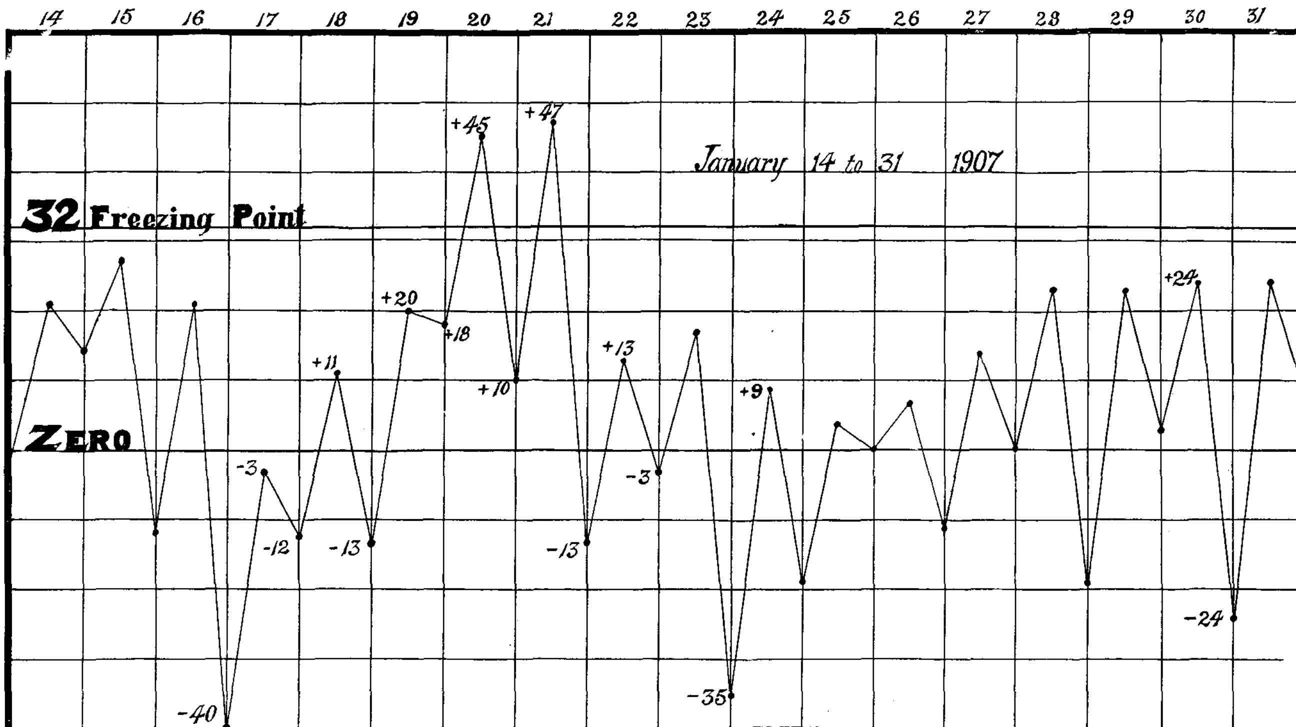

FIG. 3. Maximum and minimum temperatures in degrees F., Orono, Me., Jan. 14-31, 1907.

ond lowest record of the season, —35° F., another drop of 52° F. between observations. During the ten days following it will be seen from the figure the temperature ranged quite low, the mean for this period being only slightly above zero F. Except on the 25th these ten days were clear and the prevailing wind was northwest, although not excessive.

The weather records at Orono for nearly 40 years, 1869 to December 1, 1908, inclusive give 23 months with a minimum record of -25° or lower, these occurring in 15 different years. Only eight are -30° F. or below. January, 1878, with a minimum of -35° F. and December, 1890, with -36.3° F. are the only records through the period which in any way equal those of January, 1907, in severity. It is unfortunate that there are no authoritative records for winter-killing at hand aside from the winters of 1903-4, 1904-5, 1906-7 and 1907-8. We have the statement already quoted that the injury during the two first mentioned winters was greater than for 20 years previous. It is quite suggestive, however, to compare the records for these two winters with others in which no injury is reported. Twenty-six degrees below zero F. is given as the minimum for both January and February, 1904. Similar conditions, -27° F. for December, 1904' and -30° F. for January, 1905, are recorded for the next winter. For six years previous there had been no monthly minimum below -23° F. and for 35 years previous to this only four years, 1873, 1887, 1894 and 1898, showed two consecutive months with a minimum of -25° F. or lower, although a number of instances during the period are recorded where the minimum temperature for a single month was as low or lower than this. As has been said there are no available data to the amount of winter-killing during these years.

During the winter of 1906-07 in Maine the Baldwin and Ben Davis winter-killed much more than any other varieties, although Northern Spy, Greening and several other varieties suffered more or less severely, according to the location, slope, and drainage of the orchard. At Orono, where the weather records were taken, and at several other places, not even the hardy Russian varieties escaped without considerable injury.

It should be recognized that the above data are valuable simply as a matter of record, and any attempt to draw general conclusions from them would be fallacious. However, taken in connection with common experience it seems safe to say that it would be a matter of considerable hazard to invest much money in attempting to grow any but the most hardy varieties of apples in those portions of the State where the lowest winter temperature frequently reaches or approximately reaches -30° F. Again it may be said that the grower who confines himself to Baldwins, and possibly Ben Davis, except in the mildest parts of the State, e. g.,. where the minimum winter temperature, repeated at frequent intervals, seldom reaches below -20° F., or at the utmost -25° F., must expect greater losses than his neighbor who plants most any of the other commercial varieties grown in Maine.

It is admitted that other states farther south frequently suffer nearly as much from winter killing of apples but it should also be remembered that this is probably due to frequent and abrupt changes from severe cold to mild weather, these changes being more common than is the case with the climate of Maine.

Crotch Injury of Apple Trees, Caused by Weather Conditions.

In the spring of 1907 the writer was called to Dover, Maine, to examine an orchard of about 1200-1500 trees from 8 to 12 years old. On the lower portions of this orchard many of the trees were plainly winter-killed, including 5 to 10 per cent of the whole orchard. Quite frequently trees could be found with "frost patches" or portions of the bark killed and loose on the more exposed parts of the larger limbs and trunk, but the most characteristic thing about this orchard was the constant occurrence of the crotch injury illustrated by Fig. 2. This occurred to a greater or less degree on probably 75 per cent of the trees in the orchard, the varieties being largely Ben Davis, and Stark. The bark showed every appearance of recent death, with no invasion of fungi, neither were there any scars, cankers, or other evidence of past injuries of this kind. The dead bark was drying down and cracking away from the healthy portion—it was too early in the season to see evidences of attempts to heal the wounds. The owner, an intelligent and careful observer—a business man who for the sake of out of door work had spent all of his spare time for several years in giving this orchard his personal attention and care—was confident that nothing of this kind had appeared on *any* of the trees before.

Whetzel has shown * that not only can injuries to the bark and cambium which are usually called "sun scald" and "winter injury" be caused by the pear blight organism *Bacillus amylovorus* Burrill, but a crotch injury as well, which very closely resembles that which is here figured and discussed. It was thought at first that this was possibly the same trouble as he described, but careful observation followed up for two seasons leads to the conclusion that it is an entirely different trouble—simply an unusual form of "winter injury" or "frost patch." In this connection it should be remarked that the thousands of apple trees in Maine which in the summer and fall of 1906 appeared perfectly healthy gave ample evidence in the spring and summer of 1907 that winter-injury or frost patches are very real things and can occur independently of bacteria or fungi.†

In addition to the reasons already given the following may be cited as showing that probably adverse weather conditions and not fungi or bacteria are the cause of the crotch injury in this instance. Examination showed that crotch injury was almost universally found in previously healthy orchards which in the spring and summer following the severe winter of 1906-07 showed a large percentage of dead or dying trees. It was very common in hundreds of orchards where the injury was present largely in the form of frost patches on the limbs or trunks, but where there was every reason to believe the trees were perfectly healthy the season before. Orchards owned by the University and by Director Woods of the Station furnished excellent opportunity for personal observation upon this point. These had been given the best of care and attention. Both were in very healthy condition up to this time. There is positive evidence that there were no cankers, or dead areas on the limbs or in the crotches of these trees, previous to the winter of 1906-7. Both orchards had a large per cent of trees killed outright and nearly all which were not killed were badly injured

* Whetzel, H. H. Cornell Exp. Station, Bul. 236, 1906.

† See pages 12-17 of this bulletin.

in the crotches and showed conspicuous dead areas on the limbs and smaller portions of the trunks. In the Woods orchard a solid acre of Spys about 8 years old which were perfectly healthy in the fall showed in the spring every tree, either killed or so badly injured that they put forth a few leaves and then died. Crotch injury and frost patches were a very constant occurrence on these trees. An adjoining acre of trees 15 or more years old, largely Mildings with some Russian varieties and a few pear trees, lost only a comparatively small number, but here again the crotch injury was very prevalent, more so than frost patches on the limbs. A very noticeable fact was that in this part of the orchard whole limbs or parts of the tree were killed only on the northwest side of the trees where most exposed to the cold winds. The bark on the northwest side of the trunks on nearly all of the trees in the northern row was entirely killed, while only a few like instances could be found in the remainder of this block of trees.

Repeated attempts to isolate *B. amylovorus* from the injured crotches or limb patches only resulted in failure. Neither was there any constant association of a fungus with the patches, although various fungi, largely sapophytes, began to appear in the injured areas as the season progressed. The writer is perfectly familiar with the appearance of bacterial blight of the pear, but after spending two and one-half years in Maine, has yet to see a case of pear blight in the State, and no specimens of this disease have been sent in to the Station during that time. This indicates that while the disease without doubt occurs in the State it is by no means common.

At Orono all pear trees were killed by the winter but at Dov r there were several living pear trees growing along side of the crotch-injured trees. These showed no bacterial blight during the past two seasons which would not have been the case had the organism been present in sufficient quantities to cause the amount of crotch injury which appeared in the apple orchard.

Since the crotch injury was coincident and almost invariably associated with the winter-killing resulting from the severe winter of 1906-07 and since it would seem that all other probable causes are eliminated it is fair to assume that it was in some way brought about by the same adverse weather conditions. As a possible suggestion let us again refer to the weather records. We find a snow storm complicating matters just at the time of the thaw between the two low temperature records of the season. See Fig. 3, p. 15. On January 19 the maximum thermometer read $+20^\circ$ F. and dropped off to only 2° F. toward night, when the weather changed and by 2 P. M. the next day the temperature was $+45^\circ$ F. Four inches of snow fell in the afternoon and night of the 19th, but with the rising temperature this was probably of such a consistency as to load up and adhere to the trees particularly in the crotches. The storm stopped before morning, ending with a trace of rain but not enough to dispose of the snow. The thermometer dropped to $+10$ on the night of the 20th following the record of $+45^\circ$ F. On the day following it rose again to $+47^\circ$ F. only to fall [illegible] degrees F. during the night to -13° F. It seems then that the loading up of the trees with soft snow which later thawed some and suddenly froze again two days in succession, the second a very severe drop in temperature, gives conditions which may account for the crotch injury. The crotches would be filled with greater or less deposits of ice which radiated heat with more rapidity than the parts of the trunk not so covered and caused the injury described.

Correspondence with Prof. W. T. Macoun of the Central Experimental Farms, Ottawa, showed that he had observed the same trouble in various parts of the adjoining Provinces of Canada coincident with its occurrence in Maine. Without knowing that the crotch injury was being studied by the other both Prof. Macoun and the writer arrived at practically the same conclusion as to the cause, as will be seen from the following quotations kindly furnished by Professor Macoun from the forthcoming report of his Department for the year 1907.

"*Crotch Injury.*—The effects of crotch injury have been very serious in the Province of Quebec and in some parts of Ontario in recent years. On examination it is found that in the center of the crotch and on the branches diverging from it, but close to it, the bark is dead. As a result of this killing in the crotch the tree loses its strength there, rot sets in and eventually the tree is destroyed by the loss of one limb after another at the crotch. This crotch injury is probably due to ice lodging in the crotch. There are several theories as to why the ice should cause the bark to die. One is, that it acts as a lens and concentrates the rays of the sun, causing a scalding of the bark. The position of the injured limbs alone would seem to be sufficient to show that this theory is not a good one. It seems more likely that the injury is caused by the softening of the bark by the melted snow or water before freezing, and that after freezing the bark which is, even before this probably tenderer than at any other part, owing to its being most shaded there in summer, is subjected to a severe frost and it and the cambium are both destroyed. One of the best means of preventing crotch injury is to grow trees with as little crotch as possible, training with a central leader."

Winter Injury of the White Pine in 1908.

Coincident with the large amount of winter-killing of fruit trees in Maine there has also appeared a diseased condition of the white pine, particularly of those young trees which are springing up over waste lands and abandoned pastures and which are leading to a natural reforestation of these areas. The matter has received considerable attention from the public and agricultural press of the State. This naturally led to widespread and general alarm among owners of such young pine growth, and has influenced many who were contemplating planting of pines on waste lands, to either give up the project or put it off indefinitely. This trouble has been known *popularly* as "pine blight" and apparently the term has been used to cover every condition of the tree which the observer considered to be abnormal from the normal, yearly death and shedding of the oldest set of needles on the twigs to the troubles herein described.

The general notion exists that the so-called pine blight is due to some parasitic agency, although the cause attributed is as varied as the number of writers on the subject. Fungi, various insects, gases from the sulphite mills, etc., are some of the causes assigned by different individuals in articles, correspondence or in conversation.

There appeared to be a lack of definite information on the subject, based upon careful observation of the trees in the field over any considerable portion of white pine area of the State. Therefore, the writer has made it a point to investigate the conditions with regard to the white pine in every part of the State to which his duties called him during the past season. Many acres of pine growth were examined, distributed over and giving a pretty fair representation of that part of the State lying south of the Canadian Pacific Railroad except Franklin and Washington counties. The data thus gathered leads to the following conclusions, namely: There are two well marked leaf trouble of the white pine in Maine. One, which constituted nearly all of the so-called "pine blight" of the State in 1908, is plainly due to adverse weather conditions and while it may occur again at any time is only temporary and need not be feared like a contagious parasitic disease. The other the writer has found only in a few scattered localities, and, so far as observed during two seasons, is not spreading, at least not to an appreciable extent, and no single fungus parasite could be found constantly associated with the diseased needles. The reasons for these conclusions will be given somewhat briefly. The reader is also referred to the report for the current year (1908) of the Hon. E. E. Ring, Forest Commissioner, State of Maine.*

The discussion which follows should be distinctly understood to be confined to what has popularly been called "pine blight" in Maine and is not based on observations elsewhere in New England, although correspondence and other available information indicates that some of the trouble elsewhere may be due to similar causes.†

The common, or practically universal leaf and twig blight of the pine in Maine observed by the writer in the spring and summer of 1908 was characterized by the sudden withering and death of tufts of entire needles early in the spring, which needles soon turned a deep, rich, reddish brown. In cases of severe injury where entire trees were killed it was impossible at a distance to distinguish from scorching by fire. Young trees were invariably more severely affected

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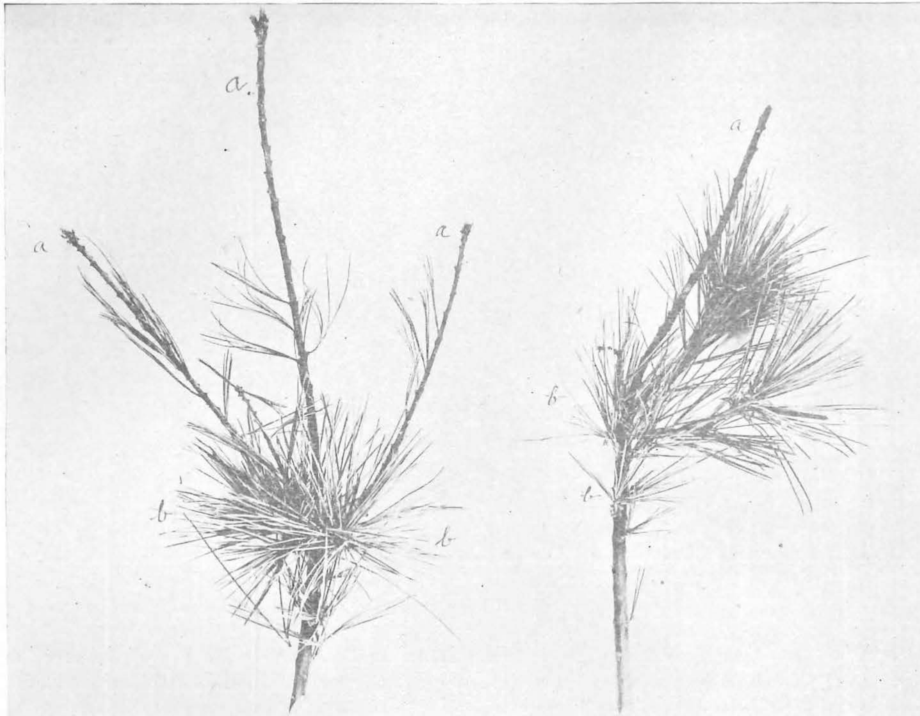
* Morse, W. J. White Pine Blight in Maine. Rept. of Forest Commissioner for 1907-08, p. 20, Augusta, 1908.

† Clinton, G. P. Rept. 14. Conn. Exp. Sta. p. 353, 1907; Stone, G. E. Rept. 20, Mass. Exp. Sta. p. 125, 1907.



WINTER INJURY OF WHITE PINE.

Small branches photographed October 7, 1908. a-a Injured tips of the twigs from which the dead needles have fallen. b-b Tufts of young needles which started out late in the season at the base of the injury.

than old trees. In fact, all other things being equal, the younger the tree the more severe the injury. Large trees only showed scattering tufts of dead needles and these usually only on the more exposed sides. In severe cases the twigs themselves were killed back several inches. In fact acres of young trees in some parts of the State which were apparently healthy in the fall of 1907 were entirely dead by the last of May, 1908. *The most characteristic thing about the trouble was that the injury was usually confined almost wholly to the north and northwest sides of young trees growing in the open or somewhat scattered.* As a rule young trees occurring in clumps or otherwise protected were injured only on the more exposed parts. Young pines—2 to 4 feet high—were frequently observed early in May on exposed hillsides with the branches on the north and west sides of the tree and the entire top dead while the lower, more protected branches on the south side were still green and apparently uninjured.

Young pines which were badly injured when first seen in the spring were kept under observation during the summer and except in the few cases described later in this article *where the trees, like those at Brunswick, were plainly affected with an entirely different trouble,* there was no sign of disease on the needles formed the present year. The old needles and injured twigs gradually dropped off, and many trees by the first of September had the appearance of being severely pruned off on one side. About July first it was noted that in almost every case adventitious buds were showing and little tufts of new needles were forming near the base of the injury on each twig. This is shown by the accompanying photograph (Fig. 4) taken October 7. The new needles are not so long as those put forth in the spring but they are now (November 1908) entirely healthy, with no signs of disease.

Nor was this injury confined to the pines alone, for spruces and firs and some other conifers showed the same trouble and in the same manner. It was especially severe in the case of the arbor vitæ. Hedges of this tree were practically exterminated in some localities.

Microscopic examination by means of sections of the needles of affected pines and other conifers failed to show any parasitic fungus constantly associated with the disease. In fact dead needles collected from the trees early in the season usually showed no signs of fungi of any kind.* An opportunity came to examine the roots of trees dug up out of an arbor vitæ hedge early in May. The hedge was apparently healthy in the fall before but now the foliage appeared practically dead. The roots appeared perfectly healthy when dug up and the leaves showed no sign of fungi upon them.

It seems to the writer only a logical inference to attribute the injury above described to adverse weather conditions particularly when we summarize the observations. "Pine blight" in 1907-1908 was coincident with the most destructive winter injury of fruit trees in the history of Maine orcharding. A similar trouble appeared to a greater or less extent on other conifers. The disease which constituted the major part of the trouble did not begin in particular centers and gradually spread outward from them, but appeared simultaneously in all parts of the State wherever the pine thrives. It did not appear on the young needles during the summer but came on suddenly in the early spring. Only the young and actively growing trees were badly attacked and these very much more severely on the sides exposed to the prevailing cold dry winds of winter.

While it is possible for frost coming late in the spring to cause the death of young needles,† it is very improbable that low temperatures alone were responsible for the injury in this instance. The fact that the injury recorded in 1908, the milder of the two winters, was by far the most severe and widespread is entirely against this interpretation. It is more probable that the trouble may be accounted for as the result of excessive transpiration

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* Pine needles lying on the ground were usually quite thoroughly infested with saprophytic fungi. Late in the season these fungi were found in some cases to have spread to the dead needles still adhering to the trees. Examination of needles on the same trees earlier in the season failed to show any pustules on them and no mycelium within the tissues, except in an occasional instance. Spots on the needles of pines in the State due to fungus attacks can be found quite frequently but these were by no means constantly associated with the trouble here described.

† Hartig, R. Text-book of the Diseases of Trees. English translation, by Somerville and Ward. p. 111 (London, 1894).

bringing about a condition in the plant tissues comparable to drouth in summer. Leaves on conifers remaining on throughout the year remove more or less water from the tissues all winter by transpiration. In the case of young, shallow-rooted trees the ground may be frozen to the depth and often below where the roots extend, thus effectually cutting off the upward current of water to the branches. Now if the tree is exposed to severe and long continued dry winds, particularly if accompanied by bright sunlight during a part of the day, the tissues may become sufficiently dried out in this manner as to injure them beyond recovery. The fact that the larger trees are deeper rooted, and their trunks much better protected against the radiation of heat and the consequent stoppage of the upward current in them doubtless explains in a measure why the large pines suffered only slightly as compared with younger trees.

As has already been stated there is another well marked pine leaf trouble in Maine. The writer has seen a few trees showing this disease in Brunswick, Winthrop and Orono, and has received specimens of the same thing from Lewiston. The Orono trees have been under observation for two years. The disease appeared on the young needles the second year much the same as when first observed, and in this respect as well as the general aspect of the diseased trees the trouble is decidedly difffernt from the winter injury. At Orono branches of healthy trees, interlocking with those of affected trees did not develop the disease either season. This disease is very well described in a circular issued in May 1908 by the United States Forest Service and entitled "Extent and Importance of White Pine Blight."

"Trees affected by the blight may readily be recognized from the characteristic reddish-brown color assumed by the newest needles. The tip of the needle is always affected first and needles with the base or middle turned brown but the tip green are practically never seen. The extent of the decoloration varies greatly in the different nedles, and in different trees; sometimes only the tip is affected, sometimes the whole needle. Attacked trees look as if they had been scorched by fire, or as if the tips of the needles had been dipped in reddish-brown dye.******** A tree which is attacked one year appears rarely to escape the next."

"Trees of all ages and sizes whether growing in the open or in closed stands seem to be almost equally affected, with two apparent exceptions: (1) Large full crowned trees with a diameter of 18 inches or more, standing in the open, seem to be rarely affected; and (2) trees in the interior of a dense stand seem to be more rarely affected than those near the edge. Otherwise the blight seems indifferent to the health or to the situation of the tree or to the character or moisture of the soil in which the tree is growing."

In the summary we find the following:—

"So far the disease has done but little damage, but it has now obtained such a foothold that if it proves to be infectious it may have serious results. The cause of the trouble is still unknown. The situation is not one which calls for alarm, but simply for watchfulness and investigation."

In the above discussion nothing has been said with regard to the relation of insects to the present trouble affecting the pines. Fortunately the Station Entomologist, Miss Edith M. Patch, was making the study of certain forest insects one of her important lines of investigation during the past summer. Consequently she had the opportunity and did make quite careful observations on the insects of the pine, particularly those found on diseased trees scattered over extensive and widely separated areas in the State.

In Bulletin 162, p. 366 Miss Patch after discussing various insects found upon the pine makes the following statement: "On account of the precarious condition of white pine in certain parts of the State considerable alarm has been aroused by various insects found upon the pine this season and indeed it has seemed as though an unusual number of species had taken advantage of the pines this year.

Besides the standard borers to be continually reckoned with, the pine sawflies and pine leaf eating caterpillars have made noticeable inroads, while spittle insects and plant lice (*Lachnus strobi* and *Chermes pinicorticis* have been unusually prevalent.

None of these insects, however, have been the cause of the 'white pine blight,' though several of them *Chermes pinicorticis* and spittle insects, *Aphrophora parallela*, for instance, have been in some cases conspicuously associated with the ailing trees."

BULLETIN No. 165.

POULTRY NOTES—1908.

RAYMOND PEARL and FRANK M. SURFACE.

The purpose of this bulletin is to present a brief report of the progress of the work of the Station with poultry during the year 1908. In this year a number of changes were made in the material equipment of the poultry plant, and in methods. It is desirable that a record of these changes be made, as well as the results of certain specific experiments carried on during the year. In this account there will be no discussion of topics which are to appear in other Station bulletins.

TECHNICAL STUDIES ON POULTRY ALREADY PUBLISHED.

A considerable portion of the more technical scientific work of the department of biology of the Station, which has in charge the work with poultry, is published in current biological journals, not readily accessible to the agricultural public. During the past year two papers of this sort directly relating to poultry have been published. One of these papers † is the first installment of the results of an investigation which is being made into the special physiology of egg production. The laying of an egg is a very complicated physiological process of which only the most general features are known. The attempt is being made to determine the exact part in the process played by the ovary and each portion of the oviduct or egg tube. In the paper under discussion it is shown that a hen may lay a perfectly normal egg after the removal of a considerable portion of that part of the oviduct which secretes the white of the egg.

The second paper * referred to deals with a related question regarding the physiology of the oviduct or egg tube. In this

† Resection and End-to-End Anastomosis of the Oviduct in the Hen, without Loss of Function. Amer. Journ. of Physiology. Vol. 22. pp. 357-361.

* Studies on the Physiology of Reproduction in the Domestic Fowl. I. Regulation in the Morphogenetic Activity of the Oviduct. Journ. Exper. Zool.

tube the egg shell is deposited and given its shape. Hens are often found which lay misshapen or malformed eggs. This paper deals with the result of an analytical study of a case in which a pullet began by laying a very abnormal egg, and gradually came to lay a normal egg. This change from an abnormal shape of the egg to a normal shape was found to follow a definite mathematical rule. Studies are now in progress to find out whether the change in size of pullets' eggs with continued laying follows the same rule. The character of the eggs laid by the pullet under discussion is shown in Fig. 5.

Fig. 5. Showing the change in the shape of the successively laid eggs of bird No. 183. All the eggs shown were laid by this same bird. The numerical order of arrangement on the plate is: Top row (beginning at left) eggs 1, 2, 3, 4. Second row: Eggs 5, 6, 7, 8. Third row: Eggs 9, 10, 11, 12. Fourth row: Eggs 18, 30, 42, 54. The eggs of this bird were saved until nearly 90 had been laid but as there was no essential deviation from the normal shape in the later ones they are not figured. The figures given show clearly the gradual change in the shape of the eggs from the very abnormal No. 1 to the normal No. 54.

Changes in Equipment and Plant.

The changes which have occurred during the last year in the material equipment of the poultry plant will be noted under three heads, viz: 1. New buildings. 2. Modification of brooder houses. 3. A new trap nest.

NEW BUILDINGS.

In the summer of 1908 it became necessary to make some provision for the storage of the surplus supplies of grain which had to be carried at the poultry plant for feeding purposes. The needs of the plant had outgrown the space available. To meet this demand for storage space a two-story building was erected between House No. 2 and House No. 3.* This new house is 40 x 40 feet and contains, besides a main grain storage room, and a loft for the storage of brooders, surplus supplies of fence wire, and other miscellaneous material, an egg sorting and storing room and a fire room in which are placed hot water

* See Bulletin No. 117 of the Maine Agricultural Experiment Station for description and location of these houses.

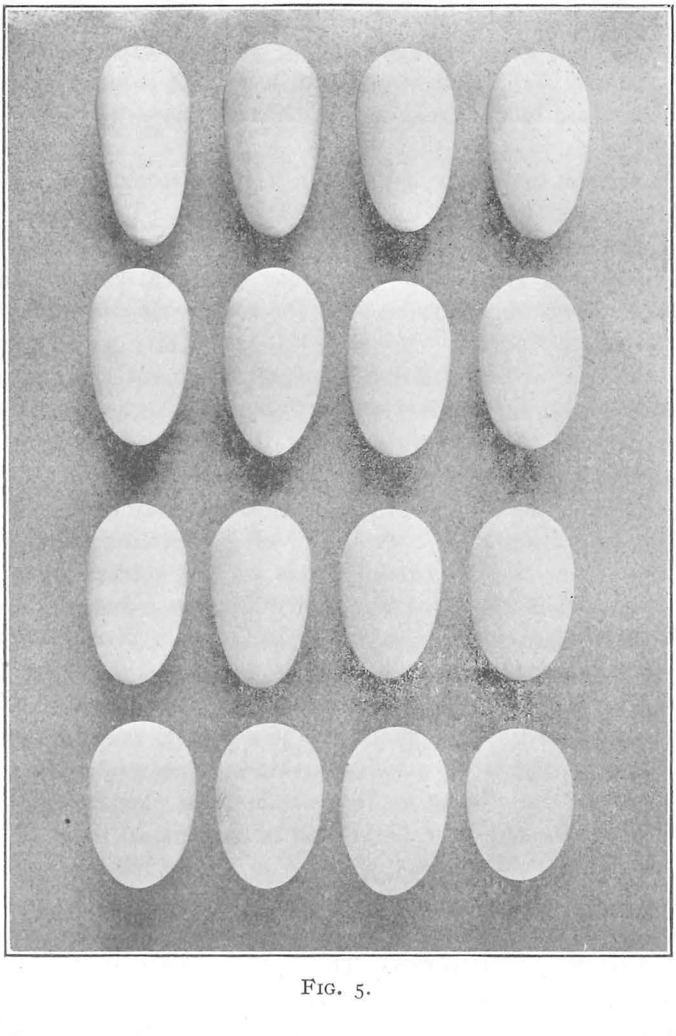

FIG. 5.

heaters for providing water for the use of the poultryman and for heating the poultry laboratory. This poultry laboratory occupies the whole north side of the ground floor of the building. It consists of three rooms especially equipped for carrying on experimental studies of a physiological character on poultry. The grain storage house is built in direct connection with House No. 2 and House No. 3 so that there is now an uninterrupted indoor passage way between the extreme ends of these houses.

During the summer of 1908 it was decided to abandon the old heated house belonging to the poultry plant. This house has been described in previous bulletins of the Station under the designation of House No. 1. It has not been used in recent years for any other purpose than the storage of cockerels during the winter months. It was not a satisfactory house for the carrying over of laying birds, nor could it be used as a breeding house. It was turned over to the College of Agriculture of the University of Maine in the summer of 1908. It was then torn down and the material was used in the building of the poultry plant used by the College of Agriculture for instruction work.

This disposition of House No. 1 left the Station plant without any space for the carrying over of any special classes of birds other than what was provided in Houses 2 and 3. It was deemed necessary to have in connection with the plant some sort of house in which sick birds could be isolated from the rest of the flock. To provide for this need a so-called "hospital" house was constructed. This house is 36 x 16 feet and is divided through the middle by a solid partition. The western half of the house is constructed on the curtain front plan like a single unit of House No. 2 or No. 3 and is used as an isolation pen for sick birds. Whenever any bird in House No. 2 or House No. 3, in an egg laying test, or in any other experiment, appears to the attendant to be ailing in any particular it is at once transferred to this isolation pen. There the progress of the ailment may be watched and treatment given to the bird if it is thought desirable. In any event the danger of spreading a possible infection through the general flock is avoided by this procedure. If the bird recovers its health and returns to an entirely normal condition it may then be taken back and put in its proper pen in House No. 2 or House No. 3.

The eastern half of the "hospital" house is divided into two rooms, both tightly sheathed with matched boards on both walls and ceilings. These rooms are intended for use in the carrying out of experiments of a physiological character with poultry in which it is necessary to confine individual birds in separate cages. At the present time these rooms are being used in a study of digestion in poultry.

In building this hospital house a number of features were introduced which differ from the plans followed in the construction of the other poultry houses of the Station's plant. The house is set on 10 concrete posts high enough so that there is from 6 inches to a foot clear space under the floor timbers over the whole of the house. Concrete posts are also used to support the plank walk which runs along the front of the house. It is believed that this arrangement will materially lessen the trouble arising from the rotting out of floor timbers which has always prevailed in the houses where the sills rest on a more or less tight stone wall. An attempt was made in the construction of the "hospital" house to make it rat proof by filling in with cement the space from the top of the sills up to the level of the top of the floor between the outside boarding and the floor timbers clear around the house. This makes a rim of cement around the floor about 4 inches wide and 4 inches deep. It is felt that it will be difficult for a rat to gnaw through this and get into the space between the sheaathing and the boarding of the walls. Time alone, however, will tell how successful this scheme is in abating the rat nuisance. This "hospital" house is located about three feet to the west of House No. 2 and in line with it. The appearance of the house is shown in Fig. 6.

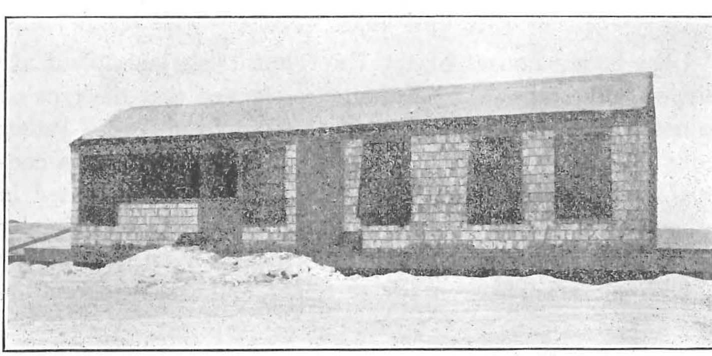

Fig. 6. Front view of new "hospital" house.

A MODIFICATION OF THE STATION BROODER HOUSE.

As has been described in previous bulletins, the Station raises its chickens in small brooder houses. Each one of these houses contains two Peep-O'-Day brooders. While these houses have been found in general to be satisfactory, there are some minor points in which they have not been entirely so.

What is shown by our experience to be an improvement has recently been made in these houses by providing for better ventilation. When the weather is very hot there is no movement of air within one of these houses, even though the door and windows are open. The air within the house is practically stagnant, and on account of its relatively small volume, becomes intensely hot and stifling when the temperature outside gets high. The effect on the chicks under such circumstances is bad. They retreat to the house to get shade, but only to be injured if not killed entirely by the hot, stifling air of the house. To remedy this difficulty a slot 2 feet long and 1 foot wide has been cut in the back of each house high up under the eaves. This slot is closed with a wooden slide, running in grooves, which is put on the outside of the house. The opening is covered on the inside with a 2" mesh chicken wire. On very hot days the slide is pulled out completely, so to expose the whole opening of the slot. At night, or during a period of wet, cold weather the size of the opening is regulated to suit the conditions. It enables one to keep a current of fresh air through the house in the warmest weather. The effect on the well-being of the chicks during a period of hot weather is most marked and satisfactory. All of the Station's brooder houses have been equipped with these slots.

A NEW TRAP NEST.

All the laying houses of the Experiment Station's plant are equipped with trap nests. Experience showed that the type of trap nest which was formerly used suffered from several rather serious defects so far as accurate experimental work was concerned. It was felt that these defects could be eliminated in another type of nest. During the past year a new and simpler trap nest has been devised which works in a very satisfactory way both in respect to accuracy, certainty, and ease of operation.

This new nest has now been installed throughout the plant. A complete description of it is given in a special circular which will be sent to anyone who may apply for it.

Notes on New Methods.

Every progressive poultry plant whether conducted for experimental purposes or commercially is continually trying to improve its methods of management or devising new methods to meet new conditions which may arise. Certain new methods worked out at the Station are deemed of sufficient general interest to warrant description here.

METHODS USED IN PEDIGREE POULTRY BREEDING.

There is an increasing tendency in all stock breeding work to give closer attention to pedigree records than has hitherto been the case. All progress in breeding depends on having carefully pedigreed stock. The importance of this has been generally recognized for the larger domestic animals, like horses and cattle, but it has not been recognized that it is equally important for small animals like poultry. The moment one begins to make any systematic attempt to breed a desired character such as high egg production into a strain of poultry, the keeping of accurate pedigrees becomes absolutely essential. Furthermore such pedigrees must be known for both sides of the ancestry. It is not sufficient merely to take account of the female line and let the male line go, but it is necessary for successful work to know the *individual* ancestors of both sexes. The Experiment Station is carrying on investigations in breeding for egg production. In this work it is necessary to know the individual ancestors of every bird. This is known at the present time for one generation. The band numbers of the mother and the father of every pullet put into the laying houses of the Experiment Station plant in the fall of 1908 are known.

In order to rear poultry of known pedigree it is necessary to have methods particularly adapted to this kind of breeding work. During the last year special study has been made in the direction of devising such methods and putting them on a practical basis. A bulletin (Bulletin No. 159) has been issued giving a detailed account of the methods and devices which the Station has found to be useful in pedigree poultry breeding. This bulletin included an account of methods of leg banding newly hatched chicks, of incubating pedigree eggs in such a way as to be absolutely certain of the pedigrees of the chickens when they hatch from the eggs, and of keeping pedigree records in general. Anyone interested in putting their poultry breeding on a strict pedigree basis so that at any time they can tell the ancestry of their birds may obtain this bulletin on application to the Director of the Station.

LIQUOR CRESOLIS COMPOSITUS AS A GERMICIDE AND DISINFECTANT.

There can be no doubt that one absolutely necessary supply about every well conducted poultry plant must be some sort of disinfecting solution. Furthermore, such a disinfectant ought to fulfill satisfactorily several requirements. In the first place, it must be inexpensive. Further, it must be powerful and certain in its action even in dilute solutions. Finally, it must be of such a character as not to injure the birds if it, by accident or design, comes in contact with them. There are a great many commercial disinfectants on the market. Some of the most successful and widely used of these have either a phenol (carbolic acid) or a cresol base. Many of these preparations are excellent and their excellence is attested by their very wide popularity among poultrymen. There is one objection, however, to all of them. That is, that they are relatively expensive. The farmer or poultryman who uses them pays a good round price for the manufacture of something which he could manufacture himself, the only cost in that event being the cost for the raw materials. With this consideration in mind, it was felt to be desirable to experiment with the making of disinfecting solutions at the Station until one could be found which would combine the advantages which have been mentioned above together with ease and simplicity of manufacture. A number of such experiments were carried out during the past year. No useful purpose will be served by a detailed description of all these experiments, but we may proceed at once to the final conclusion reached, namely, that, on the whole, the *liquor cresolis compositus* of the United States Pharmacopoeia most closely meets the need for an ideal poultry plant disinfectant of anything now available. Experiments carried out by the Bureau of Animal Industry of the Department of Agriculture* have shown that bulk for bulk a solution of *liquor cresolis compositus* made from the least effective kind of cresol is on the average one and a half times as effective a germicide as carbolic acid. The experiments showed that this solution was one of the most powerful known germicides and disinfectants. The experience of the Station shows that in addition to the germicidal value of a cresol solution, it has a very considerable value as a poultry insecticide. It has even been used with satisfactory results to rid hens of lice by direct spraying of the birds. A very small application in spray was found to rid a bird of lice without harmful effect to the bird itself.* Furthermore in the experience of the Station it is, when applied as a spray, very effective in ridding the houses, nests, etc., of lice.

Liquor cresolis compositus, or as it may for convenience be called, cresol soap, may be easily manufactured by any poultryman. The only requisite is a careful attention to the details in the process and a rigid following of the instructions given below. In order to make clear the reasons for the method of manufacture which will be outlined it may be well to give some account of the nature of the substance itself. The active base or cresol soap disinfecting solution is commercial cresol. This is a thick, sirupy fluid varying in color in different lots from a nearly colorless fluid to a dark brown. It does not mix readily with water, and, therefore, in order to make satisfactorily a dilute solution of it is necessary first to incorporate the cresol with some substance which will mix with water and will carry the cresol over into the mixture. The commercial cresol as it is obtained, is a corrosive substance, being in this respect not unlike carbolic acid. It should, of course, be handled with great care and the pure cresol should not be allowed to come in contact

* McBryde, C. N., The Germicidal Value of Liquor Cresolis Compositus (U. S. P). Bur. Amer. Ind. Bulletin 100, pp. 1-24, 1907.

* We do not recommend this method of ridding birds of lice because of the danger that the bird will take cold as a result of the wetting. This experiment was performed simply to test the value of the cresol solution as an insecticide under the most unfavorable conditions for its action.

with the skin. If it does so accidentally the spot should be immediately washed off with plenty of clean water. The price of commercial cresol varies with the drug market. It can be obtained through any druggist. On the day that this is written the quotation on cresol in the New York market is 24c. per pound. In purchasing this article one should order simply "commercial cresol."

Since cresol will not mix with water some method of making it do so must be found if it is to be used as a disinfecting solution. The plan which has been adopted is to make a cresol *soap* which shall be, like other soaps, soluble in water and at the same time carry over into the solution a considerable amount of the cresol. This is done in the following way.

Measure out 4 quarts of raw linseed oil in a 4 or 5 gallon stone crock; then weigh out in a dish 1¾ lbs. of commercial potassium hydroxide or caustic potash, which may be obtained from any druggist at a cost of from 10 to 15 cents a pound. Dissolve this caustic potash in one pint of water; let it stand for at least 3 hours until the potash is completely dissolved and the solution is cold; then add the *cold* potash solution *very slowly* to the linseed oil stirring constantly. Not less than five minutes should be taken for the adding of this solution of potash to the oil. For 5 hours after mixing the oil and potash mixture (soap) should be stirred thoroughly about once every hour and then left standing for 10 or 12 hours. By the expiration of that time saponification should be complete. The soap should then be stirred and broken up into small pieces and 5¼ quarts of commercial cresol should be added. The soap will slowly dissolve in this cresol. It may take 2 days for complete solution to be effected. The length of time taken in dissolving will depend on the condition of the soap which in turn varies with different lots of linseed oil. When the soap is all dissolved the solution, which is *liquor cresolis compositus* or cresol soap is then ready to use. This cresol soap will mix in any proportion with water and yield a clear solution.

As has been said, cresol soap is an extremely powerful disinfectant. In the Station poultry plant for general purposes of disinfecting the houses, brooders, brooder houses, incubators, nests, and other wood work, it is used in a 1 or 2 per cent solution with water. Three tablespoons full of the cresol soap to each gallon of water will make a satisfactory solution. This solution may be applied through any kind of spray pump or with a brush. Being a clear watery fluid it can be used in any spray pump without difficulty. For disinfecting brooders or incubators which there is reason to believe have been particularly liable to infection with the germs of white diarrhea or other diseases the cresol may be used in double the strength given above and applied with a scrub brush in addition to the spray.

The first consideration in choosing a disinfectant must be its *effectiveness*. It is a poor sort of economy to use a disinfectant which costs little and will kill few or no germs. Taking into account its effectiveness in dilute solutions *liquor cresolis compositus* is believed to be one of the best and cheapest germicides and disinfectants available. The Station is using it altogether in its own work, and feels justified in recommending it to poultrymen.

EGG RECORD SHEETS.

The purpose of using trap nests is to obtain records of the performance of individual hens. The records obtained from such work only attain their highest value if they are kept in such form as (1) to be easy of reference, and (2) to combine a maximum of detail with a minimum of space on paper. If large numbers of birds are trap nested it is not feasible to use the house records as the permanent records. The original records made in the poultry house must be transferred to some form of permanent record sheet.

In 1908 the permanent records of egg production were transferred to a loose leaf system in conformity with all other records taken in the poultry work.* A loose leaf record sheet (5″ x 8″) was designed for the purpose. This sheet is shown in reduced facsimile in Fig. 7. It will be observed that one sheet holds the daily egg record of one bird for one year, together with a considerable amount of pertinent data respecting the egg production of her ancestors, and her own egg production after the pullet year. Spaces are provided for totals and sub-totals at the right hand side of the sheet.

* Cf. Bulletin No. 159.

Maine Agric. Expt. Station.—EGG RECORDS.

HOUSE NO. HATCHED BIRD NO.

PEN NO. VARIETY

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTALS	
NOV.																																	
DEC.																																	
JAN.																																	
FEB.																																	
MAR.																																	
APR.																																	
MAY																																	
JUNE																																	
JULY																																	
AUG.																																	
SEPT.																																	
OCT.																																	

RELATION	BAND NO.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	TOTAL
MOTHER														
MOTHER'S MOTHER														
FATHER'S MOTHER														
SUBJECT—2ND YEAR														
SUBJECT—3RD YEAR														

FATHER FATHER'S FATHER

MOTHER'S FATHER

REMARKS

Fig. 7. Facsimile of permanent egg record sheet. Reduced about one-half.

For the house records a weekly sheet is used ruled to accommodate 50 birds on each sheet. These sheets are $8\frac{1}{2}''$ x $15\frac{3}{4}''$ in size. They have a 2″ margin on the left for binding. The heading and arrangement of columns on one of these house sheets are shown in facsimile (reduced) in Fig. 8.

House No. ....
Pen No. ....
Variety ....

MAINE AGRICULTURAL EXPERIMENT STATION
DAILY EGG RECORD
YEAR LETTER
WEEK BEGINNING

D—DEAD
B—BROODY
O—RELEASED
M—MOULT BEGUN
X—BROKEN EGG

	BIRD NUMBER	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY		

Fig. 8. Facsimile of weekly house egg record sheet. Reduced.

The additional columns at the right of this sheet are for inserting notes. At the bottom of the sheet lines are provided for eggs laid on the floor, and for daily totals. The band numbers of the birds are put in on these sheets with a hand numbering machine.

Seasonal Distribution Of Egg Production.

It is, of course, a well known fact that egg production is not distributed equally over all seasons of the year. In general there is a tolerably close accord between egg production and the four seasons of the year—spring, summer, fall and winter. The usual relation in the northern part of the country is that pullets hatched in the spring begin to lay sometime in the late fall, and lay more or less well during the winter according to a variety of circumstances. In the early spring they begin to lay heavily and keep this up usually throughout the spring. In the summer the egg production drops off and, finally, in the fall, molting occurs and the production drops very low during the early fall months. The details regarding the seasonal distribution are well brought out if the average production for each month of the year be plotted as a polygon. Such a diagram has been prepared for this bulletin and is shown in Fig. 9. This polygon is based on the Station's egg records collected during the past nine years. The average production for each month as plotted in the diagram is the weighted mean production for that month based on all the normal records which exist at the Station. In calculating these general means the average egg production for a particular year is weighted according to the number of birds which were trap nested that year, or, in other words, according to the number of birds which made the average.

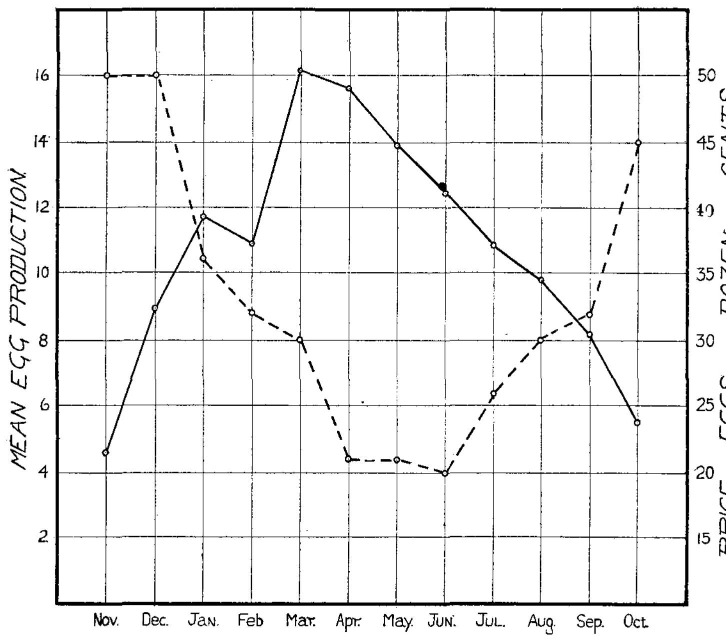

Fig. 9. Diagram showing the average egg production in each month of the year based on nine years trap nest records. The egg production curve is given by a solid line. The dotted line represents the average maximum New York price of eggs for each month of the year 1907 as taken from the Crop Reporter. The scale of egg production is given on the left hand margin of the diagram. On the right hand margin is given the scale of egg prices in cents per dozen.

This diagram shows that beginning with an average production of between 4 and 5 eggs in November the line rises rather sharply to an average production of nearly 12 eggs per bird in January. The line drops slightly in February, then rises very sharply to a maximum of a little more than 16 eggs per bird for the month of March. From March on the line drops very steadily forming almost a straight line until it reaches a low point in October. There is a slight deviation of the line upward in August and September marking a summer rise in egg production.

It has been thought a matter of some interest to plot on this same diagram with the average monthly egg production line, a line showing the price of eggs in the same months. This price curve is given by the dotted line and is based on New York market quotations for the year 1907 taken from the April, 1908, Crop Reporter. It will be seen that as is to be expected, the price line looks very much like the egg production line turned upside down. In the months when the egg production is high, the price of eggs is low, and *vice versa*. It is of interest to note that while the general form of the price curve is similar to that of the production curve turned upside down, yet there is a lag of the price curve behind the production curve. The explanation of this lag, of course, lies in such factors as rate of shipment, movement of sold storage eggs, and similar things.

It is usual to attribute the most strikingly marked features of such egg production curves as that given in Fig. 5 to climatic influences. It is commonly said that when it begins to warm up in the spring the hens begin to lay better and the relationship between climate and egg production is thought to be a causal one. There is a tacit assumption that it is *because* it gets warmer in the spring that the hens lay more eggs in the spring. As a matter of fact there is strong evidence to show that the shape of the egg production curve is based upon deep seated biological factors rather than directly on these climatic changes. It is not the place here to go into an extensive discussion of the evidence on this point. Such evidence will be presented later in another publication.

Whatever the cause of the unequal seasonal distribution of egg production may be the fact of its existence must be granted by all. If this fact be granted it immediately raises the question as to whether it will not be advantageous in studying the problem of egg production in general to endeavor to use a time unit which conforms to the natural periodicity displayed by hens. In recent years it has been the custom in the discussion of egg production to make the unit one year. This custom has been followed in the work of this Station; in the egg laying competitions in South Australia, which have excited world wide interest, and by many other institutions and experimentors. It is safe to say, however, that all experimentors and students of the subject of egg production have felt that the year was not in all respects an ideal unit for such studies. A serious objection to it is immediately apparent if one makes a close study of individual egg records. The total number of eggs laid by a bird in a year gives an inadequate and incomplete idea of her egg producing ability. Birds which make the same yearly total records are by no means always equivalent as egg producers. This fact can be easily shown by examples taken from the Station's individual trap nest records. Some such illustrative examples are shown in Table I. In this table are given the monthly egg records of four individual birds, each of which was an unusually high producer. In addition to the egg records there are given also (1) the price of a single egg in each month of the year based as before on the 1907 New York market quotations taken from the Crop Reporter, and (2) the total worth of the eggs laid by each hen in each month calculated on the basis of these prices.

TABLE I.

Table Showing the Distribution of Egg Production and the Worth of the Eggs Laid by Four High Producing Hens.

Laying—Bird No. 7.	Price per egg.	Total worth of eggs.	Laying—Bird No. 46.	Price per egg.	Total worth of eggs.	Month.	Laying—Bird No. 379.	Price per egg.	Total worth of eggs.	Laying—Bird No. 505.	Price per egg.	Total worth of eggs.
0	$4\frac{1}{6}$c	0	0	$4\frac{1}{6}$c	0	November..	15	$4\frac{1}{6}$c	.625	0	$4\frac{1}{6}$	0
0	$4\frac{1}{6}$c	0	21	$4\frac{1}{6}$c	.875	December..	19	$4\frac{1}{6}$c	.76	19	$4\frac{1}{6}$	.76
15	3c	.45	22	3c	.66	January....	13	3c	.39	19	3c	.57
18	$2\frac{2}{3}$c	.48	21	$2\frac{2}{3}$c	.56	February...	16	$2\frac{2}{3}$c	.43	20	$2\frac{2}{3}$	.53
25	$2\frac{1}{2}$c	.63	20	$2\frac{1}{2}$c	.50	March......	20	$2\frac{1}{2}$c	.50	2	$2\frac{1}{2}$	.05
25	$1\frac{3}{4}$c	.44	21	$1\frac{3}{4}$c	.37	April	26	$1\frac{3}{4}$c	.455	19	$1\frac{3}{4}$	.33
31	$1\frac{3}{4}$c	.54	15	$1\frac{3}{4}$c	.26	May.......	14	$1\frac{3}{4}$c	.245	22	$1\frac{3}{4}$	.385
28	$1\frac{2}{3}$c	.47	21	$1\frac{2}{3}$c	.35	June.......	18	$1\frac{2}{3}$c	.30	28	$1\frac{2}{3}$	.47
24	$2\frac{1}{6}$c	.52	7	$2\frac{1}{6}$c	.15	July.......	15	$2\frac{1}{6}$c	.325	27	$2\frac{1}{6}$	.585
8	$2\frac{1}{2}$c	.20	11	$2\frac{1}{2}$c	.275	August.....	14	$2\frac{1}{2}$c	.35	23	$2\frac{1}{2}$	.575
19	$2\frac{2}{3}$c	.51	8	$2\frac{2}{3}$c	.21	September..	15	$2\frac{2}{3}$c	.40	13	$2\frac{2}{3}$	.35
0	$3\frac{3}{4}$c	0	17	$3\frac{3}{4}$c	.64	October....	18	$3\frac{3}{4}$c	.675	12	$3\frac{3}{4}$	.45
193		$4.24	184		$4.85		203		$5.455	204		$5.055

Let us consider first the two hens whose records are given in the left hand half of the table. Bird No. 7 laid in her pullet year (November 1 to November 1) 193 eggs. In the same period bird No. 46 laid 184 eggs, that is, 9 less. In spite of the fact that No. 46 laid 9 fewer eggs than did bird No. 7, her eggs were worth 61 cents more in the year. The reason for this somewhat paradoxical fact that the hen that laid the smaller number of eggs was the more valuable, obviously arises from the fact that bird No. 46 laid more eggs when the prices were high than did bird No. 7. Bird No. 7 was an extremely poor winter layer. On the other hand bird No. 46 was a fairly good winter layer.

A similar relation is shown by the two birds in the right hand half of the table. Bird No. 379 laid in her pullet year 203 eggs while bird No. 505 laid 204 eggs. No. 379's 203 eggs were worth on the basis of the prices used, $5.46, whereas bird No. 505's 204 eggs were worth only $5.06—a difference of 40 cents in the cash production of the hens during the year. This result again is due, as is apparent from a detailed examination of the table, to the fact that No. 505 was a poor layer when prices were high and only succeeded in making her high total record by laying at a time of the year when eggs were worth very little. It is instructive to compare No. 379's record with that of No. 7. No. 379 laid 10 more eggs in the year than did No. 7. No. 379's eggs were worth, however, $1.22 more. In other words, the 10 extra eggs laid by No. 379 were worth on the basis of these figures rather better than 12 cents apiece.

The figures given in this table show how important from a purely commercial standpoint is a consideration of the *distribution* of egg production as well as of *total* egg production. In the breeding work of this Station it is felt to be very important, indeed absolutely necessary, to consider something besides total yearly records. The Station is endeavoring in its work to learn how to breed *winter* layers. In order to make any progress in this direction it is obviously necessary to consider the detailed figures for winter production as well as the figures for total production. Nothing is more certain than that a 200 egg hen is not necessarily a particularly good winter layer. Birds No. 7 and No. 505 given in Table I are examples in point. It would be possible to take from the Station's records many birds whose yearly record would not exceed 160 eggs yet which were better winter layers than either No. 7 or No. 505, both of which fall for practical purposes in the category of the 200 egg hen.

Moved by these circumstances it has been decided to adopt a new set of units in future discussions of egg production records in the work of the Station. It is impossible at this place to go into an extensive discussion as to the biological reasons for finally deciding upon the units which have been chosen. The plan which is now followed in the discussion of the egg production work here is to break the year up into four parts. The first of these includes the months of November, December, January, and February. Broadly speaking this period is thus seen to be the period of winter laying. The second period includes the months of March, April and May. This, broadly speaking, obviously corresponds to the breeding season. The third period includes the months of June, July and August and is clearly the summer period. Finally, the fourth period includes the months of September and October and is the period in which molting and its associated drop in egg production commonly occur. In future discussions of egg production it is proposed to consider separately the egg production in each of these periods. By this method it will be possible to compare for example the production in the winter laying period of different lots of birds, or their ability to lay during the breeding season, and so on.

The Measurement Of Egg Production.

It has been shown in the previous section that the total yearly production of a hen is not always the most desirable measure of her egg producing capacity. A little consideration of the matter will show further that no absolute figures whatever are so significant as a measure of egg production as are relative figures. In making any statement regarding the egg producing ability of a hen the time unit discussed must always be held in mind. This is apparent enough in the ordinary treatment of the subject. When one speaks of a "200 egg hen" the implication is that a hen is meant that laid 200 eggs in 365 days. Almost any hen will lay 200 eggs if allowed long enough time in which to make the record. The time factor must always be taken account of in egg production work. It seems desirable to take explicit account of this factor by making the time involved an integral part of the measure of egg production used. The simplest method of doing this is to put all records of production on a relative or percentage basis. This may be done according to the following rule. *The measure of an individual hen's egg production in any given time may be taken to be the percentage which the number of eggs actually laid is of the maximum number of eggs which might have been laid by the individual in this given length of time, assuming the production of one egg a day to be the maximum of which a hen is capable.* According to this rule if a hen lays 20 eggs in the month of June (30 days) this hen's egg production is 66 2-3 per cent for that month. Or again if a hen lays 31 eggs in the months of December and January (62 days) she would have a 50 per cent record in egg production for those months. Such a rule as this puts all egg records on a comparative basis. It will be recognized that this is a great advantage for the purpose of scientific discussion. On any other basis no records are strictly comparable which do not cover equal and the same periods of time.

In order to facilitate the calculation of such relative or percentage egg records Table II has been prepared. The purpose of this table is to show the number of days from (and including) the first day of any given month in the year to (and excluding) the first day of any other month. On the assumption that the maximum possible productivity of a hen is one egg a day the values in Table II give the maximum possible egg production for any specified period of a year. These figures then may be used in calculating the percentage egg production.

TABLE II.

Table Showing the Maximum Possible Number of Eggs Which Can be Laid Between the First Day of Any Given Month in the Year and the First Day of any Other Month, Assuming (a) that 1 Egg Per Day is the Maximum Rate, and (b) that February has 28 Days.

From To	November 1.	December 1.	January 1.	February 1.	March 1.	April 1.	May 1.	June 1.	July 1.	August 1.	September 1.	October 1.
November 1	0 365	30	61	92	120	151	181	212	242	273	304	334
December 1	335	0 365	31	62	90	121	151	182	212	243	274	304
January 1	304	334	0 365	31	59	90	120	151	181	212	243	273
February 1	273	303	334	0 365	28	59	89	120	150	181	212	242
March 1	245	275	306	337	0 365	31	61	92	122	153	184	214
April 1	214	244	275	306	334	0 365	30	61	91	122	153	183
May 1	184	214	245	276	304	335	0 365	31	61	92	123	153
June 1	153	183	214	245	273	304	334	0 365	30	61	92	122
July 1	123	153	184	215	243	274	304	335	0 365	31	62	92
August 1	92	122	153	184	212	243	273	304	334	0 365	31	61
September 1	61	91	122	153	181	212	242	273	303	334	0 365	30
October 1	31	61	92	123	151	182	212	243	273	304	335	0 365

An example will show the use of this table: Suppose a hen laid 84 eggs between March 1 and July 1. What would be its percentage production? A glance at the table shows that from March 1 to July 1 there are 122 days. To determine the percentage production we have then $(84 \times 100) \div 122 = 68.9\%$. Similar calculations may be made with equal ease for any other period of a year.

BULLETIN No. 166.

DATA ON THE INHERITANCE OF FECUNDITY OBTAINED FROM THE RECORDS OF EGG PRODUCTION OF THE DAUGHTERS OF "200-EGG" HENS.*

Raymond Pearl and Frank M. Surface.

In 1907 the experiment of the Station in breeding Barred Plymouth Rocks for high egg production which had been going on since 1898 came formally to an end. There was planned for 1908 a new experiment designed to test from another standpoint the conclusions which had been tentatively reached from the earlier experiment. It had been noted, though never particularly discussed in the bulletins describing the breeding work of the Station, that the daughters of the so-called "registered hens (namely hens that had produced 200 or more eggs each in the pullet year) did not usually make high egg records. The "200-egg" birds which made up the "registered" flock came in most instances from "unregistered" mothers. It seemed desirable to determine exactly what would be the egg production of the daughters of "200-egg" hens, when these daughters were accorded the same treatment as is given to other pullets. Accordingly the Director of the Station and the late Professor G. M. Gowell outlined an experiment to test this point. The plan of the experiment was as follows: To hatch in the spring of 1907 as many pullets as possible from "200-egg" hens and keep an exact pedigree record on the mother's side of each of these chickens. An exact pedigree record of the male ancestry

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* Papers from the Biological Laboratory of the Maine Agricultural Experiment Station. No. 10.

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was not kept. All male birds used, however, were so-called "registered" cockerels. They were cockerels in whose ancestry the females for at least seven generations had been birds laying 200 or more eggs in the pullet year. These "registered" pullets were then to be housed and fed exactly in the same manner as were the "unregistered" * pullets. The experiment as planned was begun by Professor Gowell and carried on by him until the time of his resignation from the Station in December, 1907. The continuation of the experiment was turned over to the department of biology along with the other poultry work. It is the purpose of this bulletin to report the results of this experiment.

The specific questions which this experiment was instituted to answer may be briefly stated as follows:

1. Will the daughters of high laying hens ("200-egg" birds) on the average produce more eggs in a given time unit than will birds of less closely selected ancestry?

2. What data do the performance records of such selected birds afford regarding the inheritance of egg producing ability in the domestic fowl?

PLAN OF THE EXPERIMENT.

On the first of November, 1907, there were put into House No. 2 of the Station's plant, 250 pullets. Each of these was the daughter of a hen that had laid approximately 200 eggs in her pullet year. These 250 pullets were divided into flocks of 50 each and were fed and handled in every way exactly in accordance with the usual methods of the Station (cf. Bulletin No. 144). They were an even lot of birds and had the strong, vigorous appearance which has characterized the Station's Barred Plymouth Rock stock. They were to the eye slightly small for Barred Plymouth Rocks, and also gave the general impression of being slightly smaller than the "unregistered" pullets of the same age in the other houses. The smaller size of the "registered" pullets had been noted for some years in the breeding work of the Station.

At the same time that these 250 "registered" pullets (so-called because from "registered" mothers) were put into the house

* That is, birds of similar breeding except that their mothers laid from 150 to 200 eggs each in their pullet years instead of over 200 eggs.

there were also put in 600 other Barred Plymouth Rock pullets. These were of the same average age as the 250 "registered" birds and differed in their breeding only in respect to their mothers. They came from hens that had laid less than 200 eggs during the pullet year and more than 150. "Registered" cockerels (from the "200 egg line") were used as the male parents for all the pullets both "registered" and "unregistered." The 600 "unregistered" birds were divided into flocks as follows: Two flocks of 50 birds each were kept in two pens in House No. 2 exactly like the pens in which the "registered" birds were kept. The remaining 500 birds were divided into four flocks—two of 100 birds each and two of 150 birds each and housed in the four pens of House No. 3. These pens are essentially like those of House No. 2, differing chiefly in the matter of size.

The birds used in this experiment whether "registered" or "unregistered" were not closely inbred. In the breeding work of the Station for many years Professor Gowell exercised the greatest care to avoid close inbreeding, which he felt to be wrong in theory and dangerous in practice. The breeding practiced was what is known as "line-breeding." The important point for the present discussion lies in the fact that the "registered" ("200-egg") birds were, on the average, neither more nor less closely inbred than the "unregistered" birds. "Registered" and "unregistered" were alike in this regard.

Except in the matter of flock size the treatment and management of all the birds whether "registered" or "unregistered" was exactly the same. All were given the same feed and care in every way.

All the birds were trap nested from November 1, 1907, to July 1, 1908. The trap nest records were stopped at the latter date owing to the necessity of giving the poultry houses a thorough overhauling and renovating. The records obtained, however, cover the major portion of the year and just that portion which is of most interest and significance in the study of egg production.

COMPARISON OF THE EGG RECORDS OF MOTHERS AND DAUGHTERS.

In undertaking a discussion of the results of the experiment which has been outlined the proper starting point obviously is the egg production and other characteristics of the mothers which produced the 250 so-called "registered" pullets. Then the egg production of each mother's progeny may be compared with her own production. The significant data on this matter are shown in Table I. This table gives in the first column the band number of each "registered" mother hen known to have one or more daughters among the 250 pullets. The second column of the table shows the number of eggs produced by each of these mother hens between November 1 of her pullet year and November 1 of the following year. The third, fourth and fifth columns of the table show the number of daughters which each of these mother hens had among the 250 birds. The first of these columns gives the *total* number of daughters for each mother. The second column (rubric "Nov.-Mar.") gives the number of daughters of each mother which survived to March 1, 1908. The third column gives the number of daughters surviving until June 1, 1908.

The sixth column of the table shows the number of eggs laid by each of the registered mother hens in the experiment between November 1 and March 1 of her pullet year. In other words, this column gives the individual mother's *winter* egg record. The seventh column gives the corresponding figures for the daughters. In this column there is set down the average egg production between November 1 and March 1 of the pullet year of the daughters of each individual mother. For example, it appears from the first line of the table that the 12 daughters of mother hen No. 7 averaged to lay between November 1 and March 1, 14.83 eggs each, while in the corresponding period of her own life hen No. 7 laid 33 eggs. The eighth column of the table gives the egg record of each mother hen between March 1 and June 1 of the pullet year. Finally, the last column of the table gives the corresponding figures for the daughters. In this column are the averages between March 1 and June 1 of each group of daughters coming from a particular mother.

TABLE I.

Showing the Egg Records of the "Registered" Hens and the Number and Egg Records of Their Daughters.

Band number of "registered mother" hen.	Mother's egg production from Nov. 1 of pullet year to Nov. 1 of following year.	Number of daughters of each "registered" hen in the experiment.			Winter egg production. Nov. 1—Mar. 1.		Spring egg production. Mar. 1—June 1.	
		Total.	Nov. 1–Mar. 1	Mar. 1–June 1	Mother's.	Daughter's average.	Mother's.	Daughter's average.
7	193	12	12	12	33	14.83	81	47.75
33	192	8	8	8	30	13.37	68	53.25
578	196	4	4	4	42	23.75	59	42.25
253	200	9	8	7	65	23.87	45	38.14
46	184	3	3	3	64	15.33	56	51.00
460	208	8	8	8	61	15.50	60	44.87
617	183	4	4	4	47	15.25	56	38.00
42	216	7	7	6	46	13.28	67	52.83
169	210	17	15	15	70	13.47	54	44.43
150	193	5	5	5	56	18.00	53	50.80
236	180	7	6	5	24	20.83	62	46.20
152	200	6	6	6	49	18.83	69	43.33
105	217	8	8	8	68	17.25	66	48.12
386	203	9	9	9	55	4.88	59	40.88
911	196	3	3	3	52	27.33	62	55.33
510	212	3	3	2	69	0.00	59	12.50
404	203	2	2	2	55	19.50	56	62.00
174	208	6	6	6	43	24.00	68	44.16
166	221	7	7	7	66	7.14	56	46.57
2	190	10	10	10	48	17.90	60	45.80
505	204	6	6	5	58	17.66	43	38.00
464	202	7	7	7	77	19.57	62	51.28
32	203	9	9	9	64	11.00	55	50.33
111	?	10	—	—	—	—	—	—
379	203	4	4	4	63	24.25	60	47.50
130	208	3	3	3	68	14.00	51	53.00
49	200	4	4	3	29	18.00	65	42.33
351	201	5	5	5	68	15.20	49	53.80
9	186	8	7	7	60	14.14	49	59.85
614	?	9	—	—	—	—	—	—
14	197	6	5	4	66	2.40	68	47.75
349	203	4	4	3	51	10.25	55	37.33
303	246	4	4	4	83	7.25	60	29.70
Total number of "mothers" represented.	Average "mother's" egg* production.	TOTALS.			Mother's average Nov.—Mar. production.	Daughter's average, Nov.—Mar., production.	Mother's average Mar.—June, production.	Daughter's average Mar.—June, production.
33	201.8	217	192	184	55.80	15.29	59.13	46.61

* Omitting the two birds without records, No. 111 and No. 614.

From this table a number of points are to be noted.

1. In the first place an examination of the totals shows that only 217 out of the 250 pullets supposedly in the experiment are accounted for in the table. The remainder of the 250, namely, 33 birds, do not appear in the table for one or another of the following reasons: Such birds may have lost their leg bands as chickens and hence lost their individual pedigree connection, though still known to be the daughters of *some* 200 egg hen. Or there may have been failure to make any note of the chick bands originally put on. In dealing with the results of the experiment it has been deemed wisest to leave all pullets not having definite pedigree records out of account.

2. It is further to be noted that two of the mother hens—Nos. 111 and 614—have an interrogation mark in the column devoted to the mother's egg records. The reason for this omission lies in the fact that in the past egg records of the Station there are two birds recorded as each having a band number 111 and also laying over 200 eggs, and there are two birds each having a band number 614, and each recorded as having laid over 200 eggs. There is nothing in the records of the present experiment, or in the memory of those who had the details of the work in hand to tell which of these duplicate birds were the ones actually used in this work. Consequently, it is impossible to insert in the table any egg record for them. It is certain, however, that they were both in the "registered" class.

3. Another point which needs discussion is that not all the mother birds laid 200 eggs or over between November 1 of their pullet year and November 1 of the following year. In looking through the records of the mothers whose band numbers are entered in the first column of the table it was found that they fell into three classes, as follows: (a) Those birds that laid 200 or more eggs between November 1 of their pullet year and November 1 of the following year. (b) Birds that laid 200 eggs in a year (365 days) forward from the day on which they laid their first egg. (c) Birds which neither laid 200 eggs between November 1 and November 1, nor in the year forward from the date of their first laying, but which only fell a few eggs short of doing one or the other of these two things. Such

birds were apparently included at the beginning of the experiment as "registered" hens "by courtesy." *

4. It will be seen from the totals of the table that 33 mother birds produced 217 pullets. This is at the average rate of 6.6 pullets per mother. If it be assumed that the sex ratio in fowls is approximately equal to unity or, in other words, that males are as likely to be produced as females, this means that the average production of viable offspring per mother for these registered hens during the breeding season was 13.2 birds. No record was kept to show how many eggs were involved in the production of these birds.

5. The average egg production of the mothers omitting the two birds (Nos. 111 and 614) which have no record is 201.8 eggs per bird. This average indicates that the non-uniformity of mothers described in paragraph 3 above does not in any essential way affect the point of the experiment. The birds used as mothers, all taken together, averaged slightly more than 200 eggs apiece in their pullet years. Transferring to relative figures * it appears that the mother's average egg production for the year was 55.3 per cent,† $(201.8 \times 100) \div 365$.

6. Turning now from a consideration of the mothers' gross total records to the records made in particular seasons of the year it is seen that the registered mother hens involved in the experiment averaged to lay 55.80 eggs per bird between November 1 and March 1 of the pullet year. This is, of course, an excellent winter egg record. Transferring from absolute to relative figures it is found that 55.80 eggs between November 1 and March 1 correspond to a percentage egg production of 46.5 per cent. It will be noted that this is a lower percentage record than that of these same birds in their total yearly production (55.3 per cent from paragraph 5 above).

7. The egg production of the registered mother hens in the spring months (March 1 to June 1) is seen to average 59.13

* It will be recalled (cf. p. 49 supra) that this experiment had been under way 8 months before the writers of this bulletin took charge of it. They therefore cannot be held responsible for the points noted in paragraphs 1, 2 and 3.

* According to the rule given in Me. Agr. Exp. Sta. Bulletin No. 165.

† This figure is of some interest as indicating what a *relatively* small proportion of the theoretically maximum character is being selected to, when 200 eggs birds are bred.

eggs per bird. This figure corresponds to a percentage egg production during the same period of 64.4 per cent. This is nearly a 20 per cent higher production proportionately than that of the winter months. It shows in a very striking way that even with record layers such as these hens were the egg production is markedly increased in the spring months (the natural mating and laying season) as compared with the winter months. It will be further noted that the spring percentage production is about as much above the percentage production of the same birds throughout the whole year as the winter production is below this figure.

8. Turning now to the production of the daughters of these "registered" birds in corresponding periods of their pullet years very different results are obtained. Taking first the winter production, it is seen that the 192 daughters whose records can be included averaged to produce between November 1 and March 1 of their pullet years only 15.29 eggs per bird. This absolute production corresponds to a relative or percentage production of 12.7 per cent for the same period. It is evident that the daughters do not belong in anything like the same class as the mothers as winter egg producers. The mothers' average production for the corresponding period of their pullet year was nearly 4 times as great as the daughters'. (Exactly $46.5 \div 12.7 = 3.7$). This great reduction of the daughters' average winter production below the mothers' is most striking and unexpected. It is to be expected on general grounds that there would be some regression, but so much as this would hardly be anticipated.

9. From the last column of the table it is seen that the daughters' laying during the spring months averaged to be 46.61 eggs per bird. This corresponds to a relative or percentage egg production of 50.7 per cent. It is evident that this is a relatively very much better egg production than is that of the daughters during the winter months. It still, however, is nearly 15 per cent below the mothers' egg production in the corresponding part of the year. The fact that the spring months are the natural laying season for fowls shows itself in these daughter records even more strikingly than in the records of the mothers. The daughters' spring production (*their best*) is still,

however, roughly 5 per cent lower than is the mothers' total relative yearly production (paragraph 6).

10. From the data discussed in paragraphs 6 to 9 the fact appears that the daughters' gain in spring as compared with winter egg production is proportionately much greater than the mothers' similar gain. Thus, the daughters' relative egg production is 38.0 per cent higher in the spring months than it is in the winter months, whereas the mothers' relative spring production is only 17.9 per cent higher than their winter production. The daughters gained more than twice as much as the mothers. This of course finds its explanation in the fact that the winter production of the mothers was so much better than that of the daughters that the mothers could not possibly make so great a relative gain in spring as compared with winter laying. Their winter laying was already too high. The daughters had a poor winter record and hence had no difficulty in making a relatively high gain in the spring production.

11. The general conclusion to be reached from the data set forth in Table II is clearly, so far as these data indicate, that the daughters of "200-egg" hens when kept under substantially the same conditions and treated in the same way as their mothers, are markedly inferior to them in winter and in spring egg production.

This result inevitably raises the question: Did "like produce like" in this experiment? The assumption made in much of the practical breeding of poultry is that if one wants to get good winter layers he needs only to breed from good winter layers. But in this experiment there is found no evidence whatever that the good winter layer produced the good winter layer. In fact, taking the data as a whole, exactly the contrary is the case. The mothers on the average were wonderfully good winter layers. The daughters, on the other hand, were extremely poor winter layers. These, be it remembered, are statements of fact, not of theory.

One must be very cautious about drawing the conclusion from the data set forth that there is no inheritance of fecundity from parent to offspring in the domestic fowl. There are many further points which must be taken into account before any conclusion whatever as to the inheritance of fecundity may be certainly reached. The remainder of this bulletin will be devoted to a discussion of some of these further factors which enter into the problem. The aim so far has been to set forth in as clear and unequivocal manner as possible, the definite fact that in the Station's experience thus far the daughter of a "200-egg" hen is, on the average, an exceptionally poor winter layer, instead of an exceptionally good one.

THE PERIOD COVERED BY THE RECORDS.

The first question which naturally suggests itself in connection with the data which have been presented in the Table I is as to whether it is not conceivable that different results might have been obtained had the experiment been continued for a longer time so that the daughters could have made egg records covering a longer period of their lives. In other words, it might conceivably be maintained that if the daughters' records for the whole pullet year had been compared with the mothers' records for the same period of their lives there would not have been so great a discrepancy between the averages of the two groups. It was necessary, on account of making changes in the buildings of the poultry plant to stop the trap nest records on June 30, 1908. There are then lacking records of four months (July, August, September and October) egg production of the daughters' pullet year. These are the four least important months of all, however, from the standpoint of the practical study of egg production.* We can get light on the significance of the contention that different results might have been obtained in this experiment had the daughters' records covered the whole year in two ways.

(1) The average egg production of the mothers from November 1 to June 1 of their pullet year was in round numbers 114.9 eggs per bird. Since the average total production of the mothers for the whole year was 201.8 eggs per bird it, of course, follows that their average production from June 1 to November 1 was 86.9 eggs per bird. Now the daughters' egg production from November 1 to June 1 in their pullet year was, as has been seen, 61.9 eggs per bird. If it be assumed that after June 1 the daughters would have laid on the average just as well during the remainder of the year as did the group

* See the discussion on this point in Me. Agr. Exp. Sta. Bulletin No. 165.

of mothers what would have been the average egg production of the daughters for the whole year? This can be determined by adding 86.9, the mothers' average production from June 1 to November 1, to 61.9, the daughters' production from November 1 to June 1. In this way one gets 148.8 eggs as the average production of the daughters for the whole year, had they been allowed to make a record for the year and assumed to lay as well as the mothers during the summer and fall months.

In considering this result two things must be kept in mind. In the first place the assumption that if the daughters had been allowed to continue their records they would have laid on the average as well as the mothers during the summer months is, from the standpoint of actual experience, an absurd one. This is probably sufficiently evident on general grounds, but we further have definite mathematical evidence of it. It is not possible to take space to present this evidence in detail here, but in a word it consists in the fact that the egg production at any one part of the year has been found to be positively correlated with that of any other part of the year. That is, it has been found on the basis of the 9 years trap nest records at this Station that on the average the bird which is an unusually good layer at one period of the year will also have an unusually good egg production record for any other portion of the year whatsoever and vice versa. The poor winter layer does not on the average, and in the long run make the good summer layer, though this is often assumed to be the case.

In the second place it is clear enough that, even if the truth of the assumption that the daughters would have laid as well as the mothers during the summer could be granted, the daughters' average would still be more than 50 eggs lower for the year than the mothers'. No further comment on this point seems necessary.

(2) So far there have been considered only the results when the records are broken up into winter and spring laying periods. It is perhaps well to examine the figures for the whole period over which we have data, namely, from November 1 to July 1 of the pullet year. Comparing mothers and daughters in regard to egg production over this period (two-thirds of the year) we have the results shown in Table II.

TABLE II.

Average Egg Production of "200-egg" Hens and Their Daughters. November 1 to July 1.

CHARACTER.	VALUE.
Number of mothers completing records	31
Number of pedigreed daughters completing records	180
Mother's absolute average egg production, Nov. 1—July 1	135.13
Daughter's " " " " " 1 " 1	74.47
Mother's relative " " " " 1 " 1	55.8%
Daughter's " " " " " 1 " 1	30.8%

The figures in this table for the longer period simply confirm and make more emphatic the results obtained with the shorter periods discussed in Table I. Lengthening the period of record does not bring mothers' and daughters' averages any nearer together. There is no reason whatever to suppose that these averages would have been any nearer together if records for the daughters had been taken for the whole year.

TESTS OF THE INHERITANCE OF FECUNDITY.

There are two other points which must always be considered in discussing the inheritance of egg production besides the comparison of the daughters' average egg production with that of their mothers. In the first place it is quite conceivable that the daughters' average production might be very much lower than their mothers' average production and there still be inheritance of the egg producing ability. This seeming paradox might arise in this way. If unfavorable environmental influences acted in the case of daughters the average production of the whole group of daughters might be considerably below that of the mothers. At the same time the exceptional mother (that is the mother whose production was above the average for *mothers*) might produce the exceptional daughter (the daughter whose performance was above the average for *daughters*). Such a condition of affairs would obviously indicate the inheritance of egg producing ability and yet clearly might exist quite independently of the relative magnitude of the averages of the mother and daughter groups as wholes.

To determine whether there is such an inheritance of egg producing ability independent of the group averages it is necessary that the *correlation* between mothers and daughters in respect to egg production be actually measured. From such measurement it can be told whether on the average the exceptional mother produces the exceptional daughter or whether the exceptional daughter is as likely as not to be the daughter of the mediocre or poor mother.

In the second place if the results of an experiment in which the mothers are especially selected are to be used in the discussion of inheritance of egg producing ability it is necessary that the daughters' average production be compared not merely with the mothers' average, but also with the average of other birds of the same age as the daughters and kept under the same environmental conditions but not of selected ancestry.

THE CORRELATION BETWEEN MOTHERS AND DAUGHTERS IN RESPECT TO EGG PRODUCTION.

Taking up first the question of the correlation between the egg production of the mothers and the daughters it is necessary to answer the following question. Did the exceptionally good mother in this experiment on the average produce daughters above the average of daughters or not? Some general indication as to the answer which the data give to this question is afforded in Figs. 10 and 11. The plan on which these figures are constructed is as follows: The upper of the two horizontal zigzag lines in each figure represents the egg production of the 31 mothers included in the experiment. This upper zigzag line in Fig. 10 is the graph of the data given in the sixth column of Table I. The lower zigzag line in each figure is the graph of the average egg production of each of the groups of daughters associated with the 31 mothers. In Fig. 10 the lower zigzag line is the graph of the data given in the seventh column of Table I. In general any plotted point in the upper of the two zigzag lines shows the mother's performance during a given period of the year and the plotted point directly below it on the lower zigzag line shows the average performance of this mother's daughters.

Fig. 10 gives the data for the winter (November 1 to March 1) egg production and Fig. 11 the spring (March 1 to June 1) egg production.

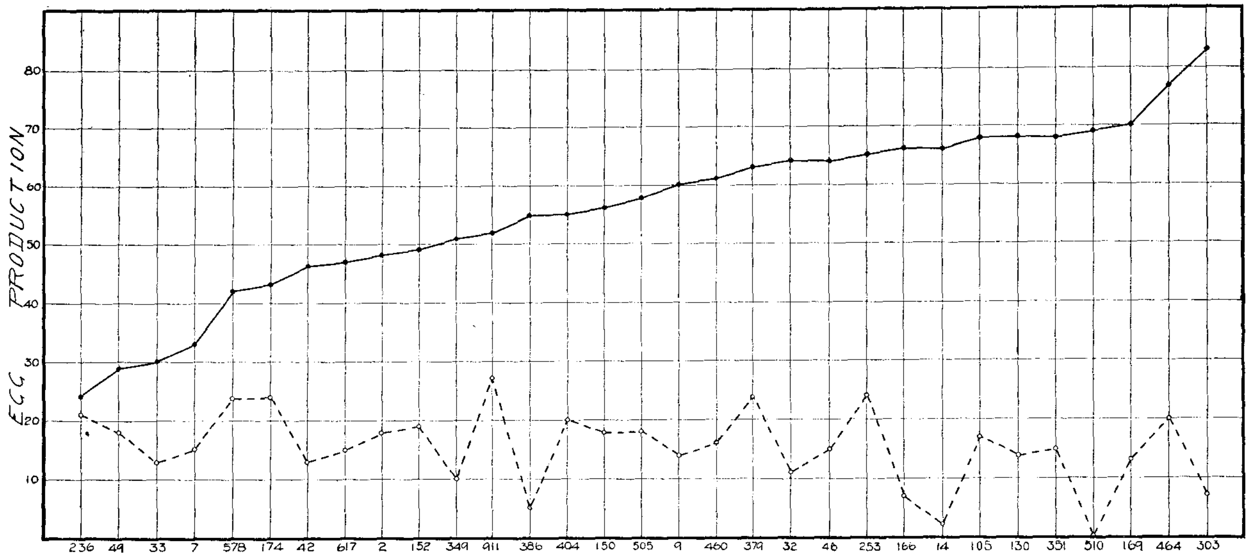

Fig. 10. Diagram showing the relation between "200-egg" hens and their daughters in regard to *winter* (November 1 to March 1) egg production. The solid line and black circles give the mother's production; the broken line and open circles the daughters' averages. Data from Table I. The figures along the bottom of the diagram are the mothers' band numbers.

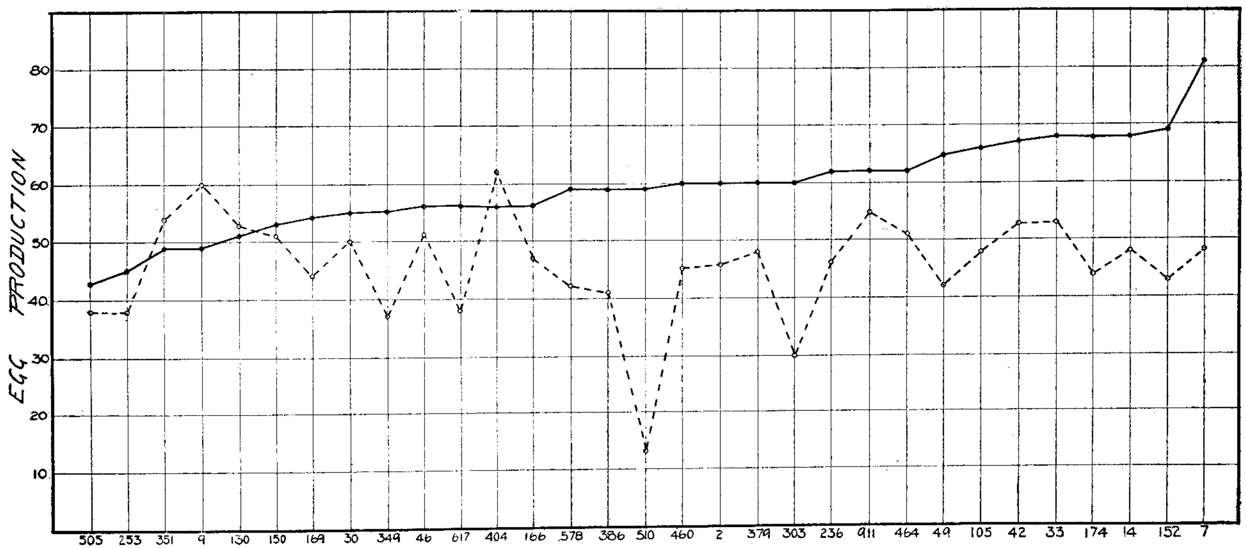

Fig. 11. Diagram showing the relation between "200-egg" hens and their daughters in regard to *spring* (March 1 to June 1) egg production. Significance of lines and figures as in Fig. 10.

If, on the average, the exceptionally good mother produced the exceptionally good daughters, and the exceptionally poor mother the exceptionally poor daughters it would be expected that the two lines in each of these two figures would run, in the main, parallel to each other. No such a parallelism is apparent, however. The two lines in each of the figures zigzag up and down in a manner quite independent of each other. The daughters' line is as liable to go up when the mothers' line is going down as to do the opposite. These diagrams clearly do not give any evidence that egg producing ability was inherited in this experiment.

Resort must be had, however, to a more exact appreciation of the correlation between mothers and daughters in respect to egg production. Such correlation may be accurately measured by proper mathematical methods. It is not necessary to enter into a discussion of these methods at this place.*

In general the procedure is as follows: A statistical table known as a "correlation table" is made showing the egg production of each individual daughter and each individual mother. From this table is calculated the so-called "coefficient of correlation" which measures the average degree of association between mother and daughter in respect to the character under discussion. This coefficient of correlation is of such character that it may take values only between the limits of zero and 1. When the correlation coefficient is equal to zero it means that there is absolutely no association or correlation between the characters under discussion. That is to say, in the present case a correlation coefficient of zero would mean that an exception-

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* Descriptions of modern biometrical methods may be found in any of the following works:

1. Pearson, K. Grammar of Science. Second edition. London (A. & C. Black) 1900. Pp. xviii+548.
2. Elderton, W. P. Frequency Curves and Correlation. London (Layton) 1907. Pp. xiii+172.
3. Davenport, C. B. Statistical Methods with Special Reference to Biological Variation. Second edition. New York (J. Wiley & Sons) 1904. Pp. viii+223.
4. Davenport, E. The Principles of Breeding. Boston (Ginn & Co.) 1907. Pp. xiii+727.
5. Davenport, E. and Rietz, H. L. Type and Variability in Corn. Ill. Agric. Exp. Sta. Bulletin No. 119, pp. 1-38. 1907.

ally high producing mother is, on the average, as likely to produce exceptionally poor as exceptionally high producing daughters and *vice versa.* On the other hand a correlation coefficient of 1 means a perfect association or correlation. In the present case a correlation coefficient of +1 would indicate that an exceptionally good mother always and invariably produced an exceptionally good daughter which was, as compared with daughters in general, exactly as exceptional relatively as the mother was as compared with other mothers. As the correlation coefficient takes different values between zero and one it indicates varying degrees of association or correlation between the characters under consideration.

There are several different ways in which the problem of the correlation between mother and daughter in respect to egg production may be approached. In the first place it is possible to make a table in which each daughter and her mother shall be individually entered. From such a table the correlation between mother and daughter in respect to egg production can be measured. It is obvious, however, that this procedure weights each mother with her own fecundity. This arises from the fact that while each individual daughter has an individual mother there are not as many individual mothers as there are daughters. If a mother produces six daughters she will appear six times in the table with whatever egg record she may have made. The mother with only three daughters will have her egg record appear only three times in the table and so on. In general, the mother's egg record by this procedure will be weighted according to the number of daughters which she had in the experiment. It is apparent that this method is not a perfect one, but it is the only practicable way of dealing with ordinary statistics of fecundity yet devised which enters every individual offspring separately in the correlation table. It is a method which has been used by Pearson * (though not exclusively) in the study of the inheritance of fecundity in race horses and of fertility in man. To be entirely fair it would be necessary in

* Cf. Pearson, K., Lee A., and Bramley-Moore, L. Mathematical Contributions to the Theory of Evolution. VI—Genetic (Reproductive) Selection: Inheritance of Fertility in Man and of Fecundity in Thoroughbred Racehorses. Phil. Trans. Roy. Soc. Vol. 192A, pp. 257-330. 1899.

determining the degree of inheritance of fecundity in this way, to use only families in which the number of daughters were equal so that each mother's record would be equally weighted.

Another possible way of approaching the problem is to enter in the correlation tables only one daughter for each mother. This gets around the weighting of the mothers with their own fecundity but only by involving the further difficulty which arises from the existence of individuality amongst the daughters. This difficulty is easily illustrated. Suppose, in the concrete case under discussion, that some particular mother hen has nine daughters, which one of these daughters shall be taken as the one to have its record entered in the correlation table with the mother's? It is, of course, obvious that, in advance of special investigations of the degree of individuality among daughters in general in regard to egg production, it will be possible to get quite different results from the inheritance of fecundity according as one picks and chooses the individual daughter to enter into the table by this method.

On the whole the element of error introduced by weighting mothers with their own fecundity appears to us likely to be less than the error arising from choosing single individual daughters as representative of their families. In view of this consideration and of the further fact that this is the method which has been quite generally adopted by students of the inheritance of fecundity it has been decided in the present case to make correlation tables of the sort wherein all daughters (and their mothers) are entered as a first point of approach to the problem. Such correlation tables for measuring the inheritance of egg production are given in Tables III, IV and V. Of these tables No. III deals with winter (November 1 to March 1) egg production. No. IV with spring (March 1 to June 1) egg production and No. V with the total (November 1 to July 1) egg production.

It is desirable, for the benefit of those not accustomed to tables of double entry such as these are, to explain and illustrate how such tables are to be read. The figures in the body of the table in each case denote the frequency of occurrence of the pair of events indicated by the marginal classes. To take a concrete illustration from Table III, it will be noted that in the first row and eighth column of the body of the table there is an entry "5."

TABLE III.

Showing the Correlation Between "Registered" Pullets and Their Mothers in Respect to Winter (November 1 to March 1) Egg Production.

Daughter's Egg Production.	Mother's Egg Production. 24–27.9	28–31.9	32–35.9	36–39.9	40–43.9	44–47.9	48–51.9	52–55.9	56–59.9	60–63.9	64–67.9	68–71.9	72–75.9	76–79.9	80–83.9	Totals.
0–3.9	1	3	2	–	1	3	7	5	3	5	12	8	–	1	1	52
4–7.9	–	3	2	–	1	2	2	3	3	3	3	8	–	2	1	33
8–11.9	1	3	1	–	–	1	1	–	–	2	5	6	–	–	1	21
12–15.9	–	1	2	–	3	2	–	1	1	1	4	1	–	1	1	18
16–19.9	1	–	3	–	–	–	3	1	1	1	–	4	–	–	–	14
20–23.9	–	–	1	–	1	–	1	2	1	1	3	–	–	–	–	10
24–27.9	–	–	–	–	–	1	1	1	–	2	–	1	–	–	–	6
28–31.9	1	–	–	–	1	–	2	–	–	1	1	1	–	1	–	8
32–35.9	2	–	–	–	–	–	–	–	–	–	1	3	–	–	–	6
36–39.9	–	–	–	–	1	1	–	–	–	–	1	–	–	1	–	4
40–43.9	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1
44–47.9	–	–	–	–	–	–	1	1	–	1	1	–	–	1	–	5
48–51.9	–	–	1	–	1	1	–	–	–	1	–	–	–	–	–	4
52–55.9	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	2
56–59.9	–	2	–	–	1	–	1	–	2	–	–	–	–	–	–	6
60–63.9	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
64–67.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
68–71.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
72–75.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
76–79.9	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
Totals......	6	12	12	0	10	11	20	14	11	19	32	34	0	7	4	192

This signifies that in the experiment there were five pullets whose own egg records for the winter period fell between 0 and 3 eggs inclusive, and whose mothers' egg records for the corresponding period of their pullet years were from 52 to 56 eggs inclusive. To take another example, it will be seen from Table V that there were three daughters whose total production from November 1 to July 1 fell between 85 and 89 eggs inclusive, and whose mothers' egg production in a corresponding period of time fell between the figures 155 and 159 inclusive. These examples will make clear how the tables in general are to be read.

Another possible way of getting at the correlation between mothers and daughters in respect to egg producing ability is to correlate the mother's performance with the *average* performance of her daughters. This method of procedure in a measure gets over both of the difficulties which have been noted above. In the first place the mothers are not weighted with their fecundity. In the second place, since the *average* daughters' performance is taken, undue weight is not given to the factor of individuality among the several daughters. It has seemed desirable

TABLE IV.

Showing the Correlation Between "Registered" Pullets and Their Mothers in Respect to Spring (March 1 to June 1) Egg Production.

	Mother's Egg Production.											
Daughter's Egg Production.	40–43.9	44–47.9	48–51.9	52–55.9	56–59.9	60–63.9	64–67.9	68–71.9	72–75.9	76–79.9	80–83.9	Totals.
0–3.9	–	–	–	2	2	3	–	–	–	–	–	7
4–7.9	–	–	–	–	1	1	–	–	–	–	1	3
8–11.9	–	–	–	1	1	–	–	–	–	–	–	2
12–15.9	–	–	–	–	1	–	–	–	–	–	–	1
16–19.9	–	–	–	1	2	1	2	1	–	–	–	7
20–23.9	–	–	–	–	2	1	–	1	–	–	1	5
24–27.9	1	–	–	2	1	–	1	–	–	–	–	5
28–31.9	1	–	1	1	1	2	–	1	–	–	1	8
32–35.9	1	–	–	2	2	3	1	2	–	–	–	11
36–39.9	–	–	–	1	2	–	1	2	–	–	–	6
40–43.9	1	–	1	2	–	2	–	2	–	–	1	9
44–47.9	–	–	1	2	4	5	–	1	–	–	1	14
48–51.9	–	–	–	2	4	3	1	–	–	–	3	13
52–55.9	–	–	3	2	4	7	3	6	–	–	–	25
56–59.9	–	–	1	4	3	1	2	5	–	–	–	16
60–63.9	1	–	4	7	2	5	5	1	–	–	–	25
64–67.9	–	–	4	2	5	5	1	–	–	–	1	18
68–71.9	–	–	–	1	–	1	–	1	–	–	1	4
72–75.9	–	–	–	1	–	–	–	1	–	–	2	4
76–79.9	–	–	–	–	–	1	–	–	–	–	–	1
Totals..........	5	0	15	33	37	41	17	24	0	0	12	184

TABLE V.

Showing the Correlation Between "Registered" Pullets and Their Mothers in Respect to Total (November 1 to July 1) Egg Production.

DAUGHTER'S EGG PRODUCTION.

MOTHER'S EGG PRODUCTION.	0–4.9	5–9.9	10–14.9	15–19.9	20–24.9	25–29.9	30–34.9	35–39.9	40–44.9	45–49.9	50–54.9	55–59.9	60–64.9	65–69.9	70–74.9	75–79.9	80–84.9	85–89.9	90–94.9	95–99.9	100–104.9	105–109.9	110–114.9	115–119.9	120–124.9	Totals.
105–109.9	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	1	–	1	–	–	5
110–114.9	–	–	–	–	–	–	–	–	–	1	–	–	1	2	1	–	–	–	–	–	3	–	–	–	–	8
115–119.9	–	–	–	–	–	1	–	1	–	–	1	–	1	–	1	–	1	–	–	–	–	1	–	–	–	7
120–124.9	–	1	–	–	1	–	1	–	–	–	–	–	–	1	2	1	3	3	2	5	–	–	2	–	–	22
125–129.9	1	–	–	–	–	–	–	–	–	–	1	1	–	2	–	1	–	2	–	2	1	1	–	–	–	12
130–134.9	–	–	–	–	1	1	1	1	–	–	1	1	–	1	4	5	–	–	1	–	–	–	1	–	–	18
135–139.9	–	1	–	–	–	–	–	–	1	1	–	1	–	–	–	2	4	2	2	4	2	1	–	–	–	21
140–144.9	1	–	–	–	4	1	1	–	1	3	–	1	2	6	4	2	5	6	5	5	4	–	1	1	1	54
145–149.9	1	–	–	–	–	–	–	–	–	2	–	–	1	3	–	3	2	–	1	–	–	–	1	–	–	14
150–154.9	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	1	4	–	–	–	–	1	–	–	–	8
155–159.9	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	3	–	1	–	–	1	–	–	7
160–164.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
165–169.9	1	–	–	–	–	1	–	–	–	–	1	–	–	–	–	–	–	–	–	1	–	–	–	–	–	4
Totals........	5	2	0	0	6	4	3	2	2	7	5	5	6	16	12	15	20	16	11	19	11	4	7	1	1	180

to make a study of the correlation between the mother's individual performance and the daughter's average performance for each of the egg laying periods here under discussion, in order to compare the results so obtained with the results which one gets by the more usual method of allowing the mothers' records to be weighted with their fecundity. In determining the degree of correlation in this way it is neither necessary nor desirable in the present case where we are dealing with such small numbers (31 mothers only) to make a correlation table for the evaluation of the coefficient. Instead the correlation coefficient may most accurately be determined directly from the data given in Table I without grouping.

Besides the evidence as to the inheritance of egg producing ability afforded by the coefficient of correlation between mother and daughter in respect to this character, light may also be obtained on the problem from the relative values of constants measuring variability in egg production. It is a fundamental principle of breeding by selection that the offspring of selected parents will be less variable than the offspring of unselected parents, or, in other words, than the general population. It is to be expected that following selection there will be a reduction in variability. Selection is made to a type and if a line of breeding is successful it is justifiable to assume that the offspring after selection will conform more closely to the type than did the individuals before selection. It is, on this account, important in all discussions regarding the inheritance of a character to determine the variability of that character following selection. In the present case the variation can be measured by well known and accurate methods in connection with the mathematical processes involved in determining the correlation coefficients. The variation constants will be tabled with the correlation coefficients.

The constants of variation and correlation measuring the degree of inheritance in egg production exhibited in this experiment are shown in Table VI. These constants have been determined from the data given in Tables I, III, IV, and V.

TABLE VI.

Constants Measuring the Degree of Inheritance in Egg Production. "200-Egg" Hens and Their Daughters. Experiment of 1907-1908.

SUBJECT.	Stand d deviation *	Coefficient of variation.*	Coefficient of correlation.
Variation in winter (Nov. 1—Mar. 1) egg production. *Mothers* unweighted. (Table I)..	14.06±1.20	25.20±2.29	-
Variation in spring (Mar. 1—June 1) egg production. *Mothers* unweighted. (Table I)..	7.73±.66	13.07±1.13	-
Variation in winter egg production. *Mothers* weighted with their fecundity. (Table III)	14.93±.51	26.57±.97	-
Variation in spring egg production. *Mothers* weighted with their fecundity. (Table IV)	8.41±.30	13.80±.49	-
Variation in total** (Nov. 1—July 1) egg production. *Mothers* weighted with their fecundity. (Table V)......................	12.69±.45	9.32±.33	-
Variation in winter egg production. *Daughters.* (Table III)............................	16.10±.55	101.14±6.44	-
Variation in spring egg production. *Daughters.* (Table IV)............................	18.10±.64	38.66±1.54	-
Variation in total egg production. *Daughters.* (Table V)	26.38±.94	35.43±1.41	-
Correlation between mothers and daughters in *winter* egg production. (Table III)........	-	-	—0.068±.048
Correlation between mothers and daughters in *spring* egg production. (Table IV)........	-	-	+0.023±.050
Correlation between mothers and daughters in *total* egg production. (Table V)..........	-	-	—0.055±.050
Correlation between the mother's individual *winter* performance and her daughter's average winter performance	-	-	—0.329±.108
Correlation between the mother's individual *spring* performance and her daughter's average spring performance	-	-	+0.034±.121

From this table the following points are to be noted:—

1. Considering first the correlation coefficients at the bottom of the table it is apparent that they give no evidence of a positive correlation between mother and daughter in respect

* These constants are measures of variation. The standard deviation measures variation in absolute units (in the present case, eggs), while the coefficient of variation measures it in relative (percentage) units. The larger each of these constants is the greater the variability denoted in the character under consideration.

** "Total" is here used simply as a convenient verbal label of the whole period covered by the egg records *in this experiment.*

to the egg production during any portion of the year. The coefficients are, with a single exception, not sensibly different from zero. In all three of the cases where the correlation is determined from the tables in which the mothers are weighted with their fecundity the correlation coefficients are not sensibly larger than their probable errors. When the mother's individual performance is correlated with the daughter's average performance the coefficient also is sensibly equal to zero in the case of the spring production.

2. In three out of the five cases the sign of the correlation coefficient is negative. In one of these cases, namely that in which the mother's individual winter performance is correlated with her daughters' average winter performance, the negative coefficient is large enough to be sensible in comparison with its probable error. The meaning of a negative coefficient of correlation is, illustrating from this particular experiment, that the mother with a record *above* the average for mothers in general, produced daughters whose records were on the average *below* those for daughters in general. In other words, the negative coefficient indicates that the relatively high producing mother produced the relatively low producing daughter. As has been said, however, only one of these negative coefficients can, when taken alone, be considered to be significant in comparison with its probable error.

3. Turning to the variation results it is seen that whether the variation is measured absolutely or relatively, the daughters, as would be expected, are much more variable than the mothers. In the case of the coefficient of variation, the daughters are from 3 to 4 times as variable as the mothers in respect to the egg production of corresponding periods of the year. The daughters show a greater variation than the mothers regardless of whether the mothers are weighted with their fecundity. The daughters' variability clearly must approach that of the general population. Its actual relation to the variability of the general population will be shown in the next section.

4. The data obtained from this experiment give no evidence whatever that there is any appreciable correlation between

mother and daughter in respect to egg producing ability. On the average pullets which did exceptionally well as compared with the other pullets in the experiment were just as likely as not to be the daughters of mothers who were exceptionally poor in production as compared with other mothers in the same experiment. In other words, the data so far obtained do not indicate that egg producing ability is sensibly and directly inherited between mother and daughter. There may be such in inheritance, but further data are needed to demonstrate it. The results of the present experiment tend to confirm the conclusion tentatively reached from a study of the past egg records of the Station accumulated during nine years of selective breeding.*

COMPARISON OF "REGISTERED" AND "UNREGISTERED" PULLETS IN RESPECT TO EGG PRODUCTION.

It was pointed out in an earlier section of this bulletin, that in addition to the evidence afforded by a study of the correlation between parent and offspring light on the problem of the inheritance of egg producing ability might be gained by a comparison of the egg production of birds whose mothers were closely selected for high egg production with birds whose mothers were not so particularly selected. Evidence from this source cannot take the place of that afforded by the study of correlation but it may and does supplement such evidence. Besides the so-called "registered" pullets in the present experiment there were 600 pullets which received precisely the same treatment, but whose mothers were birds laying between 150 and 200 eggs in their pullet year rather than birds falling into the "200-egg" or "registered" class. (Cf. p. 51 *supra.*) Of these 600 "unregistered" birds 100 were kept in two pens of 50 birds each, exactly like the pens in which the "registered" pullets were kept. Of the other 500 birds only two flocks—one of 100 and one of 150 birds—are available for strictly fair comparison with the "registered" pullets.

* Cf. Pearl, R. and Surface, F. M. A Biometrical Study of Egg Production in the Domestic Fowl. Part I—Variation in Annual Egg Production. (In press). A brief summary of the chief results of this study has been published in Me. Agr. Expt. Stat. Bulletin No. 157.

TABLE VII.

Frequency Distributions Showing the Egg Production of "Unregistered" Pullets. November 1-June 1, 1907-1908.

Eggs Laid.	Number of Pullets Producing each Specified Number of Eggs.					
	House No. 2, Pens 6&7. (50 bird pens.)		House No. 3, Pen 2. (100 bird pen.)		House No. 3, Pen 3. (150 bird pen.)	
	Nov. 1—Mar. 1.	Mar. 1—June 1.	Nov. 1—Mar. 1.	Mar. 1—June 1.	Nov. 1—Mar. 1.	Mar. 1—June 1.
0–2.9	29	–	16	2	30	5
3–5.9	6	2	6	0	17	2
6–8.9	3	1	12	2	17	2
9–11.9	3	2	2	3	6	0
12–14.9	7	1	5	3	7	1
15–17.9	3	1	8	2	5	2
18–20.9	10	2	7	1	10	1
21–23.9	4	0	5	3	10	4
24–26.9	1	1	3	3	11	1
27–29.9	4	0	6	1	3	5
30–32.9	5	1	6	4	5	3
33–35.9	6	2	4	1	4	6
36–38.9	4	3	5	6	7	2
39–41.9	2	2	4	4	4	6
42–44.9	2	2	0	1	4	7
45–47.9	4	6	1	7	2	7
48–50.9	0	4	1	6	2	14
51–53.9	1	9	0	5	1	14
54–56.9	0	5	0	5	0	14
57–59.9	3	5	3	12	2	11
60–62.9	1	12	0	3	0	8
63–65.9	0	4	0	5	1	10
66–68.9	1	6	2	5	0	8
69–71.9	–	10	0	4	1	6
72–74.9	–	4	0	3	–	1
75–77.9	–	1	0	0	–	2
78–80.9	–	2	2	0	–	1
81–83.9	–	1	–	1	–	–
Totals.....	99	89	98	92	149	143

TABLE VIII.

Comparison of the Egg Production of "Registered" and "Unregistered" Pullets. November 1-June 1, 1907-1908.

Groups of Birds Compared.	Mean or Average Egg Production		Variation in Egg Production. Standard Deviation in Egg Production.		Variation in Egg Production. Coefficient of Variation in Egg Production.	
	Nov. 1—Mar. 1.	Mar. 1—June 1.	Nov. 1—Mar. 1.	Mar. 1—June 1.	Nov. 1—Mar. 1.	Mar. 1—June 1.
"Unregistered"—(50 bird pens)................	19.38±1.18	53.38±1.30	17.45±.84	18.16±.92	90.02±6.99	34.02±1.91
"Registered"...............................	15.92*±.78	46.83*±.90	16.10±.55	18.10±.64	101.14±6.44	38.66±1.54
Difference................................	+3.46	+6.55	+1.35	+.06	—11.12	—4.64
"Unregistered" (100 bird pens)...............	21.43±1.23	45.65±1.36	18.08±.87	19.32±.96	84.37±6.33	42.33±2.45
"Registered"...............................	15.92*±.78	46.83*±.90	16.10±.55	18.10±.64	101.14±6.44	38.66±1.54
Difference................................	+5.51	—1.18	+1.98	+1.22	—16.77	+3.67
"Unregistered" (150 bird pens)...............	17.89 ±.87	47.97 ±1.01	15.78±.62	17.84±.71	88.19±5.51	37.19±1.67
"Registered"...............................	15.92*±.78	46.83*±.90	16.10±.55	18.10±.64	101.14±6.44	38.66±1.54
Difference................................	+1.97	+1.14	—.32	—.26	—12.95	—1.47

* Obtained from the grouped data of Table III and Table IV. The grouping is the cause of the insignificant difference between these averages and those of Table I.

The egg records of such of these 350 "unregistered" pullets as survived the period included in the experiment are shown in Table VII in the form of frequency distributions. The manner in which this table is to be read will be plain from an illustration. From the first column of the table it appears that of the birds kept in 50 bird pens there were 6 whose egg production between November 1 and March 1 fell between 3 and 5 eggs inclusive. Again there were 3 birds in the 100 bird pen whose egg production between March 1 and June 1 fell between 24 and 26 eggs inclusive.

The means and constants of variation deduced from these frequency distributions are given in Table VIII. The data for comparison of "registered" and "unregistered" pullets in respect to their average egg production and in respect to variation in egg production are also given in this table. The differences between "registered" and "unregistered" pullets in respect to egg production are designated as plus when the constant for the "unregistered" birds is the larger and minus when the constant for the "registered" birds is the larger.

From this table the following points are to be noted:—

1. The mean egg production of the "registered" pullets (daughters of "200-egg" hens) is, with a single exception, smaller than the egg production of the "unregistered" birds (not daughters of "200-egg" hens), regardless of the season of the year or of the size of the pens in which the "unregistered" birds were kept. The single exception to this rule is found in the comparison with reference to spring production between the "unregistered" birds kept in a flock of 100 and the "registered" birds. The difference, however, in this case is small and only arises because of the fact that the "unregistered" birds in the 100 bird pen made an exceptionally bad record during the spring months as compared with the other "unregistered" birds. The differences between "registered" and "unregistered" became smaller as the size of the flock in which the "unregistered" birds were kept was increased. During the periods under discussion the birds did not do so well in the large flocks as in the smaller ones.

The lower egg production of the "registered" as compared with the "unregistered" birds (data from 50 bird flocks) is shown graphically in Figs. 12 and 13. These figures give plottings of the data in the first two columns of Table VII and the corresponding frequency distributions for the "registered" birds.

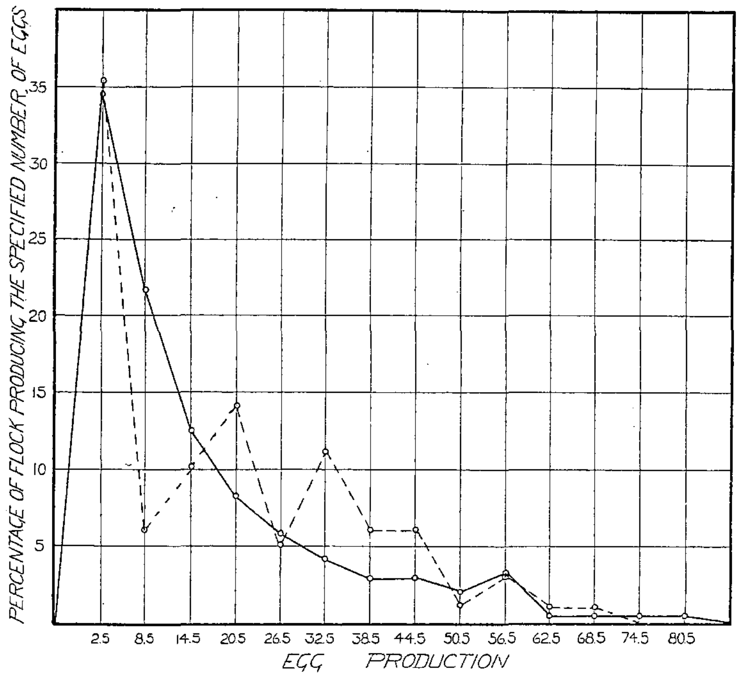

Fig. 12. Diagram showing the egg production during the winter months (Nov. 1 to March 1) of "registered" as compared with "unregistered" pullets. The solid line denotes the "registered" and the broken line the "unregistered" birds. "Unregistered" birds in 50 bird pens.

The same thing is apparent from these diagrams as is brought out by the figures in Table VIII. The lines showing the egg production of the "registered" birds fall generally to the left of the lines for the "unregistered" birds, thus denoting the smaller average production of the "registered."

2. In respect to relative variability as measured by the coefficient of variation, the differences between "registered" and "unregistered" birds are, with one exception, negative. This means that (with the single exception noted) the "registered" birds were somewhat more variable in egg production than were the "unregistered." In other words, contrary to expectation, the group whose ancestry had been most closely selected was actu-

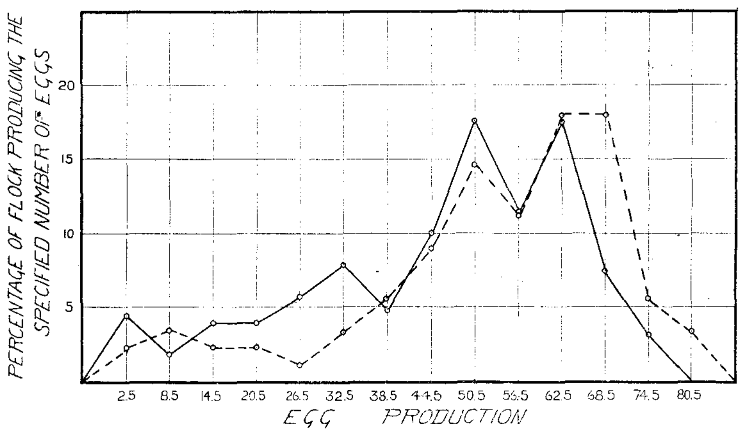

Fig. 13. Diagram comparing the spring (March 1-June 1) egg production of "registered" and "unregistered" pullets. Lines as in Fig. 12.

ally somewhat more variable (i. e., less true to type) relatively than the group whose ancestry had not been so closely selected. The exception to this rule occurs at the point where the exception in the rule regarding the means occurred, namely, in respect to the March to June egg production. The "registered" birds were less variable than the "unregistered" birds kept in the 100 bird flock. This exception, however, only emphasizes the general rule which is to be observed in the other cases. In regard to absolute variability, as measured by the standard deviation, the "registered" birds show a very slightly smaller "scatter" than do the "unregistered" birds. This is to be expected because of the smaller average production of the "registered" birds. The coefficient of variation is clearly the significant measure of variability in the study of egg production, when groups of different average productivity are to be compared."*

3. It will be noted from the values of the probable errors given in the table that some of the individual differences, particularly those between the coefficients of variation can not, when taken singly, be considered significant in comparison with the probable errors. From the practical standpoint this is more than offset by the fact that the differences, whether of means or of relative variabilities are, with the two exceptions noted, all in the same direction.

* Cf. Pearl, R. and Surface, F. M. *loc. cit.*

4. The general result of the comparison of the daughters of "200-egg" hens with other pullets not daughters of "200-egg" hens but receiving the same treatment, feed and care throughout is that the daughters of the "200-egg" hens do not show so high an average egg production as the others. Furthermore, the daughters of "200-egg" hens do not conform so closely to type as do the birds which are not daughters of "200-egg" hens. The significance of these results lies not in the absolute values of the positive differences in the case of the means and of the negative differences in the case of the coefficients of variability, but rather in the fact that they show with the greatest clearness, that daughters of "200-egg" hens on the one hand were certainly not better egg producers than other pullets, and on the other hand certainly did not conform closer to a type in egg production than did other pullets.

DISCUSSION OF RESULTS.

It is proposed to defer to another time and place the detailed discussion of the significance of the results of this investigation in their bearing on the general problem of selection. It need only be pointed out here that, so far as they go, the results of the present work are in entire accord with what has been found in all the extensive and thorough studies made in recent years on the subject of the effect of selection in different organisms. There is rapidly accumulating a mass of evidence that the chief if not the entire function of selection in breeding is to *isolate* pure strains from a mixed population. It is found in actual experience impossible to bring about by selection improvement beyond a point already existing in the pure (isolated) strain at the beginning. This is the result of the long continued extensive and brilliant work of Nilsson * in plant breeding in general. It is the essential result of Johannsen's ** selection experi-

* Cf. DeVries, H. Plant Breeding. Chicago (Open Court Publ. Co.) 1907. Pp. xiii+360.

** Johannsen, W. Ueber Erblichkeit in Populationen und in reinen Linien. Jena (Fischer) 1903. Pp. 68.

† Jennings, H. S. Heredity, Variation and Evolution in Protozoa, II. Heredity and Variation of Size and Form in Paramecium with studies of Growth, Environmental Action and Selection. Proc. Amer. Phil. Soc. Vol. xlvii, pp. 393-546. 1908.

ments with beans. Jennings † reaches the same result in one of the most extensive and thorough studies of the effects of selection ever made. In summarizing his conclusions at the end of the paper (*loc. cit.* p. 522) he makes the following statement: "Certainly, therefore, until some one can show that selection is effective within pure lines, it is only a statement of fact to say that all the experimental evidence we have is against this." Finally, to cite a single further instance, the case recently published by Arenander * showing that true mutants may occur among dairy cattle in respect to fat content of the milk makes it inferentially probable that selection in regard to this character can only bring about improvement by isolation of superior pure strains not by really increasing fat content within a strain.

All together much evidence is accumulating from widely different sources to show that simple selection of superior individuals as breeders will not insure definite or continued improvement in a strain. Some improvement may possibly follow this method of breeding at the very start but the limits both in time and amount are very quickly reached. In support of this view of the possibilities of selective breeding the results of the present paper and of the nine-year selection experiment carried on at the Station furnish definite and positive confirmatory evidence. The experience of the Station shows that in order to establish a strain of hens in which high egg production shall be a fixed characteristic it is necessary to do something more than simply breed from high producers.

In relation to the general subject of the inheritance of fecundity the results of the present work are of considerable interest. This arises in particular from the fact that in statistics of egg production in poultry we are dealing with data measuring the most fundamental factor in fecundity and fertility, namely, ovulation. Practically all of the work which has hitherto been done regarding variation and inheritance of fecundity and fertility has been upon mammals. In all viviparous, as compared with oviparous, animals, the study of these subjects is greatly complicated by the fact that the magnitude of the apparent or recorded productiveness is influenced by

* Arenander, E. O. Eine Mutation bei der Fjellrasse (Kullarasse) Jahrb. f. wiss. u. prakt. Tierzucht. Bd. 3, pp. LXXXVII—LL. 1908.

† For foot note to Jennings see preceding page.

several separate and independently varying sets of factors. The unit of such statistics is the individual offspring at birth. But the production of an individual offspring by a viviparous animal implies (1) the removal of an ovum from the ovary (*ovulation*), (2) the *fertilization* of this ovum, and (3) its successful *development* in utero. A considerable proportion of partial or complete sterility in mammals is the result of a failure of the ovum to be fertilized, this failure in no wise depending in many cases on any fault of the ovum itself. The true innate fecundity of the female organism is clearly measured by capacity for ovulation. This is primary, and the other factors concerned in the production of an individual organism are secondary, in so far as the measurement of fecundity is concerned.

In view of these considerations it seems desirable to make use of a more precise terminology than that commonly employed in discussing these matters. We would suggest that the term "fecundity" be used only to designate the innate potential reproductive capacity of the individual organism, as denoted by its ability to form and separate from the body mature germ cells. Fecundity in the female will depend upon the production of ova and in the male upon the production of spermatozoa. In mammals it will obviously be very difficult, if not impossible, to get reliable quantitative data regarding pure fecundity. On the other hand we would suggest that the term "fertility" be used to designate the total actual reproductive capacity of *pairs* of organisms, male and female, as expressed by their ability when mated together to produce (i. e. bring to birth) individual offspring. Fertility, according to this view, depends upon and includes fecundity, but also a great number of other factors in addition. Clearly it is fertility rather than fecundity which is measured in statistics of birth of mammals. The terms fecundity and fertility will be used as here defined by the present authors in future discussions of their work.

As has been pointed out the results of the present investigation do not indicate that there is a sensible inheritance of fecundity from mother to daughter in the mass. Of course, it is not proposed to let the matter rest here; this result will be tested in every possible way. In particular it is important to determine the correlation between mother and daughter in respect to egg production for a less closely selected group of mothers. Also the question as to whether there does not exist in regard to egg production something corresponding to inheritance in "pure lines" as found by Johannsen in plants. It is possible that this might be the case, without any sensible correlation between mother and daughter appearing in the mass. Further the influence of the male in transmitting fecundity to his daughters needs to be carefully studied. All these problems, and others which they suggest are now under investigation in this laboratory. Individual pedigrees are being kept for all laying birds. Not only is the *performance* in respect to egg production of each individual female tested by trap nests, but the relative ability of each individual both male and female, to *transmit* to their progeny a given degree of fecundity is being thoroughly tested and measured.

In comparing the results of the present study with previous investigations in this field it must be kept in mind that we are here dealing with fecundity *sensu strictu*. The earlier work regarding the inheritance of reproductive capacity has, in all cases known to the authors, had to do with fertility instead of fecundity, using these terms as defined in this paper. Pearson * has shown that there is a positive correlation between parent and offspring in respect to fertility in man and in thoroughbred race horses. Rommel and Phillips ** have shown that a similar correlation exists between mother and offspring in respect to size of litter in brood sows. Pearson *** studying the records of Weldon's mice breeding experiments was unable to demonstrate a sensible parental correlation in respect to size of litter in mice. The only direct positive experimental evidence which has come to our attention showing that fertility in a mammal can be increased by selective breeding is given by Marshall * for

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* Loc. cit.

† Rommel, G. M. and Phillips, E. F. Inheritance in the Female Line of Size of Litter in Poland China Sows. Proc. Amer. Phil. Soc., Vol. XLV, pp. 245-254, 1907. Also in abstract; Biometrika, Vol. V, pp. 203-205. 1907.

‡ On Heredity in Mice from the Records of the late W. F. R. Weldon. Part I. On the Inheritance of the Sex-ratio and of the Size of Litter. Biometrika, Vol. V, pp. 436-449, 1907.

** Marshall, F. H. A. Fertility in Scottish Sheep. Trans. Highland and Agr. Soc. of Scotland. 1908. Pp. (of reprint) 1-13.

sheep. He says (p. 12): "Mr. H. C. Stephens of Chalderton, Salisbury, by breeding from twin-bred rams and ewes for some years past, has noticeably increased the fertility of his flock of Hampshire Down sheep." Further details regarding this experiment are given in the original. In general there can be no doubt that there is need for much more extensive and exact experimental and quantitative evidence than we now have before it will be possible to reach any positive conclusion as to the extent and degree of inheritance of fertility among mammals.

SUMMARY.

This bulletin describes the results of an experiment in which "registered" pullets (daughters of "200-egg" hens) are compared (a) with their mothers, and (b) with "unregistered" pullets (*not* daughters of "200-egg' hens, but otherwise of the same breeding) in respect to egg production, when given the same treatment as to housing, feed and the like. These results may be summarized as follows:—

1. The daughters of "200-egg" hens were in this experiment very much inferior to their mothers in average egg production. This is particularly true of winter egg production.

2. This experiment gives no evidence that there is a sensible correlation between mother and daughter in respect to egg production, or that egg producing ability is sensibly inherited. A relatively high producing mother was as likely as not to have relatively poor producing daughters in this experiment.

3. In this experiment the daughters of "200 egg" hens were not such high egg producers as pullets whose mothers' egg records fell in the 150-200 egg class. The daughters of "200-egg" hens were most inferior (proportionately) to the "unregistered" pullets in respect to winter egg production.

4. The daughters of "200-egg" hens were in this experiment somewhat more variable (that is, conformed less closely to type) in respect to egg production than were the "unregistered" pullets. No special stress is to be laid on this greater variability. The significant thing is that the "registered" pullets were *not less* variable than the "unregistered."

It must be remembered in considering these results respecting the inheritance of egg producing ability that they are not to be

regarded as more general than the data on which they rest. The statements which are made above are intended merely to set forth the results of a concrete experiment. They are not at present intended as generalizations applying to all poultry under all conditions. The problem of the inheritance of fecundity wherever attacked is an extremely intricate and difficult one. Further experiments of the same general type as the one described in this bulletin, but planned on somewhat broader lines, are now in progress at the Station and will be carried on for such length of time as is necessary to establish absolutely and beyond all possibility of doubt the answer to the problem with which we are here concerned; namely, whether there is or is not a definite and appreciable inheritance of egg producing ability in the domestic fowl. Until this basic question is definitely answered schemes and rules for increasing egg production by breeding which involve anything further than attention to health, vigor and constitution in the breeding stock, lack foundation in ascertained facts.

BULLETIN No. 167.

FIELD EXPERIMENTS IN 1906-8.

CHAS. D. WOODS AND J. M. BARTLETT.

In addition to the field experiments conducted by the Plant Pathologists of the Station and reported in bulletins 149 and 164 a number of cooperative field experiments were planned and carried out by the writers during the years 1906-8. Some of these experiments, notably, test of varieties of potatoes for blight resistance and yield and a modified ridge *versus* the high ridge culture ordinarily practiced in Aroostook County are to be continued.

EXPERIMENTS WITH FERTILIZERS ON POTATOES IN 1906.

The object of this experiment was to compare home mixed fertilizers with ready mixed goods using the same amount of plant food as nearly as possible in each case.

The field selected for the purpose was on the "Kenney Farm," so called, about 3 miles from Houlton village and planted this season by Mr. W. S. Blake through whose courtesy the Station was allowed to make its experiment. The field was an old one and had been cultivated for many years and this season was planted to potatoes for the second crop since the land was in grass, the piece yielding about 100 barrels to the acre in 1905. The land was high, naturally well drained and the soil was somewhat finer than most of the potato lands, quite free from stone and apparently sufficiently uniform to make the different plots favorable for comparing different kinds of fertilizers. Fourteen acres were used in all for the experiment, being divided into plots of one acre each.

For a mixed fertilizer Watson's High Grade Potato Fertilizer was used and the home mixed goods were made according to the following formulas.

Home mixed formulas used for one acre in 1906.

Ingredients.	Number of Formula.			
	1	2	3	4
	Pounds.	Pounds.	Pounds.	Pounds.
Nitrate of soda	100	175	100	100
Screened tankage	200	400	–	200
Dried blood	160	–	300	160
Acid phospate	600	600	600	600
Sulphate of potash	160	160	160	320

Plant food per acre furnished by fertilizer used in 1906.

	Nitrogen.	Phosphoric Acid.		Potash.
		Available.	Total.	
	Pounds.	Pounds.	Pounds.	Pounds.
Formula No. 1	48	98	122	80
Formula No. 2	48	112	154	80
Formula No. 3	48	84	90	80
Formula No. 4	48	98	122	160
Watson's Improved	48	108	150	76

The field was planted May 19-26 to Green Mountain potatoes and about two-thirds of the fertilizer used, 1000 lbs. of the Watson and 800 lbs. of the home mixed to an acre, was applied at this time. On June 11 to 14 when the potatoes were just breaking the ground the remainder of the fertilizer was put on, making up the plant food equivalent to 1500 lbs. of Watson's fertilizer or in round numbers about 45 pounds of nitrogen, 90 pounds available phosphoric acid and 80 pounds of potash except on plot 14, where the potash was doubled making 160 pounds to the acre. The second application was made with the potato planter, the plow being removed. During the growing season the field was thoroughly tilled and sprayed but suffered considerably from the hot dry weather in August and early September, which stunted the growth of the tubers. On September 14th harvesting was begun as more than half of the tops were dead and growth of tubers had practically ceased. No late blight or rot was found on the piece.

The yield of tubers for the different plots are shown in the following table. The variations in the yields is chiefly due to slight variations in the soil of the plots, as for instance No. 5 was on the highest portion of the field and suffered a little more from drought than its neighbors and No. 12 contained a low wet spot which reduced the yield.

Arrangement of acre plots and yield of merchantable potatoes per acre.

Number of Plot.	Kind of Fertilizer.	Yield of Potatoes. bbls.*
1	Watson's	89
2	Formula No. 1	89
3	Watson's	91
4	Formula No. 2	90
5	Watson's	86
6	Formula No. 3	98
7	Watson's	101
8	Formula No. 1	102
9	Watson's	98
10	Formula No. 2	100
11	Watson's	98
12	Formula No. 3	91
13	Watson's	103
14	Formula No. 4	105

Average yield with Watson's improved	95	barrels per acre
Average for formula No. 1	95½	barrels per acre
Average for formula No. 2	95	barrels per acre
Average for formula No. 3	94½	barrels per acre
Average for formula No. 4	105	barrels per acre

Formula No. 4 with double the amount of potash gave 10 bbls. more potatoes than the average but the increase in yield cannot be attributed to the extra potash but more properly to the soil of the plot which was about the best in the field for a dry season and it will be noticed that No. 13 yielded only 2½ barrels less and it was not quite so good a plot as regards location.

* One barrel equals 2.75 bushel.

High Ridge vs. Modified Ridge Culture for Potato Growing.

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, that is, 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 four 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 dirt 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. Of course, in a wet season as is frequently experienced in 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 plants were below the level as they are when modified level culture is practiced.

The two dry seasons of 1905 and 1906 were somewhat disastrous to potato fields cultivated with the high ridge and the crop was considerably below a normal crop in the dry sections of the county. For this reason the experiments here reported were undertaken in 1907 for the purpose of comparing a more nearly level culture such as is practiced in southern New England and some dryer sections of the country with the ridge method common in Aroostook County.

Mr. Oscar A. Benn who lives a short distance out of Houlton has practiced a modification of a ridge and level culture for several years and reports it as successful. He plants the seed as deep as possible with a Robbins planter and keeps the field free from weeds by frequently going over it with the weeder, in three different directions—crosswise, lengthwise and diagonally. In this way he claims to keep the weeds down during the first stages of growth without injury to the plants more cheaply than he can by the ridge method. The weeder is used until the plants get too high for a weeder, then the cultivator is run between the rows until the plants are 8 to 9 inches high. At this time the horse hoe is used to throw up a low ridge which is broader and flatter on the top than the ordinary ridge and is not more than half as high. The horse hoe is used only once and this is usually the final hoeing of the field. Mr. Benn claims that the potatoes are more easily taken care of by this method; more easily harvested, and in a season that is at all dry, better crops are obtained than by the method of ridging.

The experiments here reported were carried on practically by Mr. Benn's method. It was not thought best to attempt to use strictly level culture as the planter in common use in the county does not put the seed sufficiently deep for a perfectly level culture and it was not thought that potatoes could be as easily harvested by the digger that is in common use.

EXPERIMEKNT IN 1907.

The season of 1907 proved an extremely wet one and unfavorable for this experiment so that the modified method of ridge culture could not be strictly followed. Six acres on the farm of Mr. John Watson, Houlton, were given to the experiment, three acres being used alternately for the modified ridge and three check plots were cultivated by the method of high ridge.

The piece was planted May 24 and 25 and a few days after the weeder was run crosswise over the field which very nearly leveled the ground on the level culture plots and left the potatoes covered about 3 inches. Five days later, the level culture plots were again gone over lengthwise with the weeder and June 10 the weeder was run lengthwise over them. In the meantime it had been found necessary to run the cultivator between the rows. June 10 the potatoes were just appearing above the surface of the ground and on account of abundant rains they grew very rapidly and the tops were so tender that it was not deemed wise to again run the weeder through them and cultivation was restricted to hand hoes and cultivation between the rows. Two hand hoeings were deemed necessary for these plots. When the tops were about 4 inches high the horse hoe was run over them throwing up a ridge wider and flatter than the ordinary ridge used and not more than half as high. Otherwise than the cultivation the plots were treated the same as the check plots and harvesting was begun September 30 with the results shown below.

The yield on plot 2 is much below the others but this was apparently not due to the method of culture but to the soil. There was a strip of several rods on the upper part of this lot where the tubers were very scabby and only a light yield was obtained. This condition extended slightly into plot 3 reducing the yield of that plot somewhat but not nearly to such an extent as on plot 2. For this reason in a comparison plot 2 should be omitted.

Yield Per Acre for Each Plot. 1907.

No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Full ridge	Modified ridge	Full ridge	Modified ridge	Full ridge	Modified ridge
133.0 bbls.	85.9 bbls.	108 bbls.	112 bbls.	113.3 bbls.	129 bbls.

Average for full ridge culture..................	118 barrels
Average for modified ridge culture, all 3 plots....	109 barrels
Average for modified ridge culture, plots 4 and 6..	121 barrels

EXPERIMENT IN 1908.

For the modified culture experiment this year 90 rows, nearly three acres, were planted on new land on the northwest part of Mr. John Watson's farm in Houlton. The plan of planting in a solid piece instead of in strips as in 1907 was adopted for convenience in cultivating early in the season when it is desirable to run the weeder and smoothing harrow crosswise to keep down the weeds. Check acres for comparison were planted in the ordinary way, on either side of the piece planted by the modified culture method. The first check acre and 56 rows of the modified ridge culture plot were planted May 24 to 26, but on account of rain the remaining 34 rows and the other check acre were not planted until June 2. The Robbins planter was used to plant the field and for the modified ridge culture plot it was set to plant as deeply as possible the seed being on the average 3 inches below the surface of the ground after leveling the ridge off. As soon as the planting was completed the smoothing harrow was run crosswise to level off the ridges formed by the planter. A few days later the weeder was likewise run over the piece to destroy any weeds that were starting. On June 22 the rows first planted were up and the cultivator was run between them, followed by the weeder two days later. This method of culture was continued each week until the plants were about 6 inches high when the weeder was discontinued and the cultivator set wide so as to run as near the plants as possible was run over the piece twice a week. On July 7 the horse-hoe set wide so as to throw up only a low wide ridge was run over the piece. Work with the cultivator was continued and again on July 15 the horse-hoe was employed to disturb the earth around the plants and conserve the moisture. At this time the tops were getting large and cultivation was discontinued. July 20 the field was visited and the potatoes found to be growing finely, very free from weeds and apparently not suffering from the quite severe drought we were having. Sufficient rain, however, fell early in August to warrant a good crop with all kinds of culture. About September 15 killing frosts stopped further growth and digging was begun on the 18th. The yields were as follows:

	Merchantable Barrels.	Total Barrels.
High ridge check plot*	114	118
Modified ridge, 3 acres	328	341
High ridge check plot	97.5	101.5
Average for check plots	105.8	109.5
Average modified culture plots	109.3	113.3

* The plots were strictly comparable as to area but were a little less than an acre each.

The averages for the 2 years (omitting plot 2 of 1907 experiment) are:

High ridge culture	114 barrels
Modified ridge culture	117 barrels

In these two seasons there was nothing to chose between the two methods so far as yield was concerned. It is planned to continue this experiment on the same farm in 1909.

A Test of Blight Resistant Varieties of Potatoes.

About 1903 Prof. William Stuart of the Vermont Experiment Station began a study of disease resistant potatoes. After some little progress had been made, the scope of the investigation was enlarged and extended in cooperation with the Bureau of Plant Industry of the U. S. Department of Agriculture. In 1904, Prof. L. R. Jones, the Botanist of the Vermont Station was in Europe as special agent of the Department of Agriculture and made a study of the blight resistant varieties of potatoes that were in cultivation in England and on the continent particularly in Germany and Holland. A large number of the more promising varieties were brought to America and were grown for 3 years at the Vermont Experiment Station in cooperation with the Bureau of Plant Industry. Quite a number of American varieties were grown in comparison with the European varieties.

Twenty-seven of these varieties which seemed to be the most hopeful were sent to this Station in the Spring of 1908 for testing as to their disease resistance in the Maine climate. There was also grown in comparison with these, a selected Green Mountain which Mr. J. W. Lowell of Gardiner originated by selection over a period of several years. The numbers with the exception of that given to the Lowell Green Mountain are the original Vermont Station numbers.

The numbers included between 501 and 517 originated in Germany, 523 in Holland, the numbers between 540 and 597 were all of English origin, and the others are of American origin. The amount of seed that was sent varied so greatly (from 10 pounds to 120 pounds) that it was not practicable to grow these varieties for a yield test. They were therefore grown to study their blight resistant qualities and to form as one best might a judgment as to the value of the variety from the apparent crop yield, size, smoothness, general appearance and cooking qualities of the tuber.

The seed was planted May 18 and 19 on Mr. John Watson's farm, Houlton. Before planting all the seed was treated with formaldehyde gas for scab fungus. The seed of each variety was divided into two equal portions, and one portion of each kind was planted on a field which was not to be sprayed, and the other portion on a field which was to be sprayed with bordeaux mixture in the usual manner.

In the season of 1908, there was no late blight in the County but early blight was quite prevalent in some places and manifested itself on some of these potatoes. The crop was harvested September 24 and 25, 1908.

As a result of the test, 14 of the varieties have been discarded as unsuited to Maine. Seed has been saved of the following numbers,—506, 511, 512, 517, 540, 542, 594, 596, 602, 610, 736, 4229, 4517 and Lowell's Green Mountain. It is proposed to plant these both for blight resistance and for yield tests on the John Watson farm in the season of 1909. Each variety will be divided as in 1908 into two portions and part will be planted on a field that is to be sprayed and part in a field that is to be left unsprayed.

In the table which follows, there are given the notes and observations made during the season of 1908. The observations upon growth and upon the quality of tubers are made entirely upon the crop from the unsprayed field.

VARIETIES TESTED.

501 *Sophie.* Seed small white potatoes which being planted on the outside row did not have quite so good a chance as the others. Vines strong growing and showed very little injury and practically no early blight until frost. The yield was rather poor of small potatoes.

Cooking test: Boiled, quite dry and mealy. Baked, rather wet. Flavor, good.

505 *Irene.* Seed received, 60 pounds small red potatoes. Vines were vigorous and showed very little injury from early blight. Yield small and rather inferior potatoes.

Cooking test: Boiled, quite dry and mealy. Baked, quite dry and mealy. Flavor, very good.

506 *Professor Maerker.* Strong grower, vines showed very little injury, some tip burn but no early blight until very last of season. A good yield of large white tubers.

Cooking test: Boiled, quite dry and mealy. Baked, quite dry and mealy. Flavor, very good.

507 *Silesia.* Vines grew vigorously until about middle of August, showing no injury. About August 11 they showed some tip burn. On August 20 they showed considerable injury and some early blight but continued green until frost. Quite good yield medium sized white potatoes.

Cooking test: Boiled, quite dry and mealy. Baked, fairly dry. Flavor, good.

508 *Max Eyth.* Very healthy and vigorous grower, showing very little injury from early blight or tip burn. Yield light, rather small red potatoes.

509 *Mohort.* Began to show early blight and tip burn August 8 and by August 20 showed considerable blight. The vines however were vigorous and a part of the tips kept green until frost came. Gave fair yield of medium sized white potatoes.

Cooking test: Baked, rather soggy. Flavor, not very good; rather strong.

511 *President Kruger.* On August 8 the vines showed some tip burn and August 20 considerable early blight. They were large and vigorous however and a part of the tops remained green until killed by frost. Yield was fairly good, medium sized round white potatoes.

Cooking test: Baked, quite dry; fine grained. Flavor, good.

512 *Professor Wohltmann.* Vines were quite vigorous growers but showed more or less tip burn and some early blight. Gave fair yield of medium sized red potatoes.

Cooking test: Baked, not very dry. Flavor, good.

516 *Fuerst Bismark.* Showed some tip burn and early blight on August 8 and considerable on August 20 but some of the vines kept green until frost.

Cooking test: Baked, quite dry and mealy. Flavor, quite good.

517 *Appollo.* Large white good looking potatoes. Good yield.

Cooking test: Boiled, quite dry and mealy. Baked, quite dry and mealy. Flavor, good.

523 *Daisy.* Very strong and healthy. Showed practically no blight. Vine very green when frost came. Lot of small potatoes not ripe. Too late for this climate.

540 *Factor.* Good strong vines showing very little blight. Good yield large white potatoes.

Cooking test: Boiled, quite dry and mealy. Baked, quite dry and mealy. Flavor, good.

542 *Langworthy.* Good strong growing vines that showed no injury until late in the season when some early blight was noticeable. September 1 a larger part of the tops remained green and tubers growing until frost killed the vines. Yield fair of medium sized white potatoes.

594 *Evergood.* On August 8 this variety showed some vine injury and on August 20 considerable injury and early blight which continued to increase to end of season. Somewhat reducing the yield. Fair yield of small white potatoes.

Cooking test: Boiled, quite dry and mealy. Baked, not very dry. Flavor, good.

595 *Goodfellow.* A strong vigorous grower and showed very little vine injury until the very last of the season. It was affected by the light early frosts and had some early blight. Small yield of medium to small white potatoes.

Cooking test: Boiled, quite mealy. Baked, rather wet. Flavor, fair.

596 *Up-to-date.* Strong, vigorous grower and showed practically no injury until frost. A large yield of good sized smooth white round potatoes.

Cooking test: Boiled, fairly dry. Baked, not quite as good. Flavor, quite good.

597 *North Star.* Vines quite healthy and vigorous but showed some injury and early blight on August 20. Vines mostly remained green until frost. Yield not very good. Potatoes small, not ripe and clinging to the vines. Too late for this climate.

Cooking test: Boiled, quite dry and mealy. Baked, quite dry and mealy. Flavor, good.

602 *Cambridge Russet.* On August 8 this variety showed some tip burn but was quite healthy. On August 20 it showed very little early blight but on August 28 it showed a good deal of early blight and the two rows could be easily detected on the unsprayed plot while the sprayed was green. On September 9 vines were dead but on sprayed portion still green. Yield fairly good, medium sized white potatoes. The potatoes were larger and better on the sprayed plot than the unsprayed.

Cooking test: Boiled, dry and mealy. Baked, dry and mealy. Flavor, very good.

610 *Blight Proof.* Vines very healthy and showed very little injury up to coming of frost. Fair yield of large round and handsome potatoes. A desirable variety.

Cooking test: Boiled, dry and mealy. Baked, dry and mealy. Flavor, very good.

617 *Late Blightless.* Tops vigorous and showed very little injury. Yield fair but not ripe. Potatoes rather small. Too late for this climate.

637 *Alexander No. 1.* Vines healthy and vigorous, large top. Yield good, of good sized red potatoes but not very ripe.

652 *Professor Maerker.* Vines vigorous and strong; showed very little injury. Yield not very large. Potatoes white, medium size, not ripe, clinging to vines.

Cooking test: Boiled, fair quality. Flavor fair.

736 *Smith's Blight Proof.* Showed a little early blight last of the season but generally healthy. Fair yield good sized white potatoes.

Cooking test: Boiled, only fairly good. Baked, only fairly good. Flavor, fair.

4229 *Lawrence Seedling.* Tops were vigorous and strong and showed very little injury from early blight. Yield very large, round reddish-colored potatoes. A desirable potato except for color and its deep eyes.

Cooking test: Boiled, dry and mealy. Baked, dry and mealy. Flavor, good.

4518 *Rust Proof.* Vines remained vigorous and showed very little early blight up to time of frost. Yield good, large round white potatoes.

Cooking test: Boiled, quite mealy. Baked, quite mealy. Flavor, fair.

28 *Lowell's Green Mountain.* The vines remained nearly free from any injury and were very little affected by early blight. It suffered less than unselected Green Mountains which were sprayed. Yield was good on both the sprayed and the unsprayed.

Cooking test: BBoiled, quite dry and mealy. Baked, quite dry and mealy. Flavor, good.

Target Brand Fungicide on Potatoes.

At the request of the Horticultural Distributing Company of Martinsburg, W. Va., the Station undertook an experiment with potatoes in which the Target Brand Fungicide was to be used in the place of the Regular Bordeaux Mixture.

The following were the essential points in the agreement which were entered into between the Expriment Station and the Company.

Three-acre strips shall be used in the experiment. These plots shall be adjoining each other. The character of soil, preparation (including fertilizer), planting, cultivation, etc., shall be uniform on all three plots except: Plots A and C shall be sprayed with Regular Bordeaux Mixture and on same dates Plot B shall be sprayed with Target Brand Fungicide.

The Bordeaux Mixture and the Target Brand Fungicide will both be applied with a Watson Improved 4-rowed automatic sprayer and so far as possible, equal number of gallons of each shall be applied per acre and on same dates.

The Director of the Maine Agricultural Experiment Station personally or by a competent representative shall supervise all the work, including spraying and harvesting.

The American Horticultural Distributing Company may send a representative to observe any or all of the details of the experiments.

The American Horticultural Distributing Company shall deliver free of charge at Houlton, Maine the fungicide necessary for use on Plot B and shall deposit with the Houlton Trust Company of Houlton, Maine, one hundred and twenty-five ($125) dollars to be paid in part or entirely to the owner of the field when the experiment is concluded provided injury is done to the potatoes which injury is due to the use of the Target Brand Fungicide.

Whether or not there is injury shall be determined:

(a) If the yield of merchantable potatoes upon plot B shall be less than the average yield (Plots A plus C ÷ 2) upon plots A and C, the injury shall be in proportion to the decrease in yield at market price in Houlton on December 1, 1908.

(b) If the quality of the potatoes grown upon Plot B shall be inferior so as to affect the market value, the injury shall be considered as due to the fungicide and the financial loss shall be decided by one or three of the large buyers of potatoes in Houlton.

In any case the Station shall have the right, if it desires, to publish the results of the experiment.

The following letter was sent October 6, 1908 to the company reporting the results of the experiment:—

"We have harvested the potatoes on the acre upon which fungicide was used and upon the two acres grown upon either side. There was no late blight in the county this year. You may remember that the Target Brand Bordeaux which you sent to us was not received until very nearly time to use it and in consequence of this it was impossible for us to use the Quick Bordeaux which you sent to us, and the experiment was wholly with the Target Brand Fungicide and did not include the Quick Bordeaux. The yields were as follows:—

Fungicide plots:	merchantable potatoes	103 barrels
	small potatoes	6 barrels
	Total	109 barrels
Check plot to the south:	merchantable	122 barrels
	small	5 barrels
	Total	127 barrels

Check plot to the north:	merchantable	118 barrels
	small	4 barrels
	Total	122 barrels

The average merchantable potatoes on the two check plots was 120 barrels; and on the fungicide 103 barrels or a decrease in yield, which in my judgment is entirely due to the fungicide, of 17 barrels. The areas north and south of the fungicide were sprayed with Bordeaux and on the same days on which the fungicide was applied. Sprayings were made every 10 days during the growing season, beginning early in July.

As I stated above, there was no late blight in the County. Early in August, the fungicide plots began to show signs of vine injury and later they developed a good deal of early blight. The field sloped gently to the East so that the field was in sight as one drove on to the farm, for perhaps half a mile, and there was no time after the 10th of August but what anyone could have picked out the fungicide plot at that distance. In my judgment the decreased yield was due to this vine injury, and to its failure to protect from early blight as thoroughly as Regular Bordeaux Mixture."

ALFALFA.

The Station began experimenting with alfalfa in 1903. The reports for the work of the year 1904-5 are given on pages 35 and following of bulletin 126. A number of cooperative experiments were entered into in 1906, with seed specially furnished by the Bureau of Plant Industry of the U. S. Department of Agriculture; and at the same time three-quarters of an acre was planted with the same seed by the Experiment Station on the farm of John Watson at Houlton. A number of the experimenters reported that they obtained a fair stand and in some instances the alfalfa went through the winter of 1906-7 in very good shape. So far as we have been able to learn by correspondence, however, in no case was a permanent stand obtained.

The experimental field at Houlton gave the best stand of any that has been obtained in the State, so far as the writers know. Notes made in September 1906 show that the field was in good shape, there was a very uniform stand that had been cut twice with an estimated yield of $1\frac{1}{4}$ tons in the two cuttings. At that date it stood from 12 to 16 inches high and seemed to be in excellent shape for going into the winter, with the exception that here and there through the piece were occasional plants effected with the leaf spot of alfalfa,—*Pseudepeziza medicaginis.* The alfalfa went through the winter of 1906-7 in good shape and in the year 1907 three cuttings were made, and in the fall of 1907 the piece was still looking in very good shape. The leaf spot of alfalfa had not gained any on the field and the plants were, for the most part, free from disease. There was in the winter of 1907-8 an unusual amount of ice, with the result that the alfalfa was entirely smothered out and in the spring of 1908 there were only a few plants alive on the field. The Station has made no further experiments in the growing of alfalfa and is not likely to in the near future.

It is to be remembered, however, that although there have been hundreds of attempts in Maine to grow alfalfa and that thus far no permanent success has been obtained, that negative results do not reach to positive conclusions, and it may be that some one will find a method of growing this valuable crop that will be applicable to Maine conditions. There, however, can be no hope of success unless pains are taken to inoculate the soil with the bacteria which produce the root nodules whereby the alfalfa plant, like other legumes, is able to acquire atmospheric nitrogen. It is probable that this inoculation can only surely be accomplished by obtaining soil from alfalfa fields where the nodules are abundant. The culture method of inoculation is still in the experimental stage and cannot, so far as the writers know, be relied upon. Another seeming requisite is an abundance of lime and if alfalfa is to be successfully grown, the field will have to be heavily limed. Land that will grow clover luxuriantly will not of necessity carry lime enough for alfalfa plants.

The following quoted from bulletin 126 seems to be as pertinent now as when it was written:—

In order for alfalfa to be of value to Maine agriculture a good stand must be obtained and the stand must be able to continue not one, but several years. The Station does not advice anyone in this State to grow alfalfa at present except in an experimental way. That alfalfa would be a valuable addition to our forage crops needs no demonstration. If the difficulties which thus far have prevented its successful culture can be surmounted, it will more than recompense the cost of the many hundreds of trials that have been given this plant in Maine during the past 25 years.

WILD MUSTARD.

During several years, beginning with 1904, the writers endeavored to kill wild mustard in sown grain crops by spraying with copper sulphate and with iron sulphate. The first season's experiment was markedly successful. The second year an attempt was made to repeat the experiment on a large scale in Aroostook County and while the plants were stunted it did not result in destroying the weed. While it has been generally recognized throughout the State that wild mustard or charlock is one of Maine's worst weeds in sown crops it is not generally known and was not known to the writers in 1905 that there are two plants which differ so little in appearance that they are both known as wild mustard. One of these is the wild mustard proper, *Sinapsis arvensis,* which is also frequently and properly called "charlock." The weed which very closely resembles it and is sometimes called jointed or white charlock is the wild radish, *Raphanus raphanistrum*. Young wild mustard plants are readily killed by spraying with a solution of either copper sulphate or iron sulphate. The wild radish is very resistant and in experiments made at this Station has even defied treatment with 20 per cent solution of iron sulphate reinforced with 5 per cent of sulphuric acid. In the first year's experiments conducted on the College Farm at Orono the weed that was killed was wild mustard. In the second year's experiments in Aroostook County the failure to kill was due to the weed being wild radish.

It is perfectly possible to kill wild mustard by spraying. The only discouraging thing about spraying for wild mustard in Maine is that so much that is commonly called wild mustard is wild radish, and while it has been claimed by investigators in Germany and France that they have killed wild radish by spraying with a 20 per cent solution of iron sulphate, it is more than probable that they were wrong in identifying the plant.

TO KILL WILD MUSTARD.

If one desires to kill wild mustard (not wild radish) it can be readily accomplished in seeded crops without injury to the grain or grass by spraying with a 20 per cent solution of iron sulphate. A power sprayer on the same general plan as a potato sprayer should be used.

The solution is readily made as follows: Empty a 100 pound sack of granulated iron sulphate into an oil barrel (which will hold about 50 gallons). Fill the barrel up with water and stir vigorously for a few minutes until the sulphate goes into solution. The solution can be put into the spray tank and used at once, or it can be kept in the barrel until the desired time for use. Iron sulphate solution is not poisonous and can be handled without fear; white clothing coming in contact with it, however, will be discolored by iron stains.

The spraying should be made on a calm, bright day after the dew has disappeared. If rain follows within a few hours the spraying is not as effective. The grain fields should be sprayed when the mustard plants are in the third leaf and before the plants are in blossom. If sprayed after the plants are in bloom, it will kill the leaves but will not prevent the formation of seed.

LIME IN SEEDING DOWN.

During the past few years in many fields and in different localities marked improvements have been made upon certain crops, particularly the yield of legumes, by the liberal application of lime. There are undoubtedly thousands of acres in Maine that would be benefited by an occasional liberal application of lime, so far as clover and certain other crops are concerned.

There is probably no one money crop of greater importance in Maine than the potato. Not only does Aroostook County grow many millions of bushels each year but potato growing is now practiced successfully in other sections of the State on a large commercial scale. It has been learned how to control the ordinary fungus diseases which result in the killing of the tops and the loss of crop from premature ripening, or from rot. In potato culture the most serious obstacle at present is potato scab. This is a fungus disease and seems to grow best in the presence of an alkali. In order to study the effect of liming soils upon the development of scab in a potato crop* it was deemed best to use the lime as one would in ordinary farm practice. For this purpose a field was treated with lime and after the grain and grass crops had been removed it was experimented with for 2 years as regards the development of scab upon potatoes. The effect upon potatoes has been reported.*

An experiment upon another field was begun in 1907 on which it is proposed to follow up the effect of lime upon the development of scab on potatoes. On this field smaller amounts of lime were used than on the Watson field to see if the beneficial effect of the lime might be had and at the same time not introduce soil conditions favorable to the growth of the scab fungus. There is here reported the effect of lime upon the grain crop and the legumes when it was applied at the time of seeding down. It is planned to test the effect upon the potato crop in 1909 and 1910.

ON WATSON FARM.

The piece of land used for the purpose was on Mr. John Watson's farm in Houlton, and had been in potatoes two years, receiving about 1200 lbs. of high grade fertilizer to the acre each year. After plowing it also received a liberal coat of stable manure. When seeded in 1905 it was divided into plots of one-half acre each and 300 lbs. of a complete fertilizer were added to each plot. To plots Nos. 2 and 6 were added 500 lbs. of lime and Nos. 4 and 8, 1000 lbs. of lime to each plot which was harrowed in before the grain was sowed.

The lime seemed to have little or no effect on the oat crop and the yields of the different plots were not kept separate but the clover growing in 1906 showed a marked difference between the plots that were limed and those that were not limed. The clover plants were much longer and greener and lines between them and the plots not limed were very plain. The greatest difference was on the higher and dryer portions of the field. The ends of the plot that were low and moist showed but little difference in appearance of yield. The following is the yields estimated when the hay was loaded on to the racks.

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* See Bulletin 140 this Station, p. 4.

*Estimated Yield of Hay.**

Plot No. 2* 500 lbs. lime	3,000 lbs.
Plot No. 3, no lime	1,500 lbs.
Plot No. 4, 1,000 lbs. lime	2,600 lbs.
Plot No. 5, no lime	1,300 lbs.
Plot No. 6, 500 lbs. lime	2,800 lbs.
Plot No. 7, no lime	2,300 lbs.
Plot No. 8, 1,000 lbs. lime	3,000 lbs.
Plot No. 9, no lime	2,300 lbs.

While the above figures are not strictly accurate they show quite closely the difference in yields. If a few rods of one end of the plot that was low and moist had been left out the difference would have been still greater, for certainly on the dryer portions of the field the yield of the limed plots was at least 4 times that of the others.

ON THE EDBLAD FARM.

In 1907 a second experiment with lime was begun on the farm of Mr. H. Edblad of Houlton.

The experiment covered 6 plots of one acre each. The lime was applied with a fertilizer distributor at the time of seeding the field in 1907 to oats, grass and clover. All plots were treated alike except that to No. 1 was added 1000 lbs. agricultural lime, No. 2, no lime, No. 3, 750 lbs. lime, No. 4, no lime, No. 5, 500 lbs. lime. There was no appreciable effect on the yield of grain (oats) and straw.

The winter of 1907 and 1908 was open with very little snow, consequently much of the clover killed out. Plot No. 1 was on lower ground than the others, was better covered with snow during the winter, and being more moist suffered less from the dry weather of the summer of 1908 than the other plots. There was a very good stand of clover all over this plot. On all the other plots the clover was killed out in spots making the stand somewhat uneven. The plots were harvested July 21-22 when the clover was in bloom.

The yields estimated while loading were as follows:—

* Half acre plots.

*Estimated Yield of Hay.**

No. 1*, 1,000 lbs. lime applied	5,300 lbs.
No. 2, no lime applied	3,200 lbs.
No. 3, 750 lbs. lime applied	4,400 lbs.
No. 4, no lime applied	3,000 lbs.
No. 5, 500 lbs. lime applied	3,250 lbs.

It is clear that in these cases the application of lime materially increased the yield of clover, and it is probable that in many places where clover has not been successfully grown, that the application of lime might prove a remedy.

It is, however, a question whether in a State which is so largely dependent upon the potato as a money crop, as is Maine, whether it be wise to use lime in connection with crops until the question of the scab fungus has been more thoroughly worked out and the methods of controlling it further developed, and particularly it is learned how to fight it after a soil is once infested. It is an open question whether it is not better policy to have smaller yields of legumes and keep the soil somewhat acid, in order to make the conditions for the development of potato scab as little favorable as possible. In the experiments here reported, there is apparently no special benefit from the lime upon the grain crop or upon the ordinary English grasses, but it proved to be beneficial on the legumes. To Maine farmers who make potato growing an essential feature of their business it is suggested that if they use lime, they do so in an experimental way at the rate of perhaps 500 pounds to the acre, and that they carefully note the effect upon the yield of clover and the development of scab.

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* Acre plots.

BULLETIN No. 168.

DATA ON CERTAIN FACTORS INFLUENCING THE FERTILITY AND HATCHING OF EGGS.*

By RAYMOND PEARL and FRANK M. SURFACE.

In connection with a general investigation of the physiology of reproduction in the domestic fowl in progress at this Station especial attention has been devoted to the study of the factors which influence the hatching of eggs. As a result of the work in this direction which has been carried out during the last two years a considerable mass of data has accumulated. It is the purpose of this paper to present this material and discuss certain definite and positive results to which it leads.

It should be said at the outstart that this investigation has nothing directly to do with the problems of incubation *per se*. This will be clear if we consider briefly the questions with which the present work is concerned. The fundamental, general problem which served as the basis of the investigation may be stated in this way: What part in the determination of the relative fertility and hatching quality of eggs is played by innate, individual characteristics of the parent birds? If the eggs from a number of different females are handled in the same way and put under identical conditions of incubation it will be found that those from certain individuals will show a much higher percentage of fertile eggs and of hatched chickens than do those from other individuals. Is it not possible to determine some of the factors on which these individual differences depend? The present paper is an attempt in this direction.

Specifically we have endeavored by the use of appropriate biometric methods, to obtain reliable data on the following questions:

*Papers from the Biological Laboratory of the Maine Agricultural Experiment Station. No. 14.

This paper forms No. IV of a series of "Studies on the Physiology of Reproduction in the Domestic Fowl," in course of publication from this Laboratory.

1. Is there any definite correlation, and if so of what degree, between the fertility of eggs on the one hand and the hatching quality of fertile eggs on the other hand? In other words, is it in general the case that if a particular hen's eggs are above the average in regard to percentage fertility, they will also be likely to be above the average in regard to percentage of fertile eggs hatched?

2. To precisely what extent does the female bird (as compared with the male) determine the fertility and hatching quality of her eggs? Bad housing conditions are known, for example, to affect adversely the percentage fertility of eggs. To what extent is this due to the bad effect of the environment on the female as contrasted with the male bird?

3. Is there any correlation, and if so of what degree, between the winter egg production preceding the breeding season and the percentage fertility of eggs? Is the bird that has produced more than the average number of eggs during the winter, likely to have her eggs during the breeding season more or less fertile than the average?

4. What relation exists between winter egg production and the hatching qualities of fertile eggs? Will the relatively high winter producer lay eggs during the breeding season likely to show a percentage of fertile eggs hatched higher or lower than the average?

5. To what extent are the fertility and hatching quality of her eggs innate, unchangeable characteristics of a bird? If a pullet produces eggs above the average for pullets in either fertility or hatching quality, will the same bird's eggs in the second year of life be above the average for yearling hens in these respects?

6. Are the characters "percentage fertility" and "percentage of fertile eggs hatched" inherited in any appreciable degree? In other words, are these fundamental characters, "bred in the bone," or are they things which are entirely influenced and determined by external, environmental influences?

It will be seen that no one of these problems is primarily a problem of incubation. It is only essential that while these problems are being studied all eggs be incubated in a uniform way. These problems can in no way be regarded as secondary in importance to those of incubation. Indeed some knowledge regarding the points here raised is an almost absolutely necessary prerequisite to any adequate interpretation of the results of experiments on incubation.

The questions here raised are fundamental ones, intimately related to the general physiology of reproduction in the domestic fowl. The significance of a solution reaches farther than simply answering the immediate questions raised. For if it can be shown that these characters, fertility and hatching quality of eggs, are innate and unique qualities of the individual and are definitely inherited we shall then have a sure basis on which to proceed towards improving them by breeding. That there is room for improvement here is not to be doubted. The number of eggs which it takes to make a healthy chicken is a very important factor in the poultry industry, and one on which more than one otherwise promising commercial venture has been wrecked. Further, certain of the questions to be here discussed have a direct bearing on important problems of organic evolution in general. Thus the question of whether the fertility and hatching capabilities of eggs are correlated with fecundity (here measured by winter egg production) is one on which data are almost entirely wanting for any organism. Yet this is a question of prime importance in any discussion regarding the struggle for existence following the migration of a form into a new habitat. Definite data obtained under controlled experimental conditions regarding this correlation are needed.

Material and Methods.

At the beginning of the hatching season of 1908 a system of extensive and detailed records regarding the fertility and hatching of eggs was inaugurated in connection with the poultry work of the Station. For all eggs which have been incubated since that time the following facts are known: 1. The hen that laid the egg. 2. The male bird that was in the pen with this female and which fertilized the egg, if it was fertilized. 3. The number of the pen and the number of the house in which these birds were kept. 4. The incubator in which the egg was placed. 5. The date at which the egg was laid. 6. The date at which it was put into the incubator. 7. The date or dates at which it was tested. 8. Whether the egg was (a) infertile, or (b) started to develop but the embryo died early in incubation, or (c) the embryo died late in incubation, or (d) hatched a good or a poor chick. 9. The date at which the egg hatched or failed to hatch. 10. The number of eggs which had been laid by the hen which produced this given egg before it was laid. 11. The pedigree of this hen.

Since these records have been taken for every egg put into the incubators it necessarily means that they were taken for every bird in the breeding pens during each hatching season. Both in 1908 and 1909 the female birds which were used as breeders were chiefly pullets but they also included a number of yearling and older hens which in the past had made high egg records and were on that account put into the pens as breeders. In any study of such problems as those here under discussion it is necessary that the material be homogeneous. In consequence pullets and old hens must be treated separately. The discussion which follows deals with pullets except where a specific statement to the contrary is made; namely, birds hatched either in the spring of 1907 or 1908.

Furthermore it is necessary in a discussion of these matters that all individual birds included shall have had an equal chance to produce eggs and to have them fertilized and incubated. That is to say, only birds should be included in the statistics which make a complete record for the whole hatching season—from February to June. For practical and experimental reasons it was found desirable in the 1908 work to withdraw a number of breeding birds in the course of the season and substitute others in their places. Both the withdrawn and the substituted birds are excluded from the present statistics. Leaving these various classes of birds out of account there remain 110 pullets which made complete records for the hatching season from February 8 to June 10, 1908. In the 1909 breeding season there were 87 pullets and 58 yearling hens (hatched in 1907) which made complete records for the season extending from February 1 to May 17, 1909. In both years only Barred Plymouth Rock birds are included in the statistics.

A word should be said regarding the conditions under which the breeding was done. For the breeding investigations which the Station has under way it is absolutely necessary to know the male as well as the female parent of each chicken hatched.

In order to get at such facts in a practical way it is necessary that the birds be kept in small flocks. Otherwise very few males will be represented in the pedigrees. The only place in which it was possible to make small pens to accommodate 10 to 15 birds each in the spring of 1908 was in the old, heated house No. 1. It had long been known that this house was not at all suited to breeding work. In its past history it had made a bad reputation for itself as a breeding house. The hatching eggs obtained from it had never averaged nearly so high in either fertility or in percentage of fertile eggs hatched as had eggs produced in the curtain front houses Nos. 2 and 3. Fully aware of this fact and of the low absolute averages which it would mean in the work it was nevertheless necessary, for the reason which has already been stated, to use this house in the breeding work in 1908. This fact accounts for the low averages of fertility and hatching which are exhibited in the tables for 1908 which follow. These averages are not to be taken as representative of what the Station's birds would do under more favorable conditions.

The bad effect of house No. 1 on the fertility and hatching qualities of the eggs was very clearly shown even in the 1908 work itself since there were available for comparison the records of two pens of 15 pullets each kept in house No. 2 in curtain front pens. As will be shown farther on the records for these two pens exhibit a much superior fertility and hatching quality of the eggs than do those of the pens in No. 1 house.

Before the breeding season of 1909 the curtain front house No. 2, was remodeled and fitted up particularly for use as a breeding house. Each of the seven pens into which it was originally divided was again divided into two by a semi-removable partition. This gave 14 breeding pens 10′ x 13′, all of the curtain front pattern. All of the breeding work in 1909 was carried on in these pens.

In the 1908 work 10 female and 1 male bird were put in each of the small pens of house No. 1. In 1909 15 female and 1 male bird were put in each of the breeding pens of house No. 2 just described. This difference in method, together with the fact that in one year the breeding was done in a closed, heated house, and in the other year in a curtain front house render the statistics of one year not directly comparable with those of the other. Nowhere in this paper are the statistics of these two years lumped together. So long as the figures for the two years are not lumped together and conclusions are not drawn which depend upon joining of one of the years with the other, it is a great advantage to have the conditions so different in the two years. It affords an opportunity to determine whether relations which obtain under one set of conditions will hold under a totally different set.

The hatching in all of this work was, as in previous years, done in incubators. All incubators used were Cyphers No. 3 (360 egg) machines. The only methods used which differed at all from those previously followed in the Station's poultry work were such as were necessitated by the fact that pedigree records were kept.* The eggs from the different birds were all handled in the same way and subjected to the same conditions so that *differences* in hatching results can not be referred to the treatment which the eggs received. It is conceivable that the hatching records as a whole might be improved or made poorer by using some other methods of handling the eggs during incubation. But it is not conceivable that when all eggs are handled in the same way differences between the eggs of two individual hens in regard to hatching qualities can be explained as the result of the handling. Such differences are inherent in the eggs themselves. It is with differences of this kind that this paper has to do. Care was taken to insure that the eggs from given individual hens should be distributed at random through the different incubators, in order to guard against any possible inequality of treatment from this source.

The eggs were tested for fertility by candling in the usual way. This testing was done by Mr. Walter Anderson. His long experience in work of this sort insures the substantial accuracy of the fundamental data. In the 1908 work a check was kept on the determinations by opening eggs at intervals. It is not contended that the records of infertile eggs of that year include absolutely none that had begun development and stopped very early. Such absolute accuracy is unattainable without opening every egg. The number of errors of this kind in the records we know to be very small, however. There can be no question that they do not in any way affect the results.

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* Cf. Me. Agr. Expt. Stat. Bulletin 159.

Our certainty on this point was gained through a change of plan which was adopted in the 1909 breeding season. This year the eggs were candled and sorted as before by Mr. Anderson. Then every egg which did not hatch was opened by the writers, and the accuracy of the original candling result tested by direct examination of the contents of the egg. This method did two things. In the first place it made the 1909 records as nearly absolutely accurate as it is possible to get them, and in the second place it demonstrated to us the very high degree of accuracy of Mr. Anderson's candling.

In this discussion of the fertility and hatching of eggs it is necessary to define the terms used with some precision, since the term "fertility of eggs" in particular is used with rather widely different meanings by different writers on poultry topics. Considered from the strictly scientific standpoint there can exist no such thing as "degrees of fertility." One very commonly hears and sees the statement made that particular eggs are "strongly fertilized," or that such a cockerel, owing perhaps to lack of constitutional vigor, causes the eggs to be "weak in fertility," meaning that the embryos die in the shell after a few days incubation. From the biological standpoint an egg is either fertilized or it is not. The act of fertilization consists essentially in the union of a single spermatozoön with a single egg cell. If this union takes place the egg is fertilized. If it does not take place it is not fertilized. Reducing this consideration to a practical basis it means that the only logical process is to record as infertile only those eggs which do not start at all to develop, and to regard as fertile any egg which begins development, even though development may stop in such an egg within 24 hours after incubation begins. In taking the records at the Station eggs are usually divided into four classes; namely, (a) those which are infertile; (b) those that are fertile but in which the germs die soon (that is within two or three days) after development begins; (c) those that die in the shell at a later stage of development and (d) the eggs that hatch. In all the discussion which follows it will be understood that an infertile egg means one which does not start to develop because no spermatozoön has united with it, and that hatching means the production of a *live* chick from the egg.

The Relation between the Fertility and Hatching Quality of Eggs.

It is obvious that fertility and hatching quality or ability of eggs are two essentially different things. A hen may have a small proportion of her eggs fertile and yet hatch a very high percentage of what of the eggs are fertile, producing therefrom healthy chickens. Or, conversely, the eggs of a particular hen may run very high in fertility but none, or very few, of the fertile eggs hatch. These facts are well known to every poultryman. Some striking illustrations of them taken from the Station's records of the 1908 hatching are shown in Table I. These illustrations are not the most extreme ones which might have been found. They are simply cases which came first to hand in looking over the records, and which show clearly that high fertility does not necessarily mean good hatches and *vice versa*.

TABLE I.

Illustrative Cases Showing Relation Between Fertility and Hatching Quality of Eggs.

Band number of bird.	Total number of this bird's eggs set.	Per cent. of these eggs which were fertile.	Per cent. of fertile eggs hatched.	Number of *different* incubators in which these eggs were set.
393	57	91	12	6
27	48	92	18	7
757	62	90	23	7
707	30	100	20	3
375	45	64	41	7
705	32	66	38	5
753	57	54	61	7
745	41	59	50	4

It will be seen that the table is divided into two parts. The upper half includes 4 pullets whose eggs ran high in fertility but hatched very poorly. The lower half of the table exhibits the records of birds showing exactly the opposite condition of affairs. The eggs of these pullets ran relatively low in fertility but hatched very well. The last column of the table is inserted for the purpose of showing that the differences in these individual records are not to be attributed to differences in incubation. The figures in this column show the number of different individual machines in which the eggs of particular birds were set at different times during the hatching season. Thus, the 45 eggs of bird No. 375 during the whole season were set in 7 different incubators.

While Table I shows by illustrative cases that fertility and hatching quality of eggs are essentially different things it does not tell anything about what is the average relationship between these two phenomena or characteristics when large numbers of birds are taken into account. Granting that fertility does not necessarily denote superior hatching quality there still remains the question: what in general, or on the average, is the relation between the fertility of a hen's eggs on the one hand and their hatching quality on the other hand? On the average will hens or flocks of hens showing relatively high fertility of eggs also show relatively high hatches from the fertile eggs? In order to answer this question it is necessary to determine numerically and exactly the average relation or, as it is technically called, the *correlation* between these characters fertility and hatching quality of eggs. The nature of the problem here must be clearly grasped if what follows is to be intelligible. The first thought which comes to the reader of the questions just propounded is that the proportion of fertile eggs hatched will depend altogether on how they are incubated and that the answer to be given to the question will be determined by this obvious fact.

It is quite true that the methods and vicissitudes of incubation determine what proportion of fertile eggs shall hatch, but this has nothing to do with the answer to the question. Suppose the eggs of 50 hens to be taken for incubation. It is absolutely certain that *whatever the method of incubation*—whether it be such as to lead to good or poor average hatches—the fertile eggs of some *individual* hens among the 50 will produce more chickens than will the fertile eggs of other individual hens. Our problem is to learn whether, on the average, these hens which show relatively high hatches also show relatively high fertility of eggs. With this problem the method of incu-

TABLE II.

Showing the Correlation between Fertility and Hatching Quality of Eggs. Records for Hatching Season of 1908.

Per Cent. Infertile.	0–3	4–7	8–11	12–15	16–19	20–23	24–27	28–31	32–35	36–39	40–43	44–47	48–51	52–55	56–59	60–63	64–67	68–71	72–75	76–79	80–83	84–87	88–91	Totals.
	Per Cent. of Fertile Eggs Hatched.																							
0– 3	–	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	3
4– 7	–	–	–	–	–	–	–	1	2	2	1	1	1	–	2	2	–	–	1	–	–	–	1	14
8–11	–	–	–	1	1	1	2	1	–	–	–	2	–	1	–	1	1	1	–	–	–	–	–	12
12–15	–	–	–	1	–	2	5	–	3	–	3	1	1	4	2	1	–	–	–	–	–	–	–	23
16–19	–	–	–	–	3	–	1	1	2	1	1	1	1	–	1	–	–	–	1	–	–	–	–	13
20–23	–	–	–	1	1	–	1	1	1	–	2	1	–	–	–	–	–	–	1	–	–	–	–	9
24–27	1	–	–	–	–	1	–	3	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	7
28–31	–	–	–	1	–	–	–	–	–	2	–	–	1	–	–	–	–	–	–	–	–	–	–	4
32–35	–	–	–	–	–	–	–	1	–	2	–	1	1	–	–	–	–	–	–	–	–	–	–	5
36–39	1	–	–	–	–	1	–	–	1	–	2	–	–	–	–	–	–	–	–	–	–	–	–	5
40–43	1	1	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	4
44–47	–	–	–	–	1	1	–	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	4
48–51	–	–	–	–	–	–	–	2	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
52–55	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
56–59	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
60–63	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
64–67	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
68–71	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
72–75	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
76–79	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
80–83	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Totals......	5	2	1	4	6	7	9	10	12	8	9	8	6	5	5	5	2	2	3	0	0	0	1	110

bation or its general average result has nothing whatever to do, provided that large numbers of eggs are dealt with and all are incubated by the *same* method. It is with the average differences in the fertility and hatching of the eggs of individual hens all treated in the same way that we have to do.

From the way in which our records are taken it is easiest to use as a measure of fertility the percentage of infertile eggs in the total number of eggs set and as the measure of hatching quality the percentage of fertile eggs which were hatched. Now in order to determine the correlation between these two variables, per cent. of eggs infertile on the one hand and per cent. of fertile eggs hatched on the other hand, it is necessary to prepare a table which shall show for each bird included in our records the performance in respect to each of these variables. Having prepared such a table it is possible by the application of proper mathematical methods to deduce an exact numerical measure of the degree of correlation exhibited.*

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* For refererces to the literature describing these mathematical methods see Me. Agr. Expt. Stat. Bulletin 166, p. 64.

TABLE III.

Showing the Correlation between Fertility and Hatching Quality of Eggs. Records for Hatching Season of 1908. Pullets and Yearling Hens combined.

Per Cent. of Fertile Eggs Hatched.	Per Cent. Infertile.																						Totals. .
	0–5	5–10	10–15	15–20	20–25	25–30	30–35	35–40	40–45	45–50	50–55	55–60	60–65	65–70	70–75	75–80	80–85	85–90	90–95	95–100	100–105		
0– 5	2	1	1	–	2	–	–	–	–	1	–	–	1	–	1	–	–	–	–	1	1	–	11
5– 10	1	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
10– 15	1	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	3
15– 20	3	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
20– 25	2	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
25– 30	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
30– 35	7	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
35– 40	2	–	1	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
40– 45	9	2	2	–	–	2	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	17
45– 50	4	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
50– 55	8	2	1	2	2	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	17
55– 60	8	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9
60– 65	10	2	1	–	–	2	–	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	17
65– 70	4	1	1	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	8
70– 75	5	2	1	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10
75– 80	4	2	1	1	–	–	1	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	10
80– 85	3	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
85– 90	1	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	2
90– 95	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
95–100	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
100–105	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	2
Totals.......	77	18	11	6	7	6	7	1	2	2	0	0	3	0	1	0	0	2	1	1	1	–	146

Such correlation tables for the 1908 and 1909 records are exhibited as Tables II to V inclusive.

The data for 1909 are given in three tables, while those for 1908 are given in one. In the first of the 1909 tables (Table III) both pullets and yearling hens are included. Table IV gives the 1909 pullet records separately and Table V the 1909 yearling hen records separately. Owing to an oversight, one more bird is included in the combined than in the separate tables. This makes no difference in the results.

Even from the most casual examination of these tables it is apparent that there is a general tendency for birds showing a relatively high percentage of *infertile* eggs (i. e., *low* percentage of *fertile* eggs) to show a relatively low percentage of fertile eggs hatched and *vice versa*. Thus, if one examines the first three rows of Table II it will be seen that the majority of the

TABLE IV.

Showing the Correlation between Fertility and Hatching Quality of Eggs. Records for Hatching Season of 1909. Pullets only.

Per Cent. of Fertile Eggs Hatched.	Per Cent. Infertile. 0–5	5–10	10–15	15–20	20–25	25–30	30–35	35–40	40–45	45–50	50–55	55–60	60–65	65–70	70–75	75–80	80–85	85–90	90–95	95–100	Totals.
0– 5	2	1	1	–	1	–	–	–	–	–	–	–	1	–	1	–	–	–	–	1	8
5– 10	1	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
10– 15	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	2
15– 20	2	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	3
20– 25	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
25– 30	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
30– 35	5	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
35– 40	1	–	1	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
40– 45	4	–	2	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	8
45– 50	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
50– 55	4	–	–	2	1	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	9
55– 60	6	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	7
60– 65	6	–	1	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	9
65– 70	1	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	3
70– 75	3	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
75– 80	4	2	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	8
80– 85	1	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
85– 90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
90– 95	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
95–100	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
100–105	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1
Totals.....	46	8	8	5	5	3	5	1	1	0	0	0	2	0	1	0	0	0	1	1	87

individuals in those rows fall towards the right hand side of the table. That is, these are birds hatching relatively high percentages of fertile eggs. But, at the same time, these first three rows denote a relatively low percentage of infertile eggs or, stated the other way, denote that a high percentage of the eggs were fertile. While the existence of this general trend showing a correlation between fertility and hatching quality is evident on inspection, the degree or amount of the trend cannot be so told. What is necessary is to get some single constant which shall in one figure give a measure of the general trend exhibited by the table. Such a constant is afforded in the so-called *coefficient of correlation* which can be evaluated from the table by appropriate methods. Calculating this coefficient from each of the two tables and denoting it by the usual symbol r we have:

TABLE V.

Showing the Correlation between Fertility and Hatching Quality of Eggs. Records for Hatching Season of 1909. Yearling Hens only.

Per Cent. of Fertile Eggs Hatched.	Per Cent. Infertile. 0–5	5–10	10–15	15–20	20–25	25–30	30–35	35–40	40–45	45–50	50–55	55–60	60–65	65–70	70–75	75–80	80–85	85–90	90–95	95–100	100–105	Totals.
0– 5	–	–	–	–	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	3
5– 10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
10– 15	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
15– 20	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
20– 25	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
25– 30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
30– 35	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
35– 40	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
40– 45	5	2	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	9
45– 50	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
50– 55	4	2	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
55– 60	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
60– 65	4	2	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	8
65– 70	3	–	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	5
70– 75	2	2	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
75– 80	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	2
80– 85	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
85– 90	1	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	2
90– 95	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
95–100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
100–105	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Totals....	30	10	3	1	2	3	2	0	1	2	0	0	1	0	0	0	0	2	0	0	1	58

From 1908 records (Table II) $r = -0.417 \pm 0.053$. Pullets only.

From 1909 records (Table III) $r = -0.142 \pm 0.055$. Pullets and yearling hens combined.

From 1909 records (Table IV) $r = -0.127 \pm 0.071$. Pullets only.

From 1909 records (Table V) $r = -0.139 \pm 0.087$. Yearling hens only.

Translated into words these coefficients mean that the records under discussion show in general that there is a definite and significant negative correlation between the percentage of eggs infertile and the percentage of fertile eggs which are hatched.

It will at once be noted that the coefficients do not show the same value in both years. In the 1908 records the correlation is approximately 42 per cent of perfect correlation. Perfect correlation would indicate an absolute and unvarying relationship between the two phenomena. That is to say, if the correlation were perfect high fertility would invariably denote high hatching quality and *vice versa*. The relationship actually exhibited in the 1908 records is about half way between such perfect correlation, and the entire absence of correlation in which event the two phenomena are not in any way related. The 1909 records show a considerably smaller correlation than those for 1908. Here, however, the coefficient for the combined data is approximately 2.6 times its probable error and hence would have to be regarded, even when considered by itself as almost certainly significant. When the 1909 pullets and yearling hens are treated separately the coefficients are slightly smaller than when they are combined, and with the reduction in the number of entries in the tables the probable errors are increased in value. In both of these cases, however, the sign of the coefficient remains negative. Neither of these coefficients (1909 pullets only and yearling hens only) could be considered certainly significant in comparison with its probable error when taken by itself. Taking both years together there is no doubt as to the conclusion that, *so far as the present data indicate, there is a small but still sensible correlation between fertility and hatching quality of eggs. In the long run, or on the average, it is to be expected on the basis of this result that if a hen under a given set of conditions produces eggs high in fertility the fertile eggs will also run high in hatching quality, and vice versa.* It is to be understood that no wider generality is claimed for this conclusion than arises from the data on which it is based.

It is not unlikely that the absolute degree of the correlation between fertility and hatching quality of eggs may be different for different breeds. The present data show that this correlation is different for different conditions of housing, treatment, etc. The further analysis of the precise effect of these factors present interesting problems for further work in this connection. It seems unlikely, however, that under any circumstances the correlation would be turned about so that high fertility was associated *regularly* with low hatching quality and *vice versa*.

VARIATION IN FERTILITY AND HATCHING QUALITY OF EGGS.

From the figures which are given in Tables II to V inclusive, it is possible to get some exact information regarding the degree and character of variability shown by the pullets under discussion in respect to fertility and hatching quality of eggs. The important variation constants for these two characters are given in Table VI.

TABLE VI.

Constants of Variation in Fertility and Hatching Quality of Eggs. Calculations from the Data of Tables II-V inclusive.

CHARACTER.	Mean or average.	Standard deviation. (A measure of variation.)
Per cent. of eggs infertile, 1908	21.71±0.96	15.00±0.68
" " " " " 1909, pullets and yearling hens combined	14.14±1.15	20.56±0.81
Per cent. of eggs infertile, 1909, pullets only	13.65±1.38	19.10±0.98
" " " " " 1909, yearling hens only	15.09±2.01	22.65±1.42
" " " fertile eggs hatched, 1908	37.24±1.16	17.99±0.82
" " " " " " 1909, pullets and yearling hens combined	50.68±1.35	24.16±0.95
Per cent. of fertile eggs hatched, 1909, pullets only	47.67±1.80	24.92±1.27
" " " " " " 1909, yearling hens only	54.48±1.94	21.91±1.37

From this table the following points are to be noted:

1. The mean or average percentage of infertile eggs shown in the breeding records of the 1908 group of birds is approximately 22. This is an unduly high percentage of infertility. It is to be explained, however, by the fact, pointed out above, that the breeding work in that year was done under unsuitable housing conditions. In 1909 the average percentage of infertility taking all birds of the year together, was approximately 14. This reduction of about 8 per cent in the number of infertile eggs is directly attributable to the improvement in housing conditions. The figure for 1909 represents a very fair average condition of fertility, taking the whole breeding season through, and remembering that this represents returns on from 5000 to 6000 incubated eggs. If the early portion of the breeding season were left out of account the average percentage of infertility would be considerably reduced below 14, the figure given.

2. The mean or average percentage of fertile eggs hatched in the 1908 season is seen to be approximately 37. This again is an unduly low value. One has a right to expect a considerably better hatching quality of eggs than this. Like the poor average record for fertility it is, however, to be explained chiefly by the unsuitable housing conditions under which the birds were kept in that year, and in small part by the fact that only pullet records are available. This is shown to be the case by the 1909 figures where we have the percentage of fertile eggs hatched increased to 51 per cent in round numbers taking all the birds of the season together. This last figure would again be increased if the records of the early part of the breeding season were omitted. It is believed, furthermore, that by selection of breeding stock on the basis of hatching records it may be possible to improve the average hatching quality of eggs still more, (cf. discussion of this joint in summary).

3. The degree of absolute variability as measured by the standard deviation is seen to be in all but one case (1909 yearling hens only) somewhat greater in the case of hatching quality than in the case of fertility. The standard deviation is a precise measure of the degree to which a group of individuals conform to a type with respect to any character under investigation. The closer to type a given lot of individuals run the smaller will be the standard deviation exhibited by that lot. On the other hand the more widely the individuals are scattered about the type the larger will be the standard deviation. It is not necessary in this place to go into the matter of how the standard deviation is calculated. It suffices to say that it is a scientifically accurate measure of the degree of closeness to type.

4. While hatching quality appears from the present statistics to be absolutely a slightly more variable character than fertility, if we consider the degree of variation in proportion to the mean, the opposite is the case. This is shown if from Table IV the percentage which the standard deviation is in the mean is calculated for each of the two characteristics. Performing this operation the following results are obtained:

1908—Fertility: percentage of standard deviation in mean = 69.1%.

All birds, 1909—Fertility: percentage of standard deviation in mean = 145.4%.

Pullets only, 1909—Fertility: percentage of standard deviation in mean = 140.0%.

Hens only, 1909—Fertility: percentage of standard deviation in mean = 150.2%.

1908—Hatching quality, percentage of standard deviation in mean = 48.3%.

All birds, 1909—Hatching quality, percentage of standard deviation in mean = 47.7%.

Pullets only, 1909—Hatching quality, percentage of standard deviation in mean = 52.3%.

Hens only, 1909—Hatching quality, percentage of standard deviation in mean = 40.2%.

These figures show that in proportion to the mean of the characteristic, hatching quality is relatively much less variable than fertility. Both of the characters—fertility and hatching quality—are, so far as may be judged from the present statistics, highly variable as compared with other characters of poultry which have been studied in this connection.

5. From the data given in the preceding paragraph it appears that in proportion to the mean the fertility of eggs varied much more in 1909 than in 1908, while in respect to hatching quality the relative degree of variability was substantially the same in the two years. This would suggest that the difference in housing conditions of the two years had a much greater effect on the *variability* (as distinguished from the absolute average condition) of fertility than on that of hatching quality. This, however, can, in the light of the present data, be only a suggestion, the correctness of which must be tested by further work.

6. From the data of Table VI it appears that in 1909 the yearling hens were superior to the pullets in regard to both the average fertility and the average hatching quality of their eggs. The difference between the two groups in mean fertility is, however, hardly significant. More data are needed before any final conclusion as to the relative ability of pullets and yearling hens as breeders may be drawn.

THE RELATION OF THE HEN TO THE FERTILITY OF EGGS.

There is a rather common belief that when hatching eggs run low in fertility the fault is chiefly or entirely in the male bird which is with the flock. For some reason which is difficult to understand very little influence is attributed in the popular mind to the females in causing poor results of this kind, the belief rather being that the male bird has an almost exclusive influence in determining fertility of eggs. It seems somewhat remarkable that this notion of the predominant influence of the male bird in determining the fertility of eggs among poultry should be so widespread, in view of the fact that the popular belief with reference to other domestic animals is exactly the opposite. For example, in cattle and horse breeding the failure of the female to become pregnant (the equivalent in part of the fertilization of the egg in poultry) is commonly attributed to some defect in the female rather than in the male. The standpoint which the known facts of biology lead one to take is that in all bisexual animals the influence of the two sexes is in general equal in determining whether any given egg shall or shall not be fertilized. That is to say, there is on general grounds every reason to suppose that the infertility of eggs is as likely to be due to a defect of the female as to a defect of the male and *vice versa*. It seems desirable to determine with some precision whether this general statement is true for poultry or not. When the average fertility for a flock of hens runs low what proportion of this low fertility is to be attributed to the poor breeding performance of the hens and what proportion to the male birds? The practical importance of the question is obvious. If the man who is selling eggs for hatching can learn that one particular hen, for example, in his flock never produces a fertile egg, it will be greatly to the advantage of his trade to eliminate that bird from those which are producing his hatching eggs.

In order to bring out with completeness and precision the comparative influence of male and female birds on the fertility of eggs Tables VII and VIII have been prepared. These tables show for each breeding pen the following facts: (1) The band number of the cockerel which was placed in that pen.

TABLE VII.

Percentage of Infertile Eggs Produced by Each of the Barred Plymouth Rock Pullets Making Complete Records in the Hatching Season of 1908. Arranged According to Pens and Cockerels.

Pen No.	Cockerel No.	Band number and per cent. of *infertile* eggs for each pullet (Band numbers are in brackets; percentages unbracketed.)	Average percentage of infertile eggs for each cockerel.
5	D 70	(19)24, (21)14, (358)32, (357)36, (393)9, (712)20	22.5
6	D 2	(10)36, (27)8, (112)18, (160)42, (402)30, (705)34	28.0
7	D 60	(29)29, (87)17, (352)14, (353)17, (717)19	19.2
8	D 32	(61)21, (122)15, (357)14, (374)22, (381)4, (406)24	16.7
9	D 65	(12)19, (18)48, (38)9, (172)27, (366)13, (367)21, (414)7	20.6
10	D 5	(39)26, (66)12, (415)50, (438)45, (707)0	26.6
11	D 56	(20)73, (118)12, (197)12, (407)18, (726)20	27.0
12	D 11	(23)28, (428)20, (709)20, (730)31, (737)13	22.4
13	D 58	(368)15, (431)10, (734)4	9.7
14	D 16	(121)41, (152)11, (185)15, (224)11, (432)37, (731)23	23.0
15	D 61	(52)53, (99)33, (168)5, (719)40, (736)14	29.0
16	D 35	(129)48, (223)38, (382)8, (725)6, (728)12, (732)14	21.0
17	D 57	(359)15, (389)29, (395)24, (743)82, (744)24	34.8
18	D 17	(377)16, (401)16, (405)32, (410)3, (411)14, (774)14, (784)47	20.3
19	D 68	(419)14, (422)15, (424)45, (745)41, (746)15	26.0
20	D 26	(388)50, (397)6, (434)17, (441)33, (442)38, (749)4, (750)16, (752)6, (753)46, (757)10, (768)20, (770)10, (771)13	20.8
21	D 31	(400)16, (408)16, (409)4, (443)6, (444)8, (447)5, (450)4, (758)19, (759)12, (761)8, (762)10, (763)5, (764)13, (765)3, (766)5	8.9

(2) The band number of each of the pullets placed in that pen. (3) The percentage of infertile eggs produced by each of these pullets. (4) In the last column of the table are given the average percentages of infertile eggs produced by all the hens running in each pen. These averages in the last column are, in other words, the only measures which it is possible to get of the relative ability of the individual cockerels in fertilizing eggs. They are pen or cockerel averages.

TABLE VIII.

Percentage of Infertile Eggs Produced by Each of the Barred Plymouth Rock Pullets and Yearling Hens Making Complete Records in the Hatching Season of 1909. Arranged According to Pens and Cockerels.

Pen No.	Cockerel No.	Band number and per cent. of *infertile* eggs for each female. (Band numbers are in brackets; percentages unbracketed.)	Average percentage of infertile eggs for each cockerel.
2	E 551	(125)3, (184)31, (212)2, (255)22, (287)4, (304)12, (296)0, (327)1, (343)93, (350)3, (354)2, (361)30, (415)0, (419)32	16.7
3	E 552	(201)0, (204)0, (229)3, (231)2, (238)25, (241)8, (250)15, (251)12, (270)10, (272)3, (280)4, (293)63, (295)6, (310)17	12.0
4	E 553	(17)2, (92)36, (94)15, (186)21, (221)0, (239)6, (248)32, (258)0 (303)0, (334)34, (382)21, (388)2, (406)14, (449)3	13.2
5	E 554	(3)0, (18)3, (160)44. (208)0, (224)4, (226)2, (228)3, (237)3, (266)2, (278)10, (324)8, (333)8, (352)12, (405)27	9.0
6	E 555	(74)5, (114)25, (155)0, (183)17, (202)2, (209)0, (232)20, (249)0, (302)0, (323)97, (325)0, (326)2, (377)2, (403)71	17.2
7	E 556	(206)0, (207)5, (215)18, (225)14, (235)0, (257)20, (263)0, (276)4, (294)3, (385)12, (420)0, (422)7	6.9
11	D* 56	(1063)0, (1069)4, (1070)12, (1071)100, (1072)28, (1073)0, (1074)47, (1075)47, (1076)0, (1078)87, (1079)5, (1080)31, (1081)2, (1082)0, (1083)85	29.8
12	D 11	(1005)2, (1046)0, (1047)5, (1050)63, (1051)20, (1053)9, (1056)2, (1057)7, (1058)32, (1060)5, (1062)24, (1065)0, (1067)0, (1068)0	12.0
13	D 58	(1003)0, (1024)0, (1026)27, (1027)0, (1028)2, (1030)0, (1032)10, (1033)0, (1038)7, (1039)6, (1040)0, (1041)4, (1043)0, (1044)3, (1045)4, (E 427)0	3.9
14	D 31	(E 220)0, (1001)5, (1006)0, (1008)0, (1009)18, (1010)4, (1013)0, (1014)10, (1016)0, (1017)5, (1019)0, (1022)0, (1023)40	6.3

From these tables the following points are to be noted:

1. There is clearly a very great difference among different pullets in their ability to produce fertile eggs. The extent of such differences may be grasped by a detailed examination of the tables. Some examples on this point may be cited, taking Table VII first. In pen 9, one bird (No. 414) had only 7 per cent. of her eggs infertile. In the same pen, and hence with the same cockerel, another pullet (No. 18) had 48 per cent of her

* Males having band numbers prefixed by the letter D are cock birds, and those with the letter E are cockerels. Females having band numbers above 1000 are hens (hatched in 1907), all other females are pullets, (1908 hatch).

eggs infertile. It is difficult to see how anyone can attribute the infertility of the eggs of No. 18 to the cockerel (No. 65) when in the same pen No. 414 made such a fine record in respect to fertility. To take another example, in pen 10 No. 707 produced no infertile eggs. Every egg which this pullet produced between February and June—30 in all—was fertile, yet in this same pen and with the same cockerel, pullet No. 415 had 50 per cent and pullet No. 438 had 45 per cent of their eggs infertile. If one attempts to account for the poor performance of Nos. 415 and 438 in regard to fertility as due to some inherent fault in cockerel No. 5 he is at once confronted by the perfect record of fertility made by No. 707. In pen 11 again, there are wide extremes in regard to fertility. Pullet No. 197 had but 12 per cent of her eggs infertile while with the same cockerel pullet No. 20 had 73 per cent of her eggs infertile. In pen 18 pullet No. 410 had but 3 per cent of her eggs infertile, while pullet No. 784 had 47 per cent infertile. Anyone who will take the trouble to study Table VII carefully will find just as wide extremes of fertility shown by the pullets in other pens.

The same thing is apparent in the data of Table VIII showing that this result is not something peculiar to one single season or set of birds. Thus in pen 11 there were four birds (1063, 1073, 1076, 1082) that produced no infertile eggs throughout the breeding season, though the total numbers of eggs laid by these birds during the season were: 23, 26, 26, 36. Yet in this same pen 1071 had 100 per cent. and 1078, 87 per cent. of infertile eggs.

The facts set forth in these tables make it absolutely certain that there are wide differences in the breeding ability (measured by fertility of eggs) of different females, which are quite independent of the relative ability of the male birds running with the females as breeders.

2. An examination of the last column of the table indicates that there was proportionately much less variability among the cockerels used as breeders than among the pullets, in respect to their influence in determining the fertility of eggs. In 1908 with the exception of three pens (Nos. 13, 17 and 21) the fertility performance of the cockerels runs very evenly. Furthermore, a study of the table shows that in two out of these three

widely varying pens the deviation is to be explained as the result of too few hens on which to base a fair average. Consequently there is an overwhelming influence on the average of the performance of one exceptionally good or one exceptionally poor pullet. Thus in the case of pen 13 (1908) the cockerel average of 9.7 per cent. of infertile eggs is based on the performance of only three birds, and one of these (No. 734) made (for that year) the very exceptional record of only 4 per cent. infertile eggs. Similarly in pen 17 the very poor cockerel record of 34.8 per cent. infertile eggs is largely due to the influence of one particular pullet (No. 743) 82 per cent. of whose eggs were infertile. When an average is based upon but 5 cases as in pen No. 17 and one of these deviates so widely from the others as does the record of 743 it is not remarkable that the general average is affected.

The pen averages do not run quite so smoothly in 1909 as in 1908. This is in part to be acounted for by the fact that in 1908 only young birds (pullets and cockerels) are included in the table, whereas in 1909 pens 11-14 inclusive were made up of birds hatched in 1907. In general the indications from both tables are that the male birds used in these two years were a fairly even lot so far as breeding ability is concerned.

3. The effect of the closed, heated house No. 1 in reducing the fertility of eggs is brought out in two ways by these tables. It is clearly shown in the data of Table VII alone. Breeding pens 20 and 21 (1908) were in the curtain front house No. 2. Breeding pens 5 to 19 inclusive of that same year were in house No. 1. The difference in the average infertility of the eggs from the two houses is shown in the following figures.

Average from House No. 1 (pens 5-19 inclusive)=23.1%.

Average from House No. 2 (pens 20 and 21)=14.8%.

The bad effect of house No. 1 on fertility is, of course, further shown by comparison of the last columns in Tables VII and VIII, the first 15 entries in this column in Table VII representing data from house No. 1 and Table VIII data from house No. 2.

It is noteworthy that the average fertility shown by the two breeding pens which were in the curtain front house No. 2 in 1908 (pens 20 and 21) is very nearly the same as the average fertility from all pens in the same house in 1909 (14.8% and

14.14% from Table VI. This indicates again how direct and important an influence housing conditions have upon the fertility of the eggs of breeding birds.

4. It is of some interest to compare the fertility records of the same male bird in his first and second breeding years, though the amount of data available for such comparison in the present statistics is small. The four birds D 56, D 11, D 58, and D 31 appear in both Table VII and Table VIII. Their records of average pen fertility of eggs in the two years are as follows:

Average Percentage of Infertile Eggs.

Male bird.	1908. (Cockerel year.)	1909. (Cock year.)
D 56	27.0%	29.8%
D 11	22.4%	12.0%
D 58	9.7%	3.9%
D 31	8.9%	6.3%

Of these four birds only one (D 31) did his breeding under identical housing conditions in the two years. In this case there is practically no difference in the average fertility. In two cases (D 11 and D 58) there is a very considerable reduction in the average percentage fertility, but this is probably to be explained almost entirely as the result of the action of the better housing conditions of 1909 on the breeding birds, particularly the females. D 56 has a worse record for 1909 than for 1908, but this bad average is due very largely to the effect of three hens, viz: 1071, 1078, and 1083, with 100, 87, and 85 per cent of infertile eggs respectively. This is a heavy handicap in an average based on only 15 birds.

5. An examination of these tables and of the detailed hatching records on which they are based emphasizes the value of trap nesting breeding hens during the breeding season at least, particularly if one is to engage in selling eggs for hatching. A study of the records shows that it would have been possible to have thrown out early in the hatching season such poor performers as, for example Nos. 18, 415, 438, 784 in 1908, and 1071, 1078, 1083, 160 and 403 in 1909. These birds were

TABLE IX.

Showing the Correlation between Fertility of Eggs and Winter (November 1 to March 1) Egg Production. Data for 1908.

Winter Egg Production.	Per Cent. Infertile.																					Totals.
	0–3	4–7	8–11	12–15	15–19	20–23	24–27	28–31	32–35	36–39	40–43	44–47	48–51	52–55	56–59	60–63	64–67	68–71	72–75	76–79	80–83	
0– 5	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
5–10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
10–15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
15–20	–	1	2	–	–	–	–	–	–	–	1	1	1	–	–	–	–	–	–	–	–	6
20–25	1	–	1	1	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
25–30	–	1	1	5	3	1	1	1	1	1	–	–	1	–	–	–	–	–	–	–	–	16
30–35	1	4	1	6	1	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	15
35–40	–	3	–	2	2	–	–	–	1	1	1	1	–	–	–	–	–	–	1	–	–	12
40–45	–	1	2	1	2	2	1	–	1	–	–	1	–	1	–	–	–	–	–	–	–	12
45–50	–	–	1	1	3	1	1	–	1	1	1	–	1	–	–	–	–	–	–	–	–	11
50–55	–	3	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
55–60	–	–	3	3	–	1	1	2	–	–	–	–	–	–	–	–	–	–	–	–	1	11
60–65	1	1	–	1	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	5
65–70	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1
70–75	–	–	–	1	–	1	–	–	–	1	1	–	1	–	–	–	–	–	–	–	–	5
75–80	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
80–85	–	–	1	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
85–90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
90–95	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
95–100	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Totals.....	3	14	12	23	13	9	7	4	5	5	4	4	4	1	0	0	0	0	1	0	1	110

only allowed to stay in the breeding pens throughout the season in order to learn just how poor a record they would make for the purposes of the present study. The principle should be clearly recognized that some hens are "shy breeders" just as are some cows. Any method by which such birds can be thrown out and prevented from increasing the number of eggs which it takes in practical work to produce a living chick will be useful and profitable.

The Relation of Winter Egg Production to the Fertility of Eggs.

Admitting the fact brought out in Tables VII and VIII that there are great individual differences among different pullets and hens in respect to their ability to produce fertile eggs, the further problem is raised as to what influences are responsible for these differences. What underlies the fact that one hen in a breeding pen will have say 50 per cent. of her eggs infertile while another hen in the same pen will have none of her eggs

TABLE X.

Showing the Correlation between Fertility of Eggs and Winter (November to March) Egg Production. Hatching Season of 1909. Pullets and Yearling Hens Combined.

Per Cent. Infertile.	Winter Egg Production.																			Totals.
	0–5	5–10	10–15	15–20	20–25	25–30	30–35	35–40	40–45	45–50	50–55	55–60	60–65	65–70	70–75	75–80	80–85	85–90	90–95	
0– 5	6	2	4	8	3	4	13	5	9	1	6	3	6	2	1	3	1	–	–	77
5–11	–	1	2	1	1	1	3	1	3	–	2	2	–	–	1	–	–	–	–	18
10–15	–	–	1	–	2	–	1	–	–	–	–	1	1	1	3	–	–	–	1	11
15–20	–	–	–	–	–	–	–	1	–	2	1	–	–	1	–	1	–	–	–	6
20–25	1	–	–	–	–	2	–	–	1	1	–	–	–	2	–	–	–	–	–	7
25–30	–	–	–	2	1	–	–	–	2	–	–	–	–	–	1	–	–	–	–	6
30–35	–	2	–	1	–	–	1	–	–	1	–	1	–	1	–	–	–	–	–	7
35–40	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
40–45	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	2
45–50	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	2
50–55	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
55–60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
60–65	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	1	–	–	–	3
65–70	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
70–75	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
75–80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
80–85	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
85–90	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
90–95	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
95–100	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1
100–105	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Totals......	7	5	8	15	7	8	20	10	15	6	9	7	7	8	6	6	1	0	1	146

infertile? There are undoubtedly a large number of factors concerned in this matter. The only hope of ever determining what all these factors are and what is the relative influence of each one is to make an *analytical* study of the facts. One factor must be taken at a time and its relative influence determined. Proceeding in this way there is reason to believe that in time it will be possible to arrive at a more adequate understanding of the matter than we now have.

The opinion is very commonly expressed that the fertility of eggs during the hatching season, and in particular of pullets' eggs, depends very largely on the previous laying record of the bird producing the eggs. It is contended that if a bird has laid very heavily throughout the winter her eggs will not run so high in fertility, on the average, as will those of a bird whose winter production has not been so great. From what has gone before it must be clear to the reader that the only way to make an exact test of the truth of this assertion, or in general to find

TABLE XI.

Showing the Correlation between Fertility of Eggs and Winter (November to March) Egg Production. Hatching Season of 1909. Pullets only.

	Winter Egg Production.																		
Per Cent. Infertile.	5–10	10–15	15–20	20–25	25–30	30–35	35–40	40–45	45–50	50–55	55–60	60–65	65–70	70–75	75–80	80–85	85–90	90–95	Totals.
0– 5	–	1	4	1	1	7	4	6	1	5	3	6	2	1	3	1	–	–	46
5–10	–	–	–	1	–	1	1	2	–	1	1	–	–	1	–	–	–	–	8
10–15	–	–	–	–	–	1	–	–	–	–	1	1	1	3	–	–	–	1	8
15–20	–	–	–	–	–	–	1	–	1	1	–	–	1	–	1	–	–	–	5
20–25	–	–	–	–	1	–	–	1	1	–	–	–	2	–	–	–	–	–	5
25–30	–	–	1	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	3
30–35	1	–	–	–	–	1	–	–	1	–	1	–	1	–	–	–	–	–	5
35–40	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
40–45	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
45–50	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
50–55	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
55–60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
60–65	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–	2
65–70	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
70–75	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
75–80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
80–85	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
85–90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
90–95	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
95–100	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1
Totals...	1	1	5	2	2	12	7	10	5	7	6	7	8	6	6	1	0	1	87

out the relative influence of this factor is to determine the degree of correlation which exists between winter production and fertility of eggs. Just as before, one must be sure that one understands the problem involved here. Will the individual hen which has laid heavily in the winter have on the average, or in the long run, a higher record for fertility during the hatching season than one that has not laid heavily, and *vice versa?* To answer this question it is necessary to construct a correlation table between the two variables—winter egg laying on the one hand and fertility of eggs on the other hand. If there is any influence of previous egg laying on fertility of eggs we shall expect to see it manifested in this table and in the measure of correlation which can be deduced therefrom.

Such correlation tables between fertility of egg and winter production for the 1908 and 1909 seasons are presented in

TABLE XII.

Showing the Correlation between Fertility of Eggs and Winter (November to March) Egg Production. Hatching Season of 1909. Yearling Hens only.

	Winter Egg Production.												
Per Cent. Infertile.	0–5	5–10	10–15	15–20	20–25	25–50	30–35	35–40	40–45	45–50	50–55	55–60	Totals.
0– 5	6	2	3	4	2	3	6	1	3	–	–	–	30
5–10	–	1	2	1	–	1	2	–	1	–	1	1	10
10–15	–	–	1	–	2	–	–	–	–	–	–	–	3
15–20	–	–	–	–	–	–	–	–	–	1	–	–	1
20–25	1	–	–	–	–	1	–	–	–	–	–	–	2
25–30	–	–	–	1	1	–	–	–	1	–	–	–	3
30–35	–	1	–	1	–	–	–	–	–	–	–	–	2
35–40	–	–	–	–	–	–	–	–	–	–	–	–	0
40–45	–	–	–	1	–	–	–	–	–	–	–	–	1
45–50	–	–	–	1	–	–	–	1	–	–	–	–	2
50–55	–	–	–	–	–	–	–	–	–	–	–	–	0
55–60	–	–	–	–	–	–	–	–	–	–	–	–	0
60–65	–	–	–	–	–	–	–	1	–	–	–	–	1
65–70	–	–	–	–	–	–	–	–	–	–	–	–	0
70–75	–	–	–	–	–	–	–	–	–	–	–	–	0
75–80	–	–	–	–	–	–	–	–	–	–	–	–	0
80–85	–	–	–	–	–	–	–	–	–	–	–	–	0
85–90	–	–	1	1	–	–	–	–	–	–	–	–	2
90–95	–	–	–	–	–	–	–	–	–	–	–	–	0
95–100	–	–	–	–	–	–	–	–	–	–	–	–	0
100–105	–	–	–	–	–	1	–	–	–	–	–	–	1
Totals....	7	4	7	10	5	6	8	3	5	1	1	1	58

Tables IX to XII inclusive. These tables have been constructed by taking for each one of the birds under discussion the sum of the eggs laid by her in the months of November, December, January and February (winter egg-production) as one variable and the percentage of infertile eggs out of the total number of the same bird's eggs set during the hatching season as the other variable. Table IX gives the data for 1908 and Tables X, XI and XII those for 1909. Just as before the 1909 data are given first for pullets and yearling hens combined and then for each of these groups separately.

Examining these tables it is seen at once that there is no such evident correlation between the two characters as there was in the case of fertility and hatching quality of eggs. If there is any sensible influence of winter egg production on the fertility of eggs it obviously cannot be a very marked one. The individuals are apparently scattered over the table a good deal at random. There is no general trend of the statistics evident to the eye to indicate a close relationship between these phenomena. However, as has been seen before, the only way to determine the nature and degree of relationship is to calculate the coefficient of correlation between the variables. Doing this for Tables IX to XII inclusive we get the following results.

Coefficient of correlation between winter egg production and percentage of infertile eggs during the breeding season:

1908. $r = 0.077 \pm 0.064$. Pullets only.

1909. $r = -0.032 \pm 0.056$. Pullets and yearling hens combined.

1909. $r = 0.108 \pm 0.072$. Pullets only.

1909. $r = 0.009 \pm 0.089$. Yearling hens only.

From these values it is apparent that *the present statistics indicate no correlation whatever between winter egg production and fertility of eggs during the hatching season.* The correlation coefficient itself is not sensibly larger than its probable error in either year and hence cannot be regarded as significantly different from zero. A hen with a very high winter production is on the average no more likely to have her eggs run low in fertility than is a hen whose winter production has been lower, and *vice versa.* As before no wider generality is claimed for this result than arises from the statistics upon which it is based. All that is asserted is simply that when very careful records were kept during the whole hatching season for over 200 birds and over 10,000 eggs the returns show no relation whatever between winter laying and fertility of eggs.

TABLE XIII.

Showing the Correlation between the Hatching Quality of Eggs and Winter (November to March) Egg Production. Hatching Season of 1908.

Winter Egg Production.	Per Cent. of Fertile Eggs Hatched.																							Totals.
	0–3	4–7	8–11	12–15	16–19	20–23	24–27	28–31	32–35	36–39	40–43	44–47	48–51	52–55	56–59	60–63	64–67	68–71	72–75	76–79	80–83	84–87	88–91	
0– 5	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
5–10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
10–15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
15–20	–	–	1	–	1	1	–	1	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	6
20–25	–	–	–	–	1	–	–	–	–	1	–	1	–	1	–	–	–	1	–	–	–	–	–	5
25–30	1	–	–	–	–	–	1	2	2	2	2	–	1	2	1	1	–	–	1	–	–	–	–	16
30–35	–	–	–	–	–	–	1	–	2	2	2	2	2	1	1	–	1	–	–	–	–	–	1	15
35–40	1	1	–	–	1	1	1	–	1	1	1	1	1	–	–	2	–	–	–	–	–	–	–	12
40–45	–	1	–	–	1	1	–	3	–	1	1	1	–	1	2	–	–	–	–	–	–	–	–	12
45–50	1	–	–	–	–	1	2	1	1	1	1	–	1	–	1	–	–	–	1	–	–	–	–	11
50–55	–	–	–	–	1	–	–	1	1	–	–	1	–	–	–	–	–	–	1	–	–	–	–	5
55–60	1	–	–	1	1	1	2	–	–	–	1	1	1	–	–	1	–	1	–	–	–	–	–	11
60–65	–	–	–	–	–	2	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
65–70	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
70–75	1	–	–	–	–	–	1	1	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	5
75–80	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
80–85	–	–	–	2	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
85–90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
90–95	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
95–100	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Totals...	5	2	1	4	6	7	9	10	12	8	9	8	6	5	5	5	2	2	3	0	0	0	1	110

Relation Between Winter Egg Production and Hatching Quality of Eggs.

It has been seen that the statistics show no relation between winter egg laying and the fertility of eggs subsequently produced in the breeding season. This result at once suggests the further question as to whether the same thing is true in regard to hatching quality of eggs. Will the hen that has laid heavily during the winter produce on the average more or fewer chickens from a given number of fertile eggs than will a hen that has not laid heavily during the winter? It is apparent that again this is a problem in correlation. A table must be prepared and the correlation coefficient found between the two variables winter (November 1 to March 1) egg production on the one hand, and per cent. of fertile eggs hatched on the other hand. Such correlation tables for the two years 1908 and 1909 are shown in Tables XIII to XVI inclusive. The 1909 data are given in three tables as in preceding cases.

TABLE XIV.

Showing the Correlation between the Hatching Quality of Eggs and Winter (November to March) Egg Production. Hatching Season of 1909. Pullets and Yearling Hens combined.

	Winter Egg Production.																			
Per Cent. of Fertile Eggs Hatched.	0–5	5–10	10–15	15–20	20–25	25–30	30–35	35–40	40–45	45–50	50–55	55–60	60–65	65–70	70–75	75–80	80–85	85–90	90–95	Totals.
0– 5	–	–	–	1	–	2	2	1	–	1	–	–	1	3	–	–	–	–	–	11
5–10	–	–	–	–	–	–	–	1	1	1	–	–	–	–	–	–	–	–	–	3
10–15	–	–	–	–	–	–	1	1	–	–	–	–	–	–	1	–	–	–	–	3
15–20	–	–	–	–	–	–	1	–	–	–	1	–	1	1	–	–	–	–	–	4
20–25	1	1	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	4
25–30	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1
30–35	–	–	–	1	–	–	2	–	2	1	–	–	–	–	1	–	1	–	–	8
35–40	–	–	–	–	1	1	–	–	2	–	–	1	–	–	–	–	–	–	–	5
40–45	1	–	1	4	1	1	2	–	2	–	1	1	–	1	2	–	–	–	–	17
45–50	–	–	1	–	1	–	1	–	–	–	–	1	1	–	–	1	–	–	–	6
50–55	1	–	–	1	1	–	5	4	1	–	1	–	–	1	1	1	–	–	–	17
55–60	1	1	1	–	–	2	–	–	1	–	1	–	1	–	–	1	–	–	–	9
60–65	1	–	2	3	–	–	3	–	3	–	2	2	1	–	–	–	–	–	–	17
65–70	1	–	2	–	–	1	–	1	1	–	1	1	–	–	–	–	–	–	–	8
70–75	–	2	–	2	–	1	1	–	1	1	–	–	–	1	–	–	–	–	1	10
75–80	–	–	–	1	2	–	2	1	–	1	–	1	1	1	–	–	–	–	–	10
80–85	–	–	–	1	1	–	–	1	–	–	1	–	–	–	1	1	–	–	–	6
85–90	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
90–95	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	2
95–100	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1
100–105	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	2
Totals....	7	5	8	15	7	8	20	10	15	6	9	7	7	8	6	6	1	0	1	146

From an examination of these tables it is at once apparent to the eye that there is a closer relation between the phenomena here dealt with than was exhibited in Tables IX to XII inclusive. The general trend of the entries, particularly in Table XIII, from the upper right hand corner to the lower left hand corner is unmistakable. As has been seen above (p. 116) in the case of the correlation between fertility and hatching quality this general sweep indicates that a sensible correlation will probably be found. Calculating the coefficients for Tables XIII to XVI the following results are obtained:

Correlation between winter egg production and per cent. of fertile eggs hatched:

1908: $r = -0.252 \pm 0.060$. Pullets only.

1909. $r = -0.133 \pm 0.055$. Pullets and yearling hens combined.

1909. $r = -0.010 \pm 0.072$. Pullets only.

1909. $r = -0.223 \pm 0.084$. Yearling hens only.

TABLE XV—*Showing the Correlation between the Hatching Quality of Eggs and Winter (November to March) Egg Production. Hatching Season of 1909. Pullets only.*

Per Cent. of Fertile Eggs Hatched.	Winter Egg Production.																			Totals.
	0–5	5–10	10–15	15–20	20–25	25–30	30–35	35–40	40–45	45–50	50–55	55–60	60–65	65–70	70–75	75–80	80–85	85–90	90–95	
0– 5	–	–	–	1	–	–	2	–	–	1	–	–	1	3	–	–	–	–	–	8
5–10	–	–	–	–	–	–	–	1	1	1	–	–	–	–	–	–	–	–	–	3
10–15	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1	–	–	–	–	2
15–20	–	–	–	–	–	–	–	–	–	–	1	–	1	1	–	–	–	–	–	3
20–25	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	2
25–30	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1
30–35	–	–	–	–	–	–	2	–	1	1	–	–	–	–	1	–	1	–	–	6
35–40	–	–	–	–	1	1	–	–	1	–	–	1	–	–	–	–	–	–	–	4
40–45	–	–	–	2	–	–	1	–	–	–	1	1	–	1	2	–	–	–	–	8
45–50	–	–	–	–	–	–	1	–	–	–	–	1	1	–	–	1	–	–	–	4
50–55	–	–	–	–	–	–	1	3	1	–	1	–	–	1	1	1	–	–	–	9
55–60	–	1	1	–	–	1	–	–	1	–	1	–	1	–	–	1	–	–	–	7
60–65	–	–	–	1	–	–	2	–	3	–	1	1	1	–	–	–	–	–	–	9
65–70	–	–	–	–	–	–	–	–	1	–	1	1	–	–	–	–	–	–	–	3
70–75	–	–	–	1	–	–	1	–	–	–	–	–	–	1	–	–	–	–	1	4
75–80	–	–	–	–	1	–	2	1	–	1	–	1	1	1	–	–	–	–	–	8
80–85	–	–	–	–	–	–	–	1	–	–	1	–	–	–	1	1	–	–	–	4
85–90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
90–95	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
95–100	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1
100–105	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
Totals....	0	1	1	5	2	2	12	7	10	5	7	6	7	8	6	6	1	0	1	87

TABLE XVI—*Showing the Correlation between the Hatching Quality of Eggs and Winter (November to March) Egg Production. Hatching Season of 1909. Yearling Hens only.*

Winter Egg Production.	Per Cent. of Fertile Eggs Hatched.																					Totals.
	0–5	5–0	10–15	15–20	20–25	25–30	30–35	35–40	40–45	45–50	50–55	55–60	60–65	65–70	70–75	75–80	80–85	85–90	90–95	95–100	100–105	
0–5	–	–	–	–	1	–	–	–	1	–	1	1	1	1	–	–	–	–	–	–	1	7
5–10	–	–	–	–	1	–	–	–	–	–	–	–	–	–	2	–	–	1	–	–	–	4
10–15	–	–	–	–	–	–	–	–	1	1	–	–	2	2	–	–	–	–	1	–	–	7
15–20	–	–	–	–	–	–	1	–	2	–	1	–	2	–	1	1	1	1	–	–	–	10
20–25	–	–	–	–	–	–	–	–	1	1	1	–	–	–	–	1	1	–	–	–	–	5
25–30	2	–	–	–	–	–	–	–	1	–	–	1	–	1	1	–	–	–	–	–	–	6
30–35	–	–	1	1	–	–	–	–	1	–	4	–	1	–	–	–	–	–	–	–	–	8
35–40	1	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	3
40–45	–	–	–	–	–	–	1	1	2	–	–	–	–	–	1	–	–	–	–	–	–	5
45–50	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1
50–55	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1
55–60	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1
Totals..	3	0	1	1	2	0	2	1	9	2	8	2	8	5	6	2	2	2	1	0	1	58

These coefficients (cf. p. 134) indicate that the present statistics show in general a sensible correlation between the winter egg laying and the per cent. of fertile eggs hatched during the hatching season. The correlation coefficient for 1908 is roughly 4 times its probable error, while that for 1909, all birds included, is 2.4 times its probable error. The 1909 pullets alone show a very low coefficient, which, taken by itself, could only be regarded as not significantly different from zero. It, however, is negative like all the other coefficients. There is little doubt that this 1909 pullet correlation would have been higher, had there been data from a larger number of birds. All the figures taken together indicate with a high degree of probability that there is a real and significant relationship between the phenomena shown by the statistics. The negative sign of the coefficients indicates that the relation is of the sort that *the higher the winter egg production the lower is the percentage of fertile eggs hatched and vice versa.*

Putting all the results together the present statistics show that while the high winter layer is not essentially different from the poor winter layer in regard to the fertility of eggs she is on the average distinctly inferior in respect to the hatching quality of her eggs. The hen that has laid heavily during the winter produces during the hatching season fewer viable chicks from a given number of fertile eggs.

The Fertility and Hatching of Eggs in the Pullet and Second Year of Life.

In this section we have to do with the questions raised in paragraph 5 of the statement of problems in the introduction. The questions were: To what extent are the fertility and hatching quality of her eggs innate, unchangeable characteristics of a bird? If a pullet produces eggs shown above the average for pullets in either fertility or hatching quality, will the same bird's eggs in the second year of life be above the average for yearling hens in these respects?

To answer these questions it will be clearly necessary to appeal again to the method of correlation. Correlation tables must be formed which have, to take fertility of eggs as an illustrative case, as one variable the percentage eggs infertile in the pullet year, and as the other variable the percentage of the

TABLE XVII—*Showing the Correlation between the Pullet and Second Year Performance in Respect to Fertility of Eggs.*

Per Cent. Infertile—Pullet Year.	Per Cent. Infertile—Second Year. 0–5	5–10	10–15	15–20	20–25	25–30	30–35	35–40	40–45	45–50	50–55	55–60	60–65	65–70	70–75	75–80	80–85	85–90	90–95	95–100	100–100	Totals.
0–5	3	1	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6
5–10	5	1	2	—	—	1	—	—	—	1	—	—	—	—	—	—	—	1	—	—	—	11
10–15	7	1	1	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	1	12
15–20	2	1	—	—	1	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	6
20–25	5	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8
25–30	1	1	—	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	4
30–35	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
35–40	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
40–45	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
45–50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
50–55	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
55–60	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
60–65	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
65–70	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
70–75	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
75–80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
80–85	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
85–90	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Totals..	26	10	3	1	2	2	2	0	1	2	0	0	1	0	0	0	0	1	0	0	1	52

TABLE XVIII—*Showing the Correlation between the Pullet and Second Year Performance in Respect to Hatching Quality of Eggs.*

Per Cent. of Fertile Eggs Hatched—Pullet Year.	Per Cent. of Fertile Eggs Hatched—Second Year. 0–5	5–10	10–15	15–20	20–25	25–30	30–35	35–40	40–45	45–50	50–55	55–60	60–65	65–70	70–75	75–80	80–85	85–90	90–95	95–100	100–105	Totals.
0–5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
5–10	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
10–15	—	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	2
15–20	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
20–25	—	—	—	—	—	—	—	—	2	—	—	1	—	—	—	—	—	—	—	—	—	3
25–30	—	—	—	—	—	—	—	1	1	—	—	—	—	—	2	—	—	—	—	—	—	4
30–35	1	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	1	—	—	—	4
35–40	1	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	3
40–45	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	2
45–50	—	—	—	—	—	—	—	—	—	—	—	—	2	2	1	—	1	—	—	—	—	6
50–55	—	—	—	—	1	—	—	—	—	—	—	—	1	—	2	—	—	—	—	—	1	5
55–60	1	—	—	—	1	—	1	—	1	—	2	—	—	—	—	—	—	—	—	—	—	6
60–65	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	2
65–70	—	—	—	—	2	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	4
70–75	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	1	—	—	—	—	3
75–80	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1
80–85	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1
85–90	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1	—	—	2
90–95	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1
95–100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
100–105	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1
Totals....	4	1	0	1	4	0	2	1	7	1	6	2	7	4	5	1	2	2	1	0	1	52

same birds' eggs infertile in the second breeding year. We have available complete records for two successive hatching seasons of 52 birds. The correlation tables for per cent. of infertile eggs and per cent. of fertile eggs hatched for these birds are given in Tables XVII and XVIII.

From these tables the variation constants given in Table XIX have been calculated.

TABLE XIX.

Constants for First and Second Years' Hatching Records of the Same Birds.

CONSTANT.	Per cent. infertile.	Per cent. fertile eggs hatched.
Pullet year mean	16.83±1.28	49.81±2.03
" " standard deviation	13.66±0.90	21.67±1.43
Second year mean	14.42±2.00	51.63±2.29
" " standard deviation	21.37±1.41	24.46±1.62
Coefficient of correlation	-0.111±0.092	0.331±0.083

From these tables the following points are to be noted:

1. There is comparatively little difference in the mean fertility or mean hatching quality of the eggs of this group of birds in the two years, so far as the data enable any conclusion to be drawn. This result would seem to indicate that the supposed superiority of hens over pullets in breeding performance arises in the main from the fact that the hens kept as breeders the second year are usually selected, consciously or unconsciously with regard to their first year breeding records. An average improvement of about two per cent, such as is shown by this group of birds, is certainly not indicative of any marked tendency for a bird to be a better breeder in her second year than in her first.

2. The variability, both in regard to fertility and hatching quality of eggs is absolutely and relatively greater in the second year than in the first.

3. Having regard to the magnitude of its probable error the correlation in respect to the fertility of eggs in first and second year is probably to be regarded as not significant. In other words it would appear that, so far as may be judged by the

present statistics, on the average a bird whose eggs run high in fertility in the pullet year is as likely as not to produce eggs running low in fertility in the second year, and *vice versa*. This result is independent of the fact that the birds were with cockerels of generally equal breeding ability in the two years, as shown by their pen averages.

4. There is a significant positive correlation between the percentage of fertile eggs hatched from the same group of birds in two successive breeding years. The coefficient here (0.331) is 4 times its probable error. This result means that in the long run the bird whose fertile eggs give high percentage hatches in the pullet year, will show the same characteristics in her second breeding year. And similarly the bird whose fertile eggs hatch poorly in her pullet year will on the average, make the same kind of a record in her second year. This result emphasizes the importance of a carefully kept hatching record when one is saving pullets for the next year's breeding work or to furnish eggs to sell for hatching.

Are the Fertility and Hatching Quality of Eggs Inherited Characters?

In this section we shall undertake the discussion of a very interesting and, at the same time difficult point. Theoretically it is a simple matter to determine whether the two characters, fertility and hatching quality of eggs, are inherited. If the question be put in this form: "Will the daughters of a hen whose eggs are above the average (for mothers) in percentage fertility produce eggs which will in turn be above the average (for daughters) in fertility?" it is at once apparent that the necessary procedure is to form a correlation table in which one variable is the percentage fertility of the mother's eggs and the other the percentage fertility of the daughters' eggs. The correlation coefficient determined from such a table should then be a measure of the degree to which this character is inherited from mother to daughter. The same line of reasoning and treatment of the data is also to be adopted to determine whether the hatching quality of eggs is inherited from mother to daughter. While the problem is thus theoretically simple, actually there are a number of difficulties as will presently appear.

TABLE XX—*Showing the Correlation between Mother and Daughter in Respect to Fertility of Eggs.*

	Mother's Per Cent. Infertile.											
Daughter's Per Cent. Infertile	0–5	5–10	10–15	15–20	20–25	25–30	30–35	35–40	40–45	45–50	50–55	Totals.
0–5	4	18	5	6	8	1	3	–	–	1	–	46
5–10	–	5	1	–	1	–	–	–	–	–	1	8
10–15	1	3	–	3	–	–	–	1	–	–	–	8
15–20	1	1	1	–	1	1	–	–	–	–	–	5
20–25	–	1	–	3	–	1	–	–	–	–	–	5
25–30	1	2	–	–	–	–	–	–	–	–	–	3
30–35	–	4	1	–	–	–	–	–	–	–	–	5
35–40	–	1	–	–	–	–	–	–	–	–	–	1
40–45	1	–	–	–	–	–	–	–	–	–	–	1
45–50	–	–	–	–	–	–	–	–	–	–	–	0
50–55	–	–	–	–	–	–	–	–	–	–	–	0
55–60	–	–	–	–	–	–	–	–	–	–	–	0
60–65	1	–	–	–	–	–	1	–	–	–	–	2
65–70	–	–	–	–	–	–	–	–	–	–	–	0
70–75	–	1	–	–	–	–	–	–	–	–	–	1
75–80	–	–	–	–	–	–	–	–	–	–	–	0
80–85	–	–	–	–	–	–	–	–	–	–	–	0
85–90	–	–	–	–	–	–	–	–	–	–	–	0
90–95	1	–	–	–	–	–	–	–	–	–	–	1
95–100	–	–	–	–	–	1	–	–	–	–	–	1
Totals...	10	36	8	12	10	4	4	1	0	1	1	87

TABLE XXI—*Showing the Correlation between Mother and Daughter in Respect to Hatching Quality of Eggs.*

	Mother's Per Cent. of Fertile Eggs Hatched.															
Daughter's Per Cent. of Fertile Eggs Hatched.	15–20	20–25	25–30	30–35	35–40	40–45	45–50	50–55	55–60	60–65	65–70	70–75	75–80	80–85	85–90	Totals
0–5	–	2	–	–	1	–	–	–	1	4	–	–	–	–	–	8
5–10	–	–	–	1	–	–	–	–	–	1	–	–	–	–	1	3
10–15	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	2
15–20	–	–	–	–	–	–	–	–	1	1	–	–	–	1	–	3
20–25	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	2
25–30	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1
30–35	–	–	3	–	–	–	1	–	2	–	–	–	–	–	–	6
35–40	–	–	–	–	1	–	–	–	2	–	–	1	–	–	–	4
40–45	–	1	1	–	2	–	–	1	1	2	–	–	–	–	–	8
45–50	–	–	–	–	1	–	–	–	1	1	–	–	–	1	–	4
50–55	–	–	2	–	1	–	1	–	–	3	–	1	1	–	–	9
55–60	–	–	2	–	1	–	–	1	1	–	–	–	–	–	2	7
60–65	–	1	1	2	–	2	–	–	–	3	–	–	–	–	–	9
65–70	–	–	–	1	–	–	1	–	–	1	–	–	–	–	–	3
70–75	–	–	–	–	–	–	–	1	1	–	2	–	–	–	–	4
75–80	–	–	–	1	–	–	–	2	–	2	2	–	–	–	1	8
80–85	–	–	–	–	–	1	1	–	–	2	–	–	–	–	–	4
85–90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
90–95	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
95–100	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1
100–105	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1
Totals....	0	4	9	5	7	3	4	5	12	24	5	2	1	2	4	87

At the outstart it will be well to examine correlation tables such as have been described correlating mother and daughter with respect to fertility and to hatching quality of eggs. Such tables are given as Tables XX and XXI.

The constants calculated from these tables are given in Table XXII.

TABLE XXII.

Constants Calculated from Tables XX and XXI.

CONSTANT.	Fertility, table XX.	Hatching quality, table XXI.
Mothers' mean	13.88±1.49	52.96±1.23
" standard deviation	20.61±1.05	17.00±0.87
" coefficient of variation	148.47±17.66	32.00±1.80
Daughters' mean	13.65±1.38	47.67±1.80
" standard deviation	19.10±0.98	24.92±1.27
" coefficient of variation	139.96±15.87	52.27±3.32
Coefficient of correlation	−0.035±0.072	0.031±0.072

From this table we note the following points:

1. The figures apparently do not indicate that there is any correlation between mother and daughter with regard to either of the characters considered. Neither coefficient of correlation sensibly differs from zero.

2. The mothers, though a selected class are not less variable than the daughters so far as per cent. of infertility of eggs is concerned. They are much less variable than the daughters in per cent. of fertile eggs hatched. In selecting pullets for breeding in 1909 (i. e., "daughters" of the present discussion) particular attention was paid to the breeding records of their mothers as regards per cent. of fertile eggs hatched. This means that the mothers which are in the correlation tables XX and XXI are a selected group, whereas the daughters in these tables are not selected at all, with reference to their own fertility and hatching records. While some attention was paid to fertility of eggs in this selection of breeding stock, the selection was not so close as in regard to per cent. of fertile eggs hatched.

3. There is a much more marked diminution of the daughters' mean below the mothers' mean in the case of hatching

quality than in the case of fertility. This is again to be explained as the result of the closer selection with reference to the one character than to the other. The mothers' mean fertility of eggs is not significantly above the general population mean. Hence the daughters' mean shows no sensible lowering as compared with the mothers. On the other hand the mothers' mean percentage of fertile eggs hatched is well above the general population mean (52.96 as compared with 37.24) and consequently it is to be expected that there will be a relatively more pronounced reduction of the daughters' mean.

Let us now examine more particularly the result stated in paragraph 1, viz., that there is no *apparent* parental inheritance of these characters, fertility and hatching quality of eggs. It is conceivable that the observed correlation coefficients have their values reduced by the action of various circumstances affecting the statistical material, not yet taken account of. In other words there may be a real inheritance of these characters, fertility and hatching quality of eggs, and yet it may be so masked by other factors as to show no trace of itself in the statistical table. It is necessary to determine, if possible, whether this is the case.

First, let us see whether the selection of mothers may have been the factor which has reduced the parental correlation. It has been shown by Pearson * that when the selection of a parent is stringent with reference to any character, the correlation between parent and offspring will be much reduced. The formula covering the case which we have to deal with here is,

$$R_{12} = \frac{s_1}{\sigma_1} \frac{r_{12}}{\sqrt{1 - \left(1 - \frac{s_1^2}{\sigma_1^2}\right) r_{12}^2}}$$

wherein the significance of the letters is as follows, stated in terms of the present problem:

R_{12} = correlation between mother and daughter *after* selection of mothers has occurred. This is the observed coefficient of correlation of Table XXII.

s_1 = standard deviation of mothers after selection.

σ_1 standard deviation of general population from which mothers were drawn.

* Phil. Trans. Roy. Soc. Vol. 200 A, p. 39.

r_{12} = correlation between mothers and daughters in the absence of (or preceding) any selection of mothers.

We have the following observed values for these quantities.

Fertility of Eggs.	Hatching Quality of Eggs.
$R_{12} = -0.035$	$R_{12} = 0.031$
$s_1 = 20.61$	$s_1 = 17.00$
$\sigma_1 = 15.00$	$\sigma_1 = 17.99$

It is at once apparent that in the case of fertility of eggs there was no effective selection of the mothers. The variability of the mothers is actually greater than that of general population from which they were drawn. In the case of the hatching quality of eggs the selection was far from stringent, as measured by the variabilities. We get in this case

$$r_{12} = 0.034$$

This indicates that the small observed value of the parental correlation is not to be accounted for, except in an insignificant degree, by the selection of mothers. This is the result which was to be expected since the selection was so slight.

So far we have discussed the inheritance of the characters fertility and hatching quality of eggs in the female line only, i. e., from mother to daughter. It is a pertinent question to ask whether these characters may not be transmitted through the male line. It is quite conceivable that this might be the case just as in dairy cattle milking qualities are transmitted through the male line. Unfortunately it is a very difficult matter to determine whether any character which only reaches its objective expression in the female is transmitted through the male line. The reason for this is obvious. It is not possible to get any good measure of the innate germinal constitution of a male individual with reference to any such female character. Thus a male bird may bear within its germ cells the tendency to produce good hatching quality in the eggs of its daughters and yet this fact cannot be distinguished except through the performance of the daughters themselves. These considerations make it necessary to adopt a somewhat different method of study than that which is used in the investigation of inheritance in the female line.

The only practical measurement which can be obtained regarding male birds and which is pertinent in the present connection is the average fertility and hatching quality of the eggs

TABLE XXIII.

Comparison of Fathers' Average Pen Records of Infertility and Hatching of Eggs, with the same Characters in their Daughters.

Cockerel number.	Average per cent. of infertile eggs shown by females mated with the male designated. (Father's pen average infertility.)	Average per cent. of infertile eggs shown by the daughters of the designated male.	Average per cent. of fertile eggs hatched shown by female mated with designated male. (Father's pen average of hatching quality.	Average per cent. of fertile eggs hatched shown by the daughters of the designated male.
D 31	8.9	9.7	46.0	41.2
D 32	16.7	0	44.3	61.0
D 60	19.2	6.3	26.4	38.3
D 17	20.3	1.0	41.4	70.0
D 65	20.6	10.7	31.4	65.0
D 26	20.8	78.0	50.3	76.5
D 35	21.0	16.5	32.1	44.3
D 11	22.4	49.6	33.8	40.5
D 70	22.5	6.0	36.5	60.1
D 16	23.0	1.8	24.6	54.7
D 68	26.0	13.1	48.2	40.7
D 5	26.6	7.7	26.2	33.0
D 56	27.0	3.0	25.6	35.0
D 61	29.0	25.2	31.4	38.4
D 57	34.8	10.0	34.2	36.2

laid by all the birds in the pen headed by each cockerels. Provided sufficiently large numbers of females are used with each male in a breeding pen so that it may be supposed that they give a fair random sample of breeding females in general, the average fertility and hatching quality of eggs from the pen through the whole season may be taken as in some degree a measure of that particular male bird's breeding ability. Assuming that the females represent average samples, differences in the average fertility and hatching quality of the eggs from different pens may be attributed to innate differences in the breeding ability of the cockerels, always provided other conditions are kept the same. Now this question may be raised: What is the degree of correlation existing between a male bird's average pen fertility of eggs (such as is

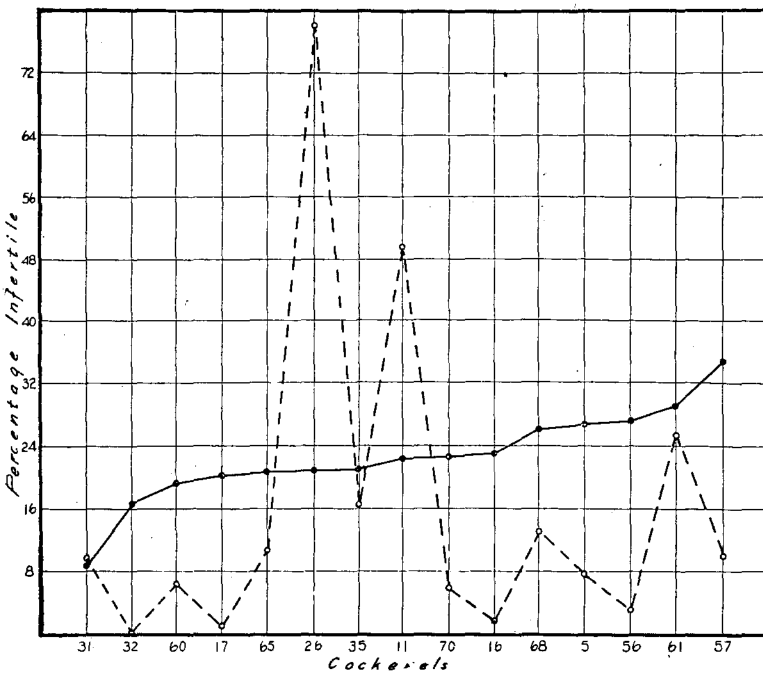

Fig. 14. Diagram showing the relation between fathers' average pen records of infertility, and the average infertility of their daughters' eggs. The solid line gives the average per cent. of infertile eggs shown by the females mated with each male. The dotted line gives the average per cent. infertile for the family of daughters corresponding to each father.

given for example in the last columns of Tables VII and VIII) and the percentage of eggs infertile and of fertile eggs hatched shown by the daughters of this male bird in the next season's breeding? To answer this question would obviously be to apply somewhat the same test to inheritance in the male line as we have to inheritance in the female line. It is impossible, however, to apply this test at present because of lack of sufficient material. The number of male birds whose daughters appear as breeders the second year is so small as to make a determination of correlation coefficients a waste of time on account of the magnitude of the probable errors which would be involved. It is possible, however, to get some little light on the matter in an indirect way. This can be done by comparing the father's average pen fertility and average pen hatching quality of eggs as given in Table VII with the average fertility and hatching quality of eggs exhibited by his daughters. Such a comparison is made in Table XXIII and in Figures 1 and 2. The arrangement of the data in this table and the figures is fully explained in the legends.

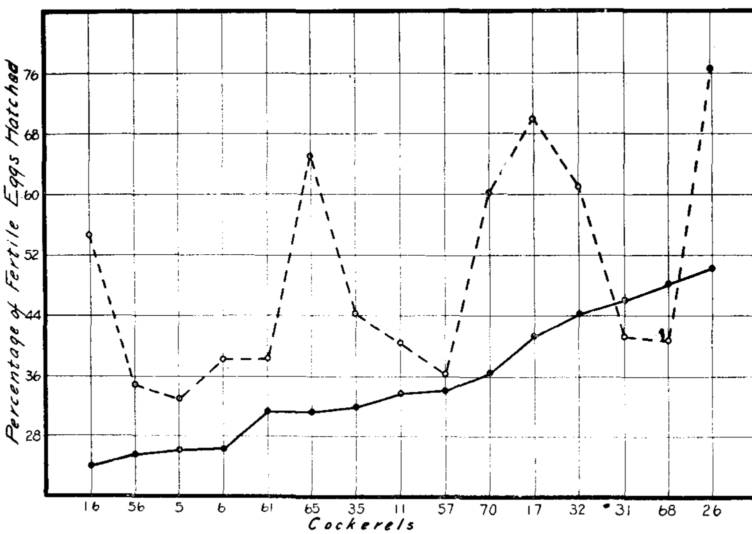

Fig. 15. Diagram showing the relation btween the fathers' average pen records of hatching quality, and the average hatching quality of their daughters' eggs. The solid line gives the average per cent. of fertile eggs hatched from the females mated with each male. The dotted line gives the average per cent. of fertile eggs hatched for the family of daughters corresponding to each father.

From the table and the diagrams we note the following points; it must be understood that, on account of the meagerness of the data, these results are simply suggestions to be tested by further work, rather than definite conclusions:

1. There clearly is no significant relationship, so far as the present data show, between the father's average pen percentage of eggs infertile and the daughters' average for the same character. The zigzag daughter line in Fig. 14 shows no tendency to parallel the line for the fathers.

2. With reference to the percentage of fertile eggs hatched the case appears to be somewhat different. Here, as is shown in Fig. 15, there is a distinct tendency for the zigzag line of daughter averages to run more or less parallel to the fathers' line. In other words, there is some indication of a distinct tendency for the daughters of a male whose average pen record for hatching quality of eggs is high to show the same characteristic themselves. Too much stress must not be laid upon the result, however, because of the small number of males included in the statistics.

3. These results, so far as they go, accord with those previously obtained in so far as that there appears to be a difference in the behavior of the character "fertility of eggs" as distinguished from "hatching quality." Fertility seems to be much more a matter of external factors than hatching quality, which appears to be very largely determined by innate constitutional characters. This point will be more fully discussed farther on.

We may now look at the question of the inheritance of these characters under discussion in still another way, namely from the standpoint of collateral inheritance. Let us turn to an examination of the so-called "fraternal" correlations respecting fertility and hatching quality of eggs. The question here is this: if one sister in a family has a percentage of fertility above the average will her other sisters (i. e., birds of the same family) tend to have fertility records above the average and *vice versa?* And similarly if one sister shows an unusually high percentage of fertile eggs hatched will the other sisters of the same family in general show hatching records above the average, and *vice versa?* It is plain that if sisters are in general alike in respect to either of these characters fertility or hatching power of eggs, it will indicate that to that extent these characters are inherited.

In order to determine whether there is on the average a closer resemblance between sisters in respect to these characters than exists between individuals taken at random it is necessary once more to appeal to the method of correlation. In forming the correlation tables in this case, however, it is necessary to adopt a slightly different method than that which was used in the case of mother and daughter records. When the correlation between mother and daughter is determined we are dealing with two entirely separate classes of individuals belonging to differ-

TABLE XXIV.

Showing the Correlation between Sisters in Respect to Percentage of Eggs Infertile.

Per Cent. of Eggs Infertile.	0–5	5–10	10–15	15–20	20–25	25–30	30–35	35–40	40–45	45–50	50–55	55–60	60–65	65–70	70–75	Totals.
0–5	50	16	14	6	6	4	10	3	–	–	–	–	–	–	4	113
5–10	16	4	–	2	2	2	2	2	–	–	–	–	–	–	2	32
10–15	14	–	8	–	2	–	–	–	–	–	–	–	–	–	–	24
15–20	6	2	–	–	–	–	–	–	–	–	–	–	–	–	1	9
20–25	6	2	2	–	–	1	1	1	–	–	–	–	–	–	–	13
25–30	4	2	–	–	1	–	1	1	1	–	–	–	–	–	–	10
30–35	10	2	–	–	1	1	2	1	–	–	–	–	–	–	–	17
35–40	3	2	–	–	1	1	1	–	–	–	–	–	–	–	–	8
40–45	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1
45–50	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
50–55	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
55–60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
60–65	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
65–70	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
70–75	4	2	–	1	–	–	–	–	–	–	–	–	–	–	–	7
Totals..	113	32	24	9	13	10	17	8	1	0	0	0	0	0	7	234

TABLE XXV.

Showing the Correlation between Sisters in Respect to Percentage of Fertile Eggs Hatched.

Per Cent. of Fertile Eggs Hatched.	0–5	5–10	10–15	15–20	20–25	25–30	30–35	35–40	40–45	45–50	50–55	55–60	60–65	65–70	70–75	75–80	80–85	85–90	90–95	95–100	Totals.
0–5	2	–	2	1	2	–	2	1	3	2	3	1	6	1	–	1	2	–	–	1	30
5–10	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	1	–	–	–	–	3
10–15	2	–	–	–	1	–	–	–	2	1	1	–	2	–	–	–	–	–	–	–	9
15–20	1	–	–	–	–	–	2	1	1	1	–	1	–	–	–	–	–	–	–	–	7
20–25	2	–	1	–	–	–	–	1	1	2	1	–	2	–	1	–	–	–	–	–	11
25–30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	2
30–35	2	–	–	2	–	–	2	2	3	–	1	2	–	–	–	–	–	–	–	–	14
35–40	1	–	–	1	1	–	2	–	1	1	1	1	–	–	1	–	–	–	–	–	10
40–45	3	–	2	1	1	–	3	1	–	1	1	1	2	–	–	–	–	–	–	–	16
45–50	2	–	1	1	2	–	–	1	1	–	1	–	2	–	1	–	–	–	–	–	12
50–55	3	–	1	–	1	–	1	1	1	1	–	2	3	1	–	2	2	–	–	1	20
55–60	1	2	–	1	–	–	2	1	1	–	2	4	–	–	1	3	–	–	–	–	18
60–65	6	–	2	–	2	–	–	–	2	2	3	–	2	2	–	2	2	–	–	1	26
65–70	1	–	–	–	–	–	–	–	–	–	1	–	2	–	–	2	2	–	–	1	9
70–75	–	–	–	–	1	1	–	1	–	1	–	1	–	–	–	3	–	–	–	–	8
75–80	1	1	–	–	–	1	–	–	–	–	2	3	2	2	3	–	2	–	–	1	18
80–85	2	–	–	–	–	–	–	–	–	–	2	–	2	2	–	2	2	–	–	2	14
85–90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
90–95	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
95–100	1	–	–	–	–	–	–	–	–	–	1	–	1	1	–	1	2	–	–	–	7
Totals...	30	3	9	7	11	2	14	10	16	12	20	18	26	9	8	18	14	0	0	7	234

ent generations. We may properly enter one set of individuals on one side of the correlation table, as the primary or x variable and the other set on the other side of the table as the secondary or y variable (cf., Table XXI). When we come to deal with pairs of sisters all of the same age, however, there is no good reason for taking one sister of a pair as the primary or x variable rather than the other. Therefore, in such cases it is necessary in order to arrive at a correct result to enter each individual of a pair of sisters twice; once as the x variable and once as the y variable of the correlation table.* This has been done in forming the two tables XXIV and XXV which show the correlation between sisters in respect to fertility and hatching quality of eggs respectively. In forming these tables every possible pair of sisters has been entered twice, with first one and then the other as the primary variables in the manner indicated.

From these tables the following coefficients have been calculated:

Correlation between sisters in respect to per cent. of eggs infertile $r = -0.064 \pm .062$.

Correlation between sisters in respect to per cent. of fertile eggs hatched $r = 0.188 \pm .060$.

From these values we note that:

1. There is no sensible correlation between sisters in respect to the percentage infertility of eggs. A bird having a percentage of infertile eggs well below the average is as likely as not to have a sister whose percentage infertility will be above the average and *vice versa*.

2. In respect to the hatching quality of eggs (percentage of fertile eggs hatched) there is a definite and sensible correlation between sisters. *This means that, in general, sisters of birds whose eggs are above the average in hatching quality have their eggs also above the average in respect to this character.* In other words, the data would indicate that there is a sensible degree of what may be spoken of as "fraternal" or

* The necessity for dealing with material of this character is the way indicated has been dully discussed by Pearson in his memoir on homotyposis, (Phil. Trans. Roy. Soc., Vol. 197A, pp. 285-379, 1901), and by Pearl in connection with a study of homogamy in the conjugation of Paramecium (Biometrika, Vol. 5, pp. 213-297, 1907).

collateral inheritance of the character "hatching quality of eggs" even though this character is *apparently* not inherited in the ancestral line.

At first thought it would seem that there is a contradiction here in saying that there is collateral but not parental inheritance. How can sisters be more alike than a random sample of the general population except because of the fact that they are the progeny of the same parents? The contradiction is only apparent and not real, however. It has been shown by Pearson * that we may expect to get relatively high coefficients of fraternal inheritance associated with low or insignificant parental coefficients, whenever the phenomenon of *prepotency* in the ancestral line occurs. This is exactly what careful study of the individual records shows to exist in the present material. The point is that the absence of parental correlations with respect to fertility and hatching of eggs shown in Tables XX and XXI does not mean that one of these characters at least (hatching quality) is not inherited. It merely means that the existence of such parental inheritance is masked by the existence of varying degrees of prepotency with reference to this character amongst the mothers. The existence of such prepotency is perfectly apparent from (a) the study of individual records, and (b) the correlation between sisters as shown in Table XXVI, in regard to this character. In passing it may be remarked that this case well illustrates the danger of which lies in too hastily drawing conclusions from *mass* material without careful study of the individual cases. Putting all our material together it leads to the conclusion that the actual fact is that there is a definite inheritance amongst poultry of what has been called in this paper "the hatching quality of eggs." Yet the manner of this inheritance is such that the fact of its existence is entirely obscured in the ordinary parent-offspring correlation table compiled to test the question.

It may be mentioned here, though a detailed discussion of the point is reserved for a future paper, that this phenomenon of sensible fraternal correlations associated with the absence of parental correlation is exactly what is to be expected if the character studied is inherited in a manner similar to that

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* Pearson, K. On the Laws of Inheritance in Man. 1. Inheritance of Physical Characters. Biometrika, Vol. II, pp. 357-462, 1903.

observed in "pure lines" in plants (Johannsen) in the case of a sexually reproducing (i. e., not self-fertilizing) organism.

3. Fertility and hatching quality again are seen to behave differently. There is no evidence of any kind that the former represents an innate, constitutional character which is inheritable.

SUMMARY OF SECTION.

Putting all the results of this section together it may be said that the data at present available indicate that the hatching quality of eggs measured by per cent. of fertile eggs hatched is an innate constitutional character which is definitely inherited in the female and probably also in the male line, though on the latter point more data are needed. On the other hand, there is no evidence that the character "fertility of eggs" is in any degree or manner inherited.

Summary and Discussion of Results.

The data represented in this paper lead to results which may be summarily stated as follows:

1. So far as the present data indicate there is a small but still sensible correlation between the fertility and hatching quality of eggs. This means that in general or on the average the hen whose eggs run high in fertility will also tend to show a high hatching quality of eggs (per cent. of fertile eggs hatched) and *vice versa*.

2. Conditions of housing have a marked and definite influence on the mean or average fertility and hatching quality of eggs. In the experiments here discussed it was found that both fertility and hatching quality of eggs were very much better when the breeding was done in a "curtain-front" house, which furnished an abundance of fresh, pure air, than when it was done in what was formerly considered to be a highly desirable type of heated house, without curtain-front but with a supposedly adequate system of indirect ventilation.

3. The hatching quality of eggs is in general less variable in proportion to the mean of the character varying than is fertility.

4. The variability in respect to both fertility and to hatching quality is markedly influenced by environmental conditions (particularly housing conditions).

5. It is shown that the individuality of the female bird is a very important factor in the determination of the fertility of eggs. Different individual females have characteristic degrees of fertility of their eggs, independent (within limits) of the character of the male bird with which they are mated. This fact emphasizes the importance to the breeder of trapnesting through the breeding season at least.

6. The present statistics indicate that there is no correlation whatever between winter (November to March) egg production and the fertility of eggs laid during the subsequent hatching season. In other words, the eggs of the heavy winter layer are not more likely on the average to be infertile than are those of the light winter layer, other conditions being the same.

7. There is a distinct correlation between the winter (November to March) egg production and the per cent. of fertile eggs hatched during the subsequent breeding season. This correlation is of such sort as to indicate that in general the higher the winter egg production of a particular bird the lower will the percentage of that bird's fertile eggs hatched probably be and *vice versa*.

8. The present statistics do not show any *marked* superiority of hens over pullets in respect to breeding performance so far as either fertility or hatching quality of eggs are concerned. It must be understood that this is merely a statement of fact and does not constitute any recommendation for the use of either pullets or hens as breeders. That question involves more than the two factors here under discussion.

9. There is no indication that the fertility of eggs in the pullet year and in the second breeding year are in any way correlated. In other words, a bird whose eggs run high in fertility in the pullet year is as likely as not to produce eggs running low in fertility the second year, and *vice versa*, when mated with the same male or with males of essentially equal breeding ability as shown by their pen averages.

10. There is a significant positive correlation between the percentage of fertile eggs hatched in the pullet year and in the second breeding year. In other words, the bird whose eggs are of superior hatching quality in the pullet year will, on the average, show the same characteristic in her second year.

11. There is no evidence that the character "fertility of eggs" (measured by per cent. of eggs infertile) is in any degree or manner inherited.

12. The character "hatching quality of eggs" (measured by per cent. of fertile eggs hatched) is definitely inherited in the female line and probably also in the male line.

In considering these results as a whole there are certain matters of general significance which need some further consideration. In the first place, taking all the results of the paper together it is evident that fertility and hatching quality of eggs are very different characters. While there are great individual differences among different females in respect to the fertility of their eggs, even when mated to the same male, it still remains the fact that this character, as compared with hatching quality of eggs, is to a very large degree influenced by external circumstances. Thus we have seen that the same relative degree of fertility is not characteristic of the same bird in two successive seasons; nor is this character affected by winter egg production. It is not inherited.

On the other hand, the hatching quality of eggs is an innate constitutional character just as much intrinsic as any other physical character such as shape of body or length of limb. Relatively the same intensity or degree of this character is persistent in the same bird in successive breeding seasons. It is adversely affected by heavy winter egg production. It is inherited.

These facts raise the question as to what the hatching quality of eggs depends upon. We have used as a quantitative measure of this quality the percentage of fertile eggs hatched. But this measurable quantity depends on underlying innate biological factors. As to what these factors *in detail* are, data are lacking. It will, however, be of some value to attempt to list such general factors as are known to have some bearing on the case. At the start of such a list it can probably be safely said that any factor which tends to reduce or impair the general constitutional vigor of breeding birds in general tends also to reduce the hatching quality of the eggs from these birds. The relative "condition" or vigor of breeding birds may be impaired in variety of ways. For example, improper feeding may bring about this result. Houssay (1907) in his very thorough study extending over six generations has investigated the effects resulting from feeding fowls a purely meat diet. He notes among other results an impairment of general constitutional vigor amongst his birds in the later generations, and also a greatly reduced hatching quality of the eggs.

The present study has shown that high winter egg production has, on the average, an adverse effect on the hatching quality of the eggs produced by the same birds in the subsequent hatching season. This again can probably be regarded as the result of a reduction of constitutional vigor following heavy laying. Continued heavy egg production involves great metabolic activity on the birds' part in the transformation of matter and energy and must fatigue the organism. It is not surprising that under such circumstances the developmental machines (fertilized eggs) produced are not absolutely perfect. The finding of a negative correlation between fecundity and hatching quality (= germinal viability or vigor) is of some general theoretical interest. There is considerable reason to believe that a similar condition of affairs exists in man. High fecundity and high infant mortality (and probably also prenatal mortality) are very generally associated. And are not the causes probably very similar in the two cases? In those social classes showing the greatest fecundity, there exist, speaking broadly, bad conditions of housing and nutrition all tending along with the organic fatigue incident to the high fecundity itself, to reduce the general vital condition or constitutional vigor, and with it the viability of the developing germ and growing organism.

Similarly adverse housing conditions most probably produce the bad effect which they have been shown (by Dryden, Stewart and Atwood, and others, as well as in the present paper) to have upon hatching quality by lowering the general vital condition of the fowls.

To this factor of constitutional vigor as affecting hatching quality of eggs the data of the present paper add another, viz., inheritance. Hatching quality of eggs is in some measure a "bred in the bone" character of poultry, and must be reckoned with as such. The existence of this factor manifests itself in two ways in our results: one by the persistence of relatively the same degree of hatching quality in the same bird in successive years, indicating to what an extent it is a character innate in the individual, and the other in the actual inheritance of this character. But if hatching quality is inherited it means that it is a character which can be improved by selective breeding. This we believe to be the case and in the breeding work of the Station this idea is being put into practice.*

The fact must not be lost sight of, however, that to be effective this selection cannot be of the "mass" character. It has been seen that *in the mass* there is no sensible inheritance of hatching quality from parent to offspring. The point is that some *individuals* possess the capability of transmitting good hatching quality of eggs to their progeny, or are prepotent with respect to this character. Other individuals, *which may be themselves just as good in respect to hatching quality of eggs,* totally lack the ability to transmit this quality to the progeny. Simply selecting birds indiscriminately on the basis of *their own* hatching records is as likely to get the latter kind of birds as the former, and will make no permanent improvement in the strain. But if a system of pedigree records is at hand an advance with each generation is possible because one by one those "blood lines" in which the transmitting ability or prepotency is absent can be discarded in favor of those in which it is present. In passing it may be said that these considerations apply with exactly the same force to breeding for egg production as to breeding for hatching quality. This point will be more fully discussed in a future paper.

The data presented in this paper emphasize the importance in practical breeding work of (a) the selection of breeding stock with reference to constitutional vigor or vitality, (b) the maintenance of the breeding birds in a vigorous condition by proper methods of housing and feeding, and (c) paying attention to the actual breeding ability (as shown by hatching performance) of the stock and the exercise of selective breeding to improve this character.

It is, of course, obvious that the present paper covers only a small part of the general subject of the factors which influence

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* Cf. a paper by the present writers having the title "Selection Index Numbers and their Use in Breeding" appearing in Amer. Nat. Vol. XLIII, No. 511, July 1909, pp. 385-400.

the fertility and hatching quality of eggs. There is need for much further work on the subject. In particular a careful and detailed study of the biological factors which underlie the observed *individuality* of both male and female birds with respect to these characters would be highly desirable. Such a study needs to be undertaken from several standpoints. One of the most urgent needs here is for a detailed study of the mating and general sexual behavior of the domestic fowl. Is the reason for the infertility of a particular hen's eggs some defect in the eggs themselves, or is it merely the result of a failure of the males ever to tread that particular hen? In other words, to what extent does preferential or assortative mating occur? Another question which needs study is as to what relation exists between frequency of copulation and fertility of eggs. Does the male whose copulations are very frequent produce a better average record of fertility than the one which treads the hens less aften? These, and many other related questions which they suggest are all problems which deserve and will receive thorough investigation.

ANNOTATED BIBLIOGRAPHY OF LITERATURE DEALING WITH FACTORS INFLUENCING THE FERTILITY AND HATCHING OF EGGS.

In preparing this bibliography the extensive literature dealing with incubation and with all of the factors which, acting during incubation, influence the hatching of eggs has been omitted as falling outside the limits of the present discussion. The attempt has been made here to include only original papers of intrinsic importance (i. e., such as really contribute something to the subject). No effort has been made to include (a) general discussions of fertility and hatching which do not contribute new data or ideas, (b) textbooks and general treatises on the embryology of the chick which incidentally discuss the fertilization of the eggs (the only exception here is the latest and best of such works, viz., that by Lillie), (c) general treatises on poultry husbandry or some of its phases, (d) classical or medieval literature containing allusions to poultry. It is not to be hoped that, even in the restricted field covered, the bibliography is complete, but it is hoped that few contributions of importance have been overlooked. It is published simply in the belief that it will prove useful as a nucleus for a subsequent and more complete bibliographical resume of the subject treated.

Anon. 1894.

Egg Fertility.

Agrl. Student, Vol. I, No. 1, pp. 6 and 7.

Data on influence of duration of mating on fertility of eggs.

———. 1909.

Experiments at Llangamarch Wells.

Monthly Hints on Poultry (London, Eng.) Vol. IV, No. 35, July, 1909.

———. 1909.

Experiments at Llangamarch Wells Poultry Farm.

Monthly Hints on Poultry. Vol. IV, No. 37, Sept., 1909.

These two papers give detailed reports of some experiments carried out by A. J. Odam to determine very precisely (in hours) the duration of the period elapsing between mating and fertility. In one case a chick was produced from an egg laid 72 hours after mating.

———. 1906.
Fertility of Eggs.
Experiment Station Work, No. XXXIV (Farmers' Bulletin No. 251) pp. 18-22.
Gives an excellent brief summary of the published data on factors influencing fertility, up to the date of its appearance.

Atwood, H. 1909.
A Few Preliminary Experiments on the Effect of the Age of the Parents upon the Vigor of Chickens.
Amer. Breeders' Association. Vol. V, pp. 385-389.
Comparison of pullets' and hens' eggs with reference to fertility and hatching quality.

Barfurth, D. 1896.
Versuche über die parthenogenetische Furchung des Hühnereies. Arch. f. Entwicklungsmech. Vol. 2, pp. 303-351.
Data on persistence of fertility after removal of male. Detailed account of the results of incubating "virgin" eggs. Data on the vitality of spermatozoa.

Blount, Mary. 1907.
The Early Development of the Pigeon's Egg with Especial Reference to the Supernumerary Sperm Nuclei, the Periblast and the Germ Wall. Biol. Bulletin. Vol. XIII

———. 1909.
The Early Development of the Pigeon's Egg, with Especial Reference to Polyspermy and the Origin of the Periblast Nuclei. Jour. Morphol. Vol. XX, No. 1, pp. 2.64.
This and the preceding paper deal with certain phases of the morphology of the fertilization of the egg in birds.

Brittin, W. F. 1905.
A Hatching Experiment.
Rel. Poult. Jour. Vol. 12, No. 2, p. 237.
Effect of ration on hatching of eggs, particularly influence of feeding oyster shell. Obtained better results without it.

Brown, E. T. 1906.
Some Practical Observations on Fertile Eggs.
Farm Poultry, Vol. XVII, No. 2, p. 29.
General discussion.

Buffon. 1772.
Histoire naturelle des oiseaux.
Paris. Vol. III.
"Le coq," pp. 88-186. Pl. II. Has much interesting discussion regarding fertility, fecundity and incubation. Many references to medieval and classical literature regarding poultry.

Curtice, C. 1903.
Poultry Experiments.
R. I. Expt. Rept. for 1902. pp. 333-373.
Data on fertility and hatching of eggs in different seasons of year. No very definite conclusions.

Dryden, J. 1897.
Poultry Experiments.
Utah Agric. Expt. Stat. Bulletin 51, pp. 1-33.
Gives some data regarding the influence of the following factors on "fertility:" (a) season, (b) age of breeding stock (females), (c) exercise, (d) length of time eggs have been kept. No statement as to whether embryoes dying early were distinguished from truly infertile eggs. Results not conclusive.

————. 1907.
Poultry Experiments.
Utah Agric. Expt. Stat. Bulletin 102, pp. 203-237.
Gives data on the effect of housing on the fertility of eggs.

Féré, Ch. 1901.
Réponses à quelques questions du questionnaire concernant les oeufs et l'incubation chez les oiseaux domestiques.
Ornis, Vol. 11, pp. 425-426.

Gilbert,, A. G. 1901.
Report of the Poultry Manager.
Canada Expt. Farms Rept. 1900, pp. 251-277.
Conclusion is reached, but not supported by numerical data, that winter laying and confinement adversely affect the hatching quality of eggs.

———. 1904.
Report of the Poultry Manager.
Canada Expt. Farms Rept. 1903, pp. 239-255.
Some data on effect of housing conditions on fertility and hatching quality of eggs.

———. 1905.
Report of the Poultry Manager.
Canada Expt. Farm Rept. 1904, pp. 283-311.
Data on duration of fertility after removal of male. Maximum observed 11 days.

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BULLETIN No. 169.

TWO RECENT EPIDEMICS OF LATE BLIGHT AND ROT OF POTATOES IN AROOSTOOK COUNTY.

W. J. MORSE.

The summer and fall of 1907 and that of 1909 presented ideal weather conditions for the development of late blight and rot of potatoes in Aroostook county and some other parts of Maine. As a direct result of these weather conditions and the consequent development of the blight, by very conservative estimate, the loss in diminished or damaged crops in each of these years amounted to several hundred thousand dollars. Much of this loss occurred on fields where the owners were attempting to spray with bordeaux mixture, and in many cases felt that they were spraying carefully and thoroughly.

During the season of 1907 the writer was engaged in carrying on spraying experiments in Houlton and in Foxcroft, both to test the relative efficiency of thorough spraying as compared with that usually practiced by most growers, and to test the relative efficiency of certain substitutes for standard bordeaux mixture. No such experiment was conducted in 1909 but during both seasons the conditions in various parts of the State were closely observed and carefully followed up as soon as weather conditions indicated that an outbreak was imminent. Repeated visits were made to the various potato growing sections, particularly where blight was appearing and careful notes were made of spraying operations and the resulting successes or failures therefrom.

The results secured from the experiments of 1907 and the field observations during the two seasons of severe epidemic blight and rot, taken in connection with results previously obtained by Director Woods of this Station under similar conditions,* and at other experiment stations, particularly those obtained at the Vermont and the New York State Station lead to but one conclusion, namely: *that from 75 to 95 per cent of the loss from blight and rot even under the severe weather conditions experienced during the two growing seasons under consideration is unnecessary and unwarranted.* In fact there are few plant diseases which are so completely and thoroughly controlled by bordeaux mixture as the late blight of potatoes and the resulting decay of the tuber caused by the same fungus.

Granted that the above statement is true, why has there been an apparent almost universal failure from spraying during the season of 1909, and to a somewhat similar extent in 1907, instead of universal success? There are several factors responsible for this condition of affairs, some of which it is proposed to discuss in some detail. The general lack of knowledge of the nature of the fungus causing the disease and its method of distribution, the intimate relation of the development of the disease to weather conditions, improperly made bordeaux mixture, inefficient or improperly constructed spraying machinery, resulting in imperfectly covering the foliage, too few applications, or if the number of sprayings are sufficient, applied at the wrong time, digging and storing too early if blight gains a foothold on the foliage.

RELATION OF FUNGUS TO PLANT AND SPRAY TO FUNGUS.

The late blight of potatoes is caused by a parasitic fungus, a low form of plant life, which is made up of minute, almost colorless threads which permeate the tissues of the healthy leaf, killing the living cells of which the leaf is made and drawing its nourishment therefrom. In the summer when once established on a few leaves in a field it spreads very rapidly, if weather conditions are right, by means of little reproductive bodies called spores, which every blighting leaf produces by thousands, if not millions.

Certain soluble copper compounds in exceedingly minute quantities are almost immediately fatal to these little spores as soon as solutions containing such copper salts touches them. The efficiency of bordeaux mixture as a fungicide depends upon

* Me. Agric. Expt. Sta. Bul. 73 (1901) and Bul. 87 (1902).

the copper sulphate or blue vitriol used in its preparation. The lime when added makes a very finely divided, but temporarily insoluble compound suspended in water which we call bordeaux mixture. The lime forms with the copper salt, compounds which slowly become soluble and makes an adhesive mixture, when dry, which slowly gives up the copper—fast enough to kill the fungus spores but not fast enough to damage the potato leaves. A very weak solution of copper sulphate would have the same effect but it would have to be applied daily in rainy weather. Spraying then serves a two-fold purpose, primarily to cover the entire healthy leaf with a thin protective film of bordeaux mixture which is constantly giving up minute quantities of soluble copper salts which kill all blight spores which find lodgment thereon before they can germinate and enter the leaf, and secondly if the blight is already started the spray may at the time of application kill many millions of spores which are ripe and ready for distribution.

The relation of the fungus to the disease is better understood by reference to Fig. 15, page 169. At the left is seen a section of an infected potato leaf, highly magnified. It will be seen that the leaf is made up of many irregularly shaped units or cells. Those above and below being flattened and forming a protective layer. In the lower layer certain lip-shaped openings are seen. These are the breathing pores or stomata through which the fungus most easily enters the leaf. It is possible, however, for the germ tube of the fungus to penetrate directly through the cell wall as shown in the illustration. Running between the cells of the leaf may be seen the threads of the fungus. In the drawing these fungus threads, though naturally nearly colorless, have been colored to make them stand out more distinctly. Projecting downward from the underside are two different appearing bodies. The tapering, pointed ones are natural leaf-hairs. The others, thread-like and branched and bearing the knob-like bodies, are the fruiting organs of the fungus, each little knob being a spore. The top row at the right shows the stages in the development of a spore. After the spore is formed it may divide up into from 6 to 16 little swarm spores, each provided with two little hair like processes by which it is enabled to swim around in drops or films of rain or dew. Later these lose their swimming organs and begin to throw out a germ tube. If the swarm spore is lodged upon a potato leaf the tube usually enters the leaf through the breathing pores, branches and permeates the tissues, killing them as it goes. Thus it produces the characteristic blotches on the leaves as shown by Fig. 16, page 171. The spores may be washed down into the soil also and infect the tubers in the soil, or if the crop is dug while the tops are still partly green, but blighting badly, the tubers may become infected at this time and the rot develop in storage as in the season of 1909.

The remaining illustrations of Fig. 15, page 169, show the stages in the formation of swarm spores and how they finally germinate and enter the leaf. After a small dead area is produced the fungus throws out the fruiting organs as illustrated on the large section of the leaf and the process already described is repeated over again. This makes plain why it is absolutely necessary to cover each and every potato leaflet with a thorough protective coating of bordeaux mixture, and why spraying partially or improperly done may be practically useless.

When potatoes are blighting badly, if the margins of blighting spots are examined on the under sides of the leaves a delicate white fringe may be seen. (See Fig. 16.) This is made up of hundreds of little fruiting organs each bearing from one to several fruiting bodies, each of which will divide into from 6 to 16, usually about 10, swarm spores and *each of these swarm spores capable, under proper conditions, of producing another blighting leaf or capable of causing the destruction of a merchantable tuber.* It is thus easily seen how that one blighting leaf may produce sufficient spores to infect every hill of potatoes on an acre of land, provided all the spores produced could come in contact with these plants. This explains why a field, apparently free from blight, may be found to be badly affected only a few days later, and how potatoes showing a comparatively small amount of blight on the foliage before being killed by frost or before being dug, may develop a large amount of rot in the field or in storage as the case may be. In the first instance the blight existed for some days on the lower and more shaded leaves (where it would not be noticed by the ordinary observer) till a day or two of favorable weather occurred. Then a large crop of spores were produced which infected the plants on the whole field. In the case of tuber

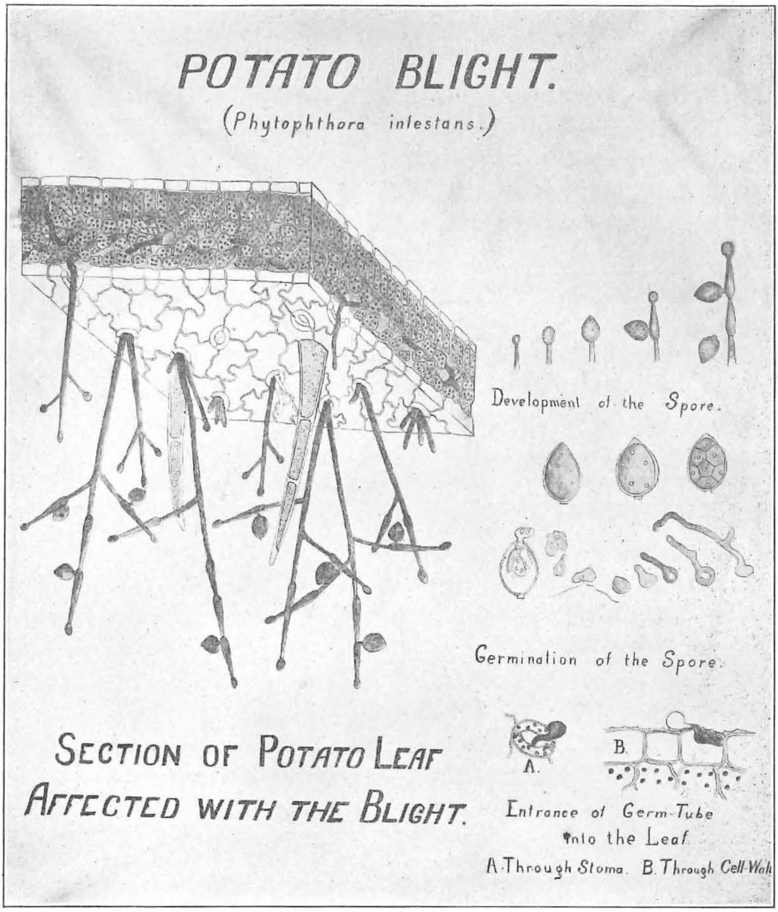

FIG. 15. From drawings by De Bary, Ward and Jones. The fungus threads and spores, though nearly colorless, are colored in the drawing to make them stand out more distinctly.

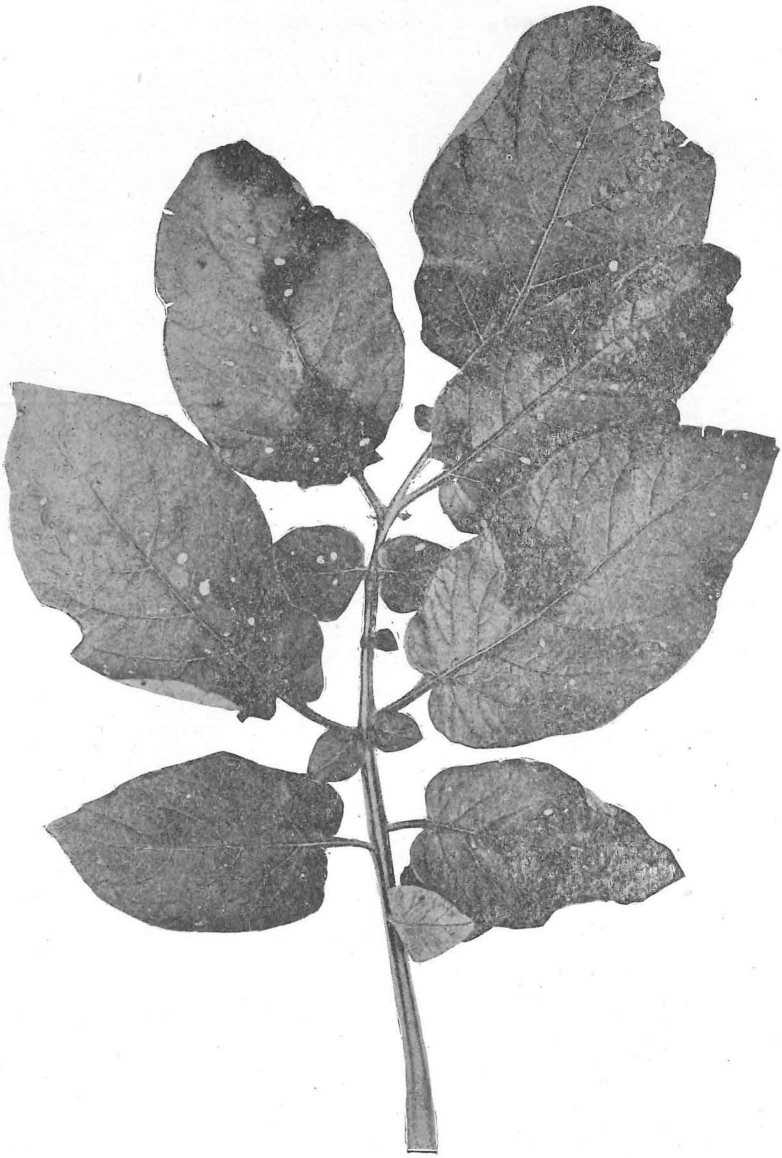

FIG. 16. Potato leaf attacked by late blight, as shown by the darkened areas on the leaflets. One of the large leaflets on the right is turned bottom up to show the delicate fringe of spore producing organs.

infection the blight may be well started on the leaves and a heavy rain wash the spores down onto the tubers in the soil, and decay at once starts up, or if the tops are producing an abundance of spores when the crop is dug, the weather cloudy or rainy, the atmosphere humid, and the tubers after being showered with millions of spores from the blighting leaves are at once picked up and stored in large bins without being allowed to dry off infection is almost sure to result as in the fall of 1909.

WEATHER CONDITIONS AND THE DISEASE.

Rain, dew, wind and insects are the chief agencies for distributing the disease. So far as known the only way that the crop of any one year is first infected is from planting diseased tubers in which the fungus has remained semi-dormant over the winter. Hence the first blow to be struck in the fight against this disease is to plant nothing but healthy, sound tubers.

Late blight revels in moist, cloudy weather and, contrary to the general notion, in relatively cool or moderate temperatures.* The spores are produced in greatest abundance in rainy or cloudy weather and are extremely susceptible to drying and hence one need never fear an outbreak in dry, hot, sunshiny weather. Wet weather is almost sure to bring it on unless spraying is kept up during the continuance of such weather. In fact there is no other disease of our common field or garden crops where a careful observer can predict with more accuracy its probable appearance or absence. From a financial standpoint this is a point that no progressive potato grower should overlook. While spraying operations should not be delayed till favorable conditions for blight appear, how thoroughly they are followed up may well be governed by weather conditions if one thoroughly understands the significance of the latter. In this latitude late blight seldom occurs to any extent before the last of July, hence the main fight against it must be conducted throughout August and September, *even up to the very day the crop is dug or the plants are killed by frost.* As will

* "Humid, still days, with a temperature of about 73° F. Above 78° F. and below 50° F. there is practically no germination of the spores." Fraser, Samuel, The Potato, p. 114, Orange Judd Co., N. Y. (1908).

be seen later this latter recommendation is not in accordance with the most common practice where spraying operations are suspended much too early in the season.

PROPERLY MADE BORDEAUX ESSENTIAL.

In attempting to point out the factors which have been found to be responsible for most of the failures to secure complete protection from late blight and rot by spraying with bordeaux mixture, the methods of preparing the mixture, which are commonly practiced, will first be considered. Unfortunately lack of ability to implicitly follow directions is a common fault of humanity and the maker of spray mixtures is no exception to the rule.

Bordeaux mixture as now recommended is the result of over 20 years of investigation and experimentation by some of the most careful workers in this country and in Europe and the formula recommended for potatoes conforms to the general consensus of opinion among these investigators. Anyone who departs from the formula, or who does not follow carefully the directions for preparing the spray should bear in mind that he alone is responsible if his bordeaux mixture fails to keep off the disease on account of being too dilute or, if unproperly prepared kills the foliage of the potato itself.

A rather surprising state of affairs was discovered when the methods of making of bordeaux mixture by potato growers in Aroostook county was investigated. The amount of copper sulphate used for each 50 gallons of spray varied from 2 1-2 to 12 or 15 pounds. Very commonly indeed, with a desire to do more efficient work, the amount of copper sulphate is increased to 8 and 10 pounds to 50 gallons of spray without any attempt made to more thoroughly cover the foliage by means of more nozzles per row or better adjustments of the nozzles on the sprayers. Fortunately the potato plant is much less susceptible to such strong sprays than fruit trees which would be ruined by such treatment.

It is a common practice, also, to use much more lime than copper sulphate—the maker reasoning that lime is inexpensive and a considerable excess may do good and certainly will do no harm. The function of the lime is to unite with the copper sulphate and convert it into temporarily insoluble compounds, and it is doubtful if a large excess of lime adds to the fungicidal value of the mixture. Experiments have shown, however, that an excess of lime materially decreases the adhesive qualities of the mixture. "Those mixtures are best in adhesiveness, and in efficiency, in which the approximation of equal parts of copper sulphate and lime are maintained." *

One season's experiments conducted at this Station indicate that the prepared or hydrated lime will give equally good results as stone or lump lime used in making bordeaux mixture, judged by the appearance of the foliage and by the yield per acre at harvest time.**

Guess work is very frequently substituted for weights and measures, and the amount of lime and copper sulphate, or the stock solutions of these ingredients in a given amount of spray varied with the ability or judgment of the maker. One remarkable case was found where the individual prepared his stock solution of copper sulphate as follows: 50 pounds of the crystals were placed in a sack and suspended in a 50 gallon barrel of water in the usual way and allowed to dissolve. Then as fast as 5 or 10 gallons of this stock solution were taken out an equal amount of water was put in to replace it and this continued through the season. From time to time another 50 pounds of blue vitriol would be dissolved in the liquid. Thus it will be seen that except for the first lot of stock solution removed none used was of standard strength throughout the season. Bordeaux mixture prepared from such stock solutions cannot be expected to produce satisfactory results.

Properly prepared bordeaux mixture should contain 5 pounds each of copper sulphate and lime to 50 gallons of water, and the ingredients should be weighed and measured. The copper sulphate should be dissolved and the lime slaked in separate vessels. *Never pour concentrated solutions of lime and copper sulphate together.* The most adhesive and satisfactory mixture is prepared by diluting each strong solution with half of the water and then these two *dilute* solutions should be united quickly and thoroughly mixed at once. Full directions for preparing bordeaux mixture are contained in a circular entitled

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* Crandall, C. S. Ill. Exp. Sta. Bul. 135, p. 218.

** Woods, C. D. Me. Expt. Sta. Bul. 98, p. 191-200 (1903).

"How to Fight Potato Enemies" which will be sent on application to the Maine Experiment Station.

Properly prepared and applied bordeaux mixture is a remarkably adhesive compound. If it once becomes dry on the foliage, which only requires a short time, it will be effective and resist excessive washings of rain for some time. The writer has preserved specimens of potato leaves taken at Foxcroft October 5, 1907, which are well coated with bordeaux mixture yet none had been applied to them for 38 days previously. At Orono during this period 6.66 inches of rain fell; 2.18 inches of this fell in 24 hours. These leaves had been thoroughly sprayed 6 times during the season. If bordeaux mixture does not show these adhesive qualities there is some fault with the method of preparation which should be remedied.

IMPROPER SPRAYING.

During a four-day trip over several of the larger potato growing towns in Northern Aroostook shortly after the blight had become well established, just two fields were seen which had been properly sprayed, yet some two or three thousand acres of potatoes were inspected. These conclusions as to spraying methods were arrived at by noting the condition of the fields, inspecting the spraying machinery and questioning the owners as to the methods of preparing the mixture, number of applications, time of application, etc.

The sprayers as a rule are deficient in that they do not carry enough nozzles and do not have sufficient adjustments. Bearing in mind the nature of the fungus which causes the disease, and the millions of spores which it produces, and bearing in mind also that each and every one of these spores is capable of infecting from one to several other leaves or tubers under right conditions, it will be seen that under some circumstances *a sprayer which does not cover every leaf with a thin film of spray may be practically useless* unless this defect can be remedied. The results obtained from such sprayers being so unsatisfactory that spraying often becomes discredited with the user and is abandoned. The majority of sprayers in use are equipped with single nozzles to the row which cannot be raised much above the tops of the plants, when the latter are full grown. Such a sprayer used at the time when late blight is rife, and when the tops cover the ground, covers as a rule less than one-third of the foliage. All the remaining leaves being unprotected are killed with blight and millions of spores are washed down into the soil to infect the tubers. No matter how many times or how often such a sprayer is used on a field the resulting rot may be as great in seasons like those of 1907 and 1909, as if it had not been used at all.

EFFICIENT SPRAYERS AND SPRAYING.

One nozzle alone to a row should never be used on a potato sprayer when the tops grow as large as they do in Maine, except when the plants are small. When the plants are large, two or more nozzles should be used to the row, so arranged that the cones of spray will interfere with each other as little as possible, thus covering the widest possible area, or a strip at least 3 feet wide when the foliage covers the ground. There should be an up and down adjustment, sufficient so that the whole battery of nozzles may be raised as the plants grow taller. A side to side adjustment, to be varied with the distance between the rows is desirable also. Those sprayers which have additional nozzles which direct the spray sidewise into the tops from between the rows possess a distinct advantage in that they not only tend to more thoroughly cover the leaves but they also tend to reach the very ones which are first attacked by blight—the lower and more shaded leaves and those resting on the ground.

The finer the spray and the greater the pressure with which it is thrown the more effective will be the work. A very fine mist forcibly applied covers the leaf with a thin film which adheres, while even greater applications of spray applied in coarse drops may be less effective, first because it is not so evenly distributed and, secondly, because there is much more danger of the larger drops running together and dripping off the leaves. High pressure also tends to drive the mixture in among the leaves thus touching the lower leaves, and more effectually coating both sides of the leaves which is very important.

The Vermorel type of nozzle appears to be the most satisfactory and is the one most used by our growers. New brass caps should be applied to these each year, however, as the small holes in these soon become worn and throw too coarse spray as a result. In use these nozzles should be carefully watched to see if each and every one is constantly working and throws a spray of maximum fineness. If not the machine should be stopped and the difficulty corrected. In purchasing a sprayer care should be taken to determine if the pump is powerful enough to throw a fine mist when the maximum number of nozzles necessary are in use. Sprayers equipped with hand pumps and designed to cover three or four rows at a time as fast as a horse can walk are not recommended. In practice the pressure usually maintained on these pumps is much too low to do effective work.

Unfortunately there has crept into our literature on potato spraying the statement, and the notion is quite firmly grounded in the minds of many of the potato growers and apparently in the minds of makers of potato spraying machinery as well that 50 gallons of spray per acre is a sufficient and proper amount to apply. A little thought will show how erroneous it is to conduct spraying operations on such a basis when the object is to cover the entire foliage. When the tops are small 50 gallons will usually do this, but it is absolutely impossible to do thorough work with this amount of spray when the plants are full grown. *Every leaf should be covered at each spraying, regardless of whether it takes 50, 100 or 150 gallons of bordeaux per acre.* In bad seasons like those under consideration it is advisable during the times when conditions are very threatening to go over the field twice at each spraying, in opposite directions on the row. However on account of danger of loss from drip, the second application should not be put on till the first is dry. This procedure is by all means recommended in place of using a stronger mixture, if more thorough work is desired.

WHEN TO SPRAY.

Very commonly men were found who did not spray during rainy weather as they considered it to be useless. This also is a mistaken notion. As has already been pointed out it is during rainy weather that spore production is the most rapid and infection is most sure to take place. Therefore, it is conceivable that one spraying during rainy weather may be more beneficial, even though it be washed off within a few hours as is supposed to be the case by most people, than one applied during bright, clear weather. However, as previously stated, properly prepared bordeaux mixture is remarkably adhesive and will stand considerable washing if once dried on the foliage. Hence, *never omit to spray on account of rainy weather,* provided the rain stops long enough to apply the mixture and to allow it to dry on. There is often no excuse for the man who loses his crop by blight on account of rainy weather. If everything is in readiness it is a very exceptional season when the rain does not stop long enough to spray at least a part of a field at a time and to allow the spray to dry on after it is applied.

In 1909 many failures can be traced directly to too few sprayings and in every case investigated the spraying was discontinued much too early, considering the nature of the season. Large numbers of instances were found where the fields were sprayed but three times and cases where only two or even one application was made were by no means rare. Where these few applications were made, they were invariably made too early in the season, and while they doubtless did some good they were by no means distributed to the best advantage.

If one thoroughly understands the weather conditions which are likely to produce late blight it is possible to so distribute 3 or 4 thorough sprayings in such a manner as to give practically complete protection to the crop in ordinary seasons, but it would doubtless be impossible in such seasons as those of 1907 and 1909. If only 3 sprayings are made in this section it would usually be best to wait till late in July or the first of August before beginning. However, for the general grower who has not the benefit of long experience or the advice of a trained observer on these points it is unsafe to depend upon so few sprayings in a season. It has been the policy of this Station to recommend that spraying be begun when the tops are 6 to 8 inches high and repeated every 10 days (every week, if the weather is very cloudy or rainy)* until the last of August or the first of September, or later if necessary. In the light of the experience obtained during 1909 the only modification

* Cases might occur in exceptional seasons when the rains are very heavy and conditions very threatening where two or even three of the sprayings might be made at a less interval between.

of these recommendations suggested is to lay particular stress upon the clause "or later if necessary." In ordinary years the tops are killed by frost early in September and there is enough spray still adhering to them to furnish adequate protection till this takes place or the crop is dug. This year the tops were partially killed late in August but much of them were untouched till digging time. As a result of inefficient spraying, combined with excessive washing of rain, these were slowly dying of blight all through September and showering millions of spores onto the water-soaked soil, which resulted in an abnormal amount of tuber infection. Hence, *the tops should be protected by spray up to the day they are killed by frost or the crop is dug,* particularly in rainy seasons. As far as late blight is concerned some of the earlier sprayings might be dispensed with, but these early sprayings are necessary as protection against the early blight and ravages of the flea-beetle.

SPRAYING IS EFFECTIVE.

Spraying must be looked upon as a form of insurance but records covering a series of years show that it is the most profitable kind of insurance. Long continued experiments at the New York and Vermont Experiment Stations show that spraying is seldom conducted at a loss, after allowing for time and materials, and frequently it is the means of saving a large per cent of the crop. Records of yields of sprayed and unsprayed plots side by side covering a period of 17 years show an average increase of 113 bushels per acre or 68 per cent as a result of spraying. The greatest increase in any one year was 224 bushels and the least was 32 bushels per acre.* The writer upon Commissioner Gilman's farm in Foxcroft in 1907 secured an increase over unsprayed plots of 231 bushels of sound tubers per acre from 6 double sprayings, 162 bushels from 6 single sprayings, and 186 bushels from 3 double sprayings plus one single spraying. He also secured from 6 double sprayings on the John Watson farm at Houlton 420 bushels of sound tubers on a measured acre with no decay following in storage, while fields in this vicinity either unsprayed or less thoroughly protected were showing from 25 to 75 per cent of

* Jones, L. R. and Giddings, N. J., Vt. Exp. Sta. Rep. 20, p. 339 (1908).

rot. Other well sprayed fields nearby were equally well protected. The plots at Foxcroft which had 6 double sprayings gave 0.6 per cent of rot while those at Houlton showed 9.1 per cent. There is no doubt that equally good results might have been obtained on nearly every field in Aroostook county in 1909 if they had all received as thorough spraying. In fact a few cases, particularly in the vicinity of Houlton, were found where spraying had been thoroughly done. Here the foliage was fully protected through the season and little or no rot was found on digging. Though dug early, two of these lots showed no rot and one other a slight amount after about three weeks of abnormally warm weather in storage.

These demonstrations that thorough spraying with bordeaux mixture will give entire protection from the ravages of late blight are by no means new in Maine. Nine years ago Director Woods of this Station secured with four sprayings at Houlton increased yields valued at over $40.00 per acre at the current price of potatoes at an estimated expense of $2.50 per acre.*

DECAY IN STORAGE 1909.

The season of 1909 in Aroostook county demonstrated again on a large scale what has previously been shown to be true experimentally, namely; that where potatoes are blighting it is unsafe to dig and store the crop for at least ten days after the tops are killed by frost, and even a longer delay will do no harm.**

The crop on many fields where the blight had secured more or less of a foothold was dug early in September. In many cases these tubers were practically all sound when dug but the blighting leaves were producing spores abundantly which were showered on the potatoes. These potatoes on account of the excessive rains came out of the soil wet and in most cases were not allowed to dry off before being picked up and placed in barrels, thus furnishing ideal conditions for infection by late

* Woods, C. D. Me. Expt. Stat. Bulletin 112 pp. 2-5 (1905).

** Jones, L. R. and Morse, W. J. Repts. Vt. Exp. Sta. 15, pp. 219-223 (1902); 16, pp. 161-163 (1903).

See also Proceedings Society for Promotion of Agricultural Science (1904).

Woods, C. D., Me. Expt. Stat. Bulletin 112, pp. 2-5 1905).

blight.* They were then placed in storage or shipped to market. The weather following was quite warm and humid. As a result of this infection, much of the stock which went to market was a total loss, and in some cases the results in storage were nearly equally bad. If a repetition of this disaster is to be avoided, it will be necessary to first keep the blight off by thorough spraying such as has been previously recommended in this article. If blight does gain a foothold to any extent, if possible do not disturb the crop till at least ten days after the tops are killed by frost, two weeks will be better. There will be some rot in any event if the tops show much blight, but the net result of sound tubers in the end will be largely in favor of late digging.

OTHER CAUSES OF DECAY.

In closing this discussion it should be remarked that there are present in the State two other potato diseases which cause decay of the tuber and which cannot be prevented by any amount of spraying. There is no evidence, however, up to the present time, that either of these diseases have been a contributing factor to the epidemics of tuber decay which have occurred in Maine. One of these is the Fusarium dry rot which differs from the late blight rot in that it nearly always begins at the stem end of the tuber in the form of a brownish or blackened ring a short distance below the surface, and the later stages of the rot are more or less different also. The other tuber decay is a soft bacterial rot caused by the same organism which produces the Blackleg disease of the stem. Potatoes affected by the late blight fungus usually develop a soft, stinking rot in storage under moist, warm conditions, but the writer believes that most of this decay is due to a secondary infection by ordinary saprophytic soil bacteria which otherwise could not attack the healthy tubers themselves.

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* This is not a mere supposition for the writer has assisted in performing an experiment where these conditions were producted artificially with identical results. See Jones, L. R. and Morse, W. J. Vt. Exp. Sta. Rept. 18, pp. 284-287 (1905).

Director Woods also cites a similar experience as occurring in 1902. See Me. Expt. Sta. Bull. 112, p. 1 (1905).

SUMMARY.

Adverse weather conditions were responsible for severe epidemics of late blight and rot of the potato in Maine, particularly in Aroostook county, during the seasons of 1907 and 1909. (P. 165.)

Blight is caused by a parasitic fungus which spreads through the leaves, killing the tissues as it goes. Each blighting leaf produces thousands of minute fungus spores each capable of infecting another leaf, or a potato tuber. (P. 166.)

Bordeaux mixture forms a protective film on the healthy leaves, kills the spores which fall thereon, and also kills those produced on the diseased leaves at the time of application. (P. 166.)

Much, if not all, of the disease comes originally from planting diseased seed tubers. Rain, dew, wind, insects, etc., are the chief agencies in disseminating the spores. (P. 173.)

Late blight is most destructive in rainy or cloudy weather. Hot, dry, sunshiny weather is fatal to the blight spores, and outbreaks of the disease never occur under these conditions. (P. 173.)

Much of the bordeaux mixture used is carelessly and improperly prepared. Only standard bordeaux mixture containing 5 pounds of copper sulphate and 5 pounds of lime to 50 gallons of water should be used. The most adhesive mixture is made by diluting the copper sulphate and lime solutions each with half of the water and then quickly and thoroughly mixing. *The ingredients should be weighed and measured and the proportions should not be varied.* (P. 174.)

The sprayers carry too few nozzles per row and do not have sufficient adjustments of nozzles. Pumps should be powerful and nozzles in such condition that the spray will be delivered forcibly and in a fine mist. (P. 176.)

Fifty gallons per acre is not enough spray to use when the plants cover the ground. Every leaf should be coated at each application. When conditions are very threatening, go over the rows a second time in opposite directions, after the first application becomes dry. (P. 178.)

Never omit spraying on account of rainy weather, this is the one time when spraying is most needed. (P. 178.)

Under Maine conditions it is necessary to begin when the tops are 6-8 inches high and spray every week or ten days till the tops are killed by frost or the crop harvested. If weather conditions are favorable, sprayings may be less frequent early in the season, but not through August and September. If the conditions are very threatening spraying at less intervals is advised. Much loss from blight and rot results from too few sprayings and stopping too early in the season. (P. 179.)

Thorough spraying under very adverse weather conditions has been found effective both in Maine and elsewhere. Thoroughly sprayed fields in Aroostook county in 1909 showed very little loss from either blight or rot. (P. 180.)

Much storage rot in 1909 resulted from infection at digging time. If blight has not been kept off the foliage wait at least ten days, if possible, after the tops are killed by frost before harvesting. (P. 181.)

Two other tuber decays occur but these were not contributing factors in the two epidemics. (P. 182.)

BULLETIN No. 170.

APPLE DISEASES CAUSED BY

Coryneum foliicolum Fckl. and *Phoma mali* Schulz et Sacc.

CHARLES E. LEWIS.

Careful examination of the fungi associated with diseases of the apple in Maine shows that they may be divided into classes according to the extent of their parasitism. Some of these fungi have been carefully studied at a number of different places and have been shown to be the cause of disease under the conditions which exist in those localities, others have been repeatedly shown to be saprophytes, others have been either regarded as saprophytes or have not been studied sufficiently to determine to what extent they are parasites, and still others which have been usually regarded as parasites because of their association with diseased conditions are found in some cases to be saprophytes.

Since under certain special conditions, a fungus which is usually saprophytic may take on a parasitic habit and a fungus which is a parasite under one set of conditions may lose the power to cause disease under other conditions, it becomes necessary to study the fungi associated with the diseases of any host plant in a given locality as to their ability to cause disease. In the studies of apple diseases which are now under way at the Maine Experiment Station, fungi have been isolated from diseased leaves, wood, and fruit and these fungi are being studied as to the extent to which they cause disease when the different parts of the plant are inoculated from pure cultures.

Most of the results of this work will be given in later publications but at the present time it seems desirable to give the results of the study of two fungi. In the literature there is very little reference to either of these as a cause of disease, although each belongs to a genus in which there are species which are parasites of great economic importance.

Coryneum foliicolum Fckl.

This fungus occurs so commonly on leaf-spot of the apple as to suggest the possibility that, in some cases, it may be the cause of that disease. This species seems to be more or less widely distributed as it is reported as common in West Virginia by Hartley (3) and in New Hampshire by Lewis (4). Hartley suggests that it is probable that the fungus which has been reported from several states as *Hendersonia mali* Thüm, is really *Coryneum foliicolum* Fckl. and, if this be true, the distribution of the fungus would be considerably widened. It would be very easy to confuse the two species unless sections were prepared to show how the spores are borne as the spores are very similar. On a single leaf-spot several of the fruiting pustules of the fungus may be found. Spores are produced from these pustules in large numbers and become piled up in black carbonaceous masses which somewhat resemble pycnidia. When sections of these pustules are examined, however, it is found that the fungus belongs to the Melanconiales as shown by Figures 28 and 29.

Hartley (3) has made some study of *Coryneum foliicolum* in connection with a more thorough study of *Coniothyrium pirina* (Sacc.) Sheldon. He grew the fungus in pure culture and made some inoculations but came to the conclusion that *Coryneum* is less actively parasitic than *Coniothyrium*.

On account of the frequent occurrence of this fungus on leaf-spot in Maine orchards in 1908, the writer felt that further investigation was desirable. This seemed more necessary when it was found that spores similar to those found on the leaf-spots occurred very frequently in cankers on apple branches. Cultures from these spores showed that the fungus in the cankers and the one on the leaf-spots were identical.

INOCULATION EXPERIMENTS.

Experiments were carried on to determine the extent of parasitism of the fungus on leaves, wood, and fruit of the apple. Material from pure cultures was used in making all inoculations. The abundant production of spores in culture, and the fact that the spores germinate in a few hours in water should make this fungus a favorable one to use in infection experiments.

For inoculation of leaves, seedlings grown in the greenhouse, trees one year from the bud brought into the greenhouse early in the spring and grown in pots, and both old and young leaves on branches of bearing trees in the orchard were used. Sterile water containing an abundance of the *Coryneum* spores was sprayed on the leaves with an atomizer. Seedling trees 3 to 4 months old bearing a few leaves were placed in a moist chamber and kept there for a few days after inoculation. The year old trees were also in some cases placed in a moist chamber made by using a tall bell-jar arranged as shown in Fig. 17 with tubing so connected that water dropped on sheets of blotting paper under the bell-jar at such intervals as to make a moist atmosphere.

As a result of these inoculation experiments, it was found that *C. foliicolum* did not grow on uninjured leaves. When spots in the leaves were killed with a heated needle it was found that the fungus developed readily on the dead spots. One week after inoculation of such leaves there were numerous masses of spores on the dead spots which microscopic examination showed to be spores of *Coryneum*. Observations of these leaves for several weeks showed that these spots did not increase in size by the invasion of the healthy tissue by the fungus mycelium. Neither did infections occur on other healthy leaves from spores produced on the dead spots.

The results of these inoculation experiments are made more valuable by the fact that, at the same time that they were being carried on, the writer studied a number of other fungi commonly associated with leaf-spot. *Phyllosticta limitata* Pk., *Coniothyrium pirina* (Sacc.) Sheldon, *Sphæropsis malorum* Pk., and a species of *Phoma* probably *Phoma mali* Schulz. et. Sacc., were tested as to their ability to cause leaf-spot, and of these it was found that only *Sphæropsis malorum* Pk. caused the disease on uninjured leaves although the other fungi developed readily on dead spots in the leaves.

The first inoculations made to determine whether *C. foliicolum* could develop on living apple wood and thus cause cankers were made May 4, 1909, on a young tree growing in a pot in the greenhouse. Incisions were made in the bark on the branches in 7 places and material of the fungus consisting of both mycelium and spores from a young culture were placed in the incision. These places were then wrapped in moist absorbent cotton to prevent drying out.

One week after the time of inoculation, it could be noted that there was some evidence of growth and at the end of 10 days there was a region of dead sunken bark around each of the inoculated places. The fungus continued to invade the healthy tissue to such an extent that May 20, 16 days after the inoculation, the branches were almost girdled in some places and completely girdled in others. The regions injured by the fungus were 2 to 7 cm. in length. The leaves on the girdled branches were wilted while those on uninoculated branches were green as shown in Fig. 18. Fig. 19 shows two of the cankers enlarged. On the dead bark little black pustules were observed which on examination proved to be the fruiting pustules of *Coryneum foliicolum.* Sections through these pustules were prepared from which Figs. 28 and 29 were taken.

A piece of one canker was cut off and placed in 1-1000 corrosive sublimate for two minutes after which it was thoroughly washed with sterile distilled water. Eight pieces were cut from this canker at various places with a sterile scalpel and placed in plates of prune agar. After one week, the plates were examined and it was found that pure cultures of *Coryneum* had grown from 5 of the pieces while the others showed *Coryneum* which was accompanied in one case by *Alternaria,* in another by *Coniothyrium pirina* (Sacc.) Sheldon and in the third by what is probably a species of *Torula.*

Two of the one-year-old trees in the greenhouse were inoculated at 4 places each May 13, and two others in 4 places each May 18, the same method being followed that was used in the first set of inoculations. One check incision was made in each of the 4 trees. All of the places which were inoculated developed well marked cankers. The small branches were girdled and killed in from 2 to 4 weeks but inoculations on the main stem did not girdle and kill the tree in either case although considerable areas of bark were killed. The check incisions to which no fungus was added soon began to heal over by the formation of callus.

For comparison, inoculations were made May 13 with *Sphæropsis malorum* on 5 trees which were kept under the same conditions as those which were used for *Coryneum foliicolum.*

Sphæropsis did not spread more rapidly than *Coryneum* and did not do greater damage to the young trees. In each case, some of the inoculations resulted in girdling the branch and killing the part above it, and, in some other cases with each, the spread of the fungus was checked by the development of callus. Some inoculations were also made with *Coniothyrium pirina* (Sacc.) Sheldon. This fungus did not invade the healthy tissue but grew to some extent in bark which was injured by the inoculations. In this my results agree with those of Hartley (3) who carried on extensive inoculation experiments with this fungus. *Phyllosticta limitata* Pk., *Cylindrosporium pomi* Brooks, and *Epicoccum granulutum* Penz. gave negative results, the wounds healing over almost as readily as the checks.

Glomorella fructigena (Clinton) Sacc. was also used in making inoculations on 7 of the one-year-old trees in the greenhouse. Edgarton (2) has pointed out that there are two forms of this fungus, northern and southern, and that they differ in cultural characters. Inoculations made with material from cultures which agree with the southern form in the development of perithecia, both in culture and on the inoculated trees, show that this form is much more actively parasitic on the young trees than *Coryneum foliicolum* or *Sphæropsis malorum*. The cultures of this form were obtained from an apple from a grocery in Orono. The northern form which was isolated from both apples and cankers collected out of doors in Orono, grows slowly in culture, has not produced perithecia either in culture or in the cankers and does not spread so rapidly nor do so much damage to the young trees upon inoculation. Nothing has been done in comparing the two forms with *Coryneum* by inoculation of older trees in the orchard but it is expected that this can be done next year.

In order to determine the extent to which *Coryneum foliicolum* is capable of causing disease of branches of apple trees in the orchard, inoculations were made May 21, 1909, in branches one to 3 cm. in diameter on bearing trees. The inoculations were made in the same manner that has been described for the young trees, the inoculated places and check incisions being wrapped in moist absorbent cotton. On the day following the inoculations the cotton was wet and two days later rains and cloudy weather began which lasted two days. Examination two weeks later, showed that of the 20 places inoculated, in all except 2, which seemed doubtful, the fungus was growing and invading the uninjured tissue giving the bark a brown color and a somewhat sunken appearance. Observations from time to time through the summer showed that cankers were developing. The bark was killed in regions 3 to 5 cm. in length which in some cases had almost girdled the branch by September 1. The fungus began to fruit on the dead bark in 3 to 4 weeks after the inoculations. The cankers shown in Fig. 20 were removed September 1. The bark on the affected region has a sunken appearance which comes about through the death of the cambium cells so that the wood and bark cease to grow. There was no dying of bark nor cankered appearance from check incisions nor from inoculations made with *Coniothyrium pirina.*

June 24, 1909, inoculations were made on large branches of Ben Davis and Baldwin trees. *Coryneum, Sphæropsis* and *Phoma* were used. 16 inoculations were made with *Coryneum,* 6 with *Sphæropsis,* and 11 with *Phoma.* 6 check incisions were made. When these trees were examined September 30, it was found that the checks were almost healed over by callus so that the appearance was healthy. *Sphæropsis* had spread into the uninjured tissue and had formed well marked cankers in each case. *Coryneum* had spread to some extent in 14 of the 16 places but had almost healed over in the other 2. The places inoculated with *Phoma* showed about the same as has been described for *Coryneum,* one place was almost healed over and the others had spread to some extent. One point of importance which remains to be determined is the extent to which these cankers caused by *Coryneum* will spread from year to year. It is intended to keep some of this year's cankers under observation so that this question may be answered.

The results of the study of *Coryneum foliicolum* by means of inoculations of living apple trees show that this fungus is a parasite which is capable of doing great damage to young trees and the small branches of older trees. It has also proved able to keep wounds on larger branches from healing but it will be necessary to keep such branches under observation for a longer time to determine the extent of the injury.

In connection with the statement that *Coryneum foliicolum* is a parasite it is of interest to compare the parasitism of two other species of *Coryneum* which are of great economic importance. *C. beyerinckii* Oudem. has been reported by a great many investigators in widely separated places as causing diseases of stone fruits. Recently, Smith (5) has made a careful study of "Peach Blight" in California and shows that the disease is caused by this fungus which attacks both the leaves and twigs. The mycelium of the fungus is able to penetrate the bark of new shoots and kills small areas, causing spots. Spores lying about the bud scales produce mycelium which penetrates and kills outright both the bud and the surrounding bark, the spot extending from one-fourth to one inch in length.

Butler (1) gives an account of a disease of the mulberry in India caused by *Coryneum mori* Nom. This parasite attacks young trees in the nursery and the smaller branches of full grown trees. It enters through injured places in the bark but is not able to penetrate the uninjured bark. The treatment recommended for this disease is to avoid the making of unnecessary wounds, to prune in such a way as to make wounds which will heal over readily, and to burn dead and diseased wood after it has been removed.

Coryneum foliicolum agrees quite closely with *Coryneum mori* in the manner of its attack on the host. In the inoculations for leaf-spot, where large numbers of spores were sprayed upon the young branches, no case was observed in which the fungus penetrated the bark and caused disease, therefore it seems probable that the fungus is able to enter only through wounds. The control of such a disease caused by a wound parasite should not be a difficult matter. The same methods carefully applied would also go far toward controlling diseases caused by certain other fungi. All dead and diseased wood should be removed and burned, as this would destroy to a large extent the material for infection. Care should always be taken to avoid unnecessary wounds or wounds which will not readily heal over.

In connection with a study of apple decays, the writer has isolated fungi from a large number of decaying apples both by the poured plate method and by taking out material from decaying apples from regions which were either some distance from the point of infection or were on the border line between the decayed and the undecayed tissue with a scalpel which had been sterilized by heat and transferring to plates of agar. In no case has *Coryneum foliicolum* been isolated from a naturally infected apple.

In order to test the ability of the fungus to cause decay, two ripe apples were inoculated October 31, 1908. Only a very small amount of decay developed but that this decay was caused by *Coryneum* was proved by reisolating the fungus in pure culture from the decaying tissue.

Six green apples were inoculated August 24, 1909. The fungus grew to a slight extent at points of inoculation but did not spread into surrounding tissue to cause decay.

Three ripe apples were inoculated October 5, 1909. A slow decay took place. At the end of two weeks the decayed region was about 1.5 cm. in diameter, and increased very slowly after that time.

Three ripe pears were inoculated September 16. There was a little growth at the points of inoculation but the fungus did not spread to cause much decay.

These inoculations show that *Coryneum* can cause a slow decay of ripe fruit but when the decay caused by this fungus is compared with that caused by such fruit decaying fungi as *Sphæropsis* and *Penicillium* it is seen that *Coryneum* is not of much importance as a fruit decay.

CULTURAL STUDIES.

When the spores of *Coryneum foliicolum* from either leaf-spot or canker are placed under favorable conditions for growth they germinate readily. In hanging drops of sterile, distilled water nearly all of the spores had germinated at the end of 16 hours at 65° to 70° F. The cells become swollen and rounded and germ tubes are produced from one or more cells as shown by Fig. 35. About the same characters are shown by spores germinated in hanging drops of prune decoction. When spores are sown in dilution plates of prune or bean agar, the germ tubes have begun to branch by the end of 24 hours and in 4 or 5 days the mycelium has begun to produce spores after the manner of the Hyphomycetes as shown in Figures 27, 33 and 34. If this fungus were classified according to its characters when grown on prune agar, it would belong to the genus *Clasterosporium* of the Dematiaceæ.

The fungus has been grown on a number of the common culture media. It grows well and produces spores abundantly in plates of prune agar, bean agar and potato agar. Considerable ærial mycelium is produced in each case which differs in color on the different media being almost white on bean and potato agars and dark brownish gray on prune agar. The central part of the colony is wet and slimy in each case with no ærial mycelium. The spores are produced in such numbers as to form dense black masses. In the bean agar plates the black spore masses were formed in concentric rings. The fungus seems to fruit just as well when the colonies are crowded in the petri dish as when only one colony is present. Plates of prune agar were sown with spores so that from 30 to 100 colonies developed in a plate. The colonies did not merge together but were separated by quite clear-cut lines where they approached each other. The ærial mycelium was well developed and these colonies formed spores.

The mycelium of the fungus consists of large threads from which finer branches are given off and is shown well by Fig. 37 which is a photomicrograph of mycelium from a prune agar culture. The hyphæ vary in width from 1.5 to 8 microns, and the length of the cells varies greatly, being from 11 to 80 microns for the most part although, in some cases, the actively growing terminal end of a hypha is seen which shows no cross wall in more than 200 microns. Not much difference can be noted in structural characters of the mycelium on different culture media as measurements of hyphæ from a number of media gave the same results.

There is, however, considerable variation in the spores in culture as has been pointed out by Hartley for prune agar cultures. Smith (5) has shown that the same kind of variations takes place in the spores of *C. beyerinkii* and Butler (1) has described and figured the same thing for *C. mori*. The spores of *C. foliicolum* taken from either apple leaf-spot or canker do not vary greatly in size or number of cells. They are for the most part four celled and measure 4-5.5 x 13-16.5 microns. On sterilized bean pods, potato cylinders, and apple twigs in tubes, the spores are for the most part typical four-celled spores which do not differ from the spores developed under natural conditions. On potato agar in petri dishes, the spores are four celled but vary in size. On prune agar, bean agar, and in prune decoction, the spores vary in size and number of cells as shown in Figs. 31 and 32, all gradations can be easily found from typical four celled spores of the size found under natural conditions to those having as many as nine cells and measuring 9 x 43 microns.

In prune decoction, the fungus grows rapidly and when the cultures were 5 days old a thick pellicle was formed over the surface of the liquid and large numbers of spores were being produced. On sterilized apple twigs, the fungus grows well forming a considerable amount of ærial mycelium which is brownish gray in color, some of the large hyphæ being deep brown in color. The mycelium also grows in the liquid at the bottom of the tube. Spores are produced in black masses on the wood. When the spores are mature, they are mostly broken off from the stalks on which they are borne, but in some cases they were found still attached and the stalks measured 18-22 microns in length. On sterilized bean pods, potato, carrot, and turnip cylinders, there is a considerable development of ærial mycelium which is light colored in young cultures but becomes dark in old cultures. Part of the spores examined from turnip and carrot cultures were very abnormal, the cells being large and rounded and in some cases separated resembling the conditions seen in germinating spores.

Smith (5) has made a study of the cultural characters of *Coryneum beyerinckii* Oudem. He found that spores of that species taken from the bark or from leaves did not grow readily in plate cultures and that made it somewhat more difficult to isolate the fungus in pure culture, but after colonies were obtained, the fungus grew very well producing a little mycelium and thick black crusts of spores on prune agar. This differs from *C. foliicolum* in which spores taken from old cankers in the spring before the leaves open germinate in considerable numbers when sown in petri dish dilution cultures in prune agar or in bean agar. When such spores were placed in hanging drops of prune decoction, about one-half had germinated at the end of 18 hours at room temperature.

No other means of reproduction than by conidia has been observed either in culture or in nature. Smith did not find the perfect stage of *C. beyerinckii* Oudem. although Vuillemin (6) has described a species of *Ascospora* (*A. beyerinckii* Vuil.) which he considered to be the perfect form of *C. beyerinckii.*

Phoma mali Schulz. et Sacc.

Another fungus which was isolated from leaf-spots from several sources during the summer of 1908 has been studied in some detail. This fungus did not occur with enough prominence on the leaves to suggest that it caused the disease but it was kept in culture for later study. The fungus did not fruit in culture for several months, although it grew very readily. In the fall of 1908, a fungus was isolated from decaying apples which agreed in cultural characters with the one from leaf-spot.

Apples were inoculated October 31, 1908, with material from a culture of the fungus from leaf-spot. Only a few days were required to prove that the fungus was able to produce a distinct apple decay which spread at about the same rate as the decay caused by some of the well known apple decay fungi. In order to prove that the fungus with which the apples were inoculated was the cause of decay, plates were made for reisolation by taking material from the decaying tissue with a sterilized scalpel and transferring it to plates of agar. All the plates produced pure cultures.

Figure 22 shows the extent of the decay in an apple two weeks after inoculation. Figure 23 is from the same apple cut open and shows that it was almost half decayed at that time. The condition of an apple 34 days after inoculation is shown by Fig. 24. The apple is completely decayed, is somewhat shrunken and wrinkled and numerous pycnidia as well as a considerable amount of white mycelium are seen on the surface. Microscopic examination showed that the pycnidia contained large numbers of hyaline, one-celled spores, which were two guttulate and measured 2.5-3 x 5.5-8 microns. Cultures were made from this apple both by making dilution plates using spores from a pycnidium and by transferring decayed tissue from the inside of the apple. In both ways pure cultures were secured and it was shown that the pycnidia belonged to the fungus with which the apples were inoculated. Material from the apple shown in Fig. 24 was fixed, sectioned, and stained and the photomicrographs shown in Figures 39, 40 and 41 were made from sections of the pycnidia.

When this fungus was grown on prune agar, in petri dishes the mycelium spread rather rapidly and in a few days had spread over the entire surface. Considerable white ærial mycelium was produced. When the cultures were a few days old, little masses of closely interwoven hyphæ began to appear which were arranged in concentric circles. These gradually increased in size and later drops of clear liquid exuded from them. The appearance of the fungus in plate cultures is shown by Fig. 38 which is from a culture 11 days old growing on prune agar from a piece of the decaying apple described above. At first, it was thought that the little masses of hyphæ were early stages in the development of pycnidia but repeated examination failed to confirm this as no bodies resembling pycnidia and no spores were found.

The mycelium consists of hyphæ 5-7 microns in diameter which in plate cultures radiate out from the center giving off finer branches. The closely interwoven network made up of the finer branches includes hyphæ some of which are less than 2 microns in diameter. The length of the cells varies from 10 to 35 microns in the large hyphæ but terminal cells 50-60 microns in length have been seen in the small hyphæ.

The fungus has been grown on only a few common culture media. The growth on bean agar is very similar to what has been described for prune agar. On sterilized bean pods, the growth is good. The whole bean pod becomes covered by the mycelium and a fine, white, cob-webby ærial mycelium develops. After the fungus had been grown for several months on bean pods, the transfers being made each month, it began to produce pycnidia. The pycnidia here had very much the same appearance as those on the apple shown in Fig. 24. In some cases the pycnidia develop singly and in other cases 2-4 pycnidia develop in a sort of stroma. They always extend above the substratum and are usually covered by fine white hyphæ. When the pycnidia are mature, the spores exude through an opening at the apex and adhere together in long chain-like masses. The spores agree in shape, size and appearance with spores from the pycinidia on decaying apple. On sterilized potato cylinders in tubes after 5 days, the slants were covered by the mycelium and some white ærial mycelium had developed. After 9 days small compact masses could be noted from which drops of clear liquid were exuding. Twenty days from the time of inoculation, mature pycnidia were found from which the spores were exuding in the manner described for bean pod cultures. On sterilized apple wood the fungus grew slowly producing a thin network of mycelium over the wood and later a small amount of white ærial mycelium. The mycelium did not extend much into the liquid but formed a rather thick crust-like pellicle. Where the mycelium came in contact with the liquid, the hyphæ took on a light brown color. Three weeks after the tubes were inoculated a few pycinidia had developed on the wood and compact masses of hyphæ such as have been described as occurring on other media were seen.

In June, 1909, small apple branches which were dying back were collected in an orchard in Orono and also in Monmouth. On examination, a fungus was found which agreed in its characters with the one described above.

In order to determine the extent to which the fungus could cause disease of the wood, 2 of the young apple trees such as were used in the work with *Coryneum* were inoculated with material from pure cultures growing on bean pods, May 17, 1909. Nine places were inoculated and 2 check incisions were made. One week after the time of inoculation, it could be noted that the fungus was growing at all the places which had been inoculated except one which was as clean and bright as the checks. June 2, there were areas of dead brownish bark around the 8 inoculated places. June 9, it was noted that the areas of dead bark had increased to some extent; and that the cankers resembled those caused by *Coryneum*. A more careful examination showed that a few pycinidia had developed on the dead bark near the incisions and the spores in these pycnidia agreed with spores from decayed apple and from bean pod cultures. June 17, some of the branches were almost girdled but in some cases callus was forming which checked the spread of the fungus to some extent. August 2, the cankers were 2-5 cm. in length and a considerable number of pycnidia were found on the dead bark. Some sections of these pycnidia were prepared and from one of these sections Fig. 42 was taken. The pycnidia develop in the bark and when they are mature the outer layers of the bark are ruptured and the pycnidia appear above the surface.

Two more young trees were inoculated May 18 in the same way and gave practically the same results.

In order to test the parasitism of the fungus on old trees in the orchard, 12 places were inoculated June 4. In some cases, an inoculation was made in a branch which had been inoculated with *Coryneum*. This fungus did not form as well marked cankers on these branches as *Coryneum* but showed that it was able to grow as a parasite. Eleven places were inoculated on branches of Ben Davis and Baldwin trees in the orchard June 24. All but one of these places developed small cankers.

Attempts were made to infect apple leaves with spores from pycnidia from bean pod cultures using the same methods which were used with *Coryneum*. In no case was there any evidence that the fungus attacked the living leaves.

It has already been shown that this fungus causes a decay of ripe apples. It is well known that some of the fungi which cause decay of ripe apples cannot cause decay of green fruit. To determine the effect of this fungus, 8 green apples were inoculated August 10, 1909. The fungus grew at the points of inoculation but the decay did not spread to a great extent in any of the apples except one. In this apple, some other fungus may have assisted in the decay but the pycnidia of the fungus with which it was inoculated appeared on the surface. The other 7 apples showed at the end of one month a small decayed region about .5 cm. in diameter as illustrated by Fig. 25.

In September and October, 1909, inoculations of ripe pears and of apples which were ripe but not over-ripe were made using material of the fungus which had been carried in culture for more than a year. The pears decayed rapidly and the fungus mycelium broke out over the surface of the decayed part. After 10 days, pycnidia in large number were found among this mycelium. The decay of the apples took place at about the same rate that has been described for the apples inoculated in 1908.

From my study of this fungus in nature, in culture, and by inoculations of fruit and wood of apple it shows the characters of the genus, *Phoma*. Several species of *Phoma* are described as occurring on apple branches. *Phoma pomarum* Thüm. occurs on the fruit of the apple in Europe but the spores of that species do not agree with the spores of the fungus under consideration. *Phoma mali* Schulz. et Sacc. is described as having spores 8 microns in length. *Phoma ambigua* (Nits.) Sacc. agrees closely with *Phoma mali* having spores 8 x 3 microns. It has seemed best to the writer to refer this fungus to *Phoma mali* Schulz. et Sacc. depending on the description which has been given of the cultural characters and of the effects on inoculated apples to enable other students of apple diseases to determine whether or not they are working with the same fungus.

SUMMARY.

Coryneum foliicolum and *Phoma mali* cause disease of the wood of young apple trees and of branches of old trees. These fungi are more actively parasitic than *Coniothyrium pirina*. As wound parasites, they attack young trees in such a way as to do as much damage as *Sphæropsis malorum* but do not spread so rapidly in the large branches of older trees.

Coryneum causes only a slight decay while *Phoma* causes a rather rapid and complete decay of ripe apples and can attack the green fruit to some extent.

Neither of these fungi has been found to cause disease of uninjured leaves, but, in common with a number of other fungi, they occur on dead spots in apple leaves.

The distribution of these fungi can be largely controlled by removing and burning the dead wood on which they occur.

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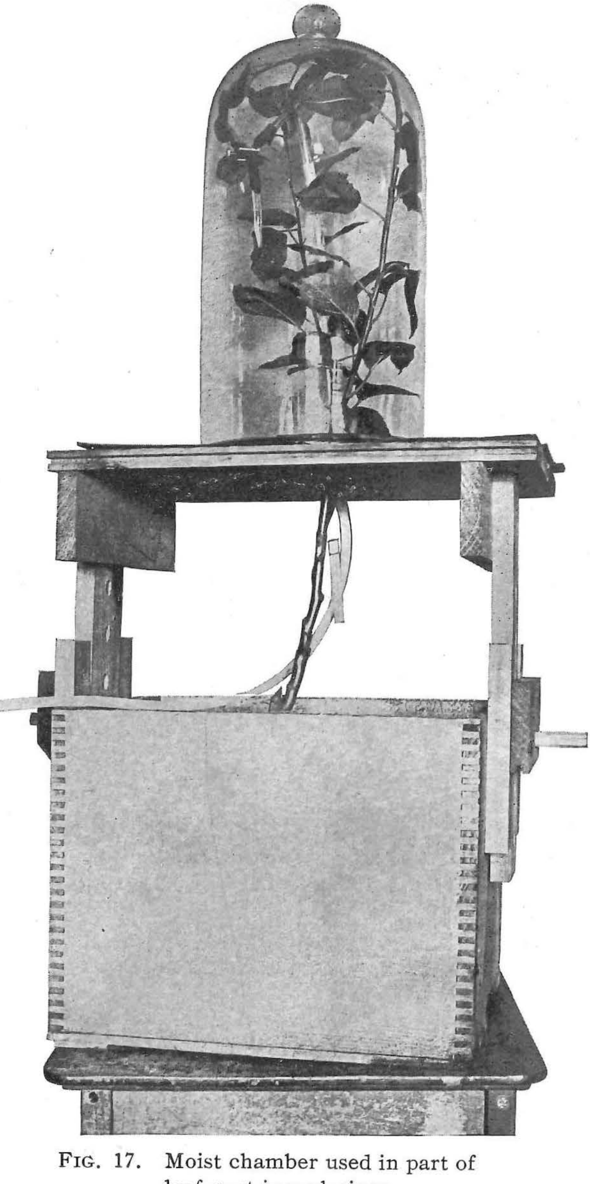

FIG. 17. Moist chamber used in part of leaf-spot inoculations.

FIG. 18. Young apple tree 22 days after inoculation of branches with *Coryneum*. Note the wilted leaves on upper branches.

FIG. 19. Cankers on the branches of the tree shown in Fig. 18. Enlarged.

Fig. 20. Cankers produced on branches of tree in orchard by inoculation with *Coryneum*.

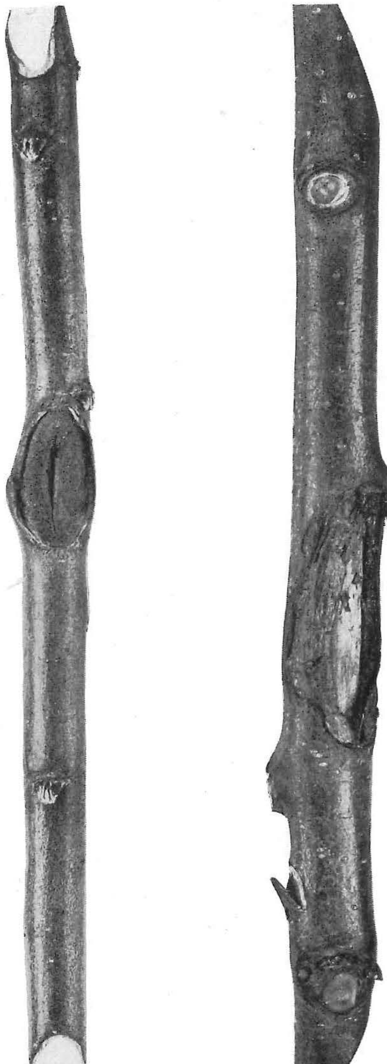

FIG. 21. At left, check incision which is healing over. At right, branch which was inoculated with *Phoma*.

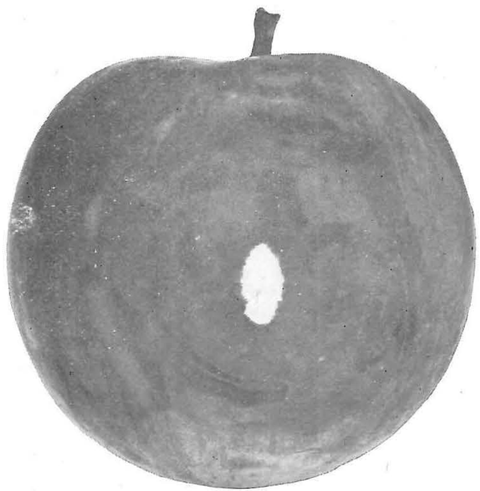

FIG. 22. Apple two weeks after inoculation with *Phoma mali*.

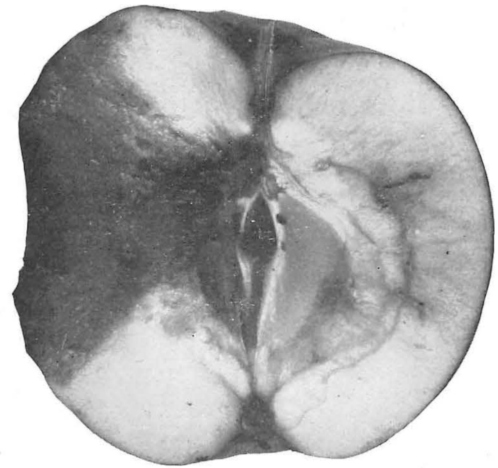

FIG. 23. Same apple cut in two to show extent of the decay.

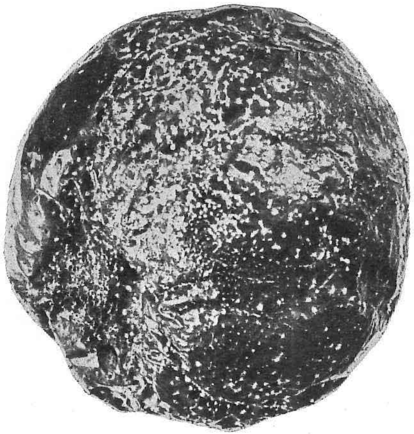

FIG. 24. Apple 34 days after inoculation with *Phoma*. Note pycnidia on surface.

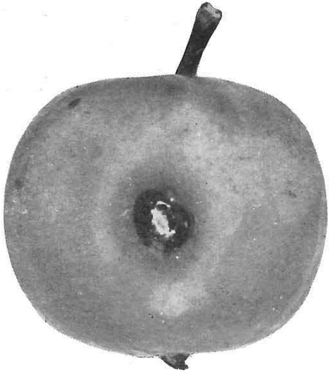

FIG. 25. Green apple 3 weeks after inoculation with *Phoma*.

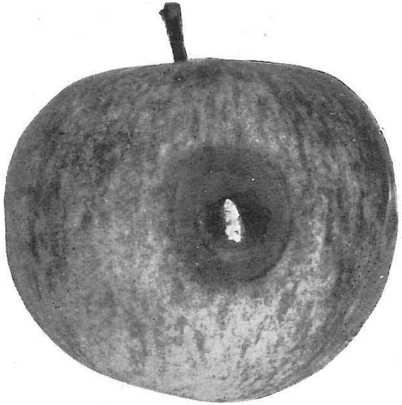

FIG. 26. Ripe apple 2 weeks after inoculation with *Coryneum*.

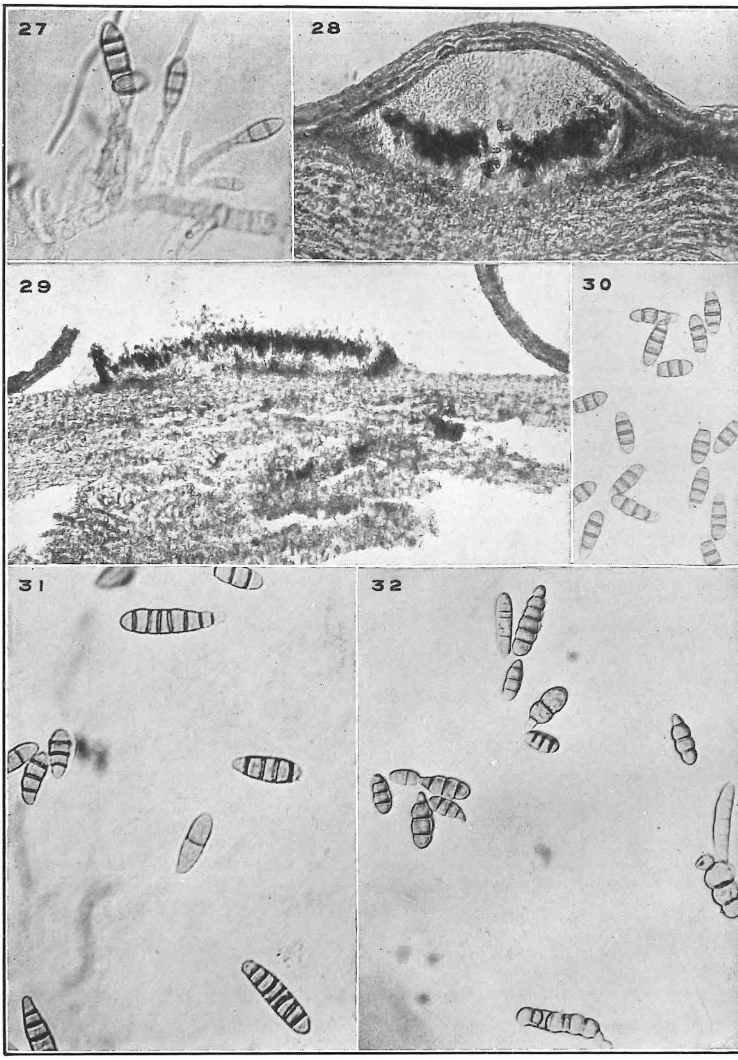

FIG. 27. Spores of *Coryneum* from prune agar culture showing stalks on which they are borne. x 475.

FIG. 28. Young fruiting pustule of *Coryneum foliicolum* from canker on tree shown in Fig. 18. x 100.

FIG. 29. Old pustule from same source as Fig. 28 in which covering of bark has broken away. x 70.

FIG. 30. Spores of *Coryneum* from canker. x 425.

FIG. 31. Spores of *Coryneum* from prune agar culture. x 475.

FIG. 32. Spores of *Coryneum* from bean agar culture. x 350.

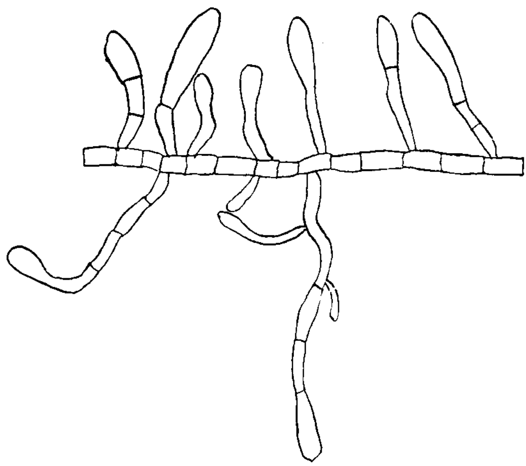

FIG. 33. Developing spores of *Coryneum* in prune agar culture. x 480.

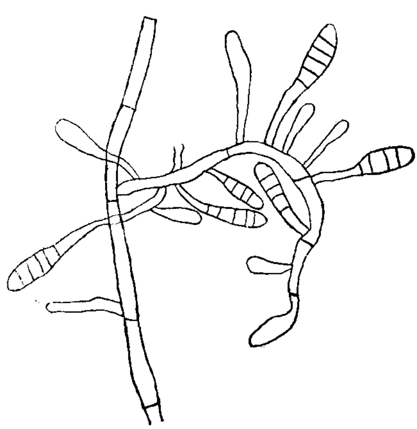

FIG. 34. *Coryneum* from prune agar culture showing how spores are borne. x 480.

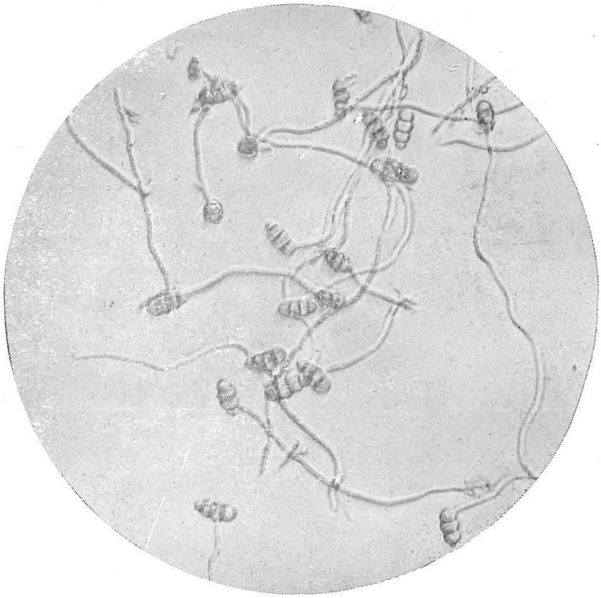

FIG. 35. Germinating spores of *Coryneum* from hanging drop, sterile distilled water. x 300.

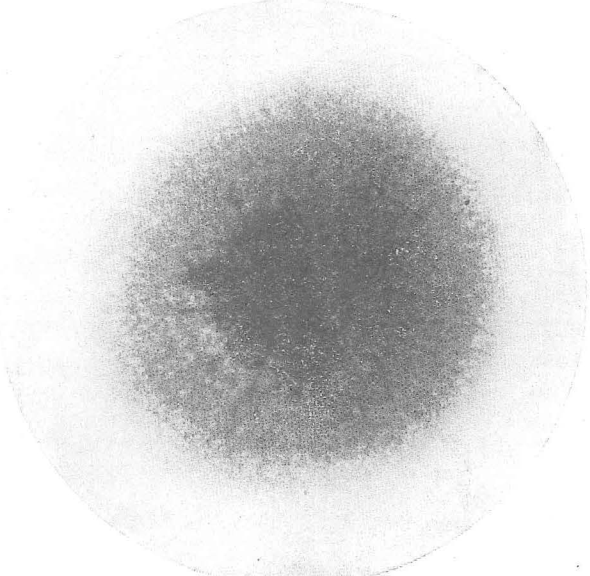

FIG. 36. Colony of *Coryneum* 12 days old on prune agar.

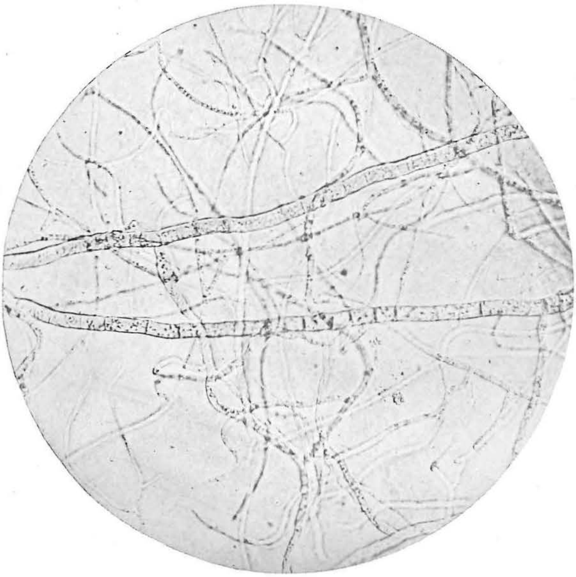

FIG. 37. Mycelium of *Coryneum*. x 300.

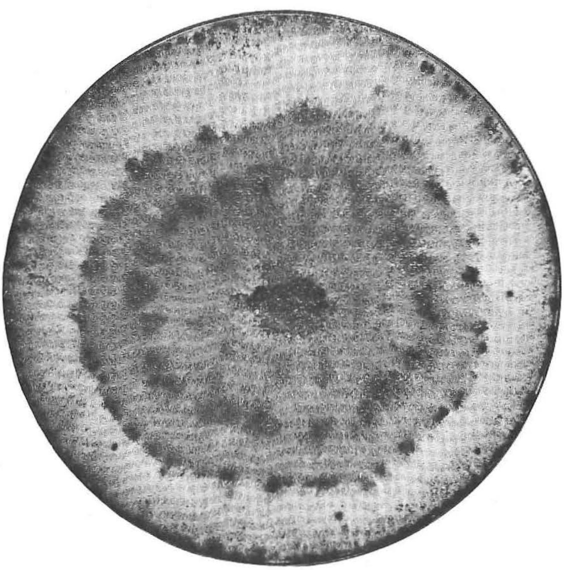

FIG. 38. Plate culture of *Phoma mali* 11 days old growing on prune agar.

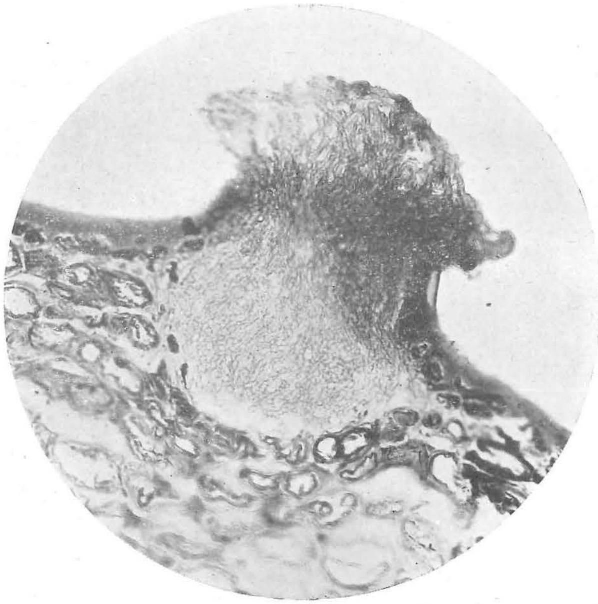

Fig. 39 Young developing pycnidium of *Phoma* from the apple shown in Fig. 24. x 180.

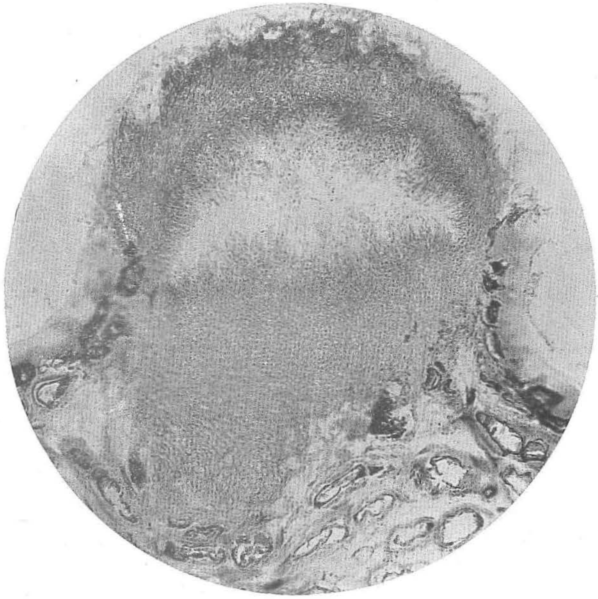

Fig. 40. Pycnidium of *Phoma*. x 180.

FIG. 41. Mature pycnidium of *Phoma* showing the cavity filled with spores. x 160.

FIG. 42. Pycnidium of *Phoma* from one of the inoculated trees. Note outer layers of bark broken away. x 80.

BULLETIN No. 171.

THE PINE-LEAF CHERMES

AND

THE GREEN-WINGED CHERMES.*

EDITH M. PATCH.

THE PINE-LEAF CHERMES (*Chermes pinifoliæ* Fitch).

On account of recent troubles, varying in nature and importance, of the white pine in Maine a close watch has been kept over the pine by people throughout the State, which has resulted in their becoming interested in many insects of the white pine heretofore attracting but little attention.

Conspicuous among such insects during the early summer of 1909 was a dark reddish-brown plant louse, "The Pine-leaf Chermes" shown in Fig. 43 in its characteristic position on the pine needles where it settles to lay its eggs. This Chermes appears upon the pine needle about the middle of June, and some years in conspicuous numbers.

The past summer (1909) hardly a pine in the vicinity of Orono could be found that was not abundantly infested with these winged forms and that the same was true in other parts of the State was shown by specimens submitted to the Station. One such report from Gilead June 25, accompanying specimens, read "Millions of the flies on white pine."

The eggs of this species are not expelled from the bodies of the females. The insects attach themselves firmly to the pine needles with their heads toward the base of the needle and die there with the eggs held in the abdomen which is like a little sac protected by the wing of the parent *Chermes*. Such a

* Papers from the Maine Agricultural Experiment Station; Entomology No. 37.

cluster contains about 100 eggs. These hatch in 8 or 10 days from the time the Chermes appear on the needle of the pine. The young settle about the new growth of the shoot and piercing the tender tissue with their beaks, suck the sap. Where the infestation is heavy this causes a yellowish and sickly appearance of the new growth which is sometimes thus considerably stunted. The young, though exceedingly minute, can be located because they produce a white flocculent waxy secretion which makes their presence discernable.*

The Pine-leaf Chermes is one of those species of plant lice that have alternate "host plants," that is, they pass one stage of their life on one plant and the succeeding stage on another species of plant.

The winged Chermes that appear suddenly upon the needles of the pine in mid-June have not developed on the white pine but in a cone-like gall common on the Red Spruce and Black Spruce, see Fig. 44. This gall is an abnormally developed shoot, the unusual form of growth being stimulated in some way by the presence of the Chermes. The young Chermes can be found in these galls by opening the sections of the galls where little reddish brown objects will be seen,—the developing Chermes.

These galls though sometimes very abundant in Maine are likely to escape notice as they are so cone-like in appearance as to seem to the superficial glance a normal part of the spruce. They were observed by Packard as common in Maine and the plant louse forming them was named *abieticolens* in 1879, the fact that they were the same species Fitch recorded for the pine needle not being known at that time.†

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* Another much smaller species of plant louse (*Chermes pinicorticis*) is frequently present on the trunk of the same tree in such numbers as sometimes to cover almost the entire trunk with a white down.

† This species develops in a cone-like gall on the black and red spruces (in which connection it was named *abieticolens* in 1879 by Thomas and subsequently merged by error with *abietis* in 1897), and migrates to the needles of the white pine (in which connection it had been previously named *pinifoliae* by Fitch in 1858, and merged by error with *pinicorticis* in 1869). This historical discussion with full reasons for resurrecting this doubly merged species under the original name of *pinifoliae,* which has been discarded for about 40 years, will be published presently in more technical form by the Maine Agricultural Experiment Station. For the purposes of this economic bulletin it is not necessary to include either detailed descriptions or discussion.

The full grown Chermes acquire wings about the middle of June when they leave the spruce galls and seek the white pine.

Remedial Measures. There would seem to be no practical method of combatting this insect in forest growth. With ornamental trees, however, the galls could be removed from the spruce previous to the emerging of the winged form. Also if the species proves constantly troublesome it might be desirable not to plant the white pine in the vicinity of black or red spruce and *vice versa.*

Spraying with whale-oil soap (1 pound to 2 gallons of water) would doubtless destroy the young on the white pine shoots, but it is doubtful that this would be usually worth while in Maine where Syrphus flies abound. The larvæ of these, little light colored maggots, have been found to feed industriously on the young Chermes. So numerous are these beneficial maggots at times in the midst of the white waxy secretion of the Chermes that they are sometimes mistaken by people submitting them for determination as the cause of the trouble.

THE GREEN-WINGED CHERMES (*Chermes abietis* Linn).

An entirely different sort of gall common in Maine on the White Spruce, and Norway Spruce, is caused by another species of Chermes which is here termed the "Green-winged Chermes" as the conspicuous and constant green tinge of the wings is a character which will readily serve to distinguish it from the "Pine-leaf Chermes" by those who would find a more technical comparison troublesome.

Fig. 45 shows 3 of these galls together with 6 cones, about natural size on a white spruce twig. It will be seen that these galls differ from those shown in Fig. 44 in not being cone-like and in not being characteristically terminal on the shoot. These *abietis* galls do not usually cause the death of the shoot on which they grow but they do cause deformed branches and frequently ruin a small tree for ornamental purposes. Such galls are very abundant on the Norway spruces on the University of Maine Campus. That they are troublesome on native spruce in this locality is shown by the fact that on a single white spruce 3 feet tall more than 990 of this season's galls were counted August 1, 1909. Where so numerous, these galls are much smaller than those shown in Fig. 45.

These galls begin to open about August 15 in Maine. The full grown pupæ walk out on the spruce needles, where they molt their pupal skins. The newly emerged winged insect is yellowish with distinctly green wings and even the wings of the aged specimens retain the green color.

Unlike the Pine-leaf Chermes, this Green-winged Chermes does not use alternate host plants. That is, it does not seek the pine or any different kind of tree to lay eggs on than that on which it produces the galls. Shortly after emerging from the gall it lays its eggs on the spruce and the young which hatch from them do not acquire wings but develop to a wingless form living solitary over winter on the twig. This is the form that lays eggs in the spring for the generation that causes the development of the gall which shelters them.

Remedial Measures. Spraying the trees in April with whale-oil soap solution (1 pound to 2 gallons of water) has been reported as effectual. (34th Report Mass. Agric. College). The practice of removing and burning the galls will serve to control this species sufficiently on ornamental trees. At Orono great numbers of the winged forms are caught in spiders' webs that are spun irregularly over the spruce twigs.

FIG. 43.—The Pine-Leaf Chermes. Migrants from the spruce-gall to the white pine.

FIG. 44—Black spruce twig with two cone-like galls caused by the Pine-Leaf Chermes.

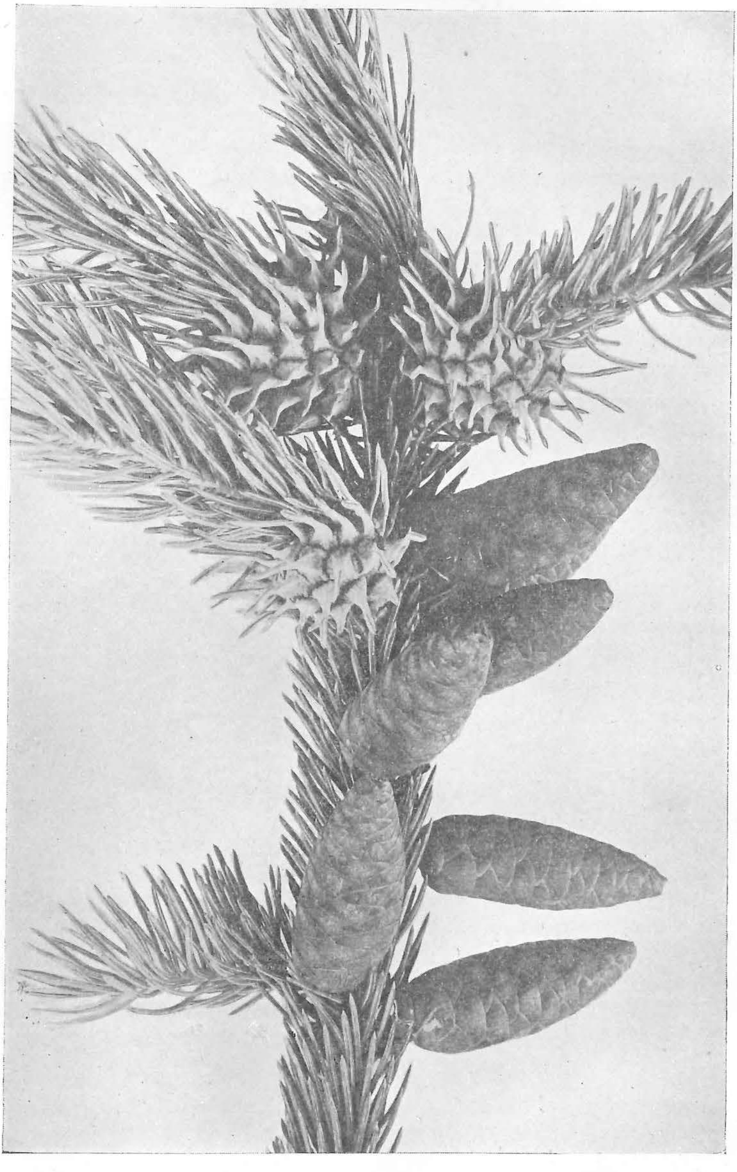


FIG. 45—Twig of white spruce with three "pine-apple galls" of *Chermes abietis* and six normal cones.

BULLETIN No. 172.

THE MYCETOPHILIDÆ OF NORTH AMERICA.

PART I.*

O. A. JOHANNSEN.

It is the purpose of this paper to present a synopsis of the fungus gnats or *Mycetophilidæ* of North America, giving descriptions of and tables to all the genera and species, and life histories when known. As these flies are for the most part quite small, inconspicuous in coloring and retiring in habit, it is not strange that they, with the exception of a few species which have been brought into prominence by reason of their economic importance, have received but scant attention from entomologists generally. In this, the first part, the lower and economically less important subfamilies are treated, while in a subsequent paper the *Sciophilinæ, Mycetophilinæ* and the *Sciarinæ* will be considered. I hope to be able to show, in my work on the *Sciarinæ,* just what relation the larvæ of *Sciara* which are so frequently and usually so numerously present in rich soil, bear to the plants which grow there. I also trust that the descriptions of the imagines of the members of this genus will be sufficiently characteristic so that neither the Economic Entomologist nor the Systematist need so often designate a species as *Sciara sp.* as has been the case heretofore.

Acknowledgments.

To the members of the Entomological Staff of Cornell University for their kindness in granting me the freedom of their laboratories, library, and collections I wish to express my

*Papers from the Maine Agriculture Experiment Station: Entomology No. 38.

heartiest thanks. I am also under great obligations to Professors W. M. Wheeler, J. M. Aldrich, John Barlow, and Messrs. Wm. Beutenmueller and C. W. Johnson for the loan of their collections, to Mr. D. W. Coquillett in permitting me to study the specimens in the United States National Museum and to Dr. Samuel Henshaw for the privilege of examining the Loew types in the museum at Cambridge, Mass. I desire also to acknowledge my indebtedness to Miss Edith M. Patch of the Agricultural Experiment Station of Maine, and to Dr. Chas. D. Woods, director of the station, for encouragement and aid in making possible the publication of this paper in its present form.

Of the literature upon the Mycetophilidæ which has been of greatest assistance I need only mention here Winnertz's "Pilzmücken," the "Centuries" of Loew from the Berliner Entomologische Zeitschrift, and the papers of Adams, Aldrich, Coquillett, Dziedzicki, Grzegorzek, Lundström, Marshall, Rübsaamen, Skuse and Williston.

Characters.

The fungus-gnats are flies of medium or small size, and more or less mosquito-like in form. They are exceedingly numerous both in number of individuals and in number of species, over fifteen hundred species contained in upward of one hundred genera, having been described from Europe, North America and Australia. Although entomologists have long been familiar with the earlier stages as well as with the adults of several members of this family, our knowledge of the life history is as yet very meagre. In 1864 Baron C. R. von Osten Sacken collected all the published records bearing upon the biology and the structural characters of the larvæ and published them together with some observations of his own. This paper was reprinted in 1884 with a few additions.

The larva is twelve segmented, footless, more or less cylindrical, slightly tapering, smooth, soft, whitish in color and with a small strongly chitinized head, which is usually brown or black. The antennæ are always very minute, almost vestigial. The mouth parts consist of a fleshy labrum, with a chitinized frame; flat lamelliform mandibles, indented or serrate on the inner side; maxillæ with inner and outer lobes, the former usually serrate; and a small chitinized labium. The body of the larva is without hair or bristles except that in some genera there are two transverse rows of simple or bifid ambulacral setulæ on the margin of each abdominal segment on the ventral side. There are usually eight pairs of spiracles, which in some of the genera at least, are protected by small chitinized conical projections, the anterior pair being largest.

The pupæ are extricated, that is, not encased in the contracted skin of the larva. The legs are applied to the breast and venter, the antennæ are bent around the eyes, and extend between the wings and legs. The prothoracic spiracle is placed a little above the root of the wing and immediately behind the antenna. The abdominal spiracles are distinct on both sides of the abdomen. The pupa is smooth, white in color and frequently encased in a delicate cocoon. The pupæ of those forms whose larvæ live in mushrooms are usually found in the soil and among the decaying parts of the plant.. The larval and usually the pupal life also is of short duration, though the insect may hibernate as a pupa. The time which elapses from the egg to the adult stage may not exceed two weeks in midsummer.

The imago may be distinguished from other flies by the following characters: Antennæ usually 16 jointed, occasionally 12 to 17 jointed; palpi usually 3 or 4 jointed; ocelli present except in one or two genera. Thorax highly arched, scutellum small, setose. Abdomen with 6 to 9 visible segments, cylindrical, conical or oval and laterally compressed; the male with complex hypopygium, the female with a short ovipositor with 2 terminal lamellæ. In the male the seventh and eighth segments are usually very small. The coxæ are very strong and excepting in the *Sciarinæ* and a few of the lower genera, are much elongated; the femora are more or less thickened, laterally compressed, often setose; the tibiæ usually slender, spurred, and setose; tarsal claws with teeth. The wings are usually oval, hairy or microscopically setulose, and without the cell 1st M_2 (discal cell). The wing venation is quite varied though it may readily be reduced to four types. The first and most primitive is that of *Palæoplatyura* (fig. 70); in the second, *Ceroplatinæ, Macrocerinæ, Ditomyia* (fig. 71) the basal section of the media is lost; in the third, *Sciophilinæ* (fig. 72) the M-Cu cross vein is wanting and R_{2+3} is crossvein-like in appearance; while in the fourth, *Mycetophilinæ* (fig. 73) and *Sciarinæ,* both the M-Cu crossvein and the vein R_{2+3} have disappeared either by coalescence or atrophy.

Below is given the Comstock-Needham terminology of wing venation which is used in the following text, together with the equivalent terms of the Schinerian system.

Costa (C)			= Costa.
Subcosta (Sc)	Sc_1.........		= Subcostal or auxiliary vein.
	Sc_2.........		= Subcostal crossvein.
Radius	...............R_1		= First longitudinal vein.
	Radial sector	R_{2+3}	= Anterior branch of third vein.
		R_{4+5}	= Posterior branch of third vein.
Media (M)			= Fourth longitudinal vein.
Cubitus (Cu)			= Fifth longitudinal vein.
Anal veins (A)			= Anal and axillary veins.

Crossveins

Subcostal (Sc_2)	= Subcostal.
Radio-medial (R-M)	= Anterior crossvein.
Medio-cubital (M-Cu)	= Posterior crossvein.

In this system each cell is given the name of the section of the vein immediately in front of it; thus the cell behind the costa is called the costal cell (or C); the cell behind the basal section of the radius is called R, that behind R_1 is called R_1, etc. In the case of *Sciophilinæ* where R_{2+3} is transverse in position, the small cell is called R_1 and the outer cell is R_{2+3}. Some writers, Winnertz among others, have erroneously considered the base of the radial sector as a crossvein, while they called the true crossvein the base of the third longitudinal vein (R_{4+5}).

In the past the characters most used for generic classification have been derived from the wing venation while color characters have been most used in describing species. In the future more attention should be paid to the structure of the palpi and antennæ, position of ocelli, arrangement of setæ on thorax and legs, relative wing and leg measurements, claws in some cases, and especially to the hypopygium of the male, for both generic and specific characters. The descriptive works of Dziedzicki, Lundström and Rübsaamen, are particularly excellent in regard to the last. For a proper study of the members of the *Mycetophilidæ* it is absolutely necessary to make a caustic potash preparation of the hypopygium. It is impossible from a pinned specimen to determine the form of the parts, owing to the fact that they are usually more or less retracted. I have found Lundström's method of preparation simpler than that of Dziedzicki. In this method it is merely necessary to relax the insect, cut off with a pair of scissors the apical segments of the abdomen; immerse in a 10 per cent solution of caustic potash for twenty-four or more hours, soak in water to remove the potash, and finally preserve in alcohol in a tiny vial bearing the number of the specimen. Besides its simplicity this method offers a further advantage in that the abdominal segment which still is attached to the hypopygium offers a hold for the needles in manipulating and arranging the part under the binocular dissecting microscope. Slide mounts alone are not desirable since it is necessary to be able to turn the object in order to see it from all sides.

The general shape of the hypopygium is that of a cup opening posteriorly, the cavity of which is the genital chamber. This cup, which is formed of the sclerites of the ninth segment, is so produced that its margin usually extends beyond the tenth segment which morphologically terminates the abdomen. The tenth segment bears the anus and is usually reduced to a small membranous lobe. Attached to the posterior rim of the hypopygium are several lobe-like appendages which are variously formed or modified. The body of the segment is made up of a dorsal, ventral and two lateral sclerites. From the floor of the genital chamber arises the penis with its variously modified guards. Although several hundred preparations have been made, owing to the complexity of structure I am not yet certain of the homologies of the parts of some of the genera and pending this investigation I must be content in the descriptive work which follows to confine myself to noncommittal terms in the designation of the various appendages. Following Dziedzicki and Lundström I shall call the upper and lower lateral appendages respectively the upper and lower forceps; when the homology seems evident I shall use the terms eighth and ninth tergum and sternum as given by Snodgrass ('04), otherwise shall speak of these appendages as the dorsal and ventral sclerites. Sometimes when one or the other of the lateral appendages are wanting or greatly reduced the remaining pair will be simply designated as the forceps. When there are appendages of sternum and tergum which require designation they will be called respectively sternal and tergal processes or lobes.

Habits and Economic Relations.

As far as known most of the members of this family live upon and destroy mushrooms, not only the wild plants but on occasion the cultivated varieties as well. Many a mushroom though apparently sound, will, upon close scrutiny reveal tiny black headed larvæ which within a few days grow to maturity and if numerous completely riddle the plant. If left upon the earth the larvæ when full grown will bury themselves, pupate, and within a short time emerge as adults. While but few references to the higher fungus gnats (*Mycetophilinæ*) are found in economic literature, nevertheless I may say from personal observation that a large percentage of the wild mushrooms are infested with the larvæ of *Mycetophilinæ,* particularly of the genera *Exechia* and *Mycetophila,* and in several instances have found them in company with the larvæ of *Phora* to utterly ruin a mushroom bed in the cellar of a grower.

The larvæ of *Mycetobia* live upon decaying wood, particularly of the apple or peach tree, though probably without injury to the sound wood. The *Ceroplatinæ* and *Sciophilinæ* as far as known live upon fungi and decaying wood. As they are comparatively rare they are not likely to be of economic importance. The *Sciarinæ* on the other hand are frequently mentioned by economic entomologists. Though often found in decaying mushrooms and in the earth in putrid vegetable matter I have never found them to be injurious to growing fungi. They are frequently present, feeding on potatoes affected by scab or rot, in some apparently well authenticated instances appear to be the precursor of some form of scab. They are found in apples associated with the railroad worm; in bulbs of tulips, and are occasionally reported by florists as damaging plant roots. Professor Forbes in the 18th report of the State Entomologist of Illinois states that they are frequently noticed in rich garden ground and among potted plants, where they are accused by gardeners of eating the roots and hollowing out the bulbs. He also says "When the spring is cool and wet after corn planting, so that the softened seed lies long in the ground without sprouting, this is especially liable to certain kinds of injury; and it is under these conditions that the black headed maggot (*Sciara sp*) seems most likely to affect it injuriously. Rotting grain is, indeed undoubtedly preferred by this insect, but it has occasionally been seen to infest kernels which had begun to grow. It lives normally in old sod, feeding chiefly, or perhaps altogether, on decaying vegetation there, and will be found in noticeable numbers in corn fields only where the field was in grass the preceding year. These maggots penetrate and hollow out the kernel, often leaving nothing more than an empty hull. A score or more of them may infest a single grain."

Lintner in his 10th report of the State Entomologist of New York says "A species (perhaps more than one) is noted in Europe, for its gregarious and migratory habits. It is there known as the army-worm or *Heerwurm* from its collecting at certain seasons in companies—sometimes consisting of millions —and traveling along in a body of often from 12 to 15 feet in length and 2 or 3 inches broad and perhaps a half inch thick. 'M. Guérin Méneville observed columns as many as thirty yards in length.' The species has not been positively determined, but it is accepted as either *Sciara Thomæ* (Linn.) or *S. militaris* Now.—but probably the latter, according to the statement of Baron Osten Sacken. Similar gatherings have been observed in this country, one of which is narrated in *Insect Life,* iv, 1891, page 214; two others recorded by Glover in the *Report of the Commissioner of Agriculture* for 1872, p. 115, as observed in Virginia (figures of the larva and fly are given); and two others by Prof. F. M. Webster, in *Science* for February 23, 1894, p. 109. With us they bear the name of 'snakeworms,' from the snake-like appearance and movements of some of the processions."

Nothing further need here be said concerning habits as it is proposed to discuss more fully the details of life history and of injury caused by any given form under the respective species.

Remedial Measures.

As a remedy against those species which feed upon the cultivated mushrooms Lintner in his 10th report suggests occasional applications of pure and fresh pyrethrum in water, using it of the strength of one ounce to 4 to 8 gallons of water, as the larvæ may be deeper beneath or nearer to the surface of the beds. As a preventive measure the cellars may be closely screened and the beds covered with small mesh screen frames. For those which are associated with scab or rot the measures taken in combatting these will also hold in check the ravages which may be occasioned by the insect. The remedies and preventive measures applied for the railroad worm or apple maggot and the codling moth will also control the apple midge.

TABLE OF SUBFAMILIES.

a. Medio-cubital crossvein (M-Cu) present; i. e., a vein connecting the media with the cubitus (figs. 70, 71), or these veins contiguous for a short distance at the place where the crossvein usually is.

b. The radio-medial crossvein (R-M) distinct, not obliterated by the coalescence of a portion of radius and media.

c. Radius with more than 2 branches, anterior branch of the radial sector sometimes short and crossvein like.

d. The M-Cu crossvein far proximad of the R-M crossvein, the cell M less or but little more than half as long as cell R. (figs. 74-76). 1. Sub-fam. *Bolitophilinæ.*

dd. The R-M and the M-Cu crossvein nearly equidistant from the base of the wing, usually only one basal cell.

e. The radius with 4 branches (European). Sub-fam. *Pachyneurinæ.*

ee. The radius with but 3 branches (figs. 77-81), 2. Sub-fam. *Mycetobiinæ.*

cc. The radius with but 2 branches (fig. 91). 3. Sub-fam. *Diadocidinæ.*

bb. The radio-medial crossvein (R-M) obliterated by the coalescence of a section of the basal portion of the radius and media at the point where the crossvein usually is. (Figs. 82-90).

c. Antennæ short, usually thick set and often flattened. (Figs. 82-89). 4. Sub-fam. *Ceroplatinæ.*

cc. Antennæ very slender, and nearly as long and often much longer than the body (fig. 90). 5. Sub-fam. *Macrocerinæ.*

aa. The medio-cubital crossvein (M-Cu) absent.

b. The anterior branch (R_{2+3}) of the radial sector distinct, short, ending in R_1 and appearing like a supernumerary crossvein bounding distally the small rectangular or trapezoidal cell R_1 (fig. 72). 6. Sub-fam. *Sciophilinæ.*

bb. R_{2+3} not distinct from R_{4+5}, the cell R_1 thus open to the margin of the wing.

c. Coxæ much elongated, (fig. 56), the R-M crossvein usually distinctly angulated from the second section of the radial sector; the cubitus usually forks noticeably distad of the base of the wing (fig. 73). 7. Sub-fam. *Mycetophilinæ.*

cc. Coxæ not greatly elongated; the R-M crossvein in the same right line with the second section of the radial sector; the cubitus forked near the base of the wing. 8. Sub-fam. *Sciarinæ.*

I. Subfamily BOLITOPHILINÆ.

Bolitophilinæ Winnertz, Verh. Zool-bot. Ges. Wien, XIII, 657. 1863.

Long slender species, with abdomen having 7 to 9 visible segments, 12 to 17 jointed antennæ, coxæ either long or short; wings long and rather narrow; radius 3 branched, both the basal cells R and M distinct and closed at the distal end by the crossveins or by the coalescence of the basal section of the media and cubitus; the cell M much shorter than the cell R.

Table of genera.

a. R_{2+3} shorter than the distance of its base from the crossvein and shorter than R_{4+5}.
  b. Antennæ 17 jointed, slender (figs. 75, 76). 1. *Bolitophila.*
  bb. Antennæ 12 jointed (fig. 74). 2. *Hesperinus.*
aa. R_{2+3} much longer than the distance of its base from the R-M crossvein (fig. 79). Fossil genus. 3. *Mycetophætus.*

1. Genus *Bolitophila* Meigen.

Bolitophila Meigen, Syst. Beschr. Zweifl. I. 220. 1818.
Messala Curtis, Brit. Ent. 581. 1836.

Head hemispherical; 3 ocelli arranged in a curved line on the broad front; palpi 4 jointed; antennæ filiform, in the male nearly as long as the body, of the female shorter, 2+15 jointed. Thorax small, highly arched. Abdomen slender, of the male with 8, of the female with 9 visible segments. Legs slender, tibial spurs short and weak. Venation as figured (figs. 75, 76).

Table of species.

a. Anterior branch of the cubitus disconnected at the base (fig. 76). 1. *disjuncta*
aa. Anterior branch of cubitus connected at the base.
  b. R_{2+3} ends in R_1 (fig. 75). 2. *cinerea.*
  bb. R_{2+3} ends in the costa.
    c. The subcosta ends at or distad of the base of the radial sector in the male. 3. *hybrida.*
    cc. The subcosta ends noticeably proximad of the base of the radial sector. 4. *montana.*

1. *Bolitophila disjuncta* Loew.

1869. *disjuncta* Loew. Beschr. europ. Dipt. I. 19. 17.

Male. Length 6 mm. Head cinereous, proboscis brownish, palpi yellowish; antennæ about as long as the insect, fuscous, scape and base of the flagellum yellow. Mesonotum with 3 broad cinereous stripes; the humeri, space between the stripes, yellow. Pleura, sternum and metanotum brownish. Abdomen wholly fuscous. Coxæ and legs yellow, tibiæ and tarsi slightly infuscated, fore metatarsus about .9 as long as its tibia, claws minute, apparently simple, pulvilli plumose, empodium like a stag's horn. Wings (fig. 76) hyaline, distinct brownish stigma at apex of R_1, subcosta ends in the costa less than the length of the R-M crossvein before the base of the radial sector, R_{2+3} ends in the costa slightly distad of the tip of R_1, base of Cu_1 wanting, veins yellowish. Length of wing is 6 millimeters which is twice as long as the fore tibia. Halteres yellow, knob brown. Several specimens collected by Prof Aldrich, Juliaetta, Idaho. The specimen in the Loew collection at Cambridge is from New Hampshire.

2. *Bolitophila cinerea Meigen.*

1818. *cinerea* Meigen, Syst. Beschr. I. 221.

Male and female. Length 4 to 6 mm. Antennæ fuscous, yellowish at the base, shorter than the body; palpi yellow. Thorax light brown, grayish pollinose, mesonotum subfuscous with yellowish humeri, sometimes with indications of 3 longitudinal stripes; scutellum brown; abdomen brown. Coxæ and femora yellow, the latter and the tibiæ sometimes subfuscous, tarsi brown, fore metatarsus is .85 times as long as its tibia. Wing (fig. 75) cinereous tinged, with brown veins and pale subobsolescent stigma, subcosta ends distad of the base of the radial sector, R_{2+3} ends in R_1, the M-Cu crossvein present, though short and stout. Length of wing is as long as the body which is about 1.75 times as long as the fore tibia. Halteres with brown knob.

Several specimens. Ithaca, N. Y. May and September.

3. *Bolitophila hybrida* Meigen.

1804. *hybrida* Meigen, Klass I. 47.

1818. *fusca* Meigen, Syst. Beschr. I. 221.

Male and female. Length 4 to 6 mm. Palpi pale, face, front and vertex brown, antennæ brown, yellow at the base. Thorax pale brown, dorsum pale brown, or more yellowish with 3 brown stripes. Scutellum yellowish. Coxæ and legs yellowish, tibiæ and tarsi more or less brown; tibiæ and tarsi of hind legs subequal in length. Wing cinereous tinged, veins and stigma brown; sometimes with indistinct spot just distad of the R-M crossvein; the subcosta ends in the costa distad of the base of the radial sector, at least in the male; the M-Cu crossvein present, though short and stout. Halteres with brown knob. White Mts., N. H. (det. Coquillett) and Mayfield Cave, Ind. (det. Adams). Selkirk Mts., B. C.; collected by J. C. Bradley.

4. *Bolitophila montana* Coquillett.

1901. *montana.* Coquillett, Proc. U. S. Nat. Museum, XXIII. 593.

Female. Length 4.5 mm. Dark brown, the base of the third antennal joint, peduncle of the halteres, coxæ, femora and tibiæ light yellow, sides of mesonotum largely brownish yellow, mesonotum polished; wings hyaline, stigma elongate oval, gray; subcosta reaches only slightly beyond middle between humeral crossvein and base of the radial sector, $R_{2}+_{3}$ terminates in the costa, the media at its base coalescing for a short distance with the upper branch of the cubitus. Mount Washington, N. H.

Male specimen from Ithaca, New York, taken in September has the antennæ over 3-4 as long as the body, and the fore metatarsus .9 as long as its tibia, which is half as long as the wing. It differs from the female in having a shining black mesonotum and dark brown pleura, and also in the length of the subcosta which ends somewhat distad of the point midway between the subcostal crossvein (not humeral crossvein) and the base of the radial sector.

2. Genus *Hesperinus* Walker.

Hesperinus Walker, List Dipt. Brit. Mus. I, 81. 1848.

Spodius Loew, Berl. Ent. Zeitschr. II. 108. 1858.

Rather large, bare, blackish species resembling *Bolitophila* in habitus. Head small, round, palpi incurved, 4 segmented; antennæ 12 jointed; eyes round, ocelli 3. Abdomen slender, with 7 or 8 visible segments. Legs long and slender, coxæ not elongate; femora somewhat thickened distally; tibiæ with small spurs; metatarsi lengthened, claws small, pulvilli and empodium distinct. Wings large and broad; Sc_1 long, extending beyond the middle of the wing; R_{2+3} shorter than the distance of its base from the R-M crossvein, the media rises at the base of the wing, the fork of the cubitus and the M-Cu crossvein equidistant from the base of the wing and far proximad of the R-M crossvein (fig. 74).

Hesperinus brevifrons Walker.

1848. *brevifrons* Walker. List. Dipt. Brit. Mus. I. 81.

Female. Length 6 mm. Wholly fuscous, legs, halteres, and center of tergum of each abdominal segment paler than thorax. Front broad, with 3 large ocelli arranged in a triangle, the middle ocellus most cephalad; palpi 4 jointed, the first and second but little longer than broad, the third more slender, about 4 times as long as broad, the fourth slightly longer than the third, each joint with 10 to 15 stout black setæ as well as with very minute setulæ which are arranged in transverse rows; antennæ 12 jointed, the first and second broader than long, the third about 3 times as long as broad, the remaining 9 joints about as broad as long and only slightly diminishing in size apically, with few short setæ. Antennæ if bent back would scarcely reach scutellum. Thorax with indications of 3 broad cinereous stripes, almost bare. Abdomen with 9 visible segments, nearly bare, ovipositor with 2 slender oval lamellæ. Legs long but rather stout, tibial spurs very short, inconspicuous and depressed. Fore metatarsus about .4 the length of the tibia, tarsal claws apparently simple, empodium pad-like, pulvilli conspicuous. Wings cinereous hyaline, veins pale fuscous, except M-Cu crossvein which is paler, stigma faintly indicated; venation as figured (fig. 74); subcostal crossvein present, anal vein slender, rather faint but prolonged to the wing margin. Length of wing 6 mm. which is 2 2-3 times the fore tibia in length. Mt. Greylock, Mass. June. C. W. Johnson, collector. The species has been recorded from Alaska, Canada, Colorado, and White Mountains, New Hampshire.

The specimen in the U. S. National Museum determined as this species as I recollect seeing it, is the same as the one described above. In habitus it reminds one far more of the Bibionid genus *Plecia* than it does *Bolitophila,* from which it differs mainly in having 12 antennal joints and but 4 palpal joints. I believe it should be placed with the Bibionidæ.

3. Genus *Mycetophætus* Scudder.

Mycetophætus Scudder. Bul. U. S. Geol. Survey 93. 19. 1892.

This fossil genus appears to be closely akin to *Hesperinus,* differing mainly in having a much longer R_{2+3}. Venation as figured (fig. 79). Legs long and slender, the fore femora considerably longer than the thorax, the tibia longer than the femora, both abundantly spinose. Abdomen 8 segmented. The only species is M. intermedius Scudder, from Florissant, Colorado.

2. Subfamily MYCETOBIINÆ.

Mycetobiinæ Winnertz. Verh. zool.-bot. Ges. Wien. XIII. 666. 1863.

A group possessing in common the following characters; 16 or 17 jointed antennæ; 3 ocelli on the vertex; wings rather broad, both the R-M and the M-Cu crossvein present and nearly equidistant from the base of the wing; radius 3 branched; legs long and slender and the tibial spurs rather short.

Table of genera.

a. Subcostal vein (Sc_1) long, reaching at least 1-4 the length of the wing and usually ending in the costa.

b. R_{2+3} and R_{4+5} both arise at the R-M crossvein. (Fig. 77). 1. *Mycetobia.*

bb. R_{2+3} and R_{4+5} separate distad of the crossvein. (Fig. 78). 2. *Palæoplatyura.*

aa. Subcostal vein (Sc_1) vestigial.

b. The media forks distad of the base of R_{2+3}. (Fig. 80). 3. *Ditomyia.*

bb. The media forks proximad of the base of R_{2+3}. (Fig. 81). 4. *Symmerus.*

1. Genus *Mycetobia* Meigen.

Mycetobia Meigen, Syst. Beschr. I. 229. 27. 1818.

Head spherical, flattened in front, 3 ocelli arranged in a triangle on the front, the anterior one smaller; palpi 4 segmented; antennæ 2+15 jointed, almost annular, the apical joint very small. Abdomen with 7 plainly visible segments. Tibiæ with short and slender spurs, lateral setæ of middle and hind tibiæ small. Wing broad (fig 77); subcosta about 1-3 as long as the wing, subcostal crossvein wanting; R_{2+3} arises at the R-M crossvein, R_{4+5} ends near the tip of the wing, the costa is prolonged a little beyond it, the media arises apparently at the M-Cu crossvein, though there is usually an indication of the true basal section of this vein in the form of a fold-like vein bisecting the basal cell; the cubitus forks slightly proximad of of M-Cu crossvein, anal vein ends in the margin of the wing.

Mycetobia divergens Walker.

1856. *divergens* Walker. Insecta Saundersiana, Dipt. I. 418.
1867. *persicæ* Riley, Prairie Farmer 15 June. vol. 35. n. s., V. 19, p. 397 (Mycetophila).
1869. *sordida* Packard, Guide to study of Insects. 388.
1903. *marginalis* Adams, Kansas Univ. Science Bulletin II. 2. 21.

Male and female. Length 3 to 4 mm. Head black, subshining, tip of palpi yellow; antennæ black including the basal joints. Mesonotum black, shining, humeri, lateral and posterior margins, and scutellum with a reddish tinge, pile yellow, pleura and metanotum black, mostly shining. Abdomen variable, shining, basal segments usually more or less yellow, apical segments blackish, pile yellow. Legs yellow, tarsi infuscated at the tip, fore metatarsus 2-3 as long as its fore tibia. Wings hyaline, subcosta ends in the costa proximad of the base of R_{2+3}; venation as figured (fig. 77). Length of wing 3 to 4 mm. which is 3 1-3 times as long as the fore tibia. Halteres yellowish. Ithaca, N. Y.; Boulder, Col. (T. D. A. Cockerell, collector); Gardiner, Maine.

In my specimens there is considerable variation in the amount of color on the abdomen, in other respects they appear identical. This variation has led me to believe that the synonymy given above is correct.

Larva. Slender, legless, resembling the larva of an aquatic Ceratopogon, 12 segmented. Head yellowish brown, oblong, about twice as long as wide; labrum with rounded margin, setose ventrally; mandibles when extended, reach cephalad of margin of labrum, brown in color, apical half oval, margined with a number of blunt teeth, mesal margin also with toothed hook produced cephalad, maxilla fleshy, its palpus short, papillate; hypopharynx setose; labium with brown margin, and with 2 pointed teeth on lateral cephalic margin; a few scattered setæ on head; 2 eye spots. Body hyaline, whitish, the 2 main tracheal trunks open on the center of the lateral margin of the first thoracic segment and extend to the apex of the twelfth abdominal segment; they are connected by a strong commissure at the cephalic end of the second thoracic segment. At the posterior end the spiracles are surrounded by a fringe of setæ which project out at right angles to the axis of the body. Length of full grown larva about 7 mm.

Pupa. Brown; tapering, with a few caudad projecting spines from the thorax and each of the abdominal segments. Length 4 mm.

Habit. This species has been reported a number of times by fruit growers as causing injury to the roots of apple and peach trees. It has been found to occur in the rotting wood of these trees but it is extremely doubtful if it is able to cause injury to the sound wood. Both Riley and Walsh as well as Glover have recorded it and all are agreed as to the inoffensive character of this insect. The specimens upon which the above descriptions were drawn, were sent to me by Mr. Gardiner, of Gardiner, Maine.

2. Genus *Palæoplatyura* Meunier.

Palæoplatyura Meunier, Miscell. Entomol. VII. 164. 1899.

Head depressed, front broad, ocelli 3 in number remote from eye margin, palpi 4 jointed; antennæ 2+14 jointed, about as long as head and thorax taken together. Thorax arched, setæ not prominent; abdomen of the male with 7 visible segments; hypopygium small, consisting of a pair of 2 jointed forceps, the basal joint stout, the terminal joint curved, about 4 times as long as broad, the apex toothed and densely ciliated on the inner side. Legs slender, tibial spurs about 1.5 times as long as the diameter of the femur at the widest part; tarsal claws toothed, empodium prominent. Wings (fig. 78) broad, longer than the abdomen; costa produced beyond the tip of R_{4+5}, almost reaching the tip of the wing; subcosta less than 1-3 the length of the wing, ending in the costa a little beyond the point where the radial sector begins; subcostal crossvein present or absent; R_1 ends about 2-3 the length of the wing, R_{2+3} about as long as basal section of the radial sector and ends a little beyond the tip of R_1, the R-M crossvein stout and very short, the media arises near the base of the wing and is represented by a delicate fold-like vein to the crossvein, beyond which it is strong, and forks about half way from the crossvein to the base of R_{2+3}; cubitus forks slightly proximad of the M-Cu crossvein; second anal vein may be produced to margin or may be abbreviated. Contains recent as well as fossil forms.

Table of species.

a. Wing immaculate; subcostal crossvein absent, anal vein not reaching margin of the wing. 1. *aldrichii.*

aa. Wing with markings; subcostal crossvein present, anal vein reaches margin of wing. (fig. 78) 2. *johnsoni* n. sp.

1. *Palæoplatyura aldrichii* Johannsen.

1909. *aldrichii* Johannsen, Genera Insectorum, Mycetophilidæ. 10.

Male. Length 4 mm. Head, face and antennæ fuscous, basal joint of the last and palpi yellow; ocelli arranged in a triangle. Thorax pale brownish, including pleura, sternum and scutellum, the mesonotum with 3 confluent darker stripes, metanotum dark brown, humeri and supra-pleural stripe yellow; black setæ arranged in 5 longitudinal lines, 3 on the mesonotum and 2 on the lateral margin; scutellar setæ fine and numerous, but little longer than those on the humeri. Abdomen brown, darker apically, with black setulæ; hypopygium as described for the genus. Coxæ and legs pale yellow, tarsi infuscated, fore metatarsus about .7 as long as its tibia; spurs yellow. Wings hyaline, with a very faint smoky tinge, heavier veins brown, slender veins more yellowish; subcostal crossvein wanting, anal vein stout but not reaching margin of the wing. Halteres yellow.

One specimen from Professor Aldrich. Friday Harbor, Wash. This species differs in several important structural characters from the following, though for the present they will be left in the same genus.

2. *Palæoplatyura johnsoni* n. sp.

Male. Length 5 mm. Head subshining black; ocelli in a transverse line set low on the front, the median one smaller than the laterals. Face fuscous, oval margin produced and covered with erect black setæ; labellæ and palpi yellow, both of medium size, the latter with 4 joints of which the first and second are subequal, the third about thrice, the fourth 4 times as long as the first, all with a few black setæ, those of the fourth small and inconspicuous; the scape yellow, the basal joints of the flagellum yellowish, the remaining joints fuscous; first flagellar joint about twice as long as wide, the other joints but little longer than their width; whole antenna if bent back would scarcely reach the metanotum. Mesonotum shining yellow with 3 brown stripes, the middle one widest, setæ black, sparse, not arranged in longitudinal rows; scutullum yellow, without prominent setæ; metanotum and pleura except at base of the wing, brown. Abdomen brown, the apical margin of the segments, except of the first, yellow; setæ black. Posterior end and hypopygium crushed in the single specimen, hence cannot be described. Coxæ and legs yellow, tarsi more dusky, fore metatarsus slightly longer than its tibia, setæ of middle and hind tibiæ small and inconspicuous, shorter than the diameter of the tibia; one spur on fore tibia, 2 subequal ones on each of middle and hind tibiæ; empodium consists of a few short setæ, the claws each with 2 short, stout, straight teeth proximad of the middle. Wings (fig. 78) grayish hyaline with markings as follows: an oval brown spot covering the R—M crossvein and extending distad to beyond the fork of the media with a tiny hyaline spot in it just distad of the crossvein; a small brown spot at costal margin and filling the space between R_{2+3} and apex of R_1; an elongate spot covering the apical end of Cu_2 and faintly merging into the posterior end of the subapical brown band which arises on the costa between the extremities of the branches of the radial sector and extends posteriorly more faintly over the branches of the media and beyond the anterior branch of the cubitus where it nearly or quite reaches the wing margin; subcosta ends in the costa well beyond base of the radial sector, the subcostal crossvein is situated half way between the humeral crossvein and the base of the radial sector; R_{2+3} arises before the apex of R_1 but ends well beyond its tip; the costa is produced well beyond the tip of R_{4+5} but does not reach the tip of the wing; the anal vein is produced to the wing margin; the apical end of the first section of the radial sector and of the media hyaline white, the remainder of the veins brown, the heavier veins darkest. Length of wing 6 mm. One specimen from Burlington, Vt. taken in June by Mr. C. W. Johnson.

3. Genus *Ditomyia* Winnertz.

Ditomyia Winnertz, Stett. Ent. Zeit, VII, 14. 3. 1846.

Head spherical, flattened in front; 3 ocelli, unequal, in a transverse line; palpi 4 jointed; antennæ 2+15 jointed, the last very small, papilliform. Abdomen with 7 visible segments. Legs long and slender, tibiæ with short spurs. Wings (fig. 80) large, hairy, subcostal vein short, incomplete; R_{2+3} arises proximad of the fork of the media; media arises apparently at the R—M crossvein, the basal section having been wholly obliterated; cubitus forks slightly proximad of the M—Cu crossvein; anal vein prolonged to the margin.

Ditomyia euzona Loew.

1869. *euzona* Loew, Berl. Ent. Zeitschr. XIII. 1.

Male. Length 6 mm. Head, scape, and base of first flagellar joint yellowish, flagellum and palpi blackish. Thorax yellow, dorsum with dusky vittæ; scutellum except the base, fuscous. Abdomen yellow, each segment with a black posterior fascia which is dilated in the middle and on the lateral margins, hypopygium dusky. Coxæ and legs yellowish. Wings hyaline, grayish tinged, with the following fuscous fasciæ; the first near the base of the wing extends from the costa into the basal cell R, the second extends across the wing from near the apex of the subcostal cell to the posterior branch of the cubitus; the third widely covers the apex of the wing. Length of wing 6.2 mm. Halteres yellow.

The type, from the District of Columbia, is now in the museum at Cambridge, Mass. Another specimen of this beautiful species is in the United States National Museum.

4. Genus *Symmerus* Walker.

Symmerus Walker, List Dipt. Brit. Mus. I. 88. 1848.

Plesiastina Winnertz, Stett. Ent. Zeit. XIII. 55. 4. 1852.

Head, antennæ, palpi, abdomen and legs as with Ditomyia. Eyes somewhat approximated on the vertex, ocelli 3 in number. Fore tibiæ on inner side with several slender setæ, the hind pairs as with Ditomyia. Wing venation (fig. 81) as with Ditomyia but differs primarily in having a shorter R_{2+3}, the base of which is somewhat distad of the fork of the media, and the costa ends at the tip of R_{4+5}.

Table of species.

a. Thorax shining fuscous black; abdomen and halteres mainly black, the basal half of peduncle of the latter, yellow; length 5 mm. Eastern states. 1. *tristis.*

aa. Thorax and usually halteres also, mainly yellow.

- b. Wings distinctly fasciate.
  - c. Wing with a single slender fascia across the cross-veins; abdomen black, segments with yellow posterior margins; length 12 mm. Mexico. 2. *lenis* n. n.
  - cc. Wing with two transverse fascia.
    - d. Thorax with 3 shining black stripes; legs mainly yellow, hind femora, tip of hind tibiæ, hind tarsi and tip of middle tibia, black, 6½-7 mm. Mexico. 3. *bifasciata.*
    - dd. Thorax yellow, reddish in the middle; legs pale, tarsi fuscous; length 10 mm. Mexico. 4. *mexicana.*
- bb. Wings not distinctly fasciate.
  - c. Thorax shining yellow, abdomen yellow, segments with wide, black posterior margins; length 7-7½ mm. Eastern States. 5. *annulata.*
  - cc. Thorax yellow with blackish median fascia; dorsum of abdomen black, the segments with pale margins; length 4.5-6 mm. New York. 6. *lauta.*

1. *Symmerus tristis* Loew.

1869. *tristis* Loew, Berl. Ent. Zeitschr. XIII. 131. 2. (Plesiastina).

Female. Length 4.5 to 5 mm. Head fuscous black, vertex and flagellum of the antenna more purely black. Thorax shining fuscous black, pleura and metanotum a little paler. Abdomen blackish, with black pile, the apical segment and appendages yellowish. Legs and coxæ fuscous, trochanters and the knees pale. Wings (fig. 81) smoky, the petiole of the media shorter than its anterior branch. Halteres black, stem yellow at base. D. C. (Osten Sacken); Massachusetts (W. M. Wheeler, col.).

2. *Symmerus lenis* n. n. (not *zonata* Stephens).

1890. *zonata* Giglio-Tos, Boll. Mus. Anat. comp. Torino. V. No. 84. (Ditomyia).

Male. Length about 12 mm. Face, front and palpi pale yellow; eyes black, pubescent; 3 ocelli arranged in a transverse row upon a black spot; antennæ yellow, longer than the head and thorax combined, the 6 apical joints black. Thorax yellow, with yellow pile, with 3 vittæ confluent posteriorly; pectus and metathorax black; scutellum yellow. Abdomen black, pilose, the first segment wholly and posterior margins of the others yellow. Legs yellow, hind femora fuscous at the base; the tips of tibiæ and tarsi blackish. Wing slender, longer than the abdomen, with a slender subfuscous transverse fascia which extends from R_1 across the crossvein nearly to the posterior margin of the wing following here the course of Cu_2. Halteres yellow.

Female. Smaller; antennæ wholly testaceous, shorter. Abdomen sparsely pilose. Recorded from Orizaba, Mexico, by Giglio-Tos.

3. *Symmerus bifasciata* Williston.

1900. *bifasciata* Williston, Biol. Centr.-Amer. I. 217. (Plesiastina).

Male. Length 6½-7 mm. Head yellow, the ocelli on small blackish spots; antennæ longer than the head and thorax together, light yellow, the last seven joints black, the flagellum flattened. Mesonotum light yellow, with three broad shining black stripes, the lateral ones abbreviated in front. Scutellum yellow, with the margin brownish. Pleura in part pitchy brown. Metanotum light yellow above, brown on the lower part. Abdomen: first segment and the venter light yellow; second to seventh segments, inclusive, shining black, with the hind margin yellow or yellowish, and clothed with yellow hair; remainder of abdomen black, with less abundant yellow hair; hypopygium yellow, with the superior organs blackish. Legs yellow; 4 posterior coxæ brownish; hind femora, tip of the hind tibiæ, the hind tarsi, and the tip of the middle tibiæ black; middle tarsi brownish; front tibiæ with weaker bristles; all the tibiæ with spurs, the hind pair with long and stout ones. Wings light yellow, with brown markings as follows: the whole of the costal cell, except sometimes a spot at the beginning of the yellow distally, the broad distal and narrow posterior margin, and a moderately broad band near the middle of the wing; the subcostal vein vanishes in a fold that ends about opposite the beginning of the radial sector; the radial sector forks before its middle, the media a little beyond the middle of the petiole of the radial sector; the costal vein ends at the tip of R_{4+5}. Mexico, Sierra de las Aguas Escondidas in Guerrero, 7000 feet.

4. *Symmerus mexicana* Giglio-Tos.

1890. *mexicana* Giglio-Tos, Boll. Mus. Zool. Anat. Comp. Torino. V. No. 84. (Ditomyia).

Male. Length 10 mm. Face and front yellow; eyes black, 3 ocelli, distant, placed in a right line upon a black spot; antennæ yellow, subfuscous toward the tip, longer than the head and thorax conjointly. Thorax yellow, reddish upon the center of the mesonotum. Abdomen black, with yellow pile, subclavate posteriorly, the whole of the first, and the posterior margins of the second and third, yellowish. Legs yellow, tarsi fuscous, each tibia with fuscous apex. Wings yellow, sparsely tomentose; longer than the abdomen, with 2 fuscous fasciæ, the first filling the basal half of the costal cell and extending across the disk of wing between the crossveins and the base of the fork of the media; the second broadly covers the apex of the wing. Halteres yellow. Recorded by Giglio-Tos from Orizaba, Mexico.

5. *Symmerus annulata* Meigen.

1830. *annulata* Meigen, Syst. Beschr. VI. 294. 3.
(Plesiastina).

Male and female. Length 7 to 7½ mm. Palpi and face yellow; front and vertex fuscous; antennæ brown, the scape and sometimes the basal flagellar joints yellow. Thorax and abdomen yellow, shining, the latter somewhat compressed, with posterior half or two-thirds of each segment fuscous. Coxæ and legs yellow, tarsi infuscated; fore tibia only slightly longer than the fore metatarsus; all femora ciliated beneath. Wings grayish hyaline, costal cell more ferruginous; veins brown; subcosta a mere tooth. Recorded from New Jersey and New Hampshire.

6. *Symmerus lauta* Loew.

1869. *lauta* Loew, Berl. Ent. Zeitschr. XIII. 132. 3.
(Plesiastina).

Male. Length 4½ to 6 mm. Pale yellow. Flagellum of antenna fuscous black; vertex in large part black. Mesonotum shining with 3 black vittæ, the median vitta paler anteriorly and divided by pale line; pleura immaculate. Tergum of each abdominal sclerite blackish with pale anterior and posterior margins, venter wholly pale yellow; hypopygium brownish, stout, superior forceps black, shorter than the inferior forceps. Legs pale yellow, tibial spurs black, tarsi infuscated. Wing tinted with cinereous; petiole of the media and M_2 subequal. Halteres yellow; knob infuscated. Recorded from N. Y. A defective specimen from Ithaca, N. Y., bears the date August 24.

3. Subfamily DIADOCIDIINÆ.

Diadocidinæ. Winnertz. Verh. Zool.-bot. Ges. Wien. XIII. 656. 1863.

This subfamily is distinguished from all others in having the M-Cu crossvein present and at the same time only 2 branches of the radius.

Genus *Diadocidia* Ruthe.

Diadocidia Ruthe, Isis. II. 1210. 1831.

Macroneura, Macquart, Suites à Buffon I. 146. 1834.

Head rounded, flattened in front; ocelli, 3, subequal, in a triangle on the front; palpi 4 jointed; antennæ 2+15 jointed, the apical joint papilliform. Thorax ovate, arched. Abdomen with 7 visible segments. Legs slender, femora somewhat thickened; hind tibiæ with 3 rows of delicate setæ. Wings (fig. 91) hairy, large, with wide base; subcostal vein, long and ends in the costa; subcostal crossvein (Sc_2) present or absent; R_1 ending in the costa distad of the mid length of the wing; the radial sector unbranched and ending in the costa before its tip; second anal produced to the wing margin.

Table of species.

a. Recent species.
- b. Subcostal crossvein wanting; apex of R_1 far proximad of tip of Cu_1. Eastern States. 1. *ferruginosa.*
- bb. Subcostal crossvein present; apex of R_1 opposite the tip of Cu_1. B. C. 2. *borealis.*

aa. Fossil species. Colorado. *terricola.*

1. *Diadocidia ferruginosa* Meigen.

1830. *ferruginosa* Meigen, Syst. Beschr. VI. 294. 4. (Mycetobia)

1831. *flavicans* Ruthe, Isis, II, 1211 (Diadocidia).

1834. *Winthemi* Macquart, Suites à Buffon. I. 147. 34. (Macroneura).

Male and female. Length 3 mm. Front, vertex, face and antennæ brown, base of the last and proboscis and palpi yellow. Thorax yellow, with 3 subcoalescent brown stripes, wanting in immature specimens; scutellum yellow; metanotum brown. Abdomen sordidly yellowish, darker apically. Legs yellow, tarsi infuscated; fore metatarsus nearly 2-3 as long as its tibia, hind tibia longer than the tarsus. Wing (Fig. 91) tinged with gray, with pale brown veins and gray setulæ; subcostal crossvein wanting. Halteres yellow. Ithaca, N. Y., August 10; Auburndale, Mass., July 16, (C. W. Johnson). Has also been recorded from the White Mountains, New Hampshire.

2. *Diadocidia borealis* Coquillett.

1900. *borealis* Coquillett, Proc. Wash. Acad. Sciences. II. 390.

Male. Length 4 mm. Head and antennæ dark brown, two basal joints of the latter, also the proboscis and palpi, yellow; thorax polished, yellow, the dorsum, except the front corners, dark brown; scutellum yellow; metanotum brown; abdomen dark brown, slightly polished, its hairs yellowish; coxæ and femora light yellow, tibiæ and tarsi brown, front tarsi slender; knob of halteres yellowish brown; wings hyaline, densely covered with short hairs, subcostal crossvein present, tip of R_1 about opposite apex of anterior branch of the cubitus. Lowe Inlet. B. C.

4. Subfamily CEROPLATINÆ.

Ceroplatinæ, Winnertz. Verh. Zool.—bot. Ges. Wien. XIII. 684. 1863.

The primary distinction possessed by the members of this subfamily is found in the wing venation. The R—M crossvein is obliterated by the coalescence of a section of the basal portion of the radius and media at the point where the crossvein usually is. The antennæ are short, usually thickened, and often more or less flattened.

Table of Genera.

a. Face and proboscis prolonged, beak-like or snout-like. (figs. 46, 49 and 87). 1. *Asindulum.*

aa. Proboscis short, not beak-like.

- b. Antennæ very much flattened, strap-like; palpi porrect, not incurved (figs. 47, 48).
  - c. R_{2+3} ends in R_1 (fig. 82). 2. *Ceroplatus.*
  - cc. R_{2+3} ends in the costa (fig. 83). 3. *Cerotelion.*
- bb. Antennæ not conspicuously flattened, palpi incurved, and moderately elongate.
  - c. Media arises at the base of the wing, basal section may be delicate and fold-like.
    - d. R_{2+3} ends in the costa (fig. 89). 4. *Hesperodes.*
    - dd. R_{2+3} ends in R_1 (fig. 88). 5. *Apemon.*
  - cc. Media apparently arises at the crossveins; i. e., its basal section wanting (figs. 84, 85, 86). 6. *Platyura.*

1. Genus *Asindulum Latreille.*

Asindulum. Latreille, Hist. Nat. Crust. Ins. XIV. 290. 1805.

Head transversely oval; middle ocellus smaller than the laterals; proboscis much elongated, deeply cleft (figs. 46, 49), palpi 4 jointed, incurved; antennæ 2+15 jointed, apical joint small, papilliform. Thorax arched; abdomen with 8 visible segments. Legs slender, the femora, particularly the hind pair, stout, the tibiæ with spurs and with delicate lateral setæ. Venation (fig. 87) as figured, resembling that of *Platyura.*

Table of species.

a. Length 8 to 8½ mm.; abdomen with the first 3 segments black, the remaining ones more or less yellow. N. Y., N. H., S. D. 1. *montanum.*

aa. Length about 5mm.

- b. Abdomen wholly and thorax mainly black; fore metatarsus .8 as long as its tibia. Canada. 2. *coxale.*
- bb. Abdomen and thorax more or less yellow. New Hampshire. 3. *flavum.*

1. *Asindulum montanum* Rœder.

1887. *montanum* Rœder, Wien. Ent. Zeit. VI. 116.

Male and female. Length 8 to 8½ mm. Black, epistome yellow, proboscis (fig. 46) black, antennæ fuscous-black. Thorax of the male black with yellow humeral angle and pleura; of the female and immature males yellow with three black longitudinal stripes; scutellum yellowish, often infuscated. The first three abdominal segments black, the remaining ones yellow though not infrequently more or less infuscated. Hypopygium yellowish brown; the inferior forceps lamelliform. Legs yellow, fore metatarsus ¾ as long as its tibia. Wings (fig. 87) hyaline; apically especially on costal margin somewhat smoky. Halteres yellow. White Mountains, N. H. (Cornell University collection); Adirondack Mountains, N. Y.; and S. D. (Aldrich).

2. *Asindulum coxale* Loew.

1869. *coxale,* Loew. Berl. Ent. Zeitschr. XIII. 132. 4.

Male. Length 5 mm. Black, including head, antennæ, proboscis (fig. 49) and body pile. Anterior part of lateral margin of the mesonotum narrowly yellowish as well as the sides of the scutellum. Abdomen and hypopygium black, the superior forceps slender, the inferior pair broad, neither very prominent. Coxæ and legs yellow, trochanters, tibial spurs and tarsi blackish; fore metatarsus .8 as long as its tibia. Wing subhyaline, slightly more cinereous apically. Halteres yellowish, knob fuscous above. Recorded from Hudson Bay Territory. I have a specimen from Montreal.

3. *Asindulum flavum* Winnertz.

1846. *flavum* Winnertz, Stett. Ent. Zeit. VII. 17. (Macrorrhyncha).

Male and female. Length 4 to $5\frac{1}{2}$ mm. Face, epistome, labellæ, lower front, base of antennæ, and occiput yellow; proboscis and remaining parts of the head black. Thorax yellow with 3 pale brown, sometimes obsolescent, stripes; scutellum with black hairs. Abdomen of the male with basal segments yellow, apical segments brown to black, hypopygium black; of the female yellow, anterior margin of each segment with a brown transverse fascia, terminal segments usually black; in immature specimens the fascia are obsolete. Coxæ and femora pale yellow; tibiæ pale brown; tarsi, spurs and setæ of tibiæ, brown; fore metatarsus $\frac{3}{4}$ as long as its tibia. Wing yellowish. Halteres whitish. The larvæ have been found in decaying wood. I have seen a specimen from New Hampshire.

2. Genus *Ceroplatus* Bosc.

Ceroplatus, Bosc. Act. Soc. Hist. Nat. Paris I. 1. 42. 1792.

Head small, ovate; three ocelli arranged in a transverse curved line; palpi (fig. 47) not incurved, 3 or 4 jointed; antennæ shorter than head and thorax taken together, very broad and flat, compressed, strap-like, 2+14 joints, the intermediate joints much broader than long (fig. 48). Thorax ovate; abdomen with 7 visible segments. Legs long, lateral setæ of tibiæ either absent or very minute. Wings (fig. 82) shorter than the abdomen; costa produced beyond the tip of R_{4+5} but ending before the tip of the wing; subcosta ends in the costa; subcostal crossvein, when present, basal in position; R_{2+3} ends in R_1; media with a short petiole; anal vein produced to the wing margin.

Table of species.

a. Thorax and abdomen black, lateral margin of abdominal segments whitish; wing with black mark; length 10 mm. Carolina. 1. *carbonarius.*

aa. Thorax more or less yellow.

b. Abdomen nearly entirely yellow; coalesced part of the media longer than the petiole. 2. *terminalis.*

bb. Abdomen with distinct brown markings.

c. Coalesced part of the media about equal to the length of the petiole; dark spot near apex of wing; abdominal segments more than half yellow. 3. *clausus.*

cc. Coalesced part of the media about twice the length of the petiole; no spot near apex of wing in male, and only feebly indicated in the female; yellow of abdomen confined to apical third of each segment. 4. *militaris.*

1. *Ceroplatus carbonarius* Bosc.

1802-4. *carbonarius* Bosc, Nouv. Dict. Nat. Hist. IV. 543.

Length 10 mm. Head black; thorax black, smooth; abdomen elongate, cylindrical, black, the lateral margins of each segment white; wing hyaline with black apex; legs dusky. Carolina.

2. *Ceroplatus terminalis* Coquillett.

1905. *terminalis* Coquillett. Journ. N. Y. Ent. Soc. XIII. 69.

Male. Length 9-10 mm. Light yellow; claws and ocellar area, black; vertex, a fine median line and 2 pairs of thoracic dorsal stripes of which the inner pair converge posteriorly, longitudinal pleural stripes, sternum, median spot on scutellum, lateral spots on first abdominal segment, knob of halteres, spot on sides of middle and hind coxæ and their apices, antennæ and forceps more or less brown. Antennæ more dusky yellow than the remaining parts. Inferior tubercle of the first antennal joint subconical, over half as long as the diameter of the second segment. Thoracic and abdominal setæ black. Wings hyaline, veins yellowish brown, an oval yellowish cloud over R_{2+3} extending into the adjacent cells, subcostal crossvein present;

coalesced part of the media a little longer than the petiole. Tibiæ and tarsi appear infuscated because of the longitudinal rows of the black setulæ; metatarsi of middle and hind legs sparsely ciliate on flexor surface with short setæ. Described from a specimen from the Western states. The species was recorded from Kaslo, British Columbia, by Mr. Coquillett.

3. *Ceroplatus clausus* Coquillett.

1901. *clausus,* Coquillett, Proc. U. S. Nat. Mus. XXIII. 594.

Male and female. Length 7 to 8 mm. Yellow, upper part of head brownish yellow, a black ocellar dot, the antennæ, 4 indistinct vittæ on mesonotum, 1 or 2 spots on pleura, a fascia at base of each segment of abdomen and knobs of halteres brown; antennæ greatly compressed, the joints except last one wider than long; wings (fig. 82) hyaline, a grayish brown spot fills the cell R_{2+3} and encroaches on the adjoining cells; subcostal vein extends considerably beyond the base of the radial sector; subcostal crossvein close to the humeral, R_{2+3} ends in R_1 at about its length before the apex of the latter, costa scarcely extending beyond the apex of R_{4+5}, cubitus forks considerably beyond the base of the radial sector. Recorded from New Hampshire and New Jersey by Coquillett. I have specimens from Ithaca, New York.

4. *Ceroplatus militaris* n. sp.

Male. Length 8 mm. Face, palpi, posterior margin of eye, and narrow space over base of antennæ, yellow; vertex posterior part of head, antennæ, and a slender streak between antennæ brown; ocellar area black; basal joint of antenna with tubercle below. Thorax mainly yellow, with 6 dark brown longitudinal stripes, the median pair meeting posteriorly and produced upon the scutellum, sometimes a slender median line between this pair, the latter sometimes connected by a transverse stripe anteriorly; the first laterals somewhat broader than the median pair; the second laterals on the margin of the mesonotum, narrow, and sometimes interrupted, usually reaching the base of the wing, pleura with large brown spot, sternum and margin of the prominent pteropleural lobes infuscated; scutellum and metanotum yellow. Setæ on thorax short, black and sparse; those on mesonotum and scutellum rather more conspicuous. Anterior 2-3 of each tergum brown, posterior third yellow, venter mainly yellow, seventh segment nearly wholly brown, terminal segment yellowish; abdominal setæ short, black, those on posterior margin of first ventral segment most conspicuous; the forceps which are pale yellow consist of 2 small conical lobes. Coxæ and legs pale yellow, extreme tips of coxæ and immediate bases of femora brown, second and third coxæ sometimes with a brown spot near middle; tibiæ and tarsi appear infuscated due to the fine, black setulæ which are arranged in longitudinal rows; metatarsi of middle and hind legs, sparsely ciliate with small setæ which are less than half as long as the diameter of the metatarsus. Wings hyaline, faintly smoky, the cell R_{2+3} somewhat more dusky, veins brown; subcostal crossvein present, basal in position; coalesced part of the media about twice as long as the petiole, Halteres yellow with brown knob. Ithaca, New York. Specimens also from Intervale, N. H. (G. M. Allen); Philadelphia (C. W. Johnson).

A female specimen from Philadelphia differs in having a suggestion of a black cloud on apex of the wing and abdomen with greater extent of brown fasciæ.

3. Genus *Cerotelion* Rondani.

Cerotelion, Rondani, Dipt. Ital. Prodromus, I. 191. 2. 1856.

This genus possesses the characters of *Ceroplatus* but differs in having the anterior branch of the radial sector R_{2+3} ending in the costa instead of in R_1 (fig. 83). As far as known the subcostal crossvein is absent and the claws have only 1 or 2 basal teeth.

Table of Species.

a. Thorax spotless, reddish yellow, pleura yellow; abdomen reddish yellow, base of basal segments and the whole of the apical segments black. Length 3.7 mm. Kansas. 1. *apicalis*.

aa. Thorax with stripes.

- b. Fore metatarsus a little longer than its tibia. Length 5 mm. Mexico, Pennsylvania. 2. *bellulus*.
- bb. Fore metatarsus 2.5 times as long as its tibia. Length 6 mm. St. Vincent. 3. *longimanus*.

1. *Cerotelion apicalis* Adams.

1903. *apicalis,* Adams, Kans. Univ. Science Bull. II. 2. 22. (Ceroplatus).

Male. Length 3.7 mm. Head brownish, anterior part of front, 2 basal joints of antennæ, face and mouth-parts yellow; thorax immaculate, reddish yellow, the black pile very short, except on the sides, pleura light yellow, halteres with knobs slightly infuscated; abdomen reddish yellow, base of second, third, fourth, and remainder of apex wholly black; legs light yellow, apical half of tibiæ and tarsi wholly blackish; wings hyaline; smoky towards apex, subcostal vein ends in the costa about midway between humeral crossvein and base of the radial sector, R_{2+3} ends in costa about midway between tip of R_1 and apex of R_{4+5}, furcation of cubitus almost opposite base of radial sector. Kas.

2. *Cerotelion bellulus* Williston.

1900. *bellulus,* Williston, Biol. Centr. Amer. I. 219 (Ceroplatus).

Male. Length 5 mm. Head black, the narrow face and the palpi brownish. Antennæ brownish-black, the first 2 joints somewhat yellowish; flagellum broad and flattened, about twice the length of the head. Mesonotum not shining, brownish in color; in the middle with 2 coalescent stripes, terminating acutely behind and separated from a moderately broad oblique stripe of the same color on each side by a slender V-shaped brown marking. Pleura light yellow along the noto-pleural suture and below the root of the wing, brown elsewhere. Scutellum brownish. Metanotum yellowish. Halteres blackish, with a yellow stem. Abdomen brown, blackish at the tip; the anterior part of the fourth and fifth segments yellow. Coxæ yellow, the distal half of the 2 posterior pairs brown; femora yellow; tibiæ and tarsi brownish. The tibiæ without bristles. Wings (fig. 83) tinged with brownish; subcostal vein strong, not connected with R_1; the radial sector arising about opposite the middle of the distance between the humeral crossvein and the tip of the subcostal vein, R_{2+3} oblique, terminating a little distance beyond the tip of R_1, the costal section intervening not as long as R_{2+3}; the costal vein extends a little distance beyond the tip of R_{4+5}; prefurca of the media nearly as long as the first section of the radial sector. Mexico, Teapa in Tabasco.

In Williston's figure the palpi appear incurved, this, however, may be the engraver's error. I have a specimen from Pottstown, Pa. (collected by C. W. Johnson) in which the face and palpi are yellow; the coalesced part of the media is but little more than half as long as the petiole; and each claw has a tooth near the base.

3. *Cerotelion longimanus* Williston.

1896. *longimanus,* Williston. Trans. Ent. Soc. Lond. 258 (Ceroplatus)

Male. Length 6 mm. Face yellow, very narrow. Palpi and first 2 joints of the antennæ yellow; remainder of the antennæ dark brown. Antennæ about as long as the dorsum of the thorax. Front narrow, the sides gently convex, black, except on the lowermost portion; the 2 large ocelli about equidistant from each other and from the margins of the eyes. Occiput black. Thorax yellow; the dorsum with 3 broad black stripes, enclosing 2 narrow yellow stripes, which are convergent posteriorly; the median stripe enclosing a slender yellow stripe, which does not reach beyond the middle; a large rounded spot on the mesopleura, another below it on the mesosternum, and the sides of the metanotum, dark brown or black, the middle of the metanotum brownish; scutellum brown. Abdomen slender, cylindrical, dark brown; each segment, save the first and last, with an elongate yellow spot on each side, reaching 2-3 of the way to the hind margin; genital organs yellow. Coxæ light yellow, the hind pair with a brown spot; femora yellow, the base of the middle and hind pairs brown; tibiæ yellowish-brown; tarsi brown; no bristles on the front femora; front metatarsi about 2.5 times the length of the tibiæ; middle metatarsi a fourth or a third longer than the tibiæ; the hind pair scarcely longer; hind tibiæ with two spurs. Wings tinged with brownish; R_{2+3} runs into the costa. St. Vincent Isl., 1000 feet.

4. Genus *Hesperodes* Coquillett.

Hesperodes Coquillett, Entomol. News. XI. 429. 1900.

Subcosta (fig. 89, diagrammatic) ends in the costa beyond the base of the radial sector; the subcostal crossvein is nearly midway between the humeral crossvein and the base of the radial sector, the latter forks beyond the apex of R_1; the media originates near the base of the wing and just before the union with the radial sector connected by the crossvein with Cu_1, and forking a short distance beyond the union with the radius; cubitus forking midway between the base of the radial sector and its union with the media; anal vein prolonged to the wing margin. Antennæ about twice as long as the head and thorax united, cylindrical but tapering to the apex; 2+14 jointed, the first joint as broad as long, the second twice as broad as long, and the others twice as long as broad; proboscis very robust, shorter than the height of the head; palpi 4 jointed, eyes emarginate opposite the antennæ; ocelli wanting. Abdomen slender, more than 3 times as long as the thorax. This genus, while superficially resembling *Hesperinus* in venation is a true Mycetophilid and more closely allied to *Apemon, Platyura,* etc.

Hesperodes johnsoni Coquillett.

1900. *johnsoni,* Coquillett, Entomol. News. XI. 429.

Male. Length 12 mm. Reddish yellow, antennæ and tarsi beyond the base changing to brown, legs destitute of strong lateral bristles, tibial spurs well developed; wings yellowish, becoming grayish hyaline on the posterior margin and at the apex, a brown spot at apex of R_1. Delaware Water Gap. N. J. July.

5. Genus *Apemon* Johannsen.

Apemon, Johannsen, Genera Insectorum, Mycetophilidæ. 20. 1909.

Resembles *Platyura* but differs in having a distinct, though delicate, fold-like basal portion of the media arising near the base of the wing, and in having no setæ, but only fine hairs upon head, thorax, coxæ and femora. The setæ of the abdomen, tibiæ and tarsi very small and inconspicuous. Antennæ 2+14 jointed, flagellar joints cylindrical, under 20 diameter magnification only indistinctly pilose; ocelli large, arranged in a transverse line on the broad front, middle one only slightly smaller than the others; eyes pilose; palpi incurved, rather long, basal joint very small, second broad, about as long as broad, third joint about half as broad but twice as long as the second, fourth slender, about 5 times as long as broad; proboscis short. Thorax moderately arched, dorsum and scutellum provided only with hairs, those over the base of the wing and on the scutellum rather longer, pleura and metathorax nearly bare. Abdomen depressed, flattened, broadened apically, segments finely setulose, particularly on basal portion; male genitalia (fig. 97) small, simple, consisting primarily of two incurved lateral lobes, toothed at the apex. Legs moderately long; coxæ long, these and the femora short haired, setulæ of the tibiæ less than $\frac{1}{4}$ the diameter of tibia in length, spurs strong; fore metatarsus shorter than the tibia; all tarsi finely setulose, claws with teeth near the base of each; empodium conspicuous. Wings (fig. 88) resembling those of *Platyura;* media arises near the base of the wing; its first section is delicate and fold-like; R_{2+3} joins R_1 near its apex; anal vein prominent, produced to the wing margin.

Table of species.

a. Subcosta short, ending at or before the base of the radial sector.
- b. Length 6 mm. Abdomen yellow with anterior portion of each segment black. 1. *gracilis.*
- bb. Length 8 to 12 mm. Abdomen reddish yellow, first segment black; female. 2. *pectoralis.*

aa. Subcosta ends distad of base of radial sector.
- b. Mesonotum and abdomen reddish yellow, pleura, metanotum and first abdominal segment black; male. 2. *pectoralis.*
- bb. Mesonotum black or with brown stripes.
  - c. Abdomen in part reddish yellow.
    - d. Mesonotum reddish yellow with 3 dark brown stripes; part of third, fourth and fifth abdominal segments yellow, other segments black. 3. *maudæ.*
    - dd. Mesonotum black, abdomen yellow, except first 2 segments. 4. *pulchra.*
  - cc. Abdomen wholly black. 5. *nigriventris* n sp.

1. *Apemon gracilis* Williston.

1893. *gracilis* Williston, Kas. Univ. Quarterly II. 60 (Platyura).

Male. Length 6 mm. Antennæ black, much shorter than the thorax; first 2 joints yellowish. Head yellow, the vertex blackish. Thorax, coxæ, and femora yellow; the mesonotum more reddish with a fringe of black hairs above the root of the wings. Abdomen slender, not shining; yellow, the anterior portion of each segment brown or blackish. Tibiæ somewhat infuscated by the minute black hairs; tarsi blackish. Wings with a strong yellow or brownish tinge, the extremity with a blackish cloud; subcostal vein very short, terminating before the origin of the radial sector, the subcostal crossvein at about its middle; R_{2+3} at some distance before the tip of R_1; third anal vein wholly wanting. Washington.

2. *Apemon pectoralis* Coquillett.

1895. *pectoralis* Coquillett, Canad. Entomol. XXVII. 199 (Platyura).

Female. Length 12 mm. Front, occiput and antennæ, black; first 2 joints of the latter, the face, cheeks and mouth parts, yellowish. Thorax and scutellum reddish-yellow, pleura and metanotum bluish-black. Abdomen reddish yellow, the first segment black, the second 3 times as long as broad. Halteres yellowish. Coxæ and femora reddish yellow, tibiæ brownish-yellow, tarsi black. Wings yellowish-grey; a brown spot extends from the costa before the tip of R_1 to posterior branch of the media near its base; apex of wing from midway between tips of R_1 and R_{4+5} to apex of anal vein, grayish-brown; a brown cloud on the radial sector near its base; tip of subcostal vein opposite base of the radial sector, subcostal crossvein 1.5 times the length of the humeral beyond the latter; R_{2+3} oblique, ending twice its length before the tip of R_1; anal vein reaches the wing margin. Nevada.

Several male specimens taken by Prof. Aldrich in June at Grangeville and Moscow, Idaho, differ as follows: the brown cloud on apex of wing (fig. 88) less extended; the subcosta ends distad of the base of the radial sector, R_{2+3} is nearly perpendicular in position; the fore metatarsus is two-thirds as long as its tibia; hypopygium as figured (fig. 97). One specimen is only 8 mm. long, but otherwise does not differ.

3. *Apemon maudæ* Coquillett.

1895. *maudæ* Coquillett, Canad. Entomol. XXVII. 199 (Platyura).

Female. Length 9 mm. Head and antennæ black, palpi yellowish. Thorax, pleura and scutellum bluish-black. Abdomen reddish-yellow, first 2 segments black, the base of the second tinged with reddish; this segment is half longer than broad. Halteres yellowish. Coxæ reddish-yellow, blackened at their bases, femora deep yellow, tibia brownish-yellow, tarsi black. Wings yellowish-gray, a brownish spot extends from R_1, before its apex, to the posterior branch of the media near its base; apex of the wing from midway between tips of R_1 and R_{4+5} to apex of anal vein grayish-brown; a brown cloud on third vein near its base; tip of subcostal vein twice the length of the humeral crossvein beyond the base of the radial sector; subcostal crossvein 1.5 times the length of the humeral crossvein beyond the latter; R_{2+3} oblique, ending nearly its own length before the tip of R_1; anal vein reaches the wing margin. Male same as the female except the second abdominal segment is twice as long as broad, and R_{2+3} is perpendicular, ending twice its length before tip of R_1. Washington.

4. *Apemon pulchra* Williston.

1893. *pulchra* Williston, Kas. Univ. Quarterly II. 59 (Platyura).

Male. Length 8 to 9 mm. Antennæ about as long as the thorax; black on the under side, toward the base, red; first 2 joints yellow. Front and face black, the latter with whitish pubescence; palpi and proboscis yellow; occiput black; epistome moderately projecting. Mesonotum shining reddish yellow, with light-yellow hair; 3 dark brown stripes, separated by slender lines, the lateral ones abbreviated in front. Scutellum black. Pleura black, with reddish spots; the projecting metapleura yellowish. First 2 segments of the abdomen black; third segment reddish yellow, with a black hind border; fourth segment and the anterior part of the fifth reddish yellow; remaining segments black; the hypopygium reddish, with whitish pubescence; abdomen shining. Coxæ and legs (the hind pair is wanting) light yellow; tibiæ infuscated by the minute black hair; tarsi blackish; middle and front tibiæ with short spinules. Wings hyaline, the tip and posterior border infuscated; a narrow brown cloud covers the tip of R_1 and reaches into the base of the cell R_{4+5}; subcostal crossvein only a little distance beyond the humeral crossvein; tip of subcostal vein beyond the origin of the radial sector; R_{2+3} terminates in R_1 near its tip; prefurca of media very short. Anal vein complete. Washington.

5. *Apemon nigriventris* n. sp.

Male and female. Length $7\frac{1}{2}$ to $8\frac{1}{2}$ mm. Head, including scape of antennæ, thorax, abdomen including venter, genitalia, and margin of the trochanters subshining black; palpi, coxæ, femora and halteres reddish yellow, tibiæ dull yellow, spurs a little paler, tarsi fuscous. Hairs of thorax, pale yellow, arranged in 3 longitudinal lines and along the lateral margins; hairs on humeri, scattering hairs on venter and hypopygium pale, elsewhere on head, thorax and abdomen black; those on the coxæ and femora pale, on tibiæ and tarsi black, setæ of the former very minute, scarcely differentiated from the hairs. Intermediate antennal joints but little longer than wide. The fore metatarsus of the male 0.75 as long as its tibia, in the female about 0.7; tarsal claws toothed, setose on basal half, empodium brush-like, as long as the claws. Wing of the male very faintly smoky; of the female more distinctly smoky on apical half; veins dark brown; R_{4+5} ends very close to the tip of the costa but noticeably before the apex of the wing; subcosta ends about the length of R_{2+3} distad of the base of the radial sector; the subcostal crossvein is situated about twice its length distad of the humeral crossvein; R_{2+3} makes about a 45° angle and ends in R_1 very close to its apex; petiole of the media is shorter than the coalesced section of the media; the fold-like basal section of this vein is hyaline; anal vein sinuous, and reaches the margin of the wing. Three specimens collected in July by Mr. J. C. Bradley. Selkirk Mts., Rogers Pass. B. C. 4600 ft. altitude; and Prarie Hill, B. C. 5800 ft. altitude.

6. Genus *Platyura* Meigen.

Platyura Meigen, Illiger's Mag. II. 264. 1803; Klass I. 101. 1804.
Zelmira Meigen, Nouv. Class. Mouches. 16. 1800. (without type).

Head small, ocelli closely approximated, median smallest; palpi 4 jointed; antennæ 2+14 jointed, cylindrical or somewhat compressed, closely sessile. Thorax oval, setose; abdomen with 7 visible segments, depressed apically. Legs long, femora somewhat thickened; tibiæ spurred, setæ very minute. Wings (figs. 84, 85, 86) somewhat broadened, as long or longer than abdomen; costa prolonged beyond the tip of R_{4+5} and ending before the tip of the wing; subcosta ends in the costa, rarely ending free, subcostal crossvein usually present, R_{2+3} very short usually ending in the costa, rarely in R_1; prefurca of media short; anal vein either incomplete or produced to the margin.

Table of species.

a. R_{2+3} ends in R_1; subcostal crossvein wanting (fig. 85); tibiæ each with but one spur. Length 2 mm. West Indies. 1. *parva*.

aa. R_{2+3} ends in the costa, beyond the apex of R_1.

b. Subcostal vein ends noticeably beyond the base of the radial sector.

c. A distinct transverse fascia or band at or near the apex of wing, or wings with several spots.

d. Wing with band; thorax brown, a median stripe on posterior half and sides yellowish, abdomen dusky, bases of segments yellowish, halteres with black knob. Length 10 mm. Washington. 2. *fasciola*.

dd. Wing spotted; length 3 mm. 7. *elegans*.

cc. Apex of wing hyaline or only indistinctly smoky, no band.

d. Apices of abdominal segments black; fore metatarsus longer than its tibia; length 4½ mm. 3. *inops*.

dd. Apices of abdominal segments, yellow.

e. Thoracic vittæ black; fore metatarsus shorter than tibia. 4. *setiger* n. sp.

ee. Thoracic vittæ reddish yellow. Washington State. 5. *lurida*.

bb. Subcostal vein ends opposite or proximad of the base of the radial sector.

c. Wing with several distinct brown spots, tibiæ each with but a single spur.

d. Dorsum black with central stripes, fore metatarsus about equal to tibia in length. West Indies, 6. *pictipennis.*

dd. Thorax opaque brownish black, often with yellow central stripe; sides, pleura and scutellum yellow; fore metatarsus shorter than its tibia. Atlantic States. 7. *elegans.*

cc. Wing with only a single preapical fascia, or wholly uniform in color.

d. Wing without a band or fascia near apex.

e. Mesonotum mainly black or dark brown.

f. Length 2 mm; subcostal crossvein apparently wanting; anal vein not produced to margin; female. Eastern States. 8. *mimula* n. sp.

ff. Length over 3 mm.

g. Subcostal crossvein wanting; thorax and abdomen black; apex of wing smoky; length 6 mm. 9. *melasoma.*

gg. Subcostal crossvein present, situated far proximad of middle of subcosta; anal vein produced to margin.

h. Scutellum, pleura and hind margins of abdominal segments yellow.

i. Metanotum yellow. 10. *pullata.*

ii. Metanotum black; fore metatarsus shorter than tibia. 4. *setiger* n. sp.

hh. Thorax wholly black, except humeral angle and at base of wings; hypopygium small (fig. 92). 11. *nigrita* n. sp.

ee. Predominant color of mesonotum yellow.

f. A blackish spot on the proximal part of hind coxæ and adjacent portion of pleura; abdomen reddish yellow; wing with feebly marked band before the tip; length 8 mm. 12. *notabilis.*

ff. Smaller species differing from the above.

g. $R_{2}+_{3}$ nearly perpendicular to $R_{4}+_{5}$.

h. Abdomen brownish yellow, with black hair; subcostal vein very short; length 3 to 4 mm. West Indies. 13. *ignobilis.*

hh. Last segment of abdomen black; faint cinereous spot near apex of wing; subcostal vein over two-thirds as long as the basal cell R; length 5 mm. Maine.
14. *fascipennis* var. *sagax* n. var.

gg. $R_{2}+_{3}$ noticeably oblique to $R_{4}+_{5}$.

h. Length 2 mm; fore metatarsus about half as long as its tibia, male.
8. *mimula* n. sp.

hh. Length over 3 mm.

i. Each tibia with but a single spur; fore metatarsus and its tibia subequal in length; apical margin of abdominal segments black; length 5 to 6 mm. West Indies. 15. *fasciventris.*

ii. Two spurs on each of middle and hind tibiæ.

j. Fore metatarsus about $\frac{5}{8}$ as long as its tibia; coalesced part of the media 2-3 as long as its petiole; anal vein to margin. 16. *moesta* n. sp.

jj. Fore metatarsus at least $\frac{3}{4}$ as long as its tibia.

k. Apex of subcosta as far proximad of the base of the radial sector as the length of the first section of the sector; anal vein to margin; hypopygium with lobe-like forceps (fig. 99). 17. *mendosa.*

kk. Apex of subcosta nearly opposite the base of the radial sector.
18. *mendica.*

dd. Wing with more or less distinct preapical spot or fascia.

e. A blackish spot on proximal part of hind coxæ and adjacent portion of pleura; thorax and abdomen reddish yellow, wing band feeble; length 8 mm. 12. *notabilis.*

ee. Not as above in all particulars.

f. R_{2+3} nearly perpendicular to R_{4+5}.

g. Last abdominal segment wholly fuscous black.

h. Wing spot distinct; length 3.5 mm. Ga. 26. *divaricata.*

hh. Wing spot subobsolete; fore metatarsus is about 0.25 longer than its tibia; length 5 mm. Maine.

14. *fascipennis* var. *sagax,* n. var.

gg. Abdomen dusky.

h. Abdomen of male including last segment slightly dusky; fore metatarsus over 0.4 longer than the tibia; coalesced part ot media noticeably longer than the petiole. 19. *subterminalis.*

hh. Fore metatarsus less than .25 longer than the tibia; coalesced part of media shorter or not longer than the petiole; female.

14. *fascipennis.*

ff. R_{2+3} distinctly oblique to R_{4+5}.

g. Subcostal crossvein wanting; blackish species, wing with slight cloud; length 6 mm.

9. *melasoma.*

gg. Subcostal crossvein present.

i. Fore metatarsus longer than its tibia.

j. Fore metatarsus about 1-6 longer than the tibia; subcostal crossvein is near the middle of the subcosta.

k. Coalesced part of media equal to or shorter than the petiole; hypopygium (fig. 98); preapical cloud subobsolete. 20. *diluta.*

kk. Coalesced part of media longer than the petiole; hypopygium (fig. 96).

21. *moerens* n. sp.

jj. Fore metatarsus over a third longer than the tibia; hypopygium (fig. 107).
19. *subterminalis* var. *nexilis* n. var.

ii. Fore metatarsus equal to or shorter than the tibia.

j. Mesonotum mainly yellow; stripes if present, pale, coalesced part of media shorter than the petiole.

k. Anal vein prolonged to margin; hypopygium with lobe-like forceps (fig. 99). 17. *mendosa.*

kk. Anal vein not prolonged to margin; fore metatarsus and tibia subequal; hypopygium robust (fig. 100). 22. *genualis* n. sp.

jj. Mesonotum black or with dark stripes, coalesced part of media usually equal to or greater than the petiole.

k. Fore metatarsus about 1-5 of tibial length shorter than the tibia; subcosta ends about twice the width of the costal cell proximad of the base of the radial sector; length 5-6 mm.
23. *scapularis* n. sp.

kk. Fore metatarsus 0.1 or less shorter than tibia; subcostal vein ends not more than the width of the costal cell proximad of the base of the radial sector; length 8-9 mm.

l. Scape of antennæ and base of some abdominal segments yellowish.
24. *elegantula.*

ll. Scape of antennæ black; abdomen of male mainly black.
25. *tæniata.*

1. *Platyura parva* Williston.

1896. *parva* Williston, Trans. Ent. Soc. London 257.

Male. Length $2\frac{1}{2}$ to 3 mm. Antennæ brownish-yellow, shorter than the thorax. Posterior part of the mesonotum, the narrow lateral margins, and 3 slender stripes, brown or black; elsewhere the thorax is yellow, save 2 spots on the pleura, and the metanotum for the greater part, which are black. Abdomen cylindrical, black, the venter and immediate base yellowish. Coxæ and legs yellow; the terminal portion of the tibiæ, and the tarsi, brownish; metatarsi about 3-4 of the length of the tibiæ; all the tibiæ with a single spur and without spines. Wings lightly tinged; R_{2+3} enters R_1 near its tip. St. Vincent, Isl.

I have seen a specimen from one of the Lessor Antilles. The ending of R_{2+3} in R_1, the length of the petiole of the *media*, the absence of the subcostal crossvein (fig. 85) and the possession of but a single spur on each tibia, are characters which combined mark this species as one widely remote from other *Platyura*. It should perhaps be made the type of a new genus.

2. *Platyura fasciola* Coquillett.

1894. *fasciola* Coquillett, Entomol. News. 126 (Ceroplatus).

Female. Length 10 mm. Head including greatly flattened antennæ and large palpi, dark brown; the retracted proboscis, base of the third antennal joint, a small spot beneath each antenna, yellow. Thorax shining brown, a medio-dorsal vitta on posterior half and lateral margins yellow; pleura yellow, a large spot above the middle coxæ and a small one above hind coxæ, dark brown. Scutellum yellow, its base brown, center of metanotum dark brown. Abdomen shining, blackish brown, base of each segment except first, yellow, on second, third and fourth segments prolonged posteriorly is an indistinct dorsal vitta; coxæ and femora yellow, bases of middle and hind femora, and of hind coxæ blackish brown, tibiæ and tarsi brownish yellow. Wings pale yellowish, the apex between tip of R_1 and apex of Cu_1, blackish, apex of Cu, bordered with blackish, this color projecting into the cell of Cu_1 near its middle. Apex of subcostal vein far beyond origin of the radial sector, being opposite origin of M. Subcostal crossvein before middle of the distance between humeral crossvein and tip of the subcostal vein; R_{2+3} very oblique, ending in costa beyond apex of R_1. Knob of halteres black. Washington.

3. *Platyura inops* Coquillett.

1901. *inops Coquillett.* Proc. U. S. Nat. Mus. Bul. 23, 594.

Male and female. Length 4.5 mm. Yellow, an ocella dot and apices of abdominal segments black, most extended on the posterior segments, tarsi yellowish brown; antennæ subcylindrical, the third joint noticeably longer than broad; wings hyaline, a grayish brown spot before apex of R_{4+5}; subcostal vein extending a short distance beyond base of radial sector, subcostal crossvein at about 1-6 of distance from the humeral to apex of subcostal vein, R_{2+3} ending in the costa at about 1-3 of distance from apex of R_1 to apex of R_{4+5}, costa extending nearly midway between apices of R_{4+5} and M_1, cubitus forking beyond base of the radial sector. Delaware Water Gap, New Jersey.

One of each sex from Brattleboro, Vermont, taken in July by Mr. C. W. Johnson, and a single specimen from Ithaca, N. Y., have the coalesced part of the media much shorter than the petiole; fore claws with 2 basal teeth each, one of the teeth slender and about 1-3 as long as the claw; the fore metatarsus 1.5 times as long as its tibia; the hypopygium as figured (fig. 101).

4. *Platyura setiger* n. sp.

Male. Length 5½ mm. Head black, subopaque, palpi and mouth parts, and whole of the antennæ fuscous; intermediate antennal joints about as long as broad. Thorax subopaque, mesonotum with three wide confluent black stripes (in one specimen not confluent), the humeri, lateral stripe to base of wings, and margin of scutellum yellow, the other parts black; the setæ on the thorax arranged in rows, a slender median row, one on each side of this on the division between the dark stripes, and a wider lateral row of rather more conspicuous setæ reaching the base of the wings. Scutellar setæ as strong as those at the base of the wing. Abdomen dusky yellowish, the dorsum of the first segment, basal half of the second, the immediate bases of the remaining segments, the whole of the prominent hypopygium (fig. 103), under side of trochanters, and setæ of abdomen, black. Legs including the coxæ, yellow; tarsi appear dusky owing to the black setulæ. Tibial setæ less than half as long as the diameter of tibia, several rows on each tibia, six to eight on the fore, eight to twelve on the intermediate, and twelve to fifteen setæ on hind tibia in each row. Tarsal claws with teeth. Fore metatarsus is about .8 as long as the tibia. Wings (fig. 86) hyaline, yellow tinged; veins dusky yellow; subcosta ends opposite or slightly beyond the base of the radial sector, R_{2+3} oblique, coalesced part of the media about half as long as the petiole, anal reaches the margin of the wing. Halteres yellow. Two specimens from Dewatto, Washington, collected by Prof. Aldrich. This species seems to be closely related to *pullata* Coq.

5. *Platyura lurida* Coquillett.

1895. *lurida* Coquillett. Canad. Ent. 199.

Female. Length 6 mm. Head and antennæ black, first two joints of the latter and the mouth parts somewhat yellowish. Thorax, pleura, scutellum, abdomen and legs, pale yellow, the tarsi toward the apex brownish yellow, the thorax marked with three reddish yellow vittæ. Wings hyaline, slightly tinged with yellowish toward the costa, otherwise unmarked; tip of subcostal vein nearly twice the length of the humeral crossvein beyond the base of the radial sector; subcostal crossvein nearly three times the length of the humeral beyond the latter; R_{2+3} oblique, ending its own length beyond the tip of R_1; anal vein reaches the wing margin. Washington.

6. *Platyura pictipennis* Williston.

1896. *pictipennis* Williston. Trans. Ent. Soc. London. 257.

Male and female. Length 3-3½ mm. Front and face yellowish or brownish, the palpi darker colored. Antennæ brownish, about as long as the thorax, moderately compressed. Thorax yellow; the dorsum, save a yellowish spot or stripe in the middle, and the yellow lateral margins, brown or black; disk and sides of the metanotum brown. Abdomen brown or blackish-brown, the posterior margin of each segment yellow. Legs, including the coxæ, yellow, the distal portion of the tibiæ, and the tarsi, brownish; tibiæ without spines; front tibiæ and metatarsi of nearly equal length; the hind metatarsi shorter than their tibiæ; all the tibiæ with a single spur. Wings nearly hyaline, with markings as follows: a large brown spot, reaching from the costa to the cubitus, over the prefurca; another of about the same size in the outer part of the cell R_4+_5; and smaller ones in all the cells on the posterior side of the wing; R_2+_3 runs into the costa a little beyond the tip of R_1. St. Vincent Isl., W. I.

7. *Platyura elegans* Coquillett.

1895. *elegans* Coquillett, Proc. Acad. Nat. Sc. Phila. 307.

Male and female. Length 3.5 mm. Head black, lower part of front and the face yellow; antennæ black, the two basal joints yellow; proboscis yellow, its apex and the palpi black. Dorsum of thorax opaque brownish black, the sides, pleura and scutellum, yellow; metanotum brown, this color extending upon the pleura to the middle coxæ. Abdomen shining brownish-black, the first segment, both ends of the second, apices of the third and fourth and the whole of the fifth, yellow; first five ventral segments also yellow. Halteres and legs yellow; tibiæ destitute of bristles. Wings grayish hyaline, marked with two irregular brown crossbands and with two brown spots; the first band begins at R_1 before its tip, is interrupted between the branches of the cubitus, and stops before reaching the hind margin of the wing, its posterior portion scarcely half as wide as the costal part; the second band starts from the tip of R_2+_3 and stops at Cu_1 a short distance before its tip, where the band is scarcely one-fifth as wide as at the costa; midway between these two bands is a large brown spot reaching from Cu_1 to the hind margin of the wing at the tip of the posterior branch; a brown cloud on R_2+_3, this branch terminating at twice its length beyond the tip of R_1. Georgetown, Florida, May; North Carolina.

I have seen specimens from Ithaca and Yonkers, N. Y.; Wisconsin and North Carolina. In the northern specimens the middle of the mesonotum is yellow, leaving two distinct dark lateral stripes; agreeing in this respect with *pictipennis* which appears to be closely related if not identical. In the Carolina specimen the middle of the mesonotum is only slightly paler brown than the sides. The fore metatarsus is about one-fifth shorter than the tibia, and the subcostal vein ends about opposite the base of the radial sector.

8. *Platyura mimula* n. sp.

Male. Length 2 mm. Head fuscous, scape of antenna and mouth parts yellowish; flagellum of antennæ dusky yellow. Thorax dusky yellow, humeri and lateral margin of mesonotum somewhat paler, metanotum brownish. First four abdominal segments dusky yellow, posterior margin slightly paler; remaining segments as well as the hypopygium dark brown, subopaque. Hypopygium about as wide as the last visible abdominal segment, the superior forceps subtriangular. Legs yellow, tarsi slightly darker, spurs black; fore metatarsus half as long as its tibia. Wings hyaline, veins dusky yellow; the subcosta ends in the costa before the base of the radial sector; the subcostal crossvein indistinct, R_{2+3} oblique, coalesced part of the media about two-thirds as long as the petiole, anal vein apparently reaches the margin. Halteres yellowish. From Polk Co., Wisconsin.

Two females from Hampton, N. H., collected in June by Mr. S. A. Shaw are marked as follows: The head, thorax and abdomen dark brown, subshining; the palpi, scape of antennæ, pleura, sterum, venter and narrow posterior margin of the abdominal segments more yellowish; wings more cinerous; anal vein does not reach the margin; in other respects, venation and leg measurements as in the male.

9. *Platyura melasoma* Loew.

1869. *melasoma* Loew, Berl. Ent. Zeitschr. XIII. 135.

Female. Length 6 mm. Black. Anterior and lateral margins of the mesothorax and margin of the scutellum, yellowish; the scutellum itself fuscous black. Abdomen black and with black pile, the first segment more fuscous. Legs and coxæ pale, tibiæ dusky yellow, tarsi blackish. Wings subhyaline, tinged with dusky yellow, darker on the costal margin; subcostal vein ends in the costa opposite the base of the radial sector, the subcostal crossvein wanting; the rather long and oblique R_{2+3} ends in the costa not far distad from the tip of R_1. Length of wing 5 mm. Halteres yellow. Recorded from D. C.

To this description I may add that the preapical wing cloud is short but distinct; the coalesced part of the media is equal or greater than the petiole. The legs in the type specimen at Cambridge are more or less broken.

10. *Platyura pullata* Coquillett.

1904. *pullata* Coquillett, Proc. Ent. Soc. Wash. VI, 171.

Female. Length $3\frac{1}{2}$ mm. Black, the mouth parts, sides of mesonotum, the scutellum, metanotum, hind margins of the abdominal segments, the genitalia, venter, coxæ, femora, tibiæ, bases of tarsi, and the halteres, yellow; hairs and bristles chiefly black. Thorax thinly gray pruinose, the abdomen polished. Wings hyaline, apex of the subcosta opposite the base of the radial sector, the subcostal crossvein near one-fourth of distance from the humeral to the apex of the subcosta, R_{2+3} very oblique terminating about its own length beyond the apex of R_1, anal vein prolonged to the wing margin. Claremont, Calif.

11. *Platyura nigrita* n. sp.

Male. Length $4\frac{1}{2}$ mm. Head black, palpi, mouth parts, antennæ including scape, fuscous, intermediate antennal joints longer than broad. Thorax subopaque, brownish black, the collar, humeral spots and narrow lateral margin of mesonotum yellowish; scutellum brownish, sparsely setose; the three narrow longitudinal rows of setulæ extending nearly to scutellum and a wider row on each lateral margin extending to base of wing. Abdomen brownish black, subshining; posterior margin of some segments on dorsum faintly on venter more distinctly yellowish. Hypopygium (fig. 92) small, black. Legs yellow, tarsi apparently more dusky due to setulæ; middle and hind tibiæ each with several rows of very short and small setæ, 6 to 10 in a row; fore claws with 2 teeth near base; fore metatarsus about 2-3 as long as its tibia. Wing hyaline, apex very slightly darker, veins yellow except the radius which is brown; subcosta ends before the base of the radial sector; R_{2+3} oblique, coalesced part of media about half as long as the petiole, anal vein reaches the margin of the wing. Halteres yellow. Taken at Friday Harbor, Washington, in June by Professor Aldrich.

12. *Platyura notabilis* Williston.

1894. *notabilis* Williston. Kansas Univ. Quart. II. 59.

Male. Length 8 mm. Antennæ black, not compressed, a half longer than the thorax; first two joints yellow. Face and lower part of the front reddish yellow; epistoma projecting, beak-like; palpi and proboscis yellowish; front, except the lowermost portion, black. Thorax yellow, the mesonotum somewhat reddish; a blackish spot on the proximal part of the hind coxæ and the adjacent portion of the pleura; a fringe of black hairs just above the root of the wings. Abdomen reddish yellow, with short, black hairs. Legs yellow, the tibiæ and tarsi infuscated or blackish; front tibiæ bare, the middle and hind pairs with short spinules. Wings yellowish, the tip infuscated; a feebly marked brownish band before the tip; the subcostal vein terminates at the origin of the radial sector; R_{2+3} joins the costa just beyond the insertion of R_1. Anal vein complete. Washington.

13. *Platyura ignobilis* Williston.

1896. *ignobilis* Williston. Trans. Ent. Soc. London. 257.

Male. Length 3 to 4 mm. Base of antennæ and the face yellow; front and occiput blackish. Thorax reddish-yellow, the dorsum with black hair arranged in distinct rows. Scutellum and metanotum brownish. Abdomen brownish-yellow, with black hair. Legs yellow, the tarsi infuscated; front metatarsi not more than three-fourths the length of the tibiæ. Wings uniformly subinfuscated; R_{2+3} is nearly rectangular, terminating in the costa; the subcostal vein is very short. St. Vincent Isl.

14. *Platyura fascipennis* Say.

1824. *fascipennis* Say. Long's Expedition. App. II. 360.

Female. Length 4½ mm. Head yellow; center of vertex black. Mesonotum yellow, unmarked or at most with only a faint indication of deeper yellow stripes. Abdomen fuscous, slender at the base, gradually broadening posteriorly; venter dusky, posterior and lateral margins inclined to dusky yellow. Legs and coxæ pale, tarsi infuscated; fore metatarsus about one and one-fifth times, the second fore tarsal joint is about two-thirds times the tibia in length. Wing yellowish with a brown band near the tip; the coalesced part of the media and its petiole subequal in length; subcosta ends noticeably before the base of the radial sector; R_2+_3 nearly perpendicular to R_4+_5; the subcostal crossvein is placed slightly proximad of the midpoint between humeral crossvein and apex of the subcosta; anal vein not produced to the margin. Halteres yellow. One specimen taken at Montreal in July.

Var. *sagax* n. var. Male. Length 5 mm. Differs from the female in having a paler abdomen, spot on wing less conspicuous and relatively longer legs. Antennæ and front except lateral margin, dark brown; occiput, face, palpi and scape of the antennæ yellow. Antennæ short, the intermediate joints no longer than wide, the hairs black. Mesonotum yellow with four narrow brown stripes, scutellum, pleura and sternum yellow, metanotum slightly infuscated; setæ of the mesonotum, pleura and sternum yellow; metanotum slightly infuscated; thoracic setæ short, black, and not arranged in longitudinal rows. Abdomen yellow, the base of the dorsum of the penultimate and the whole of the ultimate segment brown; hypopygium (fig. 102) mainly brown. Coxæ and legs yellow; tarsi apparently darker; claws each with a slender basal tooth which is over half as long as the claw; fore metatarsus is about one and one-fifth, the second fore tarsal joint about 0.9 as long as the tibia. Wings hyaline, yellow tinged, apex of R_4+_5 and costa with a faint cloud; subcosta ends noticeably proximad of the base of the radial sector; subcostal crossvein indistinct; coalesced part of the media about equal to the petiole; R_2+_3 perpendicular to R_4+_5; anal vein does not appear to reach the margin. Halteres yellow. Capens, Maine, taken in July, by Mr. C. W. Johnson.

This variety differs slightly from *subterminalis* in the relative length of metatarsi, petiole of media, and in form of hypopygium.

15. *Platyura fasciventris* Williston.

1896. *fasciventris,* Williston, Trans. Ent. Soc. London. 258.

Female. Length 5 to 6 mm. Head and basal joints of the antennæ reddish-yellow, the distal joints of the antennæ black or brownish-black; the oval ocellar spot black. Front broad, the orbits emarginate. Thorax reddish-yellow; the dorsum red, with four brown stripes, sometimes feebly marked or obsolete. Abdomen red, or reddish-yellow, with a black band of variable width at the posterior part of each segment; venter yellow. Coxæ and femora light yellow; tibiæ yellow, the tarsi brownish; tibiæ without spines; metatarsi about as long as their tibiæ; all the tibiæ with a single terminal spur. Wings uniformly brownish; $R_{2}+_{3}$ oblique, terminating in the costa. The antennæ are about as long as the dorsum of the thorax. St. Vincent Isl.

16. *Platyura moesta* n. sp.

Male. Length 4 mm. Head black; antennæ fuscous, scape and mouth parts yellow. Thorax dull yellow with five longitudinal lines of black setulæ, lateral lines widest, setulæ longest over base of wings and upon scutellum; metanotum slightly brownish. Basal half or two-thirds of each abdominal tergite black, whole of remaining tergites black, venter yellow except for the black apical margin of each segment; hypopygium (fig. 106) brown. Legs yellow, tibiæ and tarsi apparently darker; fore metatarsus about 5-8 as long as the tibia; each claw with three teeth. Wing hyaline, slightly cinereous; veins yellow, the heavier veins more dusky; subcosta ends proximad of base of the radial sector, the crossvein is proximad of the first third of distance from the humeral crossvein to apex of the subcosta; $R_{2}+_{3}$ oblique and ends about one-fourth of the distance from tip of R_1 to tip of $R_{4}+_{5}$; coalesced part of the media is about 2-3 as long as the petiole, anal vein produced to the wing margin. Halteres yellow. Taken August 2 at Longmire's Springs, Mt. Rainier, Washington, by Professor Aldrich.

17. *Platyura mendosa* Loew.

1869. *mendosa* Loew, Berl. Ent. Zeitschr. XIII. 135.

Male. Length 3.5 to 4 mm. Deep yellow, antennæ except the scape, and abdomen dusky; tarsi apparently fuscous; fore metatarsus about one-sixth shorter than the tibia. Wing yellowish, cinereous tinged, veins yellowish; apex of the $R_{4}+_{5}$ and the costa with an indistinct cinereous cloud; subcosta ends in the costa about two-thirds of the length of the basal cell. Subcostal crossvein is proximad of the middle of the subcosta;

R_{2+3} oblique; coalesced part of the media about a third as long as the petiole; anal vein produced to the margin; the distance from the humeral crossvein to the base of the radial sector is about one-fourth of the distance to the tip of the wing. Halteres yellow. The hypopygium is robust (fig. 99) the forceps lobe-like. Ithaca, N. Y.; Capens, Maine, July (C. W. Johnson); Knoxville, Tenn. My specimens are like the type in the museum at Cambridge, Mass., which is recorded from the District of Columbia.

18. *Platyura mendica* Loew.

1869. *mendica* Loew. Berl. Ent. Zeitschr. XIII. 135.

Female. Length 3 mm. Yellowish, legs paler, tarsi more dusky. Antennæ rather short, fuscous, the basal joints yellowish. The base of each abdominal segment subfuscous. Wings uniformly yellowish with a tinge of cinereous, veins fuscous; subcostal vein ends in the costa a little proximad of the base of the radial sector; R_{2+3} rather long and oblique in position; length of wing 3 mm. Halteres yellow. Recorded from New York.

A female specimen from Hampton, N. H., collected by Mr. S. A. Shaw is 4 mm. long; thorax with indications of three pale brown confluent stripes; fore metatarsus one-fifth shorter than the tibia; subcostal vein ends nearly opposite base of the radial sector; the subcostal crossvein is situated about the length of the humeral crossvein beyond the latter; the tip of R_{4+5} and costa very faintly tinged with brown; coalesced part of media about half as long as its petiole; anal vein prolonged to the margin. Excepting for the brown tinge near tip of wing these characters are also possessed by the type in the museum at Cambridge.

A female specimen from Blue Hills, Mass., collected by Mr. C. W. Johnson, in July is similar but thoracic stripes are more distinct, the brown on the abdomen more extended, and without a suggestion of brown near tip of wing.

Some defective specimens from Wisconsin, Oregon and Ithaca, N. Y., seem also to belong here.

19. *Platyura subterminalis* Say.

1829. *subterminalis,* Say. Journ. Ac. Nat. Sc. Phila. IV. 152.

Male and female. Length $3\frac{1}{2}$ to 4 mm. Body entirely pale honey yellow; antennæ excepting the two basal joints, fuscous; ocelli with a small black areola; thorax immaculate; tergum a little more dusky than the thorax. Tibiæ and tarsi dusky. Wings with a slight yellowish tinge, a blackish subterminal band, occupying on the costal margin all the space between R_{2+3} and R_{4+5} and extending to the posterior margin; R_{2+3} is perpendicular to the costa.

In two male specimens from Ithaca, N. Y., the hypopygium is as shown in figure 104; the fore metatarsus is about 1.4 times, the second fore tarsal joint 7-8 times the fore tibia in length; the subcosta ends proximad of the base of the radial sector; the subcostal crossvein is situated proximad of the mid distance of humeral crossvein and tip of the subcosta; R_{2+3} is perpendicular to R_{4+5}; the petiole of the media is less than half as long as the coalesced part; the anal vein does not reach the margin.

Var *nexilis* n. var. Differs from the typical form in having R_{2+3} oblique to R_{4+5}; the coalesced part of the media and the petiole subequal and a slight difference in the hypopygium (fig. 107). One specimen from Polk Co., Wisconsin.

20. *Platyura diluta* Loew.

1869. *diluta,* Loew. Berl. Ent. Zeitschr. XIII. 134.

Male and female. Length 5 mm. Luteous. Antennæ short, fuscous or subfuscous. The immediate bases of the abdominal tergites sometimes fuscous; the last visible segment and the hypopygium of the male fuscous. Legs pale, tarsi dusky. Wings yellowish, with a short, dilute, subapical fascia; R_{2+3} short, oblique. Halteres yellow. Recorded from D. C.

I have seen specimens from New York, North Carolina, Wisconsin and Vermont. The hypopygium is shown in figure 98. The fore metatarsus is about 1-6 longer, the second fore tarsal joint about 1-6 shorter than the tibia. The subcosta ends in the costa proximad of the base of the radial sector; the subcostal crossvein is slightly proximad of the midpoint between the humeral crossvein and the tip of the subcosta; R_{2+3} oblique;

the coalesced part of the media is about 2-3 as long as the petiole; the anal vein does not reach the margin. These characters are also possessed by the type in the Cambridge museum.

21. *Platyura moerens* n. sp.

Male and female. Length 5 mm. Head, palpi, and scape yellow; the middle of the front surrounding the ocelli and the flagella brown. Thorax wholly yellow, with only faint indications of darker lines; setæ black, not arranged in longitudinal lines. Abdomen yellow, the immediate bases of the segments more or less brownish, especially in the female; hypopygium as figured (fig. 96). Legs yellow, tarsi appearing darker due to black setulæ; fore metatarsus 1.14, the second tarsal joint 0.94 times the tibia in length. Wings (fig. 84) yellowish hyaline; the subcosta ends in the costa before the base of the radial sector; the subcostal crossvein is about in the middle of the subcosta; R_{2+3} is oblique; coalesced part of the media about one-third longer than the petiole; anal vein not produced to the margin; a pale brown diffuse preapical fascia extends from between R_{2+3} and apex of the costa to beyond the media, quite faint posteriorly. Halteres yellow. Friday Harbor Washington, July, from Professor Aldrich.

22. *Platyura genualis* n. sp.

Male and female. Length 5½ mm. Head and mouth parts yellow; the flagellum and a spot covering ocelli and extending to the occiput, brown. Thorax yellow with only faint indications of ferruginous stripes; metanotum with brownish spot; setæ of the mesonotum black, very few in number except at the base of the wing and on posterior margin where they are longer and more conspicuous. Abdomen, including venter, yellow; basal third or fourth of segment with a brown fascia which may be more or less emarginate; setæ few, black; hypopygium stout, (fig. 100) yellow, setæ black. Legs yellow, tarsi apparently fuscous; fore metatarsus subequal to, second fore tarsal joint about two-thirds as long as its tibia; empodium small, pectinate, claws each with two stout teeth. Wing hyaline, cloud at apex of costa extends indistinctly to M_2; subcosta ends before the base of the radial sector; the subcostal crossvein is placed near the middle of the subcosta; R_{2+3} is oblique and ends in the costa; coalesced part of the media is one-third shorter than the petiole; anal vein is not produced to the margin. Halteres yellow. Pine Lake, Wisconsin (W. M. Wheeler); Black Mts., N. C. (Beutenmueller); Knoxville, Tenn.

23. *Platyura scapularis* n. sp.

Male. Length 5 to 6 mm. Head piceous, front subshining black; the posterior eye margin, scape of antennæ and clypeus rufo-piceous; flagellum fuscous, palpi and proboscis yellowish. Mesonotum black subopaque, collar, scutellum, humeri, and lateral margins to the base of the wings, articulations at base of wing, junction of scutellum and metanotum, yellowish; the metanotum including the prominent lateral lobes, pleura, and sternum rufo-piceous. Setæ of mesonotum, black, short, and apparently not arranged in rows, but uniformly distributed, most conspicuous at the base of the wing; those on the scutellum numerous but short. Abdomen subopaque black, some of the ventral segments more or less yellowish, particularly on the posterior margins; hypopygium (fig. 105) black. Legs and coxæ yellow, the middle and hind coxæ sometimes, and tarsi and spurs, fuscous; the black setulæ of coxæ conspicuous at tip; claws toothed; fore metatarsus nine-tenths, the second fore tarsal joint two-thirds as long as the tibia. Wing somewhat smoky, apex from before the tip of R_{4+5}, brown; subcosta ends in the costa before the base of the radial sector; the subcostal crossvein is situated proximad of the middle of the subcosta; R_{2+3} slightly oblique, coalesced part of the media longer than the petiole in length; anal vein not reaching margin. Halteres yellow. Kendrick, Idaho, and Stanford University, Calif. (Prof. Aldrich).

Female, and immature male. The humeri, lateral margins of mesonotum, base of scutellum, and posterior margins of the abdominal segments yellow. Females from Friday Harbor and Moscow, Idaho. (Prof. Aldrich).

24. *Platyura elegantula* Williston.

1900. *elegantula* Williston. Biol. Centr. Amer. 1. 218.

Female. Length 8 mm. Head yellow, the upper portion, to a line just in front of the ocelli, shining black. Palpi and tip of the proboscis brownish. Antennæ brown, the first two joints yellow; in length equal to that of the mesonotum. Mesonotum yellow, with three coalescent black stripes, of which the lateral ones are abbreviated in front; just above the root of the wings the more abundant black hair gives the appearance of a slender black spot. Pleura yellow, the mesosternum and the lower part of the metasternum brown. Metanotum brown, the sides silvery in some lights. Scutellum blackish. Abdomen brownish; the anterior part of the first, third and fourth segments reddish yellow; venter almost wholly of the latter color. Coxæ and femora yellow; tibiæ and tarsi brownish or blackish. Wings strongly tinged with brownish-yellow, the distal portion clouded with brownish; R_{2+3} a little shorter than the section of the costa beyond the tip of R_1; subcostal vein strong, terminating nearly opposite the origin of the radial sector; prefurca of the media a little more than half the length of the first section of the radial sector. Mexico, Omilteme in Guerrero 8000 feet.

A specimen from Arizona, perhaps immature, has vertex and abdomen yellowish brown; thoracic stripes brown; palpi and scutellum yellowish; fore metatarsus is about .95 as long as the tibia; subcosta ends slightly before the base of the radial sector; the subcostal crossvein is midway between the humeral crossvein and the tip of the subcosta; R_{2+3} is quite oblique; the coalesced part of the media is about a third longer than the petiole.

25. *Plaiyura tæniata* Winnertz.

1863. *tæniata* Winnertz Verh. zool.-bot. Ges. Wien. XIII. 701.

Male and female. Length 8 to 9 mm. Reddish; antennæ, front and vertex fuscous or subfuscous; thorax with black stripes; abdomen of the male fuscous, with first segment reddish; of the female sordidly yellowish brown, the segments with fuscous posterior margins. Legs reddish, tarsi fuscous. Wings cinereous, with a fuscous subapical fascia. Fore metatarsus about a twelfth shorter than the tibia. Subcostal vein ends in the costa opposite the base of the radial sector; subcostal crossvein proximad of the middle of the subcosta; R_{2+3} oblique; anal vein strong but does not quite reach the wing margin. This European species has been recorded from New Jersey.

26. *Platyura divaricata* Loew.

1869. *divaricata,* Loew. Berl. Ent. Zeitschr. XIII. 134.

Male. Length 3.2 mm. Luteous. Flagellum of the antenna rather short, fuscous. Abdomen wholly yellow except for the small terminal segment which is fuscous, hypopygium blackish. Wings with yellowish tinge, apical third of wing cinerous fuscous, extreme tip cinereous; subcosta ends in the costa proximad of the base of the radial sector; subcostal crossvein slightly proximad of middle of subcosta; R_{2+3} nearly perpendicular to R_{4+5}; cell M_1 wider than in *P. subterminalis;* coalesced part of the media equal or slightly greater than the petiole; anal vein does not quite reach margin of the wing. Length of wing 3.2 mm. Fore metatarsus about .3 longer than its tibia. Recorded from Georgia. Described from the type specimen in the Museum at Cambridge, Mass.

5. Subfamily *Macrocerinæ.*

Macrocerinæ, Winnertz. Verh. zool-bot. Ges. Wien. XIII. 675. 1863.

This subfamily differs from the *Ceroplatinæ* primarily in having extremely long antennæ, often much longer than the body. There is but one living genus.

Genus *Macrocera* Meigen.

? *Euphrosyne* Meigen, Nouv. classif. des mouches. 16. 1800, Doubtful type.

Macrocera, Meigen, Illiger's Mag. II. 261. 1803; Klass. I. 1804.

Head broad, oval; eyes oval, slightly emarginate; the anterior median ocellus smaller than the laterals; palpi four jointed; antennæ 2+14 jointed, often much longer than the body. Thorax highly arched; abdomen depressed, with seven visible segments. Legs long and slender, the fore pair much shorter; tibial setæ wanting or very minute; spurs small. Wing (fig. 90) broad, usually longer than abdomen; subcosta ends in the costa; subcostal crossvein present, basal in position; costa produced beyond the tip of $R_{4}+_{5}$; $R_{2}+_{3}$ oblique, and often sinuous, ending in the costa; the basal section of the media usually present, though delicate and fold-like, dividing the basal cell, coalescing with the radial sector before the crossvein, differing in this respect from *Apemon* and *Hesperodes* where the coalescence takes place distad of the crossvein; anal vein more or less sinuous, and reaching the wing margin; hypopygium (figs. 93, 94) consists of simple forceps resembling those of *Apemon*.

Table of species.

a. Apex of wing hyaline.
  b. A distinct spot covering petiole of the media.
    c. Length 4 to 5 mm; thoracic stripes and bases of abdominal segments brown.
      d. With a preapical and a central spot on wing. 1. *diluta*.
      dd. No preapical spot. 2. Specimen from Wyo.
    cc. Length 3 mm; abdominal fascia subobsolete; apex of R_1 thickened. 3. *inconcinna*.
  bb. No spot covering petiole of media, or at least very indistinct.
    c. Apex of R_1 much thickened, the costa thickened from apex of R_1 to that of $R_{2}+_{3}$; tip of $R_{2}+_{3}$ four times as remote from tip of $R_{4}+_{5}$ as from R_1. 4. A defective specimen from Pine L. Wis.
    cc. Apex of R_1 not distinctly thickened. 5. *immaculata*.
aa. Apex of wing dusky.
  b. With a preapical as well as an apical band on the wing.
    c. Abdomen luteous, apex blackish.
      d. Wing with four irregular fasciæ; the first extending from apex of the subcosta to the anal angle. 6. *nebulosa*.
      dd. No fascia extending back from apex of subcosta; R_1 not thickened. 7. *hirsuta*.

cc. Apex of each abdominal segment blackish; distance from tip of R_{2+3} to R_{4+5} over twice as great as from R_1 to R_{2+3}; wing with two fascia connected with each other along the veins and two smaller spots.

d. Thorax not striped. 8. *formosa.*

dd. Thorax with stripes.

8a. *formosa,* var. *indigena* n. var.

bb. With but a single cloud on apex of wing, no preapical fascia.

c. Apex of R_1 thickened.

d. Antennæ of male four times, of female at least twice the length of the body.

e. Thoracic stripes wanting or but feebly indicated. 9. *clara.*

ee. Thoracic stripes brown. 10. *concinna.*

dd. Antennæ of female less than one and one-half times the length of the body. 11. Sp.

cc. Apex of R_1 not thickened; distance from R_1 to 2_{2+3} about three-fourths as great as from R_{2+3} to R_{4+5}. 12. *geminata* n. sp.

1. *Macrocera diluta* Adams.

1903. *diluta,* Adams. Kas. Univ. Science Bulletin II. 22.

Male: Yellow, shining; antennæ, except base, two stripes on occiput, three fascia on mesonotum, the central one joining two narrow ones coming from base of wings, three spots on pleura, lower half of metanotum, base of abdominal segments from the third, with hypopygium wholly, small spot on base of middle and posterior coxæ, tips of femora and tibiæ, dark brown; wings hyaline, fascia near central part dark brown, a small fuscous spot on anterior margin about midway between tip of R_{2+3} and apex of wing, not reaching the media.

Female: Agrees with the male, except that all of the abdominal segments, without the first, have the base dark brown; the subapical spot of wing is larger, crossing M_1. Length 5 mm.; antennæ, 7 mm. Arizona, August.

2. *Macrocera sp.*

Female. Length 4 mm. Antennæ partly missing; the first flagellar joint about as long as the second fore tarsal joint. Color reddish yellow, head infuscated; three wide black thoracic stripes; basal half of each abdominal segments blackish, last segment black; venter mainly yellowish; legs yellow, tarsi infuscated; fore metatarsus about .6, second tarsal joint about .3 as long as the tibia. Wing hyaline; medium brown band extends from apex of R_1 diagonally proximad to the posterior branch of the cubitus filling the space traversed by the petiole of the media; apex of the wing at the tip of R_{4+5} slightly yellowish; apex of R_1 slightly thickened; R_{2+3} ends nearly midway between apices of R_1 and R_{4+5}. One defective and apparently discolored specimen from Little Wind River, Wyoming, taken in September by W. M. Wheeler.

3. *Macrocera inconcinna* Loew.

1869. *inconcinna* Loew. Berl. Ent. Zeitschr. XIII. 133.

Female. Length 3mm. Yellowish, thoracic stripes and abdominal fasciæ indistinctly pale brownish. Antennæ over one and one-half times as long as the body; the flagellum black. Legs pale yellowish, tarsi deep fuscous. Wing cinereous, toward the tip and toward the posterior margin with longer pile and a little more deeply cinereous; R_1 thickened at the apex; R_{2+3} short, oblique; on the disk with a large subfuscous spot, extending from a fuscous longitudinal line which lies in the cell R_1 to Cu_2; also a faint cuneate spot in the basal cell R; length of the wing 4 mm. Halteres yellow. Recorded from the District of Columbia. In the type specimen the apex of R_{2+3} is close to tip of R_1 and widely remote from R_{4+5}, as in *M. clara.*

4. *Macrocera sp.*

Two defective specimens from Pine Lake, Wisconsin, collected by Prof. W. M. Wheeler, resemble *immaculata* and *inconcinna* in some respects but differ from each. The petiole of the media is surrounded by a very faint cloud; the subcosta ends about opposite the coalesced part of the media; R_1 is thickened at the tip and ends less than the length of the petiole of the media before the tip of R_2+_3 which is short but quite oblique. The antennæ are yellow but are infuscated beyond the third joint. Most of the legs, greater part of the antennæ and abdomen are wanting in both specimens.

5. *Macrocera immaculata* Johnson.

1902. *immaculata,* Johnson. Canad. Ent. XXXIV. 240.

Male and female. Length 5 mm. Head yellow, vertex brownish; antennæ dark brown, the 2 basal joints yellow. Thorax dark yellow, with the anterior margin and humeri light yellow. Abdomen dark brown, shining, with a wide yellowish posterior margin on each segment. Legs yellow, slightly brownish at the tips of the femora, tibiæ and tarsi; legs and abdomen in the male with fine black hairs, which are less conspicuous in the female. Wings yellowish hyaline, with a slight brownish stigma and very fine hairs. The antennæ and posterior legs each about double the length of the body. Pa. and N. Y. (June).

6. *Macrocera nebulosa* Coquillett.

1901. *nebulosa,* Coquillett, Proc. U. S. Nat. Museum XXIII. 594.

Male and female. Length 4 to 5 mm. Yellow, the antennæ except the base, three large spots on the pleura, knobs of halteres bases of abdominal segments two to five and whole of abdomen beyond the fifth segment in the male, the base of each segment except the first in the female, also the tarsi, dark brown; body polished; wings bare, hyaline, marked with four irregular brown fasciæ; the first begins at apex of subcostal vein and extends to the anal angle; the second extends from apex of R_1 to apex of the anal, and is almost, or quite, interrupted in the medial cell; the third extends from R_2+_3 to apex of Cu_1, while the last one borders apex of wing and is connected with the preceding one along R_4+_5 and both branches of the media. Recorded from New Hampshire and New Jersey.

7. *Macrocera hirsuta* Loew.

1869. *hirsuta,* Loew, Berl. Ent. Zeitschr. XIII. 132.

Male. Length 5.2 mm. Yellowish, with long black pile. Vertex subfuscous; antennæ scarcely one and one-half times as long as the body, blackish apically. Stripes on mesonotum and spots on the pleura subfuscous; abdomen blackish apically; hypopygium blackish. Coxæ yellow, posterior pairs fuscous at the apex, pile black; legs pale, tarsi subfuscous. Wings yellowish with light cinereous tinge, apically and posteriorly with rather long pile; a rather large central spot, fuscous; a complete subapical fascia and apex of wing, fuscous-cinereous; apex of R_1 not thickened; R_{2+3} very long and bent down, length of wing 5 mm. Halteres yellow. Recorded from the District of Columbia.

In the type specimen the distance from R_1 to R_{2+3} is about 1-3 or 1-4 as great as from R_{2+3} to R_{4+5}, and the bands at apex of wing are not connected with each other by clouds along the veins.

8. *Macrocera formosa* Loew.

1866. *formosa* Loew, Berl. Ent. Zeitschr. X. 6.

Male and female. Length 4 mm. Pale yellow. Antennæ yellow, darkened apically. Thoracic stripes wholly lacking or but faintly indicated. Posterior margin of each abdominal segment black, the last three in the male sometimes wholly black, forceps yellow. Legs pale, tips of the middle and hind femora black, of hind tibiæ subfuscous, tarsi subfuscous, darker towards the tip. Wing hyaline, apically and posteriorly with longer pile; a minute blackish spot near the base, a large spot on the middle extending from the costa to the cubitus; apex with two fasciæ, the first subapical, arcuate, the second apical; these bands coalescing on the costa and along the course of the veins. Recorded from New York.

Var. indigena, n. var. Differs from Loew's type specimen in having three distinct thoracic stripes which are usually brown, though in one specimen is almost black. The hypopygium is dusky yellow in the paler specimens, but is usually dark brown.

Male. Head and mouth parts yellow, vertex brown, antennæ yellow, infuscated toward the tip, about one and two-thirds times the length of the insect; mystax black. Thorax yellow with three dark brown stripes on mesonotum; sternum, metanotum and a spot on pleura near base of wing brown; setæ black; scutellum pale yellow with transverse row of small black setæ.

The first abdominal segment, the apices of the second, third, fourth, fifth, and the whole of the remaining segments brown, both dorsally and ventrally; hypopygium (fig. 93) usually dusky, setæ black, forceps with the two terminal teeth closely approximated. Coxæ and legs yellow, tips of middle and hind coxæ and tarsi infuscated; fore metatarsus .8 as long as its tibia, the second fore tarsal joint $\frac{3}{8}$ as long; pulvilli bushy, the hairs clavate, claws simple. Wings hyaline, hairy, especially towards the apex, veins brownish yellow; a brown cloud covers the petiole of the media, extending anteriorly reaching the subcosta and posteriorly to Cu_2, more or less interrupted in the second medial cell; the basal section of the radial sector with a brownish cloud; a narrow preapical fascia extends from the tip of R_{2+3} to beyond Cu_1, more conspicuous where intersected by a vein, and a broad apical band, separated from preapical fascia by a hyaline space as wide as this fascia; the subcosta ends about opposite the coalesced part of the media; R_1 is strong but not thickened at the apex; R_{2+3} is very oblique and somewhat longer than the petiole of the media, costa produced beyond the tip of R_{4+5} as far as the length of the M-Cu crossvein; anal vein strong, produced to the margin. Halteres yellow.

Female. Like the male, but the antennæ are only about one-sixth longer than the body and the brown fasciæ of the abdomen are more extended. Several specimens from Ithaca, New York.

9. *Macrocera clara* Loew.

1869. *clara* Loew, Berl. Ent. Zeitschr. XIII. 133.

Male and female. Length $3\frac{1}{2}$ to 4 mm. Slender, pale yellowish, pile of the body pale. Antennæ slender, in the male nearly four times, in the female nearly three times as long as the body, scape yellowish, flagellum fuscous. Thorax unmarked; abdomen with long pale pile; each segment fuscous at the base. Coxæ and legs pale yellow, tarsi subfuscous toward the tip. Wings hyaline, apically and posteriorly with long pile; apex of R_1 thickened and infuscated, joined with the radial sector by a fuscous spot; a central fuscous spot interrupted anteriorly at the radial sector, extends posteriorly subobsoletely along Cu_2 to the margin; apex of wing widely fuscous; R_{2+3} short, pale, oblique. Halteres yellow. Recorded from the District of Columbia.

To the above description may be added that between R_1 and the radial sector there is a thickening of the wing membrane simulating a longitudinal vein (fig. 90); fore metatarsus over two-thirds, the second foretarsal joint one-third as long as the tibia; front tibiæ suddenly dilated at their tip; thoracic stripes sometimes feebly indicated; hypopygium similar to that of *geminata*. The female specimens which I have seen, some of them coming from the same locality as the males, have black setulæ on the abdomen and rather wide black fasciæ; and the antennæ are twice not thrice as long as the body. Penn. and Tenn. (Aldrich), Wis. (Wheeler) and New York.

10. *Macrocera concinna* Williston.

1896. *concinna* Williston, Trans. Ent. Soc. London. 255.

Differs from *clara* only in having the three stripes on the thorax, a vertical stripe on the pleura, scutellum and metanotum, brown. It is more probably the same as *clara* and not *inconcinna* as Professor Williston has suggested. Recorded from St. Vincent Isl. W. I.

11. *Macrocera sp.*

A female specimen from Friday Harbor, Washington, taken in July by Professor Aldrich differs from *clara* in having shorter antennæ, but little longer than the insect; fore metatarsus a little over half as long as the tibia; and feebly indicated thoracic stripes. Venation and markings like *clara*.

12. *Macrocera geminata* n. sp.

Male. Length 4 mm. Head, face and mouth parts yellow; covering the ocelli a large brownish triangle the vertex of which extends onto the occiput; setæ of labrum and vertex black; antennæ about six mm. long, fuscous, the scape and the first flagellar joint except the base and the apex of each of the second, third and fourth joints more yellowish. Thorax shining yellow with shining brown markings as follows: the anterior margin of mesonotum with a large triangle, two broad stripes widening posteriorly and nearly meeting in front of the scutellum, a longitudinal dash behind the humeral callus and extending nearly to the base of the wing, a large oval spot just below this, the ventral margin of the pleura just above the middle coxæ and the metanotum; the two longitudinal rows of fine setæ on the mesonotum mesad of the longitudinal stripes, two rows of larger setæ extending to the base of the wing, several pairs on the posterior margin, and a few less prominent ones on the scutellum, black. Abdomen yellow, the first segment pale brown, both dorsal and ventral sclerites of the other segments each with dark brown basal fascia about half the width of the segments anteriorly but wider on the posterior segments, the dorsal sclerites also with pale brown apical fasciæ; hypopygium brown (fig. 94) the two apical teeth far apart; setæ black. Coxæ and legs yellow, extreme apex of each femur and tibia, and the tarsi wholly infuscate; fore metatarsus two thirds, second foretarsal joint one-third as long as the tibia; tibial spurs about as long as the fourth tarsal joint; empodium distinct, bushy, claws simple. Wings hyaline with a brown, more or less broken zig-zag fascia which arises proximad of the apex of R_1, extends over the petiole of the media, produced slightly into its fork, narrows behind Cu_1 and reaches Cu_2 where it again slightly widens; a spot at the base of the media which may extend to the cubitus, another at the base of the cubitus, and the entire apex of the wing from the apical half of cell R_{2+3} to beyond Cu_1 with a very faint brown cloud, more conspicuous along the course of the veins; R_{2+3} very oblique and about as long as the petiole of the media; the distance from the tip of R_1 to R_{2+3} is about three-fourths as great as from R_{2+3} to R_{4+5}. Halteres yellow.

Female. Like the male but the antennæ are a trifle shorter, the yellow of the dorsal sclerites of the abdomen is less extended and the apex of the wing is a little darker. All from Ithaca, New York; June.

LEG MEASUREMENTS.

The table which follows gives the relative lengths of the joints of the legs, the fore tibia being taken as 100. As the measurements were for the most part made upon pinned specimens the values given may not be absolutely exact, due in part to the difficulty experienced in getting the object to be measured in a true horizontal plane. A variation of as much as four or five percent. may be expected in different individuals of the same species, and the proportions in the male differ somewhat from those of the female.

Number of joint.	Fore leg. F	T	1	2	3	4	5	Middle leg. F	T	1	2	3	4	5	Hind leg. F	T	1	2	3	4	5
Palaeoplatyura aldrichii, male.	78	100	70	-	-	-	-	114	114	74	-	-	-	-	118	165	91	-	-	-	-
Palaeoplatyura johnsoni, male.	85	100	104	83	40	31	22	93	117	111	52	35	26	18	104	174	111	48	33	22	18
Ceroplatus terminalis,	90	100	142	64	41	28	22	-	-	-	-	-	-	-	109	150	138	45	32	22	15
Ceroplatus militaris, male.	98	100	118	58	38	24	18	122	169	149	60	38	24	22	129	189	145	55	35	27	24
Cerotelion bellulus, male.	90	100	116	57	37	30	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Apemon pectoralis, male.	82	100	66	42	35	22	17	96	134	91	47	37	17	16	118	204	104	45	35	21	11
Apemon nigriventris, male.	93	100	74	33	29	19	16	109	142	90	44	35	21	14	126	190	93	51	39	23	16
Apemon nigriventris, female	96	100	70	34	26	17	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Platyura scapularis, male.	88	100	80	72	62	42	34	100	164	136	78	50	34	26	114	182	146	66	48	38	32
Platyura scapularis, female.	90	100	80	67	52	37	30	112	170	128	65	45	28	25	122	185	150	57	42	22	20
Platyura fascipennis var. sagax. male.	79	100	125	92	66	38	23	103	143	147	57	36	26	23	98	169	159	49	28	26	24
Platyura fascipennis female	-	100	122	68	50	29	16	90	146	140	-	-	-	-	110	162	146	58	37	25	21
Platyura inops male.	71	100	151	71	48	30	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Platyura setiger male,	91	100	79	44	33	25	18	91	131	82	42	33	25	18	120	171	84	40	27	22	18
Platyura mimula, male.	100	100	50	43	41	33	29	105	124	82	48	36	31	24	110	166	134	41	38	-	-
Platyura nigrita, male.	84	100	68	42	39	24	19	111	112	85	48	39	26	19	116	158	93	48	37	26	19
Platyura moesta male.	87	100	65	44	34	31	25	104	134	75	47	31	28	22	106	156	87	47	37	28	22
Platyura mendosa male.	85	100	83	63	49	38	30	108	142	95	59	37	26	22	105	178	102	53	32	24	22
Platyura mendica female.	-	100	82	54	44	28	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Platyura diluta, male.	70	100	116	81	52	36	25	100	139	139	55	35	25	24	102	166	139	39	30	24	22
Platyura moerens, male.	74	100	114	94	50	33	23	94	144	136	59	35	24	15	97	156	138	47	27	23	18
Platyura genualis, male.	95	100	97	68	50	37	26	-	-	-	-	-	-	-	110	160	126	53	34	29	24
Platyura elegantula, female.	80	100	97	56	41	28	21	-	154	128	55	41	27	19	103	160	152	-	-	-	-
Macrocera formosa var. indigena, male.	75	100	77	40	-	-	-	110	150	104	44	-	-	-	153	197	115	40	15	-	-
Macrocera clara, male.	85	100	71	39	18	13	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Macrocera clara, female.	88	100	67	34	14	12	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Macrocera geminata, male.	84	100	67	35	26	16	14	124	154	100	47	28	19	14	149	188	119	49	30	19	16

Explanation of Plates.

Plate. (Figs. 46 to 69 reduced from Plate I in Johannsen's Mycetophilidæ, Genera Insectorum).

Fig. 46. Head of Asindulum montanum.
" 47. Palpus of Ceroplatus.
" 48. Antenna of Ceroplatus.
" 49. Proboscis of Asidulum coxale.
" 50. Palpus of Exechia.
" 51. Antenna of Mycetophila.
" 52. Antenna of Cordyla.
" 53. Head of Gnoriste.
" 54. Palpus of Cordyla.
" 55. Ventral aspect of mouth parts of Mycetophila punctata.
" 56. Mycetophila punctata, female.
" 57. Tarsal claw of Mycetophila.
" 58. Tarsal claw of Ceroplatus.
" 59. Antenna of Diomonus.
" 60. Tibia and tarsus of Heteropterna (after Skuse).
" 61. Head of Hadroneura (after Lundström).
" 62. Hind tibia of Exechia.
" 63. Dorsal aspect of head of Mycomya (Sciophila Winnertz).
" 64. Proboscis and palpi of Arctoneura (=Cyrtoneura, after Marshall).
" 65. Dorsal aspect of head of Diomonus.
" 66. Antenna of Platyroptilon (after Westwood).
" 67. Dorsal aspect of head of Exechia.
" 68. Head of Lygistorrhina (after Skuse).
" 69. Frontal aspect of Leia (=Neoglaphyroptera Osten-Sacken).
" 70. Diagram of Palaeoplatyura wing.
" 71. " " Ditomyia wing.
" 72. " " Sciophilinæ wing.
" 73. " " Mycetophilinæ wing.

Explanation of Abbreviations.—C = Costa; Sc_1 and Sc_2 = anterior and posterior branches of the subcosta; R_1, R_{2+3}, and R_{4+5} = branches of the radius; Rs = radical sector = $R_{2+3}+R_{4+5}$; M_{1+2} and M_3 = branches of the media; Cu_1 and

Cu_2 = branches of the cubitus; A = anal veins; R-M = radio-medial crossvein; M-Cu = medio-cubital crossvein.

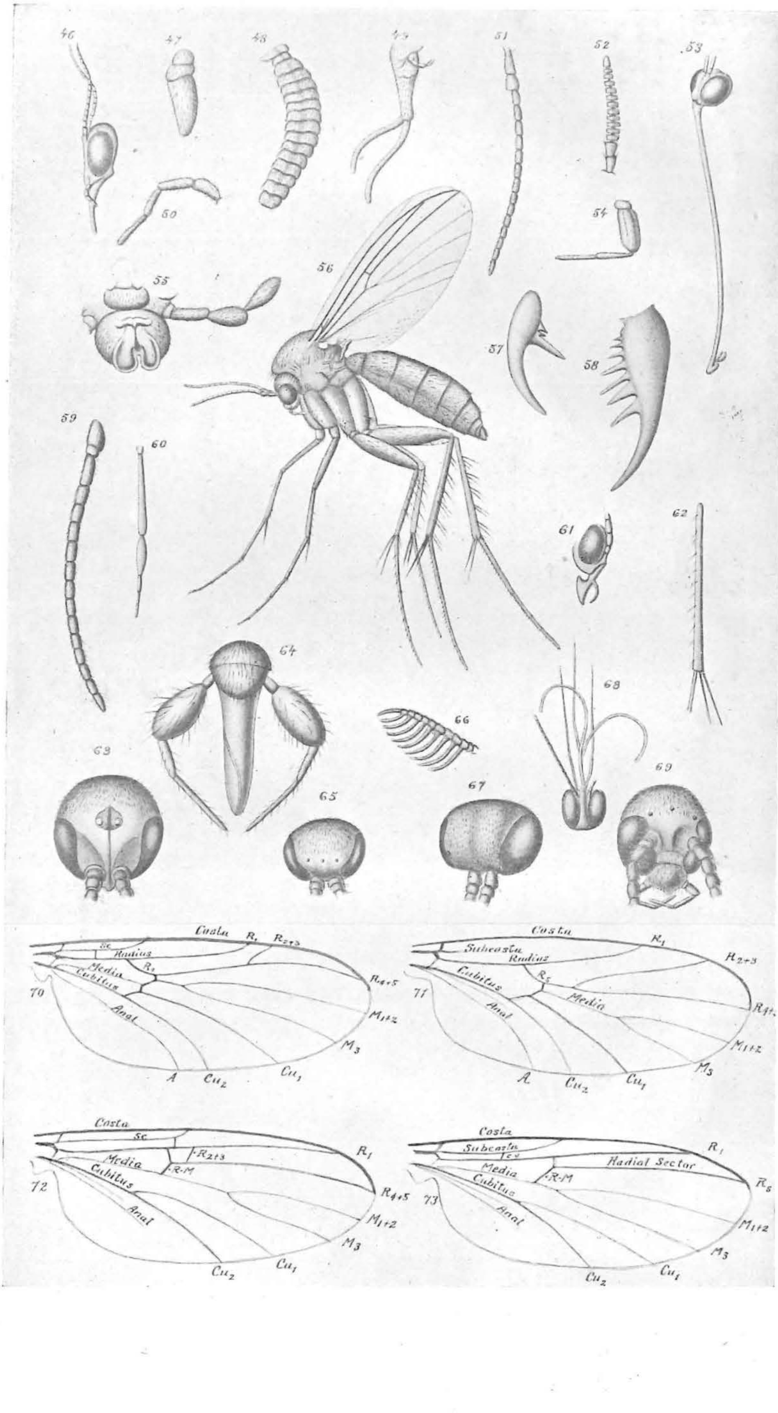
Plate.

Fig. 74. Hesperinus brevifrons.
" 75. Bolitophila cinerea.
" 76. " disjuncta.
" 77. Mycetobia divergens.
" 78. Palaeoplatyura johnsoni.
" 79. Mycetophaetus (after Scudder).
" 80. Ditomyia (after Winnertz).
" 81. Symmerus tristis.
" 82. Ceroplatus clausus.
" 83. Cerotelion bellulus.
" 84. Platyura moerens, male.
" 85. " parva.
" 86. " setiger.
" 87. Asindulum montanum.
" 88. Apemon pectoralis.
" 89. Hesperodes (diagrammatic).
" 90. Macrocera clara.
" 91. Diadocidia ferruginosa.

Plate.

Magnification 65 diameters.

Fig. 92. Platyura nigrita. Lateral aspect.
" 93. Macrocera formosa, var. indigena. Dorsal aspect.
" 94. " geminata. Dorsal aspect.
" 95. Platyura mendosa (female). Lateral aspect.
" 96. " moerens. Ventral aspect.
" 97. Apemon pectoralis. Dorsal aspect.
" 98. Platyura diluta. Ventral aspect.
" 99. " mendosa. Dorsal aspect.
" 100. " genualis. Ventral aspect.
" 101. " inops. Ventral aspect.
" 102. " fascipennis, var. sagax. Ventral aspect.
" 103. " setiger. Lateral aspect.
" 104. " subterminalis. Ventral aspect.
" 105. " scapularis. Ventral aspect.
" 106. " moesta. Ventral aspect.
" 107. " subterminalis, var. nexilis. Ventral aspect.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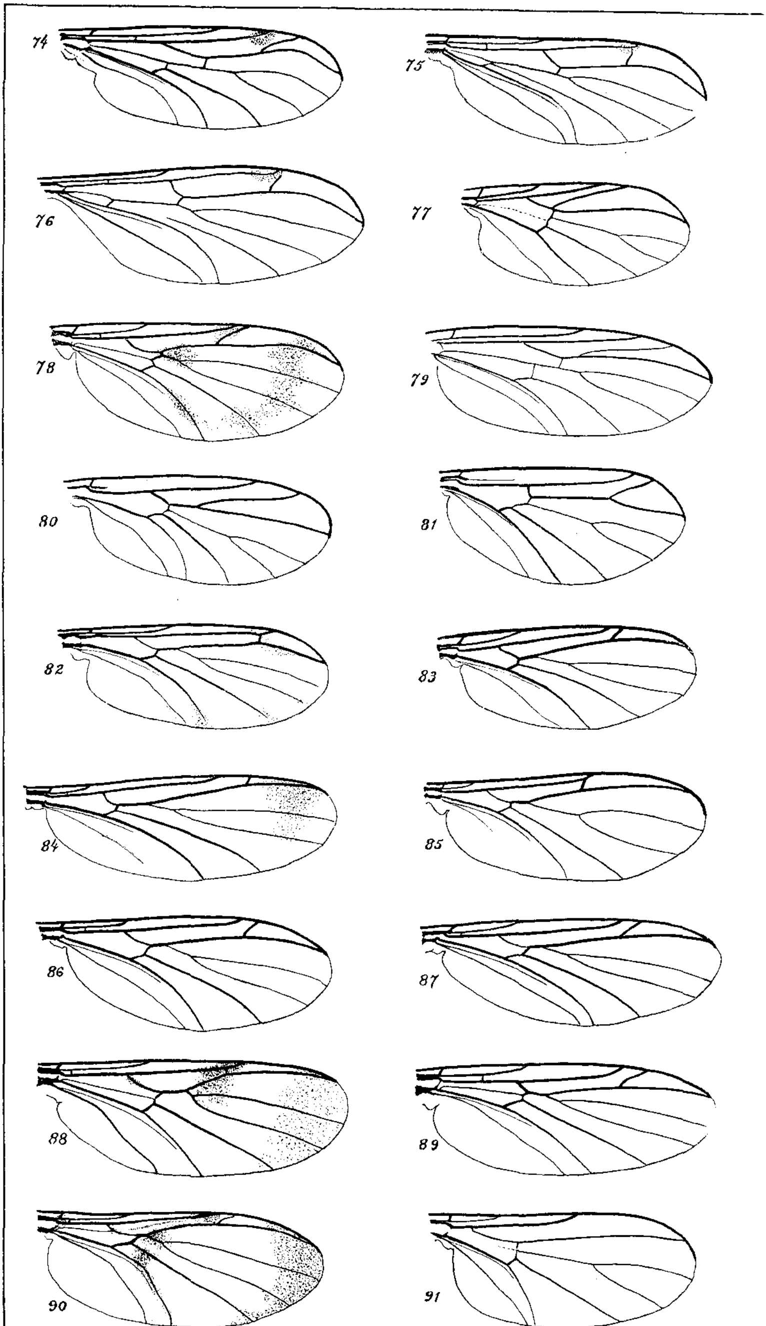
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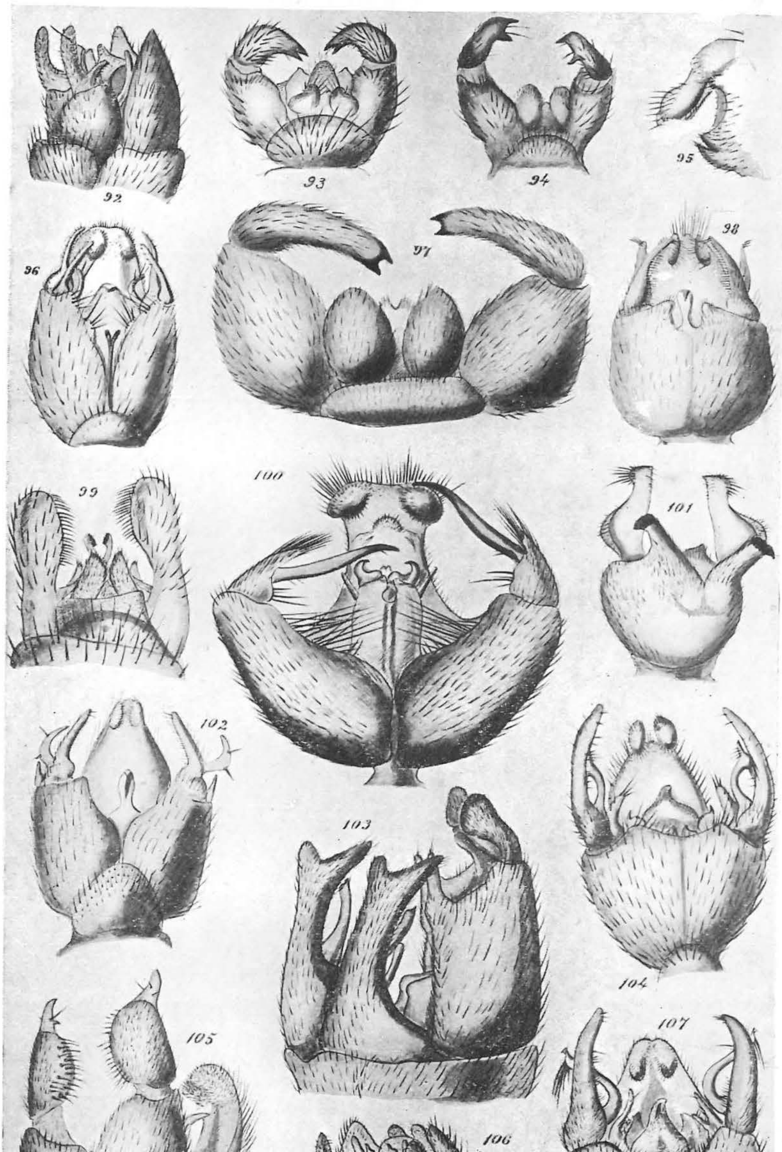
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BULLETIN No. 173.

CHERMES OF MAINE CONIFERS*

By Edith M. Patch.

The Pine Leaf Chermes.

Chermes pinifoliae Fitch.
Chermes abieticolens Thos.

It is manifestly a pleasure to reinstate a species lost in a list of synonyms and an unusually interesting situation is found in the present study which justifies removing a species merged by error with two widely different Chermes† one on pine and one on spruce, and uniting these two forms in turn under the name of the form first described.

The species under consideration develops in a cone-like gall on the black spruce and migrates to the needles of the white pine to oviposite and was named, as commonly happens with aphids with two distinct host plants, separately in each situation.

The evidence concerning each will be taken in turn. Fitch's description of *Chermes pinifoliae*,‡ (though without figures or much structural detail) is excellent in that it selects several distinctly characteristic phases of this species and is sufficient to distinguish it from any of the other *Chermes* recorded in this paper.

Fitch's published account of the species is here given in full:

"267. Pine-Leaf Chermes, *Chermes Pinifoliae*, new species.

"Stationary upon the leaves, usually towards their ends, puncturing them and sucking their juices, a very small black fly 0.08** long to the tip of its abdomen, and 0.12 to the end of

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* Papers from the Maine Agricultural Experiment Station: Entomology No. 39.

† *Chermes pinicorticis* and *Chermes abietis*.

‡ Trans. N. Y. Agric. Soc. 17: 741; id. Rept. Ins. N. Y. 4: 55, 1858.

** Fitch's measurements are given in decimals of inches.

its wings, which are dusky gray, its abdomen dusky red and slightly covered with fine cottony down.

"The females of these insects do not extrude their eggs. Clinging closely to the leaf with their heads towards its base, they die, their distended abdomens appearing like a little bag filled with eggs. The outer skin of the abdomen soon perishes and disappears, leaving the mass of eggs adhering to the side of the leaf, but completely covered over and protected by the closed wings of the dead fly. I have met with the dead females thus adhering to the leaves the first of July, and have noticed the same insects on the leaves in full life and vigor the middle of May.

"The rib vein of the fore wings runs straight to the outer margin forward of the tip, and gives off from its middle on the outer side a very oblique branch which runs to the outer margin, its tip producing a slight angular projection to the edge of the wing, and the whole space on the outer side of the rib vein beyond this branch is more opake than the rest of the wing and of a smoky yellowish color. From its inner side the rib vein sends off three simple oblique veins, the last one of which ends in the extreme tip of the wing. The hind wings have an angular point on their outer side beyond the middle, and a longitudinal rib vein, which, forward of its middle sends off a branch almost transversely inward, its tip curved backward. The antennae are short, thread-like, and composed of four or five small joints. It will hence be seen that this insect is a true Chermes—the first species of this genus that has been discovered in this country."

The fact that a *Chermes* described by Fitch as 0.08 inches long to the end of the abdomen (0.12 inches long to the tip of the wings) and the accurate and characteristic account of the place and manner of ovipositing on the pine needles could have been considered the same as *Chermes pinicorticis** for the past 40 years, is sufficient proof that none of the observers who have worked with *pinicorticis* have been familiar with Fitch's other species, i. e., *pinifoliae*.

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* 1869, Shimer. Trans. Am. Ent. Soc. II, 383.
1884, Osborn. Bull. A. E. S. Ia. No. 2, 97-105.
1898, Storment, Rept. Ent. Ill. 20 iii-xxiii, pl. i-ii.

Thomas in his third report makes the following statement† concerning *abieticolens*.

"CHERMES (ABIETICOLENS?)

"Adeleges of the Spruce. Packard.

"A rather large species mentioned by Dr. Packard as 'found in abundance on the spruce in Maine, where it produces swellings at the ends of the twigs, resembling in size and form the cones of the same tree.' The specific name is applied provisionally and only for use in this report. This is certainly distinct from the European species *Chermes abietis* Linn., which is much smaller, of a bright reddish-brown color, with the wings tinged with green."

Packard‡ reports this species as follows:

"37. The Spruce Bud-louse, *Adelges abieticolens*, Thomas.

"Deforming the terminal shoots of the spruce, producing large swellings, which would be readily mistaken for the cones of the same tree.

"We take the following account and illustration from our Guide to the Study of Insects:

" 'The genus *Adelges* was proposed by Vallot for certain broad, flattened plant-lice which attack coniferous trees, often raising swellings on twigs like pine and spruce cones. The antennae are short, 5-jointed and slender; there are three straight veinlets arising from the main subcostal vein and directed outwards, and there are no honey tubes; otherwise these insects closely resemble the Aphides. A species closely related to the European *Adelges* (*Chermes*) *coccineus* of Ratzeburg, and the *A. strobilobius* of Kaltenbach, which have similar habits, we have found in abundance on the spruce in Maine, where it produces swellings at the ends of the twigs resembling in size and form the cones of the same tree. We would add that each leaf-bud is enlarged, having an *Adelges* under it. As those nearest the base mature first and leave their domicile, the deformed leaf-bud stands out from the axis of the shoot, thus giving the conelike appearance to the end of the shoot.'

"This has since been described by Prof. Cyrus Thomas in his Third Report on the Injurious Insects of Illinois, p. 156."

† Rept. Ent. Ill. 8: 156, 1879.

‡ Insects Injurious to Forest and Shade Trees.

That Packard himself was familiar with the galls of both *abieticolens* and the European *abietis* and considered them distinct is shown by his item which follows the foregoing one just quoted:

"38. The European Spruce Bud-louse, *Adelges abietis* Linn.

"We observed this species in considerable numbers on the Norway spruces on the grounds of the Peabody Academy of Science at Salem, in August, 1881. The deformation produced in the terminal buds and twigs were like those figured in Ratzeburg's Die Waldverderbniss, Bd. i, Pl. 28, figs. 1, 2."

Thomas states that he was certain that he was dealing with a distinct species, and one brief item is sufficient to prove him correct, for he uses one difference which is alone enough to separate these two species when he says that with the European species, *Chermes abietis* Linn. "the wings are tinged with green". While color distinctions are often an unsafe basis, it is steadfast one here, for *Chermes abietis* has uniformly and conspicuously green wings while the dark species developing in that Spruce gall ("found in abundance on the spruce in Maine") which when deserted "stands out from the axis of the shoot, thus giving the cone-like appearance to the end of the shoot" has the stigmal region reddish brown, or 'smoky yellowish,' and never at all greenish either when newly emerged from the gall or upon aging.

It seemed desirable in a circumstance so complicated to give, before presenting original data, the historical situation for the species under consideration, which develops in a cone-like gall on the black spruce (in which connection it was named *abieticolens* in 1879 by Thomas and subsequently merged by error with *abietis**), and migrates to the needles of the white pine (in which connection it had been previously named *pinifoliæ* by Fitch, 1858, and merged by error with *pinicorticis*† in 1869 where it has remained for 40 years in oblivion).

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* Fernald and Cooley, 34th Report Mass. Agric. College 1897, pp. 89-100.

† Shimer. Trans. Am. Ent. Soc. 2: 383.

Chermes pinifoliae in Maine.

On June 16, 1905, I first found winged *Chermes* in great abundance on the needles of white pine (*Pinus strobus*) at Orono. My notes for that date state that on some branches nearly every pine needle had a *Chermes* stationed near the tip with the head away from the tip. On some needles were three or four. Most of the specimens observed at this date were dead. A large cluster of eggs was found beneath the wings of each *Chermes.* Eggs brought in June 16 hatched June 26.

Immediate reference to Fitch's description gave such a striking agreement of my notes with his account of the egg laying habit of *Chermes pinifoliae* that I listed the collection under the name of that species. Mounts were made of the freshest specimens a few of which were still alive. These I took with considerable other material to Mr. Pergande the following winter and he kindly compared them with Fitch's type* of *Chermes pinifoliae* and stated that the type specimen was too imperfect to give a satisfactory basis of comparison but that in size and in such points as could be compared the two agreed and that he considered the specimens from Maine to be *pinifoliae.*

July 5, 1907, at Milo, Maine, I observed this species very abundant on the needles of white pine. The specimens were all dead at this date but they still adhered to the needles, on some of which there were as many as 14 or 16 in Indian file with their heads towards the base of the needle. This was in accordance with Fitch's observation "I have met with the dead females thus adhering to the leaves the first of July." Specimens of this collection were photographed as taken. See Fig. 127.

On June 14, 190[illegible], a large number of black spruce twigs were brought to me with the statement that "almost every *cone* is infested under the scales and is abnormal in form." Some of these specimens are shown in Figs. 128 and 129. The infested growths at this stage were indeed so cone like that I took their cone-ship for granted until I read over Packard's discussion of *abieticolens* Thomas which he "found in abund-

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* Fitch's aphid types were originally mounted on card points on pins. A few of these came finally to the U. S. collection where they were removed and are preserved as balsam mounts.

ance on the spruce in Maine, where it produces swellings at the ends of the twigs resembling in size and form the cones of the same tree." Dissection of the galls, of course, proved they were not abnormal *cones* but abnormal *shoots*.

The mistaken identity of the so-called "cones" seemed a good joke entomologically and as the collector of the galls is a plant morphologist perhaps not less so botanically.

Both the galls and the *Chermes* in them are distinct from *abietis* and there seems no ground for doubting that this species is *abieticolens*.

Some of the more advanced galls of *Chermes abieticolens* were opening on date of collection, June 14, and by June 21 fresh *Chermes pinifoliae* were on the needles of White Pine everywhere in the neighborhood of Orono. Others were sent in from other parts of the state a little later. Accompanying such specimens from Gilead vicinity on June 25 "millions of the flies on white pines" were reported.

As the disappearance of the emerging *abieticolens* from the spruce coincided exactly in time with the appearance of *pinifoliae* on the white pine and as there was no apparent difference in the *Chermes* in these two situations the conclusion was obvious enough and careful microscopic comparison was, of course, made. There was no difference between the two discoverable in any structure submitted to this sort of examination. The freshest of the specimens on the white pine had of course to be used for the comparison.

A check migration test was made June 22. A lot of galls from the black spruce were placed in a cage with fresh twigs of various conifers. On June 25, more than 200 individuals had settled on the white pine where they remained with their eggs. Although specimens were found crawling over some of the spruce twigs supplied them no individual settled and oviposited except on the white pine. This was more overwhelming preference than is usual with a cage test, for often in confinement a few stray specimens oviposite amiss, as it happens also to insects in the open. Perhaps if the test had been prolonged some of these would, but three days with the uniform result of 200 to 0 seemed sufficient.

In confinement, as in the open, these *Chermes* settled on the pine needles with the head toward the base of the needle. Out of the thousands seen this season only very rarely was one found headed in the other direction. In confinement as in the open this species did not "oviposite" in the usual sense of the term, as the eggs were not expelled. As Fitch himself accurately recorded what I have observed three seasons (1905, 1907, 1909*) "the females of these insects do not extrude their eggs. Clinging closely to the leaf with their heads towards its base, they die, their distended abdomens appearing like a little bag filled with eggs. The outer skin of the abdomen soon perishes and disappears, leaving the mass of eggs adhering to the side of the leaf, but completely covered over and protected by the closed wings of the dead fly." Such an egg cluster comprises about 100 eggs.

The eggs of the *Chermes* which settled on the pine needles June 22-25, in the cage migration test recorded, were hatching July 3, in conspicuous numbers.

These young, the progeny of the migrants, settle at the tips of the new pine shoots where by the latter part of July their presence is rendered conspicuous on account of the white waxy secretion of the *Chermes*. This secretion gives a white woolly appearance to the infested portion similar to but much less dense than that of *pinicorticis* on the trunk of the white pine.

Where the infestation is heavy it causes a yellowish and sickly appearance of the new growth which is thus considerably stunted. As will be seen by Fig. 132 taken July 23, 1909, the new needles are not at this time full grown. The new needles on twig photographed were yellowish for a part of their length and the whole tip of the twig had an unhealthy appearance.

It will be seen from the date of the flight of this species from the spruce galls to the pine, about June 15-21, that the pine leaves on which they settle to oviposite are those of previous years growth, that is, the needles of 1909 have not started sufficiently for the *pinifoliae* of June 1909 to use.

This fact is in contrast with a second species, *Chermes floccus*, migrating from black spruce galls to pine needles late in July

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*I am not able at present to state whether there may be any significance in this once in two years collection or not. I had not been paying any particular attention to *Chermes* and they may have been present in considerable numbers the other years also, and I had merely neither collected nor recorded them. The notes as they stand suggest a two year cycle but no observations as regard to this are yet available.

and ovipositing both on old growth and new growth needles. There is no reason for confusing *pinifoliae* with this second species as the discussion of the latter will make plain.

On May 19, 1908, I found *Chermes* pupae common on terminal shoots of white pine. My notes for this collection read: "The pupae are massed close to the tip of the stem or at the base of needle cluster on some stems, and on others they occur singly at the same locations. They are downy enough to be noticed but are not very flocculent."

I collected a considerable number of twigs and the next day many of the pupae molted and an abundance of winged adults were secured. These I listed at the time as *pinifoliae*, and on going carefully over this preserved material this fall I can see no reason to separate it from the species which matures in the black spruce gall about the middle of June. Antennal, wing, and leg characters are apparently identical and the gland areas are so faintly indicated as to ally it with this species and separate it from any other taken in Maine.

These mid-May *Chermes pinifoliae* are, I believe, the return migrants from pine to spruce, but I have not observed this migration. They are not the generation that oviposites on the pine needles, however, as this is done by the migrants from the spruce. This collection, May 19, it will be seen, is in accordance with Fitch's statement that he had "noticed the same insects on the leaves in full life and vigor the middle of May."

It will be seen from the dates of the migrants that either the time which *pinifoliae* spends on the spruce is very short—four to six weeks—or that a two year cycle is required. It is not at present possible to say which is the case.

The galls are uniform, regular, and cone-shaped in form. In length they vary when full grown from about three-fourths to one and one-half inches. Under the stimulation of the *Chermes* the new growth at the tip of the twig is modified and the twig tip develops into a cone-shaped object. The stem itself is not much swollen. Each needle becomes a scale, broadest at the middle and concave on the inner surface. Beneath each scale-like leaf a single Chermes develops. Packard states that in the gall of *abieticolens* "each leaf bud is enlarged having an *Adelges* under it" which statement in itself would distinguish such a gall from that of *abietis* each cell of which contains not "*an*" but *many* individuals. A single gall of *pinifoliae* not under average size which I dissected was found to be composed of 139 scale-like leaves under each of which was a single pupa.

The gall when young is slender, about the same length as the young cone and often about the same purple color. Fig. 129 shows a black spruce twig with a single young cone at *A*, the tip of which is unfortunately broken; at *B* are four normal spruce tips; at *C* are four young galls of *pinifoliae*. This photograph shows very well the distinguishing feature of these three growths, the normal shoot, the modified shoot or *Chermes* gall, and the normal cone.

Fig. 128 shows a fully developed gall which at this stage is green. After the galls lose their first purple color they remain green until the time of the emergence of the migrants. Fig. 130 shows the normal cone at *A* which at this stage is purple, at *B* the normal shoot which is green, at *C* the deserted gall which is bright reddish brown. After the gall is deserted the gall leaves flare out from the stem, leaving the chambers open wide. About this time the gall becomes a bright reddish brown, that is the galled terminal shoot dies in this characteristic way.

Pupa. The full grown pupa (June 14) is dark reddish brown with thorax somewhat lighter than head and abdomen. Legs and antennae dusky. Body lightly threaded with short wax fibers, giving body a downy appearance.

Winged Female. Fig. 108. The newly molted migrant, before the wings are expanded, is glistening reddish brown with pellucid legs and antennae. The crumpled wings are distinctly yellow. The wings when expanded are smoky, the stigmal region is yellowish or reddish brown. The migrant by the time it has reached the pine needles is very dark, with "its abdomen dusky red and slightly covered with fine cottony down." The antennae and legs are dark. In size these migrants vary greatly as indeed do all the *Chermes* listed in this paper. The total length of body of this form ranged from 1.7 mm. to 2.9 mm. (.066 in. to .11 in.) the latter measurement being for the larger individuals with their abdomens fully extended. The wing expanse varies also, the average being about 8 mm. There is nothing especially striking in regard to the venation. The characteristic curves of the veins have been faithfully reproduced (Fig. 108). At the junction of *Sc* with costal margin the wing creases a little and a decided angle occurs at that point in the wings of this species except when they are newly emerged. This angle is more pronounced for this species than any other of these Maine species, though the same tendency is often shown by others to a slighter degree. The drawing was made from a wing of a newly emerged individual and this costal angle not indicated.

The most distinctive characteristic in the wings of *pinifoliae* is the decided arch of the costal margin of the fore wing and the almost circular curve of the hind margin of the hind wing. The shape of the wings alone would separate this species from the other five developing in spruce galls in Maine. Packard's figure of *abieticolens** gives the characteristic outline of this peculiar wing which alone would serve to separate it from *abietis*. The legs are very stout.

The antennae (Fig. 109) are 5-jointed, the segments stout, III, IV and V are approximately subequal in length. III and IV resemble each other closely both as to shape and sensorial areas. V has the curve of the outline less abrupt, and the sensorial area larger. Terminal hairs four or five in number and slender (Fig. 109a). The sensorial areas as well as the shape of segments and reticulations are shown in the figure of antenna more distinctly than verbal details could indicate.

The wax pores of this species are more difficult to find than on any of the other species recorded in this paper. Even in specimens fairly well cleared the gland areas were not always evident. However, from a large series of mounts of specimens cut transversely giving the clearing fluids every opportunity, the gland areas (Fig. 108) were found to be consistently as follows: head with an area of two transverse groups on anterior margin nearly coalescing, an area of two transverse groups at posterior margin; prothorax with an irregular lateral area, a median anterior area of two groups, and a row of 4 groups near posterior margin; mesothorax with a lateral group on anterior margin and a median area of two groups on posterior portion

* Insects Injurious to Forest and Shade Trees.

of the lobes; metathorax with a median area of two groups corresponding to the median rows of the abdomen; abdomen with median area in two groups (or frequently merging) on segments 1-7, and a lateral group on segments 1-9 (merged on the ninth). In addition to these there occurs between the lateral and median groups on segments 1-4 a very small group of two or three pores usually separate from the median pores, but sometimes merged with them. Most, if not all, of these wax pores would easily be overlooked and the fact that this species has its abdomen only "slightly covered with fine cottony down" indicates that the glands are not so functionally active as those of other species.

Remedial Measures. There would seem to be no practical method of combatting this insect in forest growth. With ornamental trees, however, the galls could be removed from the black spruce previous to the emerging of the winged form. Also if the species proves constantly troublesome it might be desirable not to plant the white pine in the vicinity of black spruce and *vice versa.*

Spraying with whale-oil soap (1 pound to 2 gallons of water), would probably destroy the young on the white pine shoots, but it is doubtful that this would be usually worth while in Maine where Syrphus flies abound. The larvae of these, little light colored maggots, have been found to feed industriously on the young Chermes. So numerous are these beneficial maggots at times in the midst of the white waxy secretion of the Chermes that they are sometimes mistaken by people submitting them for determination as the cause of the trouble.

Note: The foregoing evidence will make it clear enough that Shimer was in error in considering the winged specimens which he reared from *pinicorticis* to be *pinifoliæ.* That Shimer found winged *pinicorticis* "very plentifully" on the pine leaves would be natural enough for at the time of emergence the winged forms are sometimes abundant on all parts of the tree. I have seen them in considerable numbers resting on pine needles apparently just before flight, but never fixed as described by Fitch as characteristic of *pinifoliæ.* Observers of *pinicorticis* have accepted Shimer's conclusions that his *Chermes* .025 inches long which he bred from pupal *pinicorticis* was the same as *pinifoliæ* described as .08 inches long, in spite of the fact that they have had to contradict Fitch's explicit observations in regard to the very characteristic habits of *pinifoliæ.* With the meagre descriptions of the early aphid records many such mistakes are scarcely avoidable, in absence of the species itself. Fitch's comments on *pinifoliæ,* however, are distinctive enough so that with his species in hand it no longer seems "singular" and "unfortunate" that he described *pinifoliæ* as distinct from *pinicorticis,* but rather singularly interesting that this species had not been rediscovered long ago.

To see that Fitch's much discussed description of the wing of *pinifoliæ* agrees with fig. 108 it is only necessary to translate it to modern parlance "The rib vein (Rs) runs straight to the outer margin forward (proximad) of the tip, it gives off from its middle on the outer side a very oblique branch (Sc) which runs to the outer (costal) margin, its tip producing a slight angular projection* to the edge of the wing, and the whole space (stigma) on the outer side of the rib vein (Rs) beyond this branch (Sc) is more opake than the rest of the wing and of a smoky yellowish color. From its inner side the rib vein (Rs) sends off three simple oblique veins, the last one (M) of which ends in the extreme tip of the wing. The hind wings have an angular point (for hooks) on their outer side (costal) beyond the middle, and a longitudinal rib-vein (Rs) which forward (proximad) of its middle sends off a branch (M) almost transversely inward (caudad) with its tip curved backward (distad)."

1858. *Chermes pinifoliae* Fitch. *Trans. N. Y. St. Agr. Soc.* for 1857, *Vol.* 17, 1858, *p.* 741. Republished in *4th Rep. Ins. of N. Y.* 1859 *p.* 55.
Description of winged form.

1862. B. D. Walsh. *On the Genera of Aphididae Found in the U. S.* Species listed only.

1869. Henry Shimer. *Trans. Am. Ent. Soc., Vol.* 2, *p.* 384. Winged forms of *pinicorticis* mistaken for *pinifoliae.*

1879. Cyrus Thomas. *Eighth Rep. St. Ent. of Ill., p.* 156. Quotes Fitch's description.

1881. A. S. Packard. *Insects Injurious to Forest and Shade Trees. p.* 118. From Fitch.

1884. Herbert Osborn. *Bulletin No. 2. Iowa St. Agr. Coll. Dept. of Ent.* Follows Shimer's error in considering winged *pinicorticis* to be *pinifoliae.*

1885. J. A. Lintner. *2nd Rep. St. Ent. of N. Y., p.* 180-187. Follows Shimer's error in considering winged *pinicorticis* to be *pinifoliae.*

1890. A. S. Packard. *Fifth Rept. U. S. Ent. Comm. p.* 805. Fitch's description quoted, without comment.

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* See page 286 for comment.

1898. Storment. *Rept. Ent. Ill.* 20; iii-xxiii. Follows Shimer's error in considering winged *pinicorticis* to be *pinifoliae.*

1901. W. D. Hunter. *Iowa Agric. Coll. Exp. Sta. Bull.* 60. *The Aphididae of North America.* Lists *pinifoliae* as a synonym of *pinicorticis.*

1909. Edith M. Patch. *Annals of the Ent. Soc. of Am. Vol. II. No.* 2. Discussion of tracheation of wings of *Chermes pinifoliae.* Pp. 107, 111, 116 and figs. 26-30.

1909. Edith M. Patch. *Me. Agric. Exp. Sta. Bul. No.* 171. Economic treatment giving main features of life history of *pinifoliae* and stating that *abieticolens* is the gall generation of the same species.

1909. Edith M. Patch. Psyche Dec. 1909, pp. 136-137.

Chermes abieticolens.

1869. A. S. Packard. *Guide to the Study of Insects, p.* 522. Brief description with figures of this species recorded as a species of *Adelges* occurring in abundance on the spruce in Maine. Some good characters of gall also given.

1879. Thomas. *Rept. Ent. Ill.* 8: (*III of Thomas*) *p.* 156. Species named provisionally as *Chermes abieticolens* and statement made that it is certainly distinct from *abietis.* Refers to Packard.

1885. J. A. Lintner. *2nd Rep. St. Ent. of N. Y., p.* 185. Refers to Packard and Thomas.

1887. Oestlund. *Aph. Minn.* Species listed.

1890. A. S. Packard. *Fifth Rep. U. S. Ent. Comm. Adelges abieticolens* Thomas. Original account and illustration copied.

1897. Fernald and Cooley. *34th Report Mass. Agric. College, pp.* 89-100. *abieticolens* merged with *abietis* by error on the basis that in response to "about five hundred circular letters sent to different persons in the U. S. and Canada, only one species of *Chermes* was received." Excellent account of *abietis.*

Chermes abietis Chol.

This common European species has been variously designated as "The Spruce Gall-louse"*, "The European Spruce Bud-louse"†, "The Yellow Chermes"‡, "The green-winged Chermes"** and the gall has been aptly called the "pine-apple gall" on account of its form.

This species has been for a good many years annually abundant on the Norway and white spruces on the campus of the University of Maine. I have collected the gall and the insect at various stages frequently since the fall of 1903, without giving the species any especial study except to compare my own observations with published accounts.

Confusion in the literature of this species both in this country and in Europe has existed on account of other species having been confounded with it. Because of this it may not be out of place to present my own notes, though probably containing no new observations, in connection with the photographs of the galls and the drawings of the species which they concern.

The Gall. Fig. 137. The galls of *abietis* vary in size from about ½ inch to 1 inch or more in length. They occur at the base of terminal shoots and do not as a rule kill the twig. Where they are numerous they cause serious deformations of the branches, and small trees are sometimes ruined by their presence. Such galls are not only very abundant on Norway spruces but they are troublesome on the native white spruce in Maine. This season (1909) a single white spruce 3 feet tall had more than 990 fresh galls upon it. The growing galls are green, with the closed mouths of the cell marked by a ʌ-shaped red line. The shade of this line varies from purple to brick red in different galls and at different times. The galls resemble in form a little pine-apple, each section being represented by a needle much enlarged at the base and little if at all at the tip. The relation of the galls to the twig on which they grow is shown in the longitudinal sections in Figs. 138 and 139. It will be seen that in some cases the gall entirely encircles the twig which

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* 34th Report Mass. Agric. College.

† Packard, 5th Report of Ent. Comm. page 853.

‡ Die Coniferen-Läuse Chermes. Prof. N. Cholodkovsky. 1907.

** Me. Agric. Exp. Sta. Bul. 171.

continues its growth from the apex of the gall, while in others the gall is produced in a one sided manner only partly encircling the twig. The cells of the gall are closed. A sample gall about ¾ inches long contained about 50 cells each holding from 8 to 12 nymphs. This count was made August 13.

About the middle of August at Orono the mouths of the cells open and the pupae emerge to molt.

Nymphs, the Gall Generation. Specimens taken from galls June 23, 1904, are recorded as greenish yellow. July 24, 1909, nymphs are recorded as very pale yellow covered with white pulverulency. Molted skins attached to caudal extremity were filled with liquid so as to retain their shape. Many nymphs had two such molts attached so that three successive stages of the insect were in line. The excreted liquid being largely disposed of in this manner, the cell wall of *abietis* is clean and dry, a condition made further possible by a slight covering of waxy powder.

Pupae. Body length of full-grown pupa 1.9 mm. Specimens taken from galls on Norway spruce August 4, 1909, were very pale yellow, slightly pulverulent. Others taken from galls on white spruce August 17, 1909, were a little darker yellow and the finely-pulverulent abdomen had a slight rosy tint. The pupae leave the galls before molting. The time of most plentiful emergence is from about the middle to the last of August for the vicinity of Orono, though the galls in more exposed sunny places are about a week earlier in opening than the average shaded ones. The pupae creep from the open cells of the galls in a sluggish manner and often rest in Indian files on the needles near the gall, where they molt and become the winged individuals. The cast skins remain in white rows upon the needles for some time unless dislodged by rain. See Fig. 140.

The wax pores for the pupa are: (Fig. 117) head with an anterior group of pores near base of each antenna and two median groups at posterior margin; prothorax with lateral gland area, an anterior median pair of groups, a small group (4 pores) between the lateral and median ones, and four groups near posterior margin of prothorax; mesothorax with an anterior lateral area; metathorax with two separated median groups; abdomen with small and widely separated median groups on segments I-VI, those on I being composed of about 6 pores, those on II of 3 and those of III-VI of 2 each, a very small group of lateral pores occur on segments II-IX (merged to a caudal group on IX), and about half way between the median group and lateral margin an additional group of about 3 pores occurs on segments I and II. The smallness of these inconspicuous groups is correlated aptly with the fact that this is not a flocculent species, the wax secretions not exceeding the pulverulent condition. Fig. 117 shows a pupa a short time before the final molt.

Winged Oviparous Form. Fig. 115. The freshly molted individuals, August 19, 1909, have a golden brown body, the thorax, except the dorsal lobes, slightly lighter than abdomen, lobes of thorax dark, head dark, wings with whole stigmal area and margin a decided and conspicuous green, the remainder of the wing being white with a slight yellowish green tint. As the individual ages the coloring becomes darker, though the wings retain their characteristic green color. Length of body 1.7 to 2 mm., wing expanse 6.mm.

The areas of the wax pores (Fig. 115) are much as in the pupa except for the abdomen which is as follows: I with median groups comparatively large and merged, II median groups separated and composed of 2 pores each, V with two small groups between median ones referred to. I-VIII with distinct lateral groups on darkened area, III-VI with small groups of 2 or 3 pores each midway between median and lateral groups.

The wing veins of this species have, as with the other five discussed in this paper, a fairly constant characteristic trend which is shown in Fig. 115. First A of the fore wing is seen to be considerably arched.

The sensorium of each of antennal joints III-V is confined to the distal half of the joint and extends not more than half way around the joint. These three joints are much alike in general appearance. III is noticeably shorter than IV while IV and V are subequal. The usual group of smaller sensoria occurs on V and there is nothing striking about the 4 or 5 terminal hairs. Fig. 116.

Apterous oviparous form—winter female or stem mother. May 7, 1906, I observed these young females of the winter generation, minute and slightly downy clinging close to the buds or in the axle of the leaves on Norway spruce. May 31, 1906, the females were very plentiful and were readily detected on account of the little white flocculent mass surrounding her and her recently laid eggs. One such egg cluster contained about 140 eggs and the female was not through ovipositing.

The life cycle for *abietis* based upon the writer's observations is briefly as follows: Galls open about mid-August and fully grown pupae emerge and molt within a few hours becoming the winged form which deposits a cluster of 40 to 50 yellow eggs on a spruce needle. The eggs are extruded from the abdomen but the parent *Chermes* remains over them until dislodged after her death by wind or rain. The winged form often oviposites near the gall from which it emerges. A different species of host plant is never sought by this *Chermes*. In about two weeks the young "stem mothers" hatch from these eggs and seek a protecting crevice in the surface of the spruce bud where they can spend the winter. These wingless forms develop in the spring and become full grown about the last of May when they lay a cluster of 140 or more eggs. From these eggs hatch the young that inhabit the gall and are known as the "gall generation" with which we started the cycle.

For a further account of *abietis* the reader is referred to the *34th Report of the Mass. Agric. College*, 1897, and to *Die Coniferen-Läuse Chermes* by Prof. N. Cholodkovsky, 1907.

Remedial Measures. Spraying the trees in April with whale-oil soap solution (1 pound to 2 gallons of water) has been reported as effectual. (34th Report Mass. Agric. College). The practice of removing and burning the galls will serve to control this species sufficiently on ornamental trees. At Orono great numbers of the winged forms are caught in spiders webs that are spun irregularly over the spruce twigs.

Bibliography. It does not seem practical to attempt a bibliography of *Chermes abietis* for United States. That various other *Chermes* have been confused with this species is certain, but to what extent it is often impossible, on the basis of the references, to be sure. The illustration in Bulletin 56, West Virginia Agricultural Experiment Station 1899 of the "Galls and deformed twigs of the spruce gall louse" (Fig. XXXI, page 261) does not figure galls of *Chermes abietis* but those of some other *Chermes*, possibly of *similis*.

In the Spruce Gall-louse *Chermes abietis* Linn. by Fernald and Cooley (34th Report Mass. Agric. College, 1897) is presented carefully the life history and habits of this species. The figure of the gall Plate II in that paper is the characteristic *abietis* gall and the wings on the same plate show the typical curves of the veins of this species. The record of *abietis* from Colorado (page 4 of Author's separata p. 92 in 34 Report) however applies to *Chermes cooleyi* (See Gillette *Chermes of Colorado Conifers* page 3), and *abieticolens* of Packard and Thomas is by error in that publication considered to be the same as *abietis*.

CHERMES LARICIATUS Patch.

A gall resembling that of *abietis* very closely in size and form and found, like that of *abietis*, on white spruce was taken in the vicinity of Orono by Mr. William Woods, July 28, 1909. Fig. 141 shows two of these.

The galls. Like the galls of *abietis* they are not terminal on the twig and the tip of the twig extends out from their apex when they encircle it, or along one side of the gall when they do not, just as with *abietis*.

The galls were mature on date of collection. The needles of the gall are green at this season. Conspicuous wide russet lines mark the closed mouths of the galls which gives the gall a general russet color. The needles of the gall are much shorter than is usual with *abietis* on the Norway and White spruces and it is thus a little more pine-apple like in form than *abietis*. Many of the galls were opening at the time they were collected, and the pupæ walk out from the open cells before they molt, as do *abietis*. The galls become dry and brown soon after they are vacated. The cells are not as shallow as those of *abietis*.

The pupa. (Fig. 122). Described from forms just leaving the gall before the last molt. Length of body 2 mm.; head, prothorax and abdomen light reddish; thorax yellowish green; wing pads dark green; ventral prothorax and thorax yellowish green; legs and antennae greenish. The areas of wax pores are well defined; head with anterior area between antennae, and four posterior groups; prothorax with a large lateral area, an anterial row of 4 groups, a posterior area of 2 groups, and a broken line of 4 groups between the anterior and posterior groups; mesothorax with a very large anterior lateral area and a row of 4 groups across the middle of the segment; metathorax with a very large lateral area about the size of that of the mesothorax, and a row of 4 well defined and separated groups which are in line with those of the abdomen; abdomen with lateral groups on I-IX (merged to caudal group on IX), I-VI with a dorsal row of 4 groups on each segment, the median ones being largest but not merged.

The Winged Oviparous Form. Migrant. (Fig. 118). Newly molted individuals have prothorax and abdomen light yellowish brown, head and thoracic lobes dark, legs and antennae greenish, wings decidedly green with yellow proximal portion The individuals, of course, grow darker as they age. Body length about 1.9 mm.; wing expanse 6 mm. to 6.2 mm.

The well defined areas of wax pores are: head with 2 distinct anterior groups and 2 large and separate posterior groups; prothorax with the usual lateral area, a row of 4 anterior groups, and 2 posterior groups widely separated; mesothorax with two median distinct groups; metathorax with two median groups separate and in line with the median groups of the abdomen; abdomen with median groups on segments I-VI well defined and widely separated, well marked lateral groups on segments I-IX (merged to caudal group on IX), and a small group between the lateral and median groups on III-VI.

The antennae (Fig. 119), is more like that of *abietis* than any of the other species of this paper, but the outlines of the joints are less abrupt, the curves of the sensoria are more regular, and V is typically longer than IV. III and IV are about subequal.

The wings resemble those of *abietis* but are distinct enough. 1st A of the fore wing of *lariciatus* is less strongly arched and M of the hind wing is a heavier vein than that of *abietis* and strongly curved with the convexity distad.

July 31, 1909, this species was found to be common on the needles of larch everywhere in the vicinity of Orono. The migrants from the white spruce galls settled on the larch needles and oviposited. The eggs are extruded and not retained in the abdominal cavity as with *pinifoliae*, and the parent is more easily dislodged even than *abietis* and soon drops from the egg mass. There are from 50 to 75 beautiful green (paler than larch green) eggs in a cluster. (Fig. 121). They are slightly pulverulent. The glimpse through a glass at this little *Chermes* with the green eggs showing through her transparent wings is one of the prettiest sights of the insect season. Fig. 120 gives the position of this species when oviposition is nearly finished. The migrants settle on the larch needle either with head toward base of needle or toward tip, apparently indifferently.

On July 31, 1909, opening galls of this species were placed upon sprigs of conifers in cage. The twigs were in vials of water so that they remained fresh. On August 3 the individuals that oviposited were counted with the following results:

Picea rubra Dietr	Red spruce	0
Picea mariana (Mill.) B. S. P.......	Black spruce	0
Picea abies (L.) Karst	Norway spruce	1
Picea canadensis (Mill.) B. S. P......	White spruce	4
Pinus strobus L..................	White pine	0
Pinus sylvestris	Scotch pine	0
Thuya occidentalis L.	Arbor Vitae	0
Abies balsamea (L.) Mill.............	Balsam fir...........	4
Larix laricina (Du Roi) Koch......	Larch	69

The preference for larch speaks for itself. Whether the other ovipositions have any significance or are merely accidental it is, on the basis of this one test, impossible to say.

Whether *lariciatus* may be the same as *laricifoliae* Fitch I have not been able to decide. There is nothing in the brief description of Fitch's to preclude this possibility. Fitch's color description does not agree in all respects with my notes for *lariciatus* but these were made from specimens immediately after molting and would not be the same as an older specimen. The italisized portion of the original description for *laricifoliae* Fitch which is here quoted entire would apply very well to *lariciatus*. "*Solitary and stationary upon the leaves, extracting their juices, small* black shining flies *0.10 (inch) long*, having the abdomen dark green, *the legs obscure whitish, the wings nearly hyaline with pale brown veins and the large stigma-spot upon their outer margin beyond the middle more opake and pale green.* This is closely like the Pine Chermes, No. 267, but *has the wings more clear, and differs also in some of the details of its colors.*"

So far as I can judge some of the records referred to *laricifoliae* in this country really concern *consolidatus* which is certainly not *laricifoliae* Fitch. It is not improbable that *lariciatus* may prove to be the European *viridis* Ratz. as discussed by Professor Cholodkovsky in *Die Coniferen-Läuse,* 1907. The galls of *viridis* Figs. 1 and 8 in that publication very well picture the galls of *lariciatus* and the host plants are identical.

As the specific characters on which I have laid most stress, antennae, wings and wax gland areas of the winged forms, are not given in so much detail in European publications as the structure of the apterous forms, the figures do not emphasize the same points and the only basis for comparison would be determined European material which may perhaps be possible to secure.

CHERMES CONSOLIDATUS Patch.

July 20, 1909, in the vicinity of Orono Mr. William Woods collected from black spruce some pink and green galls resembling those figured by Professor Cholodkovsky in *Die Coniferen-Läuse Chermes* 1907 for *Chermes strobilobius* Kalt. The flesh of the gall on the surface is a delicate pink, the needles of the gall, much stunted, are a delicate green. Some of the galls collected on the same day were pale green instead of pink. The galls (Fig. 145), are about one-half inch long or less and are terminal. The cells of the galls contained dark red nymphs which were flocculent rather than merely pulverulent, and the cell walls were also covered with the flocculent secretion.

Specimens began to emerge from these galls in the laboratory July 30, and galls found out of doors on red spruce were opening about the same time.

Opening galls of this species were placed in a cage on twigs of red spruce, black spruce, white spruce, Norway spruce, arbor vitae, white pine, Scotch pine, hemlock, balsam fir and larch. In a few days a count of ovipositing individuals was made and it was found that they had laid eggs *very sparingly* on each of the four spruces and balsam fir—1 to 5 specimens on each plant. 9 to 12 eggs were deposited in a mass under the wings. Most of the individuals died without ovipositing at all. This test certainly gave no dependable data, nor did I chance upon this species ovipositing out of doors. The galls in this vicinity were not numerous and the species is very small.

I have taken, however, on June 20, 1909, and about the same time previous years small *Chermes* pupae developing at the base of larch cones in flocculent matter. When these molt they prove to be brown bodied with a caudal flocculent tuft and greenish wings. These winged forms I am unable to separate on microscopic comparison from *consolidatus* (Figs. 123 and 124), and think that there is no reason to doubt that they are the same species, and that the larch and spruce are alternate hosts of *consolidatus*.

Whether they prove to be *strobilobius* Kalt. can only be ascertained by comparison with authentic European material which is not at present available.

Pupa. The pupa, described from specimens removed from spruce galls. -(Fig. 125). Body dark red and flocculent, the larger ones 1.2 mm. long. Areas of dorsal wax pores; head with large groups at anterior and posterior margin; prothorax with lateral areas, a row of 4 large anterior and 4 large posterior groups; mesothorax with a curved transverse row of six well defined groups, the outer ones forming the usual anterior-lateral groups, metathorax and abdominal segments I-VI with transverse rows of 6 groups each, VII-IX with only the marginal group. Fig. 125 was drawn from a pupa in its last stage but sometime before it molted. Later the conspicuous circular space about the gland openings is not so discernable.

The Migrant from the Spruce Gall. (Fig. 123). Length .9 mm.-1.3 mm.; wing expanse 3.5 mm.-4.0 mm. The wings of this species are very rotund. The veins in the fore wing are usually like those given in fig. 123 though frequently they are straighter. M in the hind wing usually curves with the concavity distad though sometimes this vein is nearly straight.

The most striking structural distinction between this and the other 5 spruce *Chermes* is in the antennae. The constrictions between joints III, IV, V are very inconspicuous so that these joints from some positions appear almost to be consolidated into a single long terminal joint. It was this character that suggested the specific name. The antennae of *consolidatus* are distinctive in one other respect, two of the four terminal hairs are developed into strong spines (Fig. 124a). This is not true of any of the other 5 spruce species.

Apterous oviparous form on larch.

On August 1, 1909, apterous oviparous forms in woolly mass on larch twigs were common. Although the connection was not traced I believe these to be *consolidatus* Fig. 126 was drawn from one of this collection.

CHERMES FLOCCUS Patch.

Like *Chermes pinifoliae* Fitch, this species develops in galls on black and red spruce and migrates to the needles of the white pine to oviposite. Both the galls and the insects, however, of these two species are too distinct to be in any respect confused.

These galls (fig. 134) were first collected on black spruce at Orono, July 10, 1909. They resemble galls of *similis* Gillette but are more compact and better formed than any galls of *similis* which were taken this season in Maine. They occurred in great numbers in this vicinity on red and black spruce. They are terminal and comprise the total deformed shoot. In length they vary from about $\frac{3}{4}$ to $1\frac{3}{4}$ inches. The surface of the gall is green in some while some have a dark purple tinge near the base of each needle, giving the gall a purple cast. The needles of the gall are not much dwarfed and are a normal spruce green. Figs. 135 and 136 give cross and longitudinal sections of this gall.

On account of the loose structure of the gall, syrphus maggots were very abundant within, feeding on the *Chermes* nymphs.

The pupa remains within the gall until after the last molt and the winged migrant emerges ready for flight.

Pupa. (Fig. 112). Described from specimen removed from gall shortly before the last molt. Length of body about 1.8 mm. Head, antennae, wing pads and legs dark or dusky, prothorax and abdomen rather dull reddish, thorax yellowish red and paler than abdomen. Entire body pulverulent. Wax gland areas on prothorax, thorax and abdomen are plainly located under a Zeiss binocular, by warty appearance of live specimen. These areas are: head with 2 large anterior and 2 larger posterior groups; prothorax with prominent lateral groups, also 2 small median anterior groups and 2 large posterior groups; mesothorax with prominent lateral areas, large median groups and small anterior groups; metathorax with 2 median groups in line with these on head and pro- and meso-thorax and abdomen; abdomen with lateral groups on segments I-VIII, large median groups on segments I to VI and a row midway between the lateral and median groups on I to VI. None of the pore-groups are merged in the pupa.

Migrants from spruce gall to pine. (Fig. 110) 1.5 mm.-2.1 mm. long with wing expanse 5. 0-mm.-5.6 mm. Freshly molted individuals have a yellowish red body and pale buff wings. The antennae are characterized by the exceedingly large sensoria on joints III, IV, V. Each sensorium comprises the entire surface of the joint except the extreme proximal and distal portions and a narrow ridge connecting these. The constrictions between joints are abrupt. III and IV are subequal and V is longer and not so thick. The wings are rather narrow. 1st A in the fore wing curves, the convexity being distad. M of the hind wing curves, the concavity being distad. Large wax gland areas occur on head and the three thoracic segments. On the abdomen lateral groups are present on perfectly distinct darkened areas on segments I-VII, IV, V, and VI are transversely banded by wax pores across the dorsum. Merged median groups occur on I, II, III and on III a separate group (sometimes absent) midway between the median and lateral groups. I and II are without wax areas between the median and lateral groups.

These winged forms migrate, from the middle to the last of July near Orono, to pine needles where they oviposite .(Fig. 133.) The ovipositing females secrete considerable wax from head glands as well as over the rest of the body so that they are a decidedly flocculent and not pulverulent species. This character alone would distinguish them from *pinifoliae* and is chosen for the specific name on that account.

In the woods these migrants were found abundant on the white pine needles over egg clusters of about 40 eggs. Coming so much later in the season *floccus* finds both old and new growth pine needles available and deposits the egg mass indifferently on the old or new. *Pinifoliae* migrants occur in this region only on needles of previous years growth as they appear the middle of June.

Chermes floccus migrants are not so particular as *pinifoliae* as to which way they are headed, some migrants settling on the pine needles with head toward the tip and some with head toward the base.

Besides the out-of-door observation of the migrants on white pine, a laboratory test was given. July 19 a lot of galls from which *floccus* were emerging were placed in a cage among the following conifers which were kept fresh in vials.

July 21 migrants had settled and deposited egg clusters as follows:

Picea mariana (Mill.) B. S. P.	Black spruce	0
Picea rubra Dietr.	Red spruce	0
Picea abies (L.) Karst.	Norway spruce	0
Picea canadensis (Mill.) B. S. P.	White spruce	5
Abies balsamea (L.) Mill.	Balsam fir	0
Tsuga canadensis Carr.	Hemlock	0
Pinus laricio Poir.var.*austriaca* Endl	Austrian pine	0
Pinus sylvestris	Scotch pine	0
Pinus strobus L.	White pine	92
Thuya occidentalis L.	Arbor vitae	0

July 21, two small tips of white pine alone were put with *floccus* galls. In 48 hours 57 *Chermes* had oviposited on one and 117 on the other. These eggs began to hatch July 28.

Chermes similis Gillette.

On July 9, 1909, my attention was called to some scraggly twigs of Norway spruce which proved to be deformed by *Chermes*. These galls resemble somewhat those of *floccus* but they are less regular. Fig. 142 pictures these. Winged specimens were emerging from these galls on date of collection. A search of white, red and black spruces resulted in taking the same galls on all these. These galls are very loose in structure and syrphus maggots freely helped themselves to their contents.

Galls from all these spruces contained pupae practically ready to molt and become the winged form, and also a few very small apterous oviparous individuals which were laying clusters of eggs in little woolly masses. These apterous forms were also found with their eggs in woolly masses along the stem and in one case on the outside of gall of *floccus* (fig. 134.) They were reddish brown and were .5 mm. to 1.0 mm. long.

The winged forms from the Norway spruce out of doors were migrating. On the other hand, the winged ones from black spruce galls were settling and ovipositing freely on black spruce. They are a flocculent species and their wings showed dark against the woolly mass which covered their abdomens and egg clusters.

What the life-cycle relation of the apterous oviparous forms is to the migrants appearing and ovipositing at the same time I do not know. They are here considered as *similis* though their identity is not proven. The galls of *similis*, however, were the only ones discussed in this paper in which apterous oviparous forms were found. Professor Gillette also records apterous females and their egg clusters to be present in galls of *similis*.

A cage test as to preference of spruces of the migrants was made. July 9, galls from black spruce were caged with uninfested black, white and Norway spruces. By July 13 a few migrants had settled on the Norway and deposited but a decided preference was shown for the white spruce upon which they settled in plentiful numbers and deposited eggs, remaining for a time on the little white woolly masses.

July 9, galls from white spruce were placed with uninfested white, black and Norway spruces. A large majority chose the white spruce. The eggs of this species hatched in about a week.

On trees where the infestation was heavy the terminal shoots were sticky and the needles somewhat ruffled. (Fig. 144). In many places portions of the spruce needles turned whitish yellow giving a "blighted" appearance to the shoot.

The winged form (fig. 113), varied exceedingly in size, part of the emerging ones being about 1.0 mm. long with a wing expanse of 3.0 mm.-4.0 mm. while the majority were larger, ranging from 1.45 mm. to 1.7 mm. with a wing expanse of about 4.8 mm. Color of body reddish brown, wings a little smoky. Wings much as in *floccus* with the veins having a little more tendency to straightness. Antennae are more like those of *pinifoliae* than any other, both as to general shape of joints and the relative size of the sensoria. The wax gland areas are: head with dorsal surface nearly covered by the two anterior and posterior groups which nearly meet; prothorax with large lateral area, two anterior and two posterior groups; mesothorax with lateral anterior group and two very large median groups; metathorax with median groups extending nearly across the segment; abdomen with large groups on I-VI, median groups on I-VI being largest on I and graduated to smallest on VI; a group of wax pores midway between the median and lateral series on segments II-VI, those on IV-VI being much larger than those on I-II (the group on I, of 2 or 3 openings only, is sometimes missing).

Certain striking resemblances of this Maine collection to *similis* as described by Professor C. P. Gillette* led me to submit balsam mounts, galls and illustrations to him. On the basis of this data he stated that he is unable to find any good distinguishing characters to separate this Maine material from *similis*. Professor Gillette's courtesy in determining this species enables me to introduce *similis* from Maine.

CHERMES PINICORTICIS Fitch.

It frequently happens that trunks of the white pine in Maine are more or less covered by the white secretion of this minute *Chermes* which gives the bark a moldy appearance (fig. 146). The infestation has been particularly heavy during 1908 and 1909, but during the latter season so many syrphus maggots were present preying upon the *Chermes* that these natural enemies seem likely to check its increase.

Though I have reared the winged forms of *pinicorticis*, I have made no special study of this species. Whether it confines itself to the pine or possesses an alternate host is not known. I have found the winged forms resting in abundance on needles of infested small white pines, from which they took flight at the slightest jar. Whether their destination was another species of plant or merely another white pine, the present knowledge of this species does not give basis to state.

Either the wing or the antennal characters of *Chermes pinicorticis* would serve to distinguish it from any of the 6 *Chermes* discussed in this paper, though its minute size alone would prevent confusion.

The fullest account of this species is by Mr. Storment published in the Appendix to the *Twentieth Report of the State Entomologist of Illinois*. In Mr. Storment's paper, as in others

* Chermes of Colorado Conifers. 1907.

on *pinicorticis* since Mr. Shimer by error merged *pinifoliae* with *pinicorticis* about 40 years ago*, the NAME *pinifoliae* is confused with *pinicorticis* both in the discussion and bibliography. It is evident from the context, however, that neither Mr. Shimer, Professor Osborn or Mr. Storment had observed the INSECT *pinifoliae* and for this reason the mistake in synonymy is very easily corrected.

CONCLUSION.

The present paper deals with six gall forming *Chermes* of Maine conifers. The gall host and the alternate host, where there is one, has been in each case ascertained. No attempt has been made to follow the development of the winter generation. With three species of *Chermes* making galls on the white spruce and four on black spruce in one locality it is apparent that a detailed study of the winter generations could only be carried on satisfactorily on conifers raised from seed under quarantine.

A glance at fig. 134 where *Chermes similis* is seen ovipositing on galls of *Chermes floccus* is sufficient to suggest the confusion possible.

Both the galls and the winged individuals give characters sufficient to determine these six species, however, and these have been figured in each case.

Illustrations. The photographs published are selected from many taken by Mr. R. L. Hammond and have been a constant aid in recording permanently certain changing phases of the work of these *Chermes,* and have been a necessary part of the study. The drawings were made by Miss Charlotte M. King who spent most of the summer of 1909 at the Maine Agricultural Experiment Station. The structural details for each form figured were worked out independently by Miss King. During the same time the writer studied carefully with each species the arrangement and number of wax gland areas, the character of the antennal sensoria, wing characters and other significant points and the drawings as they stand record both Miss King's observations and my own critical interpretation, no detail that seemed important being left until sufficient material was examined for a mutual agreement.

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* For discussion see pp. 277-289 in this present paper.

Technique. At the time these species were studied, live material was available both for the pupae and winged forms. The general form of the individual was sketched first from live material and such structures as could then be ascertained were indicated. Details were studied and drawings completed from balsam mounts. Live specimens in some cases were mounted directly in the balsam and a few desirable results obtained for immediate use. In each case, however, a large series of mounts was carefully made for study, drawings, and photomicrographs. Total mounts were most satisfactory after the general method (modified according to size, readiness of penetration of the fluids, etc.) indicated as follows:

Killed in hot 98 per cent alcohol,
One hour in 80 per cent alcohol,
One-half hour in 98 per cent alcohol,
Ten minutes in 100 per cent alcohol,
Ten minutes in tolu.

Antennal details were taken from head mounts. Wings were in each species mounted separately. Where total mounts did not bring out clearly the wax gland areas of both thorax and abdomen, severed specimens were prepared to facilitate the more rapid and thorough clearing.

This detailed account of the method of preparation is given in order that the character of the material used may be recorded. Certain groups of wax pores, for instance, were not rendered visible in one or two species except in dissected specimens and in most, a large series was necessary to settle the number definitely. Some variation occurs in the size and arrangement of the groups of wax pores, but individuals figured and described represent the typical wax pore areas as they were seen. As the wax pores are often difficult to see the most convenient specific characters will be found in the wing and antennal characters which are distinctive and within slightly varying limits were constant, for the extended collection in this locality at least.

Wing Vein Nomenclature.

For the nomenclature of the wing veins used here the reader is referred to *Homologies of the Wing Veins of the Aphididae, Psyllidae, Aleurodidae, and Coccidae, Annals of the Entomological Society of America,* June 1909.

New Species.

It is possible that some of the species described as new may prove to be synonyms of European species, but as the inconvenience of a synonymy is so much less than the confusion of a composite species it seemed wise not to attempt comparison with European species until a careful study had been made of these *Chermes* as they occur in Maine.

The first brief descriptions of *floccus*, *consolidatus*, and *lariciatus* were published in Psyche, December, 1909.

Chermes in Europe.

Many important and admirable studies of *Chermes* species have been carried on in Europe by such careful workers as Blochmann, Börner, Cholodkovsky, Dampf, Dreyfus, Mordwilko, Nüsslin. A comprehensive review of this work with bibliography appeared in *Zoologisches Zentralblatt*, Dec., 1909. *Zusammenfassende Ubersicht. Die neueren Ergebnisse und Aufgaben der Chermes-Forschung von Prof. O. Nüsslin in Karlsruhe.*

Host Plants.

The host plants in the following key are recorded solely on the basis of one season's careful collection in the vicinity of Orono. The list of host plants may need to be extended later but it is accurate so far as it goes. In recording the collections of the galls, the botanical distinctions between the red and black spruces has been observed, though entomologically these might pass for one species. *Chermes* at any rate does not pay any attention to the distinction.

Key to the Chermes of Maine Conifers.

A. Galls on black spruce (*Picea mariana* B. S. P.) and red spruce (*Picea rubra* Dietr.)

Gall terminal.

1. Gall conelike, needles modified to thin scales. Ripening mid-June. Migrants ovipositing on needles of white pine. (*Pinus strobus* L.) *pinifoliae.*

2. Scraggly deformed twig. Gall-needles not much abbreviated. Ripening first of July. Migrants ovipositing on spruce *Picea* sp. *similis.*
3. Gall usually well formed ¾-1¾ in. long. Needles not much abbreviated. Ripening mid-July. Migrants ovipositing on needles of white pine. (*Pinus strobus* L.) *floccus.*
4. Gall small, ½ inch or less, pink or pale green. Gall needles short. Ripening first of August. Species also found on larch (*Larix laricina* Koch.) *consolidatus.*

B. Galls on white spruce.

Gall terminal,

Scraggly deformed branch. Ripening first of July. Migrants ovipositing on spruce (*Picea* sp.) *similis.*

Gall not terminal,

1. Pine-apple shaped. Ripening last of July. Migrants ovipositing on needles of larch. (*Larix laricina* Koch.) *lariciatus.*
2. Pine-apple shaped. Ripening mid-August. Winged form not migrating to oviposite. *abietis.*

C. Galls on Norway spruce, *Picea abies* (L) Karst.

Gall terminal,

Scraggly deformed branch. Ripening first of July. Migrants ovipositing on spruce, *Picea* sp. *similis.*

Gall not terminal,

Pine-apple shaped. Ripening mid-August. Winged form not migrating to oviposite. *abietis.*

Explanation of Plates.

Fig. 108. *Chermes pinifoliae* Fitch. Migrant from spruce gall to needles of white pine. Figs. 109, 109a. Antenna.

Fig. 110. *Chermes floccus* Patch. Migrant from spruce gall to needles of white pine. Figs. 111, 111a. Antenna.

Fig. 112. *Chermes floccus,* pupa developing in spruce gall.

Fig. 113. *Chermes similis* Gillette. Form which emerges from spruce gall. Figs. 114, 114a. Antenna.

Fig. 115. *Chermes abietis.* Form which emerges from spruce gall. Fig. 116. Antenna.

Fig. 117. *Chermes abietis,* pupa developing in spruce gall.

Fig. 118. *Chermes lariciatus* Patch. Migrant from spruce gall to needles of larch. Figs. 119, 119a. Antenna.

Fig. 120. *Chermes lariciatus.* Migrant on needle of larch with egg mass nearly completed and showing through the thin transparent wings. Drawn from living specimen.

Fig. 121. *Chermes lariciatus.* Egg mass on larch needle.

Fig. 122. *Chermes lariciatus.* Pupa developing in spruce gall.

Fig. 123. *Chermes consolidatus* Patch. Migrant which develops in spruce gall. Figs. 124, 124a. Antenna. Notice two strong terminal spines.

Fig. 125. *Chermes consolidatus,* pupa developing in spruce gall.

Fig. 126. *Chermes consolidatus?* Apterous oviparous form on larch.

Fig. 127. *Chermes pinifoliae* Fitch. Migrants from spruce to white pine needles.

Fig. 128. *Chermes pinifoliae.* Mature galls from black spruce still green and just before opening.

Fig. 129. Branch of black spruce. *A* cone with tip broken, *B* four normal spruce tips, *C* four young galls of *pinifoliae.*

Fig. 130. Tip of black spruce. *A* cone which is purple, *B* normal tip, *C* deserted *pinifoliae* gall which is bright reddish brown.

Fig. 131. Deserted galls of *Chermes pinifoliae* on red spruce.

Fig. 132. White pine showing injury to new growth by the young *pinifoliae* which may be located by the white secretion on twig at base of new growth. Photographed July 23, 1909.

Fig. 133. *Chermes floccus* Patch, migrants from spruce galls, ovipositing on white pine needles.

Fig. 134. Galls of *Chermes floccus* on red spruce. The white objects on the outside of the gall are waxy secretions of *Chermes similis,* apterous forms, which are ovipositing on *floccus* galls as well as on the twig.

Fig. 135. Gall of *Chermes floccus* from black spruce. Cross section. Fig. 136. Longitudinal section.

Fig. 137. Twig of white spruce with galls of *Chermes abietis.*

Fig. 138. Galls of *Chermes abietis* from Norway spruce. Longitudinal section of gall which does not enclose the whole twig. Fig. 139. Longitudinal section of gall which completely encircles the twig.

Fig. 140. Twig of Norway spruce. Show deserted gall of *Chermes abietis* and the white molted skins along twig and leaves.

Fig. 141. Twig of white spruce with galls of *Chermes lariciatus* Patch. Gall at right deserted. Gall at left not yet opened.

Fig. 142. Galls of *Chermes similis* Gillette on Norway spruce.

Fig. 143. Apterous flocculent oviparous females of *Chermes similis* showing white on stem of Norway spruce.

Fig. 144. Twig of black spruce showing injury to young of *Chermes similis.* Needles sickly yellow and covered with white flocculent secretion of the *Chermes.*

Fig. 145. Gall of *Chermes consolidatus* Patch on black spruce.

Fig. 146. *Chermes pinicorticis* Fitch on bark of white pine.

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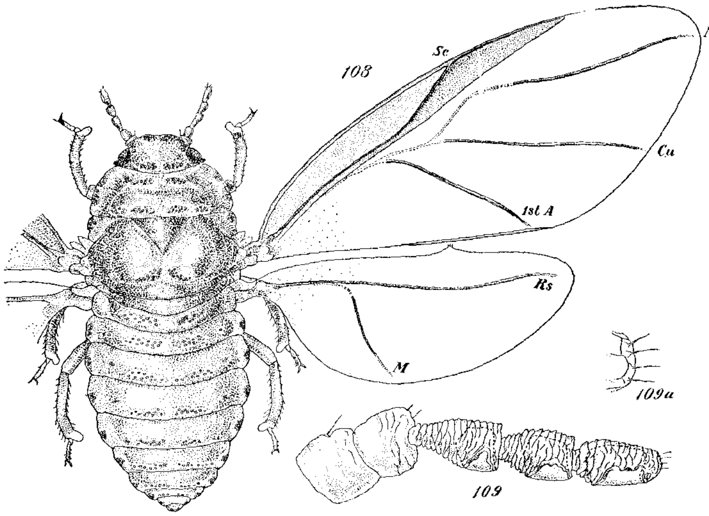

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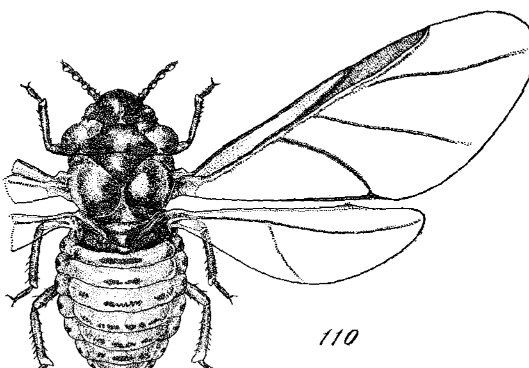

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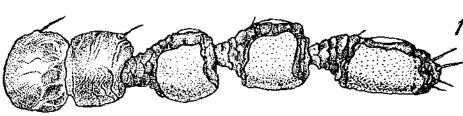

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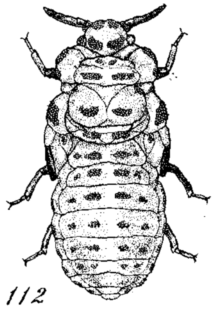

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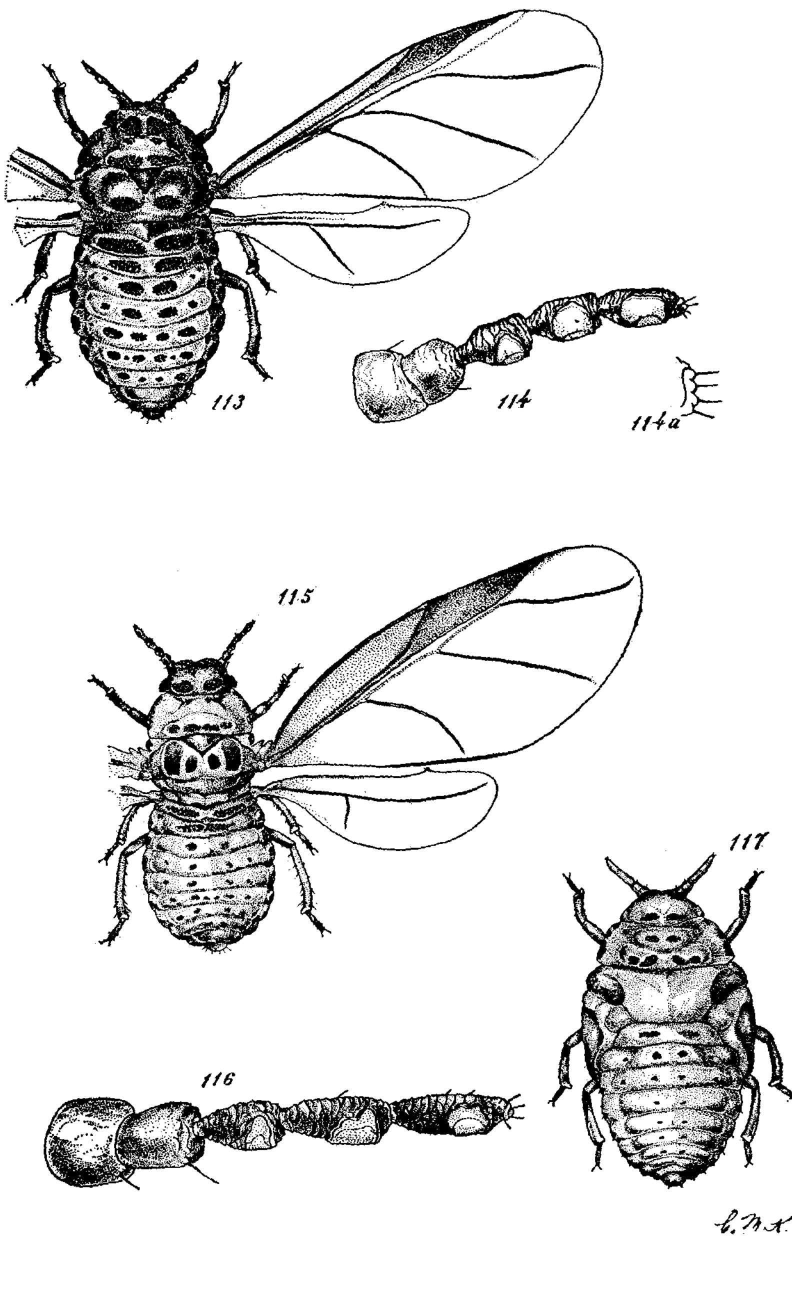
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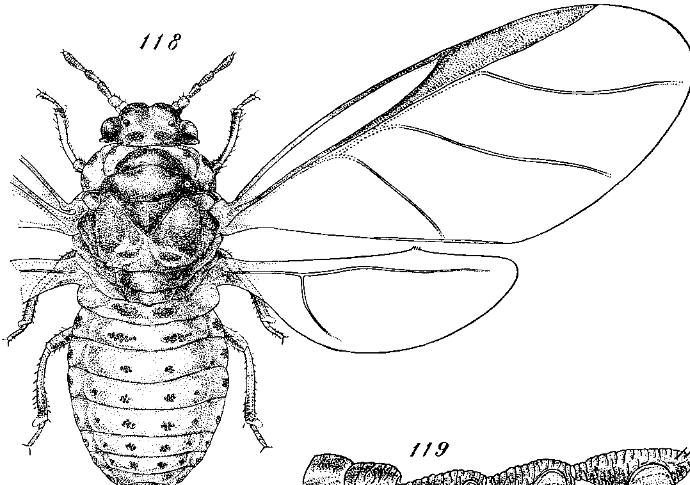

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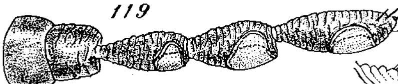

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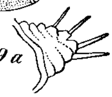

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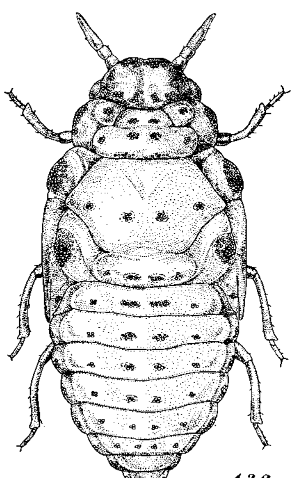

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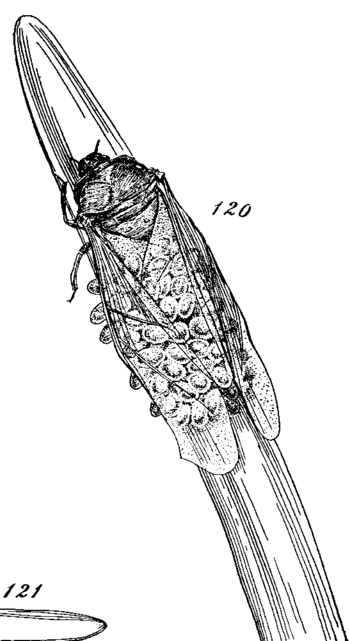

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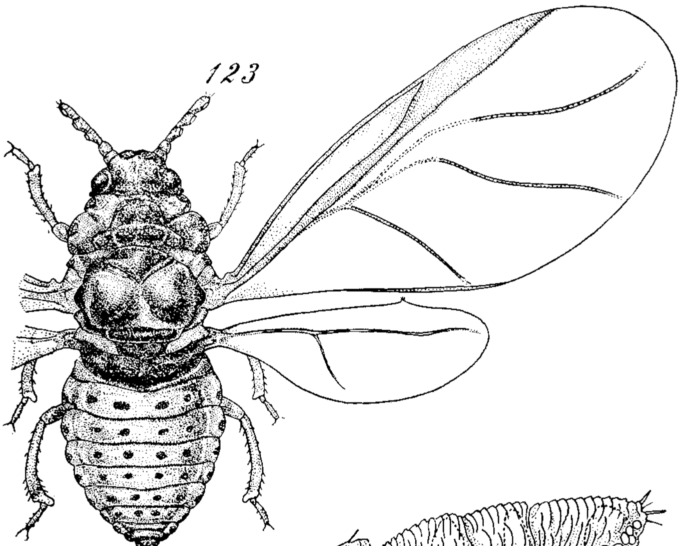

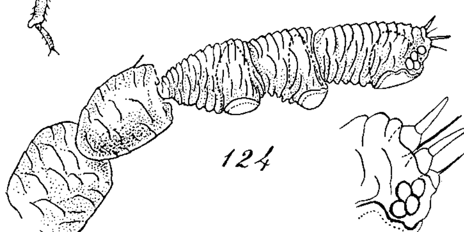

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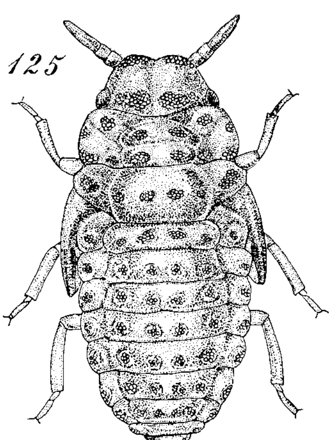

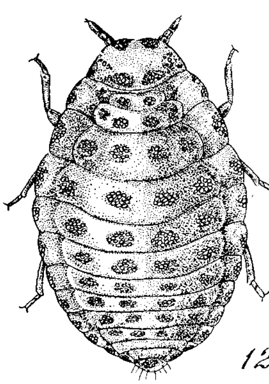

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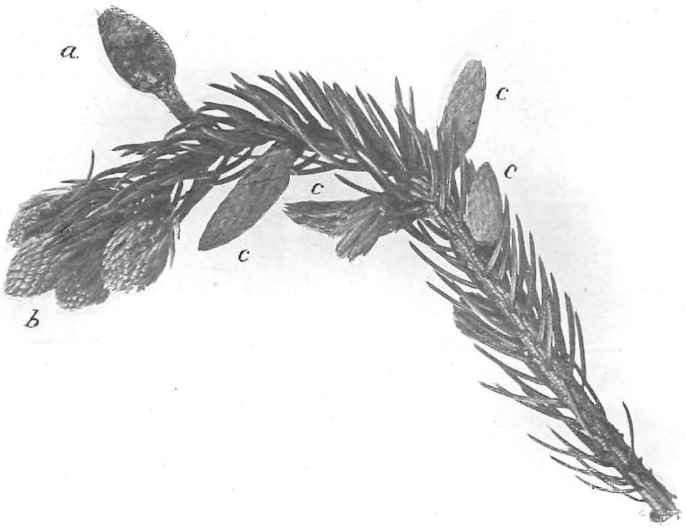
Fig. 127

Fig. 128

Chermes pinifoliae Fitch. Fig. 127, Migrants on white pine. Fig. 128, Galls on black spruce.

Fig. 129



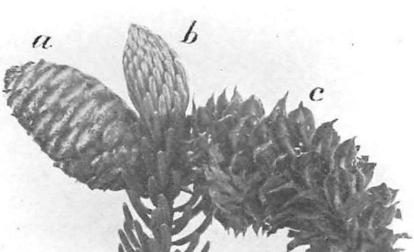


Fig. 131

Fig. 130

Chermes pinifoliae Fitch. Galls on spruce.

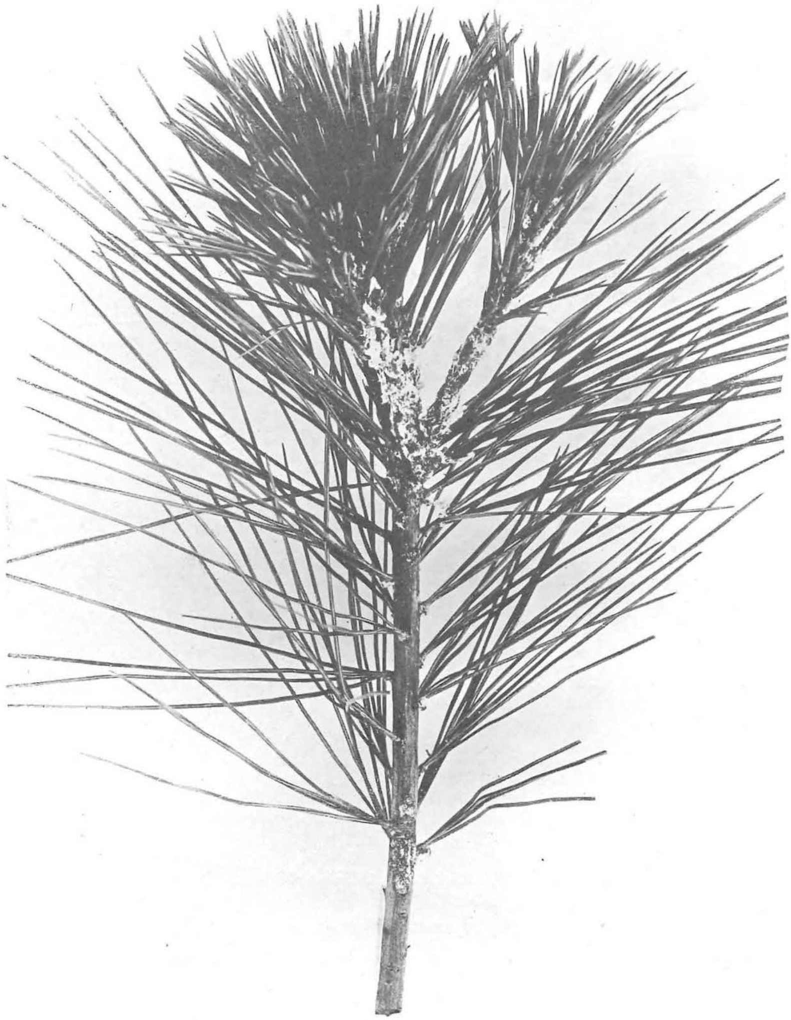


Fig. 132

Chermes pinifoliae Fitch. Young in white secretion towards tips of twigs of white pine

Fig. 133

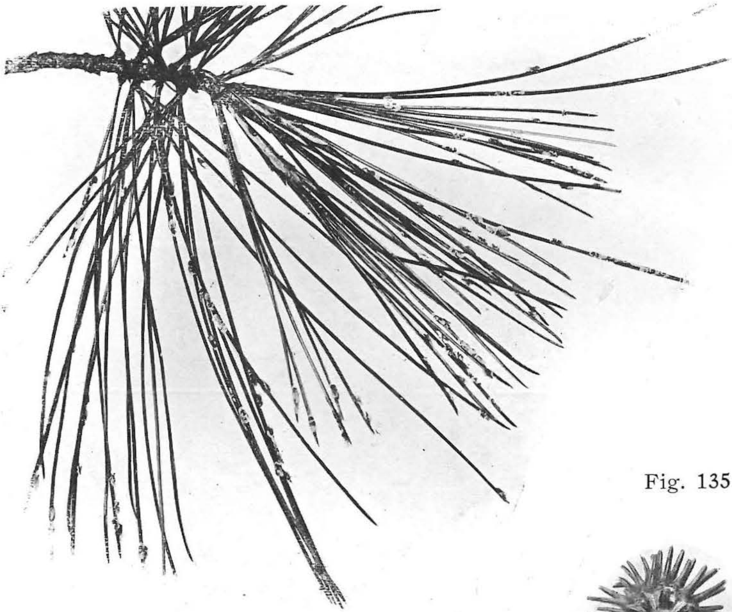


Fig. 135

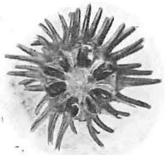


Fig. 134

Fig. 136

Chermes floccus Patch. Migrants on white pine and galls on spruce

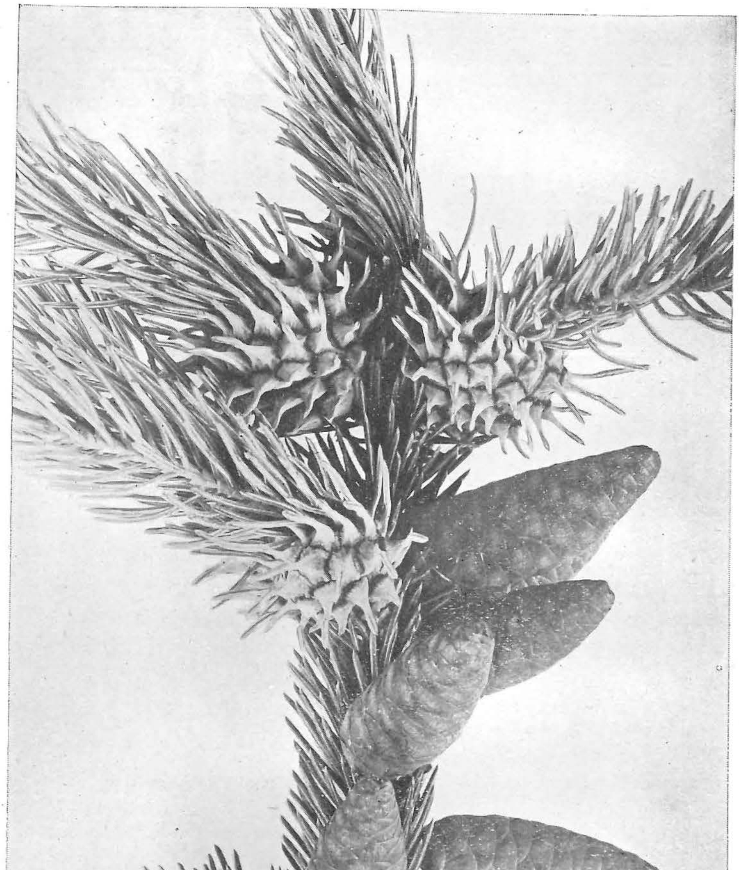


Fig. 137. *Chermes abietis* Linn. Galls on white spruce

Fig. 138

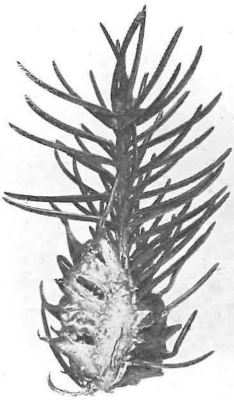
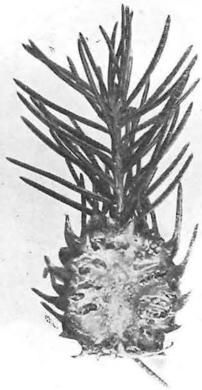


Fig. 139



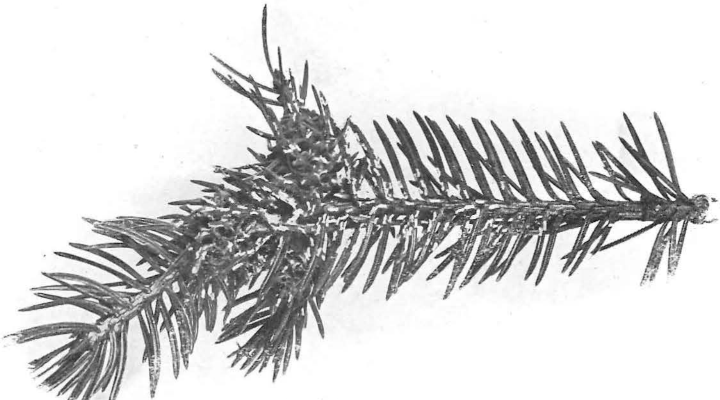


Fig. 140

Chermes abietis Linn. Galls on Norway spruce

Fig. 141. *Chermes lariciatus* Patch. Galls on white spruce

Fig. 142. *Chermes similis* Gillette. Galls on Norway spruce

Fig. 143

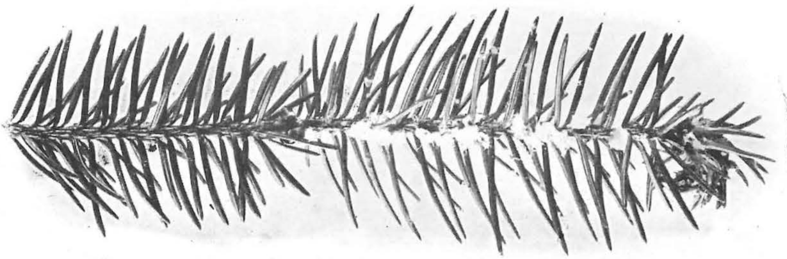


Fig. 144

Chermes similis Gillette

Fig. 145

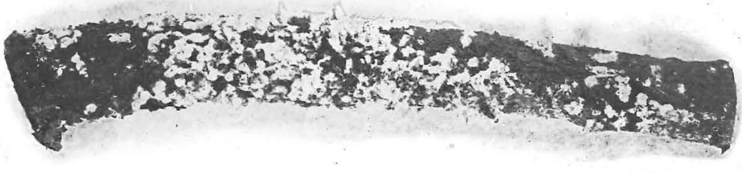


Fig 146

Fig. 145. *Chermes consolidatus* Patch. Gall on black spruce

Fig. 146. *Chermes pinicorticis* Fitch. On bark of white pine.

BULLETIN No. 174.

BLACKLEG.

A Bacterial Disease of the Stem and Tuber of the Irish Potato.*

W. J. Morse.

For the past three seasons the writer has had under observation a stem and tuber disease of the Irish potato in Maine which in some respects presents rather grave aspects unless the growers and shippers of seed potatoes, in that part of the country where the disease has become established, take immediate and radical measures to prevent its propogation and spread. In this connection it should be mentioned that it is only here and there that the disease has as yet, assumed such proportions as to produce appreciable loss in this territory, and then more frequently in wet seasons or on low ground, but careful examination of fields over a considerable portion of the potato growing area of the state shows that this is a malady of much more general distribution than was first supposed.

Unfortunately, there is considerable reason to believe that the disease is conveyed to the new crop by means of infected seed tubers. While the majority of Maine's 18 to 20 million bushels of potatoes are sold for table stock the seed trade with southern states has, in the past few years, reached such proportions that it cannot be ignored. So far as can be learned, blackleg assumes much more serious aspect in the states farther south, and this

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* Attention has been called to this disease in the following previous publications of this Station. Bul. 149, p. 323 (1907) and Bul. 164, p. 2 (1909). It was briefly described on page 6 of a revised edition of a circular entitled "How to Fight Potato Enemies" (March 1908) and in September 1908 a newspaper bulletin was issued which briefly described the appearance, nature and cause of the disease and cautioned dealers against shipping seed tubers from fields affected with this trouble.

trade is demanding seed not only pure and true to name but also free from disease.

The fact that most of the outbreaks occurred many miles from the laboratory presented certain difficulties such that the organisms associated with the disease were not isolated in pure culture till late in the summer of 1908 when the disease was definitely proven to be of a bacterial nature. The study of these organisms is not completed, but certain facts of practical importance to the seed grower have been ascertained. Therefore it seems best to issue at this time a preliminary bulletin upon the more practical phases of the subject as now known and leave the more technical studies and final conclusions for a later publication.

Blackleg in America as is shown later, is a disease of more than local distribution, doubtless occurring to some extent at least over a considerable area of the potato growing sections in Eastern United States and Canada. There is reason to believe that it has existed in some localities for many years but it is only very recently that it has been recognized and recorded in the literature of American plant diseases. So far as the writer has been able to determine the first mention of this trouble in this country as a distinct disease was when Jones recorded its occurrence in Vermont in 1906,* and described in some detail the signs of the disease as it occurs in the field. Since its appearance in every way agreed with the *Schwarzbeinigkeit* or "blackleg" which he had studied in Europe † he used the same term as a common name of the American form of the disease. The writer was fortunate enough to see the field upon which Doctor Jones based his description. Since the appearance of the diseased plants as observed in Maine was identical with those seen in Vermont and since the term "blackleg" is especially applicable, suggesting the inky-black of the diseased stems it seems best to continue the use of this term.

CAUSAL ORGANISMS.

In July 1906 Harrison began the publication of a series of articles upon "A Bacterial Rot of the Potato, Caused by *Bacillus*

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* Jones, L. R., Vt. Sta. Rept. 19, p. 257 (1906).

† U. S. Dept. Agr., Bu. Pl. Ind. Bul. 87, p. 17 (1905).

solanisaprus."* In this account he describes a disease of the stem and tuber of the Irish potato which he had under observation in different provinces of Canada at least as early as 1900. He very carefully studied and described in considerable detail the organism responsible for the disease, which he called *Bacillus solanisaprus*, n. sp., differing in some respects from the description of *B. solanicola* Delacroix and *B. phytophthorus*, the latter of which is given by Dr. Appel as the cause of the *Schwartzbeinigkeit* in Germany.† Professor Harrison found his organism to be pathogenic on various varieties of potatoes, and also demonstrated its ability to produce soft-rots on a considerable number of unrelated vegetables.

It is not the province of this article to discuss the relationship of the bacteria associated with blackleg in Maine with those already described as a cause of disease of the potato in America and elsewhere, or to take up in detail the morphological, cultural, physical and biochemical features of the organisms. When the studies now in progress are completed these questions will be discussed in detail but a general statement at this time may be of service.

Pathogens from two different sources have been secured which are not identical in all respects in cultural characters, but it is doubtful if these differences are of sufficient amount to constitute separate species. One of these agrees in most respects, as far as studied, with the published description of *B. solanisaprus*, except in its ability to ferment certain carbohydrates which Harrison says the latter does not ferment. Ordinarily this would be considered sufficient to constitute a separate species. On the other hand, extended study of the fermentation of dextrose, lactose, and saccharose by the closely related organisms causing soft-rots of various vegetables indicates that with germs of this class fermentation of the carbohydrates mentioned is not strong and is very variable. Hence with this group it is a questionable character upon which to erect a species.‡ More-

* Harrison, F. C., Central. f. Bakt. II Abt. XVII, p. 34 *et seq* (1906).

† Appel, Dr. Otto, Arb. K. Gsndhtsamt., Biol. Abt., 3 (1903), No. 4, pp. 364-432.

‡ Harding, H. A. and Morse, W. J. The Bacterial Soft Rots of Certain Vegetables. Technical Bulletin No. 11, Part 1. N. Y. Expt. Station (1909).

over preliminary work upon fermentation with an authentic culture of *B. solanisaprus* in comparison with the organisms isolated in Maine suggest the possibility that the differences in fermentative ability are not so great as was first supposed.

The blackleg organisms differ in cultural characters and in their effects upon the host from *Bacillus solanacearum* Smith, the cause of the Southern bacterial disease of the potato and egg-plant.

CHARACTER AND APPEARANCE OF THE DISEASE.

Plants affected by blackleg are readily distinguished in the field by any close observer, even at a distance. However, at first sight the general aspect of the diseased plants does not differ materially from that produced from several other causes which injure or kill the parts below or at the surface of the ground, such as the *Fusarium* disease, the *Rhizoctonia* trouble, or even mechanical injury to the stem. The affected plants appear more or less unthrifty and usually under sized, varying with the severity of the attack. The branches and leaves, instead of spreading out normally, tend to grow upward, forming a somewhat more compact top, frequently with the young leaves curled and folded up along the mid-rib. Later they become lighter green or even yellow and the whole plant gradually dies. If the disease progresses rapidly, the stem may fall over quite suddenly and wilt with very little previous signs of disease, other than the upward tend of the foliage noted above.

The diagnosis of suspected cases is easily confirmed by pulling up the affected plants. Blackleg as its name indicates, is characterized by a pronounced blackening of the stem below ground, usually running up one, two, or even three inches above the surface. Sometimes under very favorable conditions, i. e. continued wet, cloudy weather, especially where plants are growing on a naturally moist soil, the inky-black discoloration may follow up a portion of the stem for several inches above the ground.* During the active progress of the disease the invaded

* Inoculation of leaf petioles, or any part of a potato stem above or below ground with cultures of the bacteria isolated from diseased stems invariably produced the same characteristic black lesions. One plant was found in the field, however, which was affected with a rapid soft

tissues show a soft, wet decay. Preparations made from the tissues that are just being invaded, and examined with sufficient magnification show them to be filled with motile bacteria.

Ususally the seed tubers attached to affected stems are entirely decayed by a soft rot, or have disappeared entirely, while those attached to surrounding healthy plants are generally quite firm. If young tubers have been formed before the complete invasion of the stem they are occasionally affected in the same manner, although, as a rule, there is a tendency for the disease not to follows out upon the branches which bear the tubers but upward on the main stem toward the surface. Apparently the disease works more rapidly or attacks the plants as a rule at an earlier stage in their growth than the *Rhizoctonia* or "potato rosette" disease described by Rolfs in Colorado and Selby in Ohio,* for there is less tendency to produce little potatoes as there described. Occasionally when the disease makes slow progress on account of dry weather this tendency to throw out new shoots above the affected region bearing many small potatoes has been observed, even to the extent of producing small green tubers upon the stem above ground.

Out of a large number of affected fields examined only one indicated possible spreading in the field. This was in 1907. There was very little blackleg in the entire field of 20 acres except in one spot a few rods square where all the plants were diseased. It was first noticed near the center and gradually worked outward. The season was excessively wet, and the affected area coincided with a low pocket or depression in the field where water would stand for a few hours after each heavy rainfall, thus indicating how, in this exceptional case, the disease spread from hill to hill. In all other cases observed affected plants were scattered promiscuously over the field, always

decay of the aerial portions of stem without discoloration. Several cultures were obtained from colonies on plates poured from this stem. In every case tried these have, when inoculated into plants in the greenhouse, produced not the colorless decay of the stem but the characteristic blackleg decay. It may be said, however, that the bacteriological studies upon this strain, so far as made, indicate greater variation from the published description of *B. solanisaprus* than others being studied.

* Rolfs, F. M., Col. Exp. Sta., Bul. 70 (1902) and Bul. 91 (1904). Selby, A. D., Ohio Exp. Sta. Bul. 139 (1903).

more common and more severely attacked on the lower or more moist portions of the field. If one stalk from a given seed-piece was diseased any others coming from the same piece were invariably found to be affected to a greater or less degree also.

As a rule the plants first begin to show signs of disease when they are 6 to 8 inches high and growing rapidly, i. e., in northern Maine at or soon following the first of July. The progress of the disease is markedly influenced by weather conditions. Very moist, cloudy weather may tend to favor rapid progress, resulting in the early death of the young plants, so that only the dead stalks remain scattered among the healthy plants, within a month or six weeks, or even less time after its first appearance. A period of dry weather coming on after the disease is well started below ground may check its progress, but cause the death of the plant at an equally early period on account of its inability to withstand the lessened water supply. Again conditions between these extremes, such as existed during the summer of 1909, may prolong the attack well into August.

In brief there is no evidence that blackleg under ordinary field conditions in Maine spreads from plant to plant in the field. The number of diseased plants appears to be determined by the number of infected seed-pieces planted, modified by conditions of the soil wet or dry. Infection of the growing plant always, so far as observed, begins below ground, usually at the junction of the stem with the seed piece, which probably decays or begins to decay before the stem is attacked. The rapidity of the progress of the disease and its severity varies with the weather conditions, or amount of moisture in the soil, but a plant once attacked never recovers sufficiently to produce merchantable tubers.

Means of Distribution.

As suggested in the preceding paragraph there is every reason to believe that blackleg is largely, if not wholly, distributed by means of infected seed tubers. As yet this statement is not backed up by sufficient experimental data, but observations so far made all point to this conclusion. Some of these observations are as follows:—

The first case in Maine seen by the writer was on new land recently cleared of forest and never before planted to any agricultural crop. Here infection either came with the seed or existed on land never before under the plow, which latter seems improbable.

A field of four acres on the University Farm in 1907 was planted with seed from 5 or 6 different sources. Along one side 3 barrels of selected potatoes, Green Mountain variety each from a different source were planted. The plants from one of these barrel lots showed quite a percentage of blackleg but careful search, several times on different dates, over the remainder of the field failed to reveal a single diseased plant. The disease had not been previously seen on this farm. Case after case has been seen on different farms where one field or part of a field developed the disease while another field on the same farm or a part of the same field did not show it. Inquiry has invariably resulted in showing that the seed tubers from the two different areas came from different sources. Several attempts have been made to trace the seed to see if the disease was present on the farm where its was produced. A few cases presented data of some reliability, giving an affirmative answer to the question. The too common practice of growers selling their entire crop in the fall or winter and then picking up seed from mixed lots of local dealers, makes it impossible in most cases to trace the source of the seed.

In describing the outbreak on the Station farm in Vermont, Jones makes the following significant statement:—"The field was planted with Green Mountain potatoes, the seed being from Houlton, Maine."* This statement is all the more significant in view of the fact that as a specialist in the study of potato diseases he has conducted experimental work on this farm for twenty years, has had an intimate knowledge of the condition of every crop of potatoes raised thereon during this time, and this was the first recorded outbreak of blackleg.

Professor T. C. Johnson of the Virginia Truck Experiment Station says:** "I examined a field in Augusta County, (Virginia) in which some Maine grown Cobbler seed was planted, and also some home grown seed of other varieties. In portions of the Cobbler field the injury from 'blackleg' was as much as

* l. c., p. 258.

** In correspondence, September 1909.

8 to 10 per cent. The average injury from the field possibly not being over 3-5 per cent. The portions of the field planted to other varieties of home grown seed had no 'blackleg' whatever. I have not been able to find any 'blackleg' in the trucking fields in which home grown seed was used. The general opinion is that the disease was introduced with the seed potatoes but this has not been definitely proven."

Professor J. B. S. Norton writes, in answer to an inquiry, that during the past season he has seen one case of blackleg on a field planted to Maine seed in Somerset County, Maryland.

A letter from Professor G. E. Adams of Kingston, Rhode Island, states that in 1907 he found 5 hills of potatoes which appeared to be suffering from blackleg. "These potatoes were grown from seed which was obtained from England in the spring of that year." This is interesting as suggesting the possible origin of the disease in Maine. Harrison's account of the distribution and amount of damage produced by this disease in Canada,* even though we disregard the large amount of bacterial soft rot of the tuber following invasions of the late blight fungus *Phytophthora infestans* and the ordinary decay caused by this fungus itself, which he has apparently attributed to the soft rot associated with the stem-disease, indicates that blackleg is a more common and destructive disease in certain provinces of Canada than in any section of the United States thus far reported. Importation of seed stock from England would naturally be more common in Canada than to the United States. Therefore, it is conceivable that tubers infected with this disease have from time to time and at various places been introduced into Canada from England. Once in Canada, particularly in New Brunswick, the spread of the disease to Maine was a comparatively easy matter and a logical sequence, for Maine's greatest potato district borders on this latter province and quite a percentage of the potato growers of this section are former residents of the adjoining sections of Canada.

There is evidence that the introduction of the disease into some parts of Maine, at least, is by no means a matter of recent date. Many practical men when the diseased

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* l. c., pp. 34 and 391.

plants are pointed out to them will say that they have seen occasional hills showing this trouble several years past, but have looked upon it as something of minor importance. Usually the period given varies from 5 to 10 years, but Mr. Borden Blackstone of Perham assures the writer that 30 years ago he observed something which he believes to be identical with this.

Partly Decayed Seed Tubers Spread the Disease.

In an attempt to artificially inoculate seed tubers in the spring of 1909 three bushels of tubers, Green Mountain variety, were used. One bushel was planted as purchased. The tubers of the other two bushels were liberally sprayed with a living, virulent culture of the bacteria which cause the disease. They were allowed to dry off while spread on the floor under an open shed away from direct sunlight, and covered lightly with builder's paper. Then one bushel of these latter was soaked in formaldehyde solution as is customary in treating for scab.* About a week later all three lots were planted. There was a good stand on all three plots, and no blackleg was observed on any of them. This was somewhat surprising in view of the experience of the previous year which was as follows:—Attempts to isolate the specific organisms from plants growing at a distance of from 50 to 100 miles from the laboratory, generally with the disease in the later stages when found, only resulted in failure during 1907, and the early part of the summer of 1908. Then recourse was had to the following method. Seed tubers bearing short sprouts were planted in boxes on July 25. Before planting the tubers were wet with a watery extract made by crushing some diseased stems, and, after planting, this extract was poured over the soil above. On August 18 several of the young stems from these tubers showed well developed cases of blackleg. From these virulent organisms were isolated with ease. In this connection it should be said that the tubers in the boxes were kept constantly quite wet while the land on which the culture-sprayed tubers were planted in 1909 was exceedingly dry for some weeks following. Later experiments showed that the

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* Soaked 2 hours in a solution consisting of 8 fluid ounces of formalin (40% solution) formaldehyde and 15 gallons of water.

organism themselves were readily killed by drying. They were doubtless all dead before the tubers were planted.

The writer is of the opinion that the disease starts as a rule, not from organisms resting on the unbroken skin of the surface of the tuber, but rather from those lurking in wounds, cracks or decayed portions of the flesh of the tuber where the disinfecting solutions may not penetrate. Hence seed treatment with any disinfecting solution should be supplemented by rigid inspection and the rejection of seed tubers which show any diseased or unsound portions.

Geographical Distribution in America.

The extent of the distribution of this disease in the United States is indicated by the records of the Plant Disease Survey of the Bureau of Plant Industry at Washington. Mr. W. W. Gilbert, assistant pathologist, writes as follows: "I have looked through our records and find we have located the blackleg disease of potatoes in the following places: In South Carolina, in the trucking sections in the vicinity of Charleston; in Virginia, about Norfolk, Portsmouth, and at several points on the Eastern Shore; in Maryland at Beltsville; in New York, on Long Island; in Colorado in the vicinity of Greeley; in Ohio at Plainsville, and I find also a note of Mr. Orton's which states that the disease probably occurs in Oregon."

Answers to inquiries addressed to officials in experiment stations in the following states: Alabama, Connecticut, Delaware, Florida, Georgia, Kentucky, Maryland, New Hampshire, New Jersey, New York, North Carolina, Rhode Island, South Carolina, Vermont, Virginia and Wisconsin, indicates that except in Virginia the disease is not common enough to attract attention, it only being reported from the states mentioned below: From Connecticut Dr. Geo. P. Clinton writes: "I think that 'blackleg' disease you describe is the same as that I mention in my 1904 Report, p. 324, questioning if it is the southern bacterial disease." In Maryland Prof. J. B. S. Norton reports one authentic case from Somerset County, but expresses the opinion that the disease is more common than this indicates. One doubtful case is reported by Dr. F. L. Stevens of North Carolina. In Rhode Island Prof. G. E. Adams reports one case where the seed tubers were imported from England. In Vermont Prof. H. A. Edson states that it has only been observed on one farm where it was first introduced with the seed and reported by Doctor Jones in 1906.* In Virginia Prof. T. C. Johnson first reported the existence of the disease to the writer some over a year ago, and writing on September 27, 1909, he says: "The 'blackleg' is becoming somewhat general in this section of Virginia." There can be no doubt as to the identity of the disease in Virginia and Maine as Professor Johnson is perfectly familiar with its appearance as it occurs in the field in both states.

In Maine, as has already been stated, the disease is not uncommon, but as a rule it occurs only as an occasional, isolated affected stalk scattered over the fields, though several cases were found during the two wet seasons of 1907 and 1909 where from 5 to 15 or 20 percent. of the plants were affected. These latter instances represented, with one exception, small fields of from one to 5 acres.

The similar appearing trouble which Harrison has described in Canada he stated had been found throughout the Province of Ontario, its presence had been reported from Nova Scotia, New Brunswick and Quebec, and one case reported from the North West Territory.†

Economic Aspects.

There is little evidence to show that blackleg has caused or is likely to cause serious and widespread losses on Maine potato fields although its occurence appears to be on the increase. While one of the worst cases found in 1909 was on well-drained, elevated land, the soil was quite wet on account of excessive rainfall throughout the season. So far as observed it is only to be feared as a serious pest in this section upon low, wet lands or on higher ground during abnormally wet seasons. However, in localities where the disease is prevalent during wet seasons, occasional affected hills are found upon the dryer soils and during years when the rainfall is not excessive.

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* See p. 310.

† l. c. p. 35.

In Virginia so far as can be learned from correspondence, etc., the disease appears to assume more serious proportions wherever it occurs at all, and there seems to be a growing conviction around Norfolk, and in some places on the Eastern Shore that it comes from and first occurs upon fields planted with northern seed.

Inoculation into sound tubers with pure cultures of the organisms associated with the disease produces a rapid soft-rot, and no doubt some of the loss from wet rot in the field and in storage is caused by this organism. However, in the writer's experience this is largely confined to the small tubers which have been formed in the hills attacked, before the stalks are killed. Even here only a small part of such tubers are found to be decayed. The disease appears to start from the seed piece, which is invariably decayed, and passes directly up the main stem. The under-ground, tuber-bearing branches of the stem are cut off and the disease follows them out a short distance, but more frequently it stops before reaching the young tubers. If the young tubers are reached a soft, wet decay results. Out of a large number of plants grown in pots and inoculated with pure cultures of the organisms, at or near the surface of the soil, in only a very few cases did the disease spread downward and outward on the underground branches of the stem sufficiently as to reach and cause decay of the young tubers.

The fact that the organism so readily and rapidly destroys potato tubers when inoculated into them would indicate that in addition to producing a dangerous stem-disease it has potential qualities for becoming a serious pest as a cause of tuber decay. However, there is no evidence that this has been the case in Maine in the past. Epidemics of potato-rot are not infrequent, but these are invariably associated with and follow outbreaks of late blight, *Phytophthora infestans* De Bary, upon the foliage and this fungus is invariably found in the decayed tubers. Even in seasons when the late blight is rife the rot is almost entirely controlled by proper and thorough spraying of the foliage which would not be the case if the blackleg organism was a contributing factor.

In these epidemics of tuber decay following late blight while the rot as a rule shows the characteristics of that caused by the late blight fungus, there is associated with it very frequently a soft, foul-smelling decay which is apparently of a bacterial nature. While there is every reason to believe that the blackleg organism is capable of causing some of this soft bacterial decay the writer's experience leads him to believe the great majority of it is caused by secondary infection by saprophytic bacteria following the invasion and killing of the healthy tissues by the late blight fungus. Attempts to isolate bacteria capable of destroying healthy tubers from those so diseased have invariably resulted in failure. The removal of some of the soft, decayed tissue from such tubers and inserting it in sound tubers led to no decay of the latter, while the same procedure where the decayed tissue was taken from a rotting tuber previously inoculated with the blackleg organism invariably produced a characteristic and rapid decay of the healthy tuber into which it was inserted.

Moreover, this soft-rot of the tuber following and associated with the decay caused by *Phytophthora infestans* is familiar to all who have had much practical, field experience with outbreaks of disease caused by this fungus, and has been observed frequently by horticulturists and plant pathologists in this country upon fields which showed no evidence of blackleg upon the growing stems. If the organism was present in sufficient degree to cause material loss from tuber decay it would seem that its appearance on the stem could not have escaped notice.

Harrison* apparently takes an opposite view to the above and seems inclined to attribute to his *B. solanisaprus* a much more active part in the cause of tuber decay in Canada. He asserts that the Experimentalist of the Ontario Agricultural College and others have confused the terms "blight" and "rot", but fails to state distinctly that *Phytophthora infestans* not only causes the well known blight of the foilage but also is a well recognized cause of decay of the tuber often referred to as the "late blight rot." He shows, in one instance, at least, where spraying for fungi was practiced, that the real cause of the rot was of a bacterial nature. However, the statements to which he objects such as "The potatoes grown in the Experimental Department have been comparatively free from blight, although

* l. c. pp. 34 and 391.

in some parts of the Province the rot has proven very troublesome in some seasons" and "results show that there was less rot on the potatoes on which Bordeaux mixture and Paris Green were used" are not necessarily confusing. They might be made with propriety in referring to the late blight of the foliage and the infection and decay of the tuber by the same fungus resulting from spores being washed down into the soil from the diseased leaves, and in no way be confused with the bacterial trouble.

To summarize, in no part of the United States has blackleg as yet produced widespread and severe losses to the potato crop. Such losses as have been experienced in Maine are largely confined to the killing of the affected plants before the tubers have reached merchantable size but the amount of this loss appears to be increasing. Little or no loss from decay of mature tubers by this disease has been observed in this state, but much loss from tuber decay in Canada is credited to *B. solanisaprus*. However, the distribution of the disease is becoming quite general, and it may become a serious pest under certain favorable conditions and in certain sections of the country. In Maine while the losses from diminished crops have not been and may not be great, the real danger is from the possible loss of a valuable seed trade from certain sections where the disease may assume more serious proportions than it does in this state.

Means of Prevention.

The observations here recorded and the uncompleted bacteriological studies of the organisms associated with the disease indicate that the introduction of blackleg into uninfected soils can easily be prevented. The organisms are readily killed by exposure to sunlight, even in December when the intensity of the sun's rays is at its lowest ebb. They are also quite susceptible to dessication. Young, active, vigorous cultures spread upon small sterile, glass discs, allowed to dry at room temperature were found to be dead in less than half an hour after the moisture had disappeared from the surface of the smear, and thus far no evidence of spore formation has been observed in old cultures. They are, however, able to live a long time in the presence of moisture.

The introduction of small quantities of living, beef-broth cultures into tubes of sterile water containing formaldehyde or corrosive sublimate killed the germs, although the percentage of the two germicides used was many times less than that of the disinfection solution later recommended, and the exposure being for a much shorter period. The germs introduced into control tubes of pure sterile, distilled water at the same time were not killed.

The fact that the organisms are readily killed by drying and, as already stated, (p. 317), no disease was produced by spraying smooth seed tubers with vigorous active culture and allowing them to dry several days before planting indicates that the germs are probably not carried over on the surface of the tubers. Very likely they live over winter in wounds or cracks in the seed tubers or in small decayed areas, there being sufficient moisture to keep them alive but the temperature of storage is low enough to arrest their active development till after the tubers are planted and begin to put forth shoots.

Hence as a means of prevention: First, select seed, if possible, from fields upon which the disease has not appeared. Second, discard for seed purposes all tubers which have wounds, cracks or decayed areas*. Third, disinfect all seed tubers with corrosive sublimate or formaldehyde before cutting. Spreading the seed tubers out in thin layers in a clean, dry place exposed to the direct rays of the sun for several days would be an excellent supplementary practice and tend to hasten germination as well. The disinfection of seed tubers and the rejection of all such as show blemishes or diseased areas will not only prevent the spread of blackleg but also the propogation and spread of scab and most other tuber diseases which attack the potato in Maine.

Methods of Disinfecting Seed Potatoes.

For disinfecting seed tubers for blackleg the same methods are recommended as for potato scab. Either of the following may be used.

* This sorting out of the diseased tubers should always be done as far as possible before cutting on account of possible contamination of the freshly cut, moist surfaces of healthy seed pieces by germs carried by the hands or knives used in cutting those tubers where the diseased areas extended below where the disinfecting agents penetrated.

Liquid Disinfection.

No. 1.

Corrosive sublimate	2 ounces
Water	15 gallons.

Immerse seed tubers for 1½ hours in this solution.

No. 2.

Formaldehyde (40% solution) 8 fluid ounces	(½ pint).
Water	15 gallons.

Immerse seed tubers 2 hours in this solution.

Corrosive sublimate dissolves readily in water, but wooden containers must be used on account of its corrosive action upon metals. On account of its poisonous nature the corrosive sublimate solution must be kept out of reach of animals which might drink it, and the treated tubers should not be used for food. There is no danger from the use of formaldehyde, it is non-poisonous to the higher forms of animal life as ordinarily used. Since both of these solutions are effective No. 2 is recommended in preference wherever formaldehyde can be purchased, for the reasons given above.

While no experiments have been tried upon the blackleg organisms to determine the germicidal effect of formaldehyde gas generated by means of potassium permanganate its successful use in destroying the bacteria associated with certain contagious diseases of man is well known. The writer has also found this method equally, if not more effective, in treating seed tubers for potato scab than soaking in the solutions already mentioned. Therefore, if a large amount of seed tubers is to be treated at one time the following gas treatment is recommended.

Disinfection with Formaldehyde Gas.

Potassium permanganate	23 ounces
Formaldehyde (40% solution)	3 pints

The above is sufficient for each 1000 cubic feet of space.

The disinfection with formaldehyde gas should be done before the sprouts begin to start on the seed tubers. Place the seed tubers in bushel crates or shallow slat-work bins in a room where all cracks have been tightly stopped and the door made as near air-tight as possible, when closed. Spread the potassium permanganate evenly over the bottom of a large, rather deep pan or pail. If the quantity is large a small wash tub, or half of a barrel may be used. Pour in the formaldehyde and give the dish one rapid tilt to ensure thorough mixing; leave the room at once and tightly close from without. Keep closed for about 24 hours, or at least over night.

The dish used for a generator should be placed in the middle of the room. *To avoid injury from the strong gas as it is liberated no potatoes should be placed directly above the generator.* It is also better to leave a clear space of at least three feet on all sides of the generator, and the slat-work bins or crates should be so arranged that the gas can circulate on all sides of them and mix with the air of the room before it comes in contant with the potatoes. Formaldehyde gas possesses about the same specific gravity as air, but when generated in this way the strong gas is driven off very rapidly mixed with hot, watery vapor and probably the most of it goes first to the top of the room, but it quickly diffuses and mixes with the air contained therein.

Temperature is an important factor in disinfecting with formaldehyde. It is more effective above 80 degrees F. and disinfection with this gas should never be attempted where the temperature of the chamber used is below 50 degrees F. A certain amount of moisture in the air is also very essential, therefore just before placing the formaldehyde in the generator the floor of the disinfecting chamber should be thoroughly wet down with boiling water. However, no water should be placed on the tubers to be treated.

The exposure of the tubers to the gas should not be made in sacks. It takes a large volume of gas and a long exposure to penetrate the sacks. Large quantites of the formaldehyde are lost by uniting chemically with the organic matter of the fabric, and the meshes tend to convert the gas into a solid substance known as paraform.

Upon completion of the time required to disinfect, the door of the room is opened and in a very short time the gas will have diffused outward sufficiently to allow the treated tubers to be taken out. There is absolutely no danger to human beings in working with the gas as here recommended. When first going into the room it may cause some irretation of the mucous membranes of the nose and throat but this soon passes away.

It should be mentioned that the amounts of formaldehyde here recommended and the length of exposure to the gas are far in excess of that found necessary for disinfecting rooms for contagious diseases, and are doubtless considerably greater than are needed for treating seed tubers. However, experiments have shown that the large amount of gas and long exposure, if done according to directions here given, will not injure the germinating quality of the tubers and will control the scab fungus as well, therefore, it seems best to advise a treatment which will answer for both diseases at the same time. If it is desired to reduce the amount of solution and the time of exposure the writer would not advise going below 2 pints of formaldehyde solution and a proportionate amount of potassium permanganate for each 1000 cubic feet of space and 12 hours for the lower limit of exposure.

Whether or not the disease germs can remain in the soil for any length of time to infect later crops is still an open question. The fact that field observations show that the disease, as has already been stated, is almost invariably confined to scattered hills and to stalks which spring from decayed seed pieces indicates that most or if not all the infection comes from diseased seed. However, the somewhat closely related organisms which are associated with the soft rots of cabbage, cauliflower, etc., apparently remain alive in the soil for some time at least. There is no reason why the blackleg organism should not do the same. Therefore, land upon which a potato crop has been grown which was attacked by this disease should be kept in other crops, preferably grass, clover or cereals, for as long as possible before again using it for potatoes. The practice of growing two crops of potatoes on the same land in successive years should be discouraged, and low, poorly drained soils should be avoided. Fields which show scattered affected stalks should be frequently inspected during the growing season and all diseased plants and any tubers which may have formed on them dug up and burned. Under no condition should the crop from badly or even moderately affected fields be used for planting in Maine or shipped South for seed. Several of the leading seed dealers in Maine are doing their best to comply with these recommendations and all growers should cooperate with them in their efforts to furnish stock free from disease.

Summary.

Blackleg is a bacterial disease of the stem and tuber of the potato. A similar appearing malady caused by bacteria has been reported from Canada, and another from England, Germany, France and other parts of Europe. Preliminary studies of the organisms associated with the disease indicate that they are closely related to those already described as a cause of similar troubles elsewhere, but whether they are identical with any of the described species of bacteria is not fully determined. pp. 309-312.

The attacked plants are usually unthrifty, light green or even yellow, and undersized. The branches and leaves have a tendency to grow upward forming a rather compact top, often with the young leaves curled and folded up along the mid-rib. The most characteristic thing about them is the inky-black discoloration of the stem, at or below the surface of the ground, but frequently running up the stem from one to several inches above ground. The seed-piece from which the attacked plants spring is invariably attacked with a soft-rot, and the disease appears to start on the stem at its junction with the diseased seed tuber. The germs of the disease are capable of causing a rapid decay of the young tubers, and these are sometimes attacked also. pp. 312-314.

The evidence thus far obtained indicates that blackleg is largely distributed by means of germs carried in wounds, cracks and decayed areas of seed tubers. On account of the readiness with which the organisms are killed by drying there is little to fear from sound, smooth seed stock, but this should be treated with a disinfecting solution as a matter of precaution. There is some reason to think that blackleg was introduced into Canada from England and from there to the United States. pp. 314-318.

Blackleg is apparently becoming quite widely distributed throughout the Eastern part of the United States. In most states it is not common enough to attract attention, and in no region has it done much damage, although it may become a

serious pest in some sections. It is not believed that it is likely to do much damage in Maine, except in low, wet soils or during abnormally wet seasons. The similar appearing trouble caused by *Bacillus solanisaprus* Harrison is widely distributed in Canada and is there claimed to be of considerable economic importance as a cause of tuber decay. pp. 318-322.

The propogation and spread of the disease probably can be controlled largely by the selection of seed from fields free from the disease, the rejection of all seed tubers which have wounds, cracks or decayed areas and treating the remainder with corrosive sublimate or formaldehyde solutions, or with formaldehyde gas as is done for potato scab. It is not known whether or not the disease germs will remain alive in the soil to infect future crops of potatoes, but as a precautionary measure the land on which the disease occurs should be kept in grass, clover, or cereals for as long a time as possible before planting it to potatoes again. pp. 322-326.

METEOROLOGICAL OBSERVATIONS.

Lat. 44° 54′ 2″ N. Lon. 68° 40′ 11″ W. Elevation 150 feet.

The instruments used at this Station are the same as those used in preceding years, and include: Wet and dry bulb thermometers; maximum and minimum thermometers; rain-guage; self-recording anemometer, vane, and barometer. The observations at Orono now form an almost unbroken record of forty-one years.

METEOROLOGICAL SUMMARY FOR 1909.

Observations Made at the Maine Experiment Station.

1909	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Mean.	Total.
Highest temperature	53°.0	49°.0	48°.0	63°.0	79°.0	90°.0	91°.0	97°.0	80°.0	83°.0	63°.0	48°.0		
Lowest temperature	-24°.0	-17°.0	-1°.0	17°.0	27°.0	29°.0	42°.0	30°.0	33°.0	19°.0	16°.0	-12°.0		
Mean temperature	19°.20	20°.77	28°.72	40°.45	52°.00	63°.15	66°.50	66°.20	57°.55	49°.30	39°.10	23°.60	43°.88	
Mean temperature for 41 years	16°.20	18°.86	28°.01	40°.66	52°.46	61°.97	67°.05	65°.05	57°.51	45°.15	34°.35	20.60	42°.32	
Total precipitation in inchec	5.87	5.32	5.23	4.41	2.21	2.11	2.37	1.82	9.09	2.43	4.14	1.98	....	46.98
Mean precipitation in 41 years	4.28	3.87	4.27	2.92	3.49	3.47	3.24	3.43	3.52	3.84	3.68	3.69	....	43.70
No. of days with precip. of .01 in. or more	12	5	10	10	11	5	11	8	11	9	10	7	....	109
Snow fall in inches	37	14	26.5	4.5	....	....	....	....	....	Trace.	0.5	15.25	....	97.75
Mean snow fall in 41 years	23.0	21.1	16.3	5.6	0.24	....	....	....	....	0.8	7.8	16.9	....	91.74
Number of clear days	11	11	12	10	6	9	8	15	13	12	8	10	....	125
Number of fair days	4	7	6	1	8	16	9	9	4	8	6	8	....	86
Number of cloudy days	16	10	13	19	17	5	14	7	13	11	16	13	....	154
Total movement of wind in miles	5766	6342	6525	6688	5521	4885	4609	3778	4517	4699	5302	5858	....	64490

Monthly and Annual Precipitation (as rain) for the Year 1909.

Stations	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Bar Harbor	7.10	6.07	5.85	5.11	4.28	1.15	2.66	1.53	8.35	1.81	5.77	2.03	51.71
Cornish	5.08	5.79	4.38	3.92	4.03	2.56	3.13	2.34	5.54	1.17	2.09	3.65	43.68
Eastport	7.05	4.76	5.10	3.86	1.56	1.59	3.37	1.61	6.40	2.54	3.62	1.64	43.10
Fairfield	5.91	3.94	2.73	3.05	2.48	2.34	1.77	1.17	5.16	1.14	....	1.48	....
Farmington	5.79	6.32	3.92	3.94	....	1.90	2.05	2.60	7.74	1.54	3.82	3.02	....
Gardiner	5.66	4.95	3.97	3.81	2.55	2.90	2.19	1.59	6.39	1.83	3.88	2.02	42.79
Greenville	4.51	4.80	4.76	4.22	2.72	3.60	3.34	3.00	10.12	1.73	4.57	2.59	49.96
Houlton	3.64	3.70	2.95	4.09	....	3.20	2.15	1.65	6.14	1.25	2.34	2.05	....
Lewiston	6.75	5.59	4.14	3.59	2.75	2.29	2.47	1.25	6.14	1.84	2.79	2.99	42.59
Madison	6.57	5.59	3.80	3.91	2.75	2.36	2.25	2.68	10.04	1.66	4.07	2.65	48.33
Millinocket	5.24	5.36	4.24	4.64	3.05	2.91	3.09	3.07	9.70	1.80	4.92	2.07	50.09
North Bridgton	6.12	5.79	3.78	3.68	3.55	2.42	2.00	1.51	6.13	1.34	2.71	2.95	41.98
Orono	5.87	5.32	5.23	4.41	2.21	2.11	2.37	1.82	9.09	2.43	4.14	1.98	46.99
Patten	5.80	4.75	4.16	5.14	1.79	2.50	6.42	3.91	9.71	2.38	4.19	1.95	52.70
Portland	4.71	5.07	2.76	3.13	2.95	2.33	2.14	1.68	4.68	1.50	2.83	2.06	35.84
Rumford Falls	5.39	6.12	4.04	3.49	3.51	2.11	2.34	1.79	7.08	1.03	3.31	2.13	42.34
Van Buren	2.80	2.60	1.00	3.09	1.00	3.30	5.60	9.10	....	....	....	....	....
Winslow	5.16	4.80	3.17	3.87	2.59	2.54	1.95	1.76	6.71	1.88	4.35	1.48	40.26

With the exception of readings from the Orono station, the above table is compiled from the monthly bulletin of the U. S. Weather Bureau.

REPORT OF TREASURER FOR FISCAL YEAR ENDING JUNE 30, 1909.

NATIONAL FUNDS.

RECEIPTS.	Hatch Fund.	Adams Fund.	Gen'l Acct.
Balance July 1, 1908	....	....	$1,830 41
Treasurer of United States	$15,000 00	$11,000 00	
Sales, etc	....	....	2,902 00
Total	$15,000 00	$11,000 00	$4,732 41
DISBURSEMENTS.			
Salaries	$8,647 97	$7,659 13	$1,404 50
Labor	244 74	24 60	112 23
Publications	10 35	....	1 00
Postage and stationery	367 58	7 70	60 01
Freight and express	247 99	10 87	57 77
Heat, light and power	481 89	....	306 65
Chemical supplies	77 32	28 26	45
Seeds, plants and sundry supplies	340 68	955 74	152 83
Fertilizers	....	8 25	321 79
Feeding stuffs	1,002 04	....	693 09
Library	523 03	441 77	
Tools, implements and machinery	594 11	1 49	14 11
Furniture and fixtures	74 07	....	10 37
Scientific apparatus	134 75	889 02	62 96
Live stock	531 45	6 90	5 25
Traveling expenses	712 05	436 41	78 06
Contingent expenses	259 98	....	....
Buildings	750 00	529 86	313 51
Balance June 30, 1909	....	....	1,137 83
Total	$15,000 00	$11,000 00	$4,732 41

REPORT OF TREASURER FOR STATE FISCAL YEAR ENDING DECEMBER 31, 1909.

STATE FUNDS.

RECEIPTS.	Printing.	Inspections.
State appropriation	$4,500 00	$9,000 00
Analyses, fees, etc	....	1,457 36
Total	$4,500 00	$10,457 36
DISBURSEMENTS.		
Salaries	....	$7,672 17
Traveling expenses	....	1,290 15
Freight and express	....	57 31
Office supplies	....	607 52
Light and heat	....	132 33
Laboratory supplies	....	560 39
Printing bulletins and reports	2,932 44	
Balance Dec. 31, 1909	1,567 56	137 49
Total	$4,500 00	$10,457 36

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APPENDIX

Official Inspections.

7 to 18

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[339-1-09]

University of Maine.

MAINE
AGRICULTURAL EXPERIMENT STATION,
ORONO, MAINE.

Official Inspections.

7

FOOD AND DRUG STANDARDS.

The Maine Food and Drug law gives the Director of the Maine Experiment Station authority to adopt and fix standards of purity, quality and strength when such standards are not specified and fixed by law, and directs that he shall publish them with such other information concerning articles of food and drugs as may be of public benefit.

For several years the Association of Official Agricultural Chemists of the U. S. and the Association of State and National Food and Dairy Departments have through a joint committee been preparing definitions and schedules for food standards. In accordance with section 5 of the Maine food and drug law, the standards of purity, quality and strength of many foods were adopted and fixed and published in Bulletin 135 of the Maine Agricultural Experiment Station, pages 233 to 250 inclusive.

The following also were adopted for the purity, quality and strength of drugs:

"A drug bearing a name recognized in the United States Pharmacopœia or National Formulary, without any further statement respecting its character, shall be required to conform in strength, quality, and purity to the standards prescribed or indicated for a drug of the same name recognized in the United States Pharmacopœia or National Formulary, official at the time.

"A drug bearing a name recognized in the United States Pharmacopœia or National Formulary, and branded to show a different standard of strength, quality or purity, shall not be regarded as adulterated if it conforms to its declared standard."

Because the sale of alcoholic liquors as food is not lawful in Maine no standards were adopted at the time in which the other food standards were promulgated. The Director of the Station has, however, been requested by the Governor of the State "in view of the fact that the laws of Maine provide for the lawful sale of liquors from the State and Municipal agencies for medicinal purposes, to adopt and fix standards of purity, quality and strength for the various classes of liquors." The standards which are hereby adopted for beverages as foods are those recommended by the Association above referred to. The standards fixed for beverages as medicines are, as far as possible, those of the U. S. Pharmacopœia and National Formulary.

Standards for Beverages as Foods.

As empowered in Section 5, Chapter 124 of the Public Laws of 1907, the Director of the Maine Agricultural Experiment Station hereby fixes and adopts the following standards for purity of beverages for foods together with their precedent definitions as the official standards for the State of Maine.

F. Beverages for Food.

c. malt liquors.

1. *Malt liquor* is a beverage made by the alcoholic fermentation of an infusion, in potable water, of barley malt and hops, with or without unmalted grains or decorticated and degerminated grains.

2. *Beer* is a malt liquor produced by bottom fermentation, and contains, in one hundred (100) cubic centimeters, at 20° C.,

not less than five (5) grams of extractive matter and sixteen one-hundredths (0.16) gram of ash, chiefly potassium phosphate, and not less than two and twenty-five hundredths (2.25) grams of alcohol.

3. *Lager beer, stored beer,* is beer which has been stored in casks for a period of at least three months, and contains, in one hundred (100) cubic centimeters, at 20° C., not less than five (5) grams of extractive matter and sixteen one-hundredths (0.16) gram of ash, chiefly potassium phosphate, and not less than two and fifty one-hundredths (2.50) grams of alcohol.

4. *Malt beer* is beer made of an infusion, in potable water, of barley malt and hops, and contains, in one hundred (100) cubic centimeters, at 20° C., not less than five (5) grams of extractive matter, nor less than two-tenths (0.2) gram of ash, chiefly potassium phosphate, nor less than two and twenty-five hundredths (2.25) grams of alcohol, nor less than four-tenths (0.4) gram of crude protein (nitrogen x 6.25).

5. *Ale* is a malt liquor produced by top fermentation, and contains, in one hundred (100) cubic centimeters, at 20° C., not less than two and seventy-five hundredths (2.75) grams of alcohol nor less than five (5) grams of extract, and not less than sixteen one-hundredths (0.16) gram of ash, chiefly potassium phosphate.

6. *Porter* and *stout* are varieties of malt liquor made in part from highly roasted malt.

d. SPIRITOUS LIQUORS.

1. *Distilled spirit* is the distillate obtained from a fermented mash of cereals, molasses, sugars, fruits, or other fermentable substances, and contains all the volatile flavors, essential oils and other substances derived directly from the materials used, and the higher alcohols, ethers, acids, and other volatile bodies congeneric with ethyl alcohol produced during fermentation, which are carried over at the ordinary temperatures of distillation and the principal part of which are higher alcohols estimated as amylic.

2. *Alcohol, cologne spirit, neutral spirit, velvet spirit, or silent spirit* is distilled spirit from which all, or practically all of its constituents except ethyl alcohol and water are separated,

and contains not less than ninety-four and nine-tenths (94.9) per cent (189.8 proof) by volume of ethyl alcohol.

3. *New whisky* is the properly distilled spirit from the properly prepared and properly fermented mash of malted grain, or of grain the starch of which has been hydrolyzed by malt; it has an alcoholic strength corresponding to the excise laws of the various countries in which it is produced, and contains in one hundred (100) liters of proof spirit not less than one hundred (100) grams of the various substances other than ethyl alcohol derived from the grain from which it is made, and of those produced during fermentation, the principal part of which consists of higher alcohols estimated as amylic.

4. *Whisky (potable whisky)* is new whisky which has been stored in wood not less than four (4) years without any artificial heat save that which may be imparted by warming the storehouse to the usual temperature, and contains in one hundred (100) liters of proof spirit not less than two hundred (200) grams of the substances found in new whisky save as they are changed or eliminated by storage and of those produced as secondary bodies during aging; and, in addition thereto, the substances extracted from the casks in which it has been stored. It contains, when prepared for consumption as permitted by the regulations of the Bureau of Internal Revenue, not less than forty-five (45) per cent by volume of ethyl alcohol, and, if no statement is made concerning its alcoholic strength, it contains not less than fifty (50) per cent of ethyl alcohol by volume, as prescribed by law.

5. *Rye whisky* is whisky in the manufacture of which rye, either in a malted condition, or with sufficient barley or rye malt to hydrolyze the starch, is the only grain used.

6. *Bourbon whisky* is whisky made in Kentucky from a mash of Indian corn and rye, and barley malt, of which Indian corn forms more than fifty (50) per cent.

7. *Corn whisky* is whisky made from malted Indian corn, or of Indian corn, the starch of which has been hydrolyzed by barley malt.

8. *Blended whisky* is a mixture of two or more whiskies.

9. *Scotch whisky* is whisky made in Scotland solely from barley malt, in the drying of which peat has been used. It contains in one hundred (100) liters of proof spirit not less than

one hundred and fifty (150) grams of the various substances prescribed for whisky exclusive of those extracted from the cask.

10. *Irish whisky* is whisky made in Ireland, and conforms in the proportions of its various ingredients to Scotch whisky, save that it may be made of the same materials as prescribed for whisky, and the malt used is not dried over peat.

11. *New rum* is properly distilled spirit made from the properly fermented, clean, sound juice of the sugar cane, the clean sound massecuite made therefrom, clean, sound molasses from the massecuite, or any sound, clean, intermediate product save sugar, and contains in one hundred (100) liters of proof spirit not less than one hundred (100) grams of the volatile flavors, oils, and other substances derived from the materials of which it is made, and of the substances congeneric with the ethyl alcohol produced during fermentation, which are carried over at the ordinary temperatures of distillation, the principal part of which is higher alcohols estimated as amylic.

12. *Rum (potable rum)* is new rum stored not less than four (4) years in wood without any artificial heat save that which may be imparted by warming the storehouse to the usual temperature, and contains in one hundred (100) liters of proof spirit not less than one hundred and seventy-five (175) grams of the substances found in new rum save as they are changed or eliminated by storage, and of those produced as secondary bodies during aging; and, in addition thereto, the substances extracted from the casks. It contains, when prepared for consumption as permitted by the regulations of the Bureau of Internal Revenue, not less than forty-five (45) per cent by volume of ethyl alcohol, and, if no statement is made concerning its alcoholic strength, it contains not less than fifty (50) per cent by volume of ethyl alcohol as prescribed by law.

13. *New brandy* is a properly distilled spirit made from wine, and contains in one hundred liters (100) of proof spirit not less than one hundred (100) grams of the volatile flavors, oils, and other substances derived from the material from which it is made, and of the substances congeneric with ethyl alcohol produced during and carried over at the ordinary temperature of distillation, the principal part of which consists of the higher alcohols estimated as amylic.

14. *Brandy* (*potable brandy*) is new brandy stored in wood for not less than four (4) years without any artificial heat save that which may be imparted by warming the storehouse to the usual temperature, and contains in one hundred (100) liters of proof spirit not less than one hundred and fifty (150) grams of the substances found in new brandy save as they are changed or eliminated by storage, and of those produced as secondary bodies during aging; and, in addition thereto, the substances extracted from the casks in which it has been stored. It contains, when prepared for consumption as permitted by the regulations of the Bureau of Internal Revenue, not less than forty-five (45) per cent by volume of ethyl alcohol, and, if no statement is made concerning its alcoholic strength, it contains not less than fifty (50) per cent by volume of ethyl alcohol as prescribed by law.

15. *Cognac, cognac brandy* is brandy produced in the departments of the Charente and Charente Inferieure, France, from wine produced in those departments.

Standards for Beverages for Medicinal Purposes.

As impowered in Section 5, Chapter 124 of the Public Laws of 1907 the Director of the Maine Agricultural Experiment Station hereby fixes and adopts the following as the standards of purity, quality and strength of beverages for medicinal purposes.

A beverage for medicinal purposes, bearing a name recognized in the United States Pharmacopœia or National Formulary without any further statement respecting its character shall conform in strength, quality and purity to the standards prescribed or indicated for a beverage of the same name recognized in the United States Pharmacopœia or National Formulary official at the time.

A beverage for medicinal purposes bearing a name recognized by the United States Pharmacopœia or National Formulary and branded to show a different standard of strength, quality or purity shall not be regarded as adulterated if it conforms to its declared standard.

A beverage for medicinal purposes, not bearing a name recognized in the United States Pharmacopœia or National Formulary shall conform to the standard of strength, quality and purity named in the food standards adopted at the time for the State of Maine.

REGULATIONS GOVERNING THE SALE OF CARBONATED BEVERAGES FOR 1909.

Goods true to name need no label. Hence sirups made from cane sugar and flavored with extracts made from pure fruit oils or with pure fruit juices, without added coloring matter can be lawfully sold without label of any kind.

Carbonated water flavored with extract made from pure fruit oils or with pure fruit juices, without any added coloring matter and sweetened with cane sugar can be lawfully sold in bottles or from fountains as "soda water" or "soda" without label of any kind.

Sirups or soda waters flavored with imitation flavors must be so labeled.

Sirups flavored with imitation flavors cannot be lawfully drawn from soda water fountains unless the fact is conspicuously stated upon labels attached to the fountain.

If coloring matter is used, that fact must be stated. Food Inspection Decision 76 names the colors which may be lawfully used.

The words "imitation and colored" when used must be the same size and plainness of type as the name of the flavor, except that, for the present, in the case of bottled soda water where the label is upon the crown cap, the words "imitation flavor and color" may be in smaller letters than the flavor but they must be sufficiently large and plain as to be readily noted. This exception may not be allowed in interstate trade.

Saccharine cannot be lawfully used in any goods even though the fact of its presence is stated upon the label.

Benzoate of soda (see F. I. D. 89 and 101) in amounts not exceeding one-tenth of one per cent may be used in fruit sirups if the fact of its presence is stated on the label. No other preservatives or chemicals (except as stated on page 1, F. I. D. 76) can be lawfully used under any circumstances.

Sirups containing benzoate of soda may be used in soda fountains provided a conspicuous sign is shown stating that fact.

Sirups containing benzoate of soda may be used in bottled sodas, provided the fact is stated on the label.

Trade marked or proprietary beverages sold under a descriptive name must be true to name and if the goods are artificially colored that fact must be stated.

During the season of 1909, root beer, birch beer and ginger ale may be sold without a statement on the label that they are artificially colored and flavored.

If there is more than one label on imitation goods, the secondary label must correspond in fact with the principal label. Goods carrying "imitation flavor and color" on the crown cap, will not permit the use of a side label bearing a name unless it also carries "imitation flavor and color."

It is unlawful to substitute an imitation or adulterated article of food or drugs without calling attention to the fact of the substitution even if the goods are properly and correctly labeled. For example, if Pineapple soda is asked for, it is unlawful to sell a soda that contains an artificial flavor or color even though it be labeled "Pineapple soda imitation flavor and color," without calling attention to the fact that it is an imitation.

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Both the spirit and the letter of the Maine Inspection laws demand freedom from adulteration and truthful labeling.

Labeling Goods Sold From Opened Packages.

Dealers are again reminded that beginning with April 1, 1909, the labeling requirements of the food and drug law will be enforced on goods put up by the retailer and delivered by him to his customers. This applies to every article of food and drug ordinarily sold. It is not enough that the box in which the retailer keeps an article in stock be properly branded, but the package he gives to his customer must, after April 1, be similarly branded. It is to be noted, however, that *goods that are exactly what their names imply and that are exactly what they seem to be, do not need to be labeled.* All goods that are not strictly true to name do require labeling. This is explained in detail in Official Inspections 4.

To The Consumer.

DO YOU KNOW WHAT YOU EAT?

Practically all of the package goods that are on sale in Maine are correctly labeled and after April 1, the goods put up from bulk will be labeled. In order for the individual to have full protection under the Maine food and drug law, it is necessary to *read the labels carefully*. Your protection from fraud and your surety against using goods that are artificially colored and chemically preserved depends upon this.

Practically all adulterations are of two kinds. A treatment so as to make the goods appear better than they are, or substituting an inferior for a superior article of food. The coloring of catsup and preserves, the coating of rice with talc, and the bleaching of flour are illustrations of treatment which makes goods appear better than they are. Bleaching of fruits by sulphur dioxide and the adding of preservatives to fruits are frequently resorted to in order to make possible the sale of goods that otherwise would be unsaleable. This is even a greater argument against buying goods artificially colored and chemically preserved than the poisonous effects of the colors and preservatives themselves. The masquerading of cheaper under the names of better articles of food, even though they are equally nutritious is a fraud and when it comes to the treatment of sausage meat by the addition of starch for the purpose of making it hold up added quantities of water, the fraud is still greater.

Do not simply *read* your labels, but *study* them and find out what they mean. Read the small print as this is often more important than the large. When for instance you purchase sausage and the label reads "Pork sausage cereal and water added," ask yourself what it means, and if you do not understand, write to the Director of the Maine Agricultural Experiment Station, Orono. In this particular instance, it means that by the addition of 5 pounds of starch to 50 pounds of meat, there can be added nearly 50 pounds of water so that the 50 pounds of meat may masquerade as 100 pounds of "sausage, cereal and water added."

Bleached Flour.

Flour bleached with nitrogen peroxide has been made the subject of careful investigation by the U. S. Department of Agriculture and the results are announced in Food Inspection Decision 100. Based upon all of the testimony given at an extended hearing, upon the reports of those who have investigated the subject, upon the literature, and upon the unanimous opinion of the Board of Food and Drug Inspection, the U. S. Secretary of Agriculture has reached the decision that "The character of the adulteration is such that no statement upon the label will bring bleached flour within the law; and that such flour cannot legally be made or sold in the District of Columbia or in the territories; or be transported or sold in interstate commerce." Because of the extent of the bleaching process and of the immense quantity of bleached flour on hand or in the process of manufacture, the U. S. Department of Agriculture will not make prosecutions against its manufacture and sale until about July 1, 1909.

As there is no bleached flour manufactured in Maine, this decision by the U. S. Department of Agriculture will doubtless result in the stopping of the sale of flour bleached with nitrogen peroxide in Maine without recourse to the Maine law.

Benzoate Of Soda.

The use of benzoate of soda as a preservative in foods is for the present allowed in interstate trade under the National food and drug law, and is also permitted in Maine. It may be used in quantities not to exceed 1-10 of one per cent and in those foods in which generally heretofore it has been used. The addition of benzoate of soda shall be plainly stated upon the label of each package of food. No other preservatives or chemicals can be lawfully used under any circumstances.

Sirups containing benzoate of soda may be used in soda fountains provided a conspicuous sign is shown stating that fact. Sirups containing benzoate of soda may be used in bottled sodas provided the fact is stated on the label.

It is now possible to obtain pure fruit sirups that are put up without the use of preservatives of any kind. It will doubtless require greater care on the part of the retailer to keep these sirups in good condition in the fountain, but the consumer has the right to insist upon such care and cleanliness as is needed to make it practicable to use sirups free from chemicals.

Sulphur Dioxide in Foods.

For the present the U. S. Secretary of Agriculture is allowing, under the National Food and Drug Act, sulphur dioxide to be used in foods in ordinary quantities "if the fact that such foods have been so prepared is plainly stated on the label of each package." Until further notice, goods *delivered directly to the consumer in Maine in his own receptacle which contain sulphur dioxide but are otherwise strictly pure,* need not be labeled to show that fact. For example,—Molasses which carries sulphur dioxide but is otherwise pure, may be sold directly to the consumer without a label. If the goods are put up in a package belonging to the seller, even though he delivers directly to the consumer, it must be labeled to show that the goods contain sulphur dioxide, if such be the fact.

Standards For Beverages.

At the request of the Governor of the State of Maine Standards have been fixed for alcoholic beverages. These are published in detail in Official Inspections 7, a copy of which will be sent on request to any address in Maine.

Official Inspections 7 also contains the regulations concerning the sale of soda waters, either bottled or from fountains, and soda water sirups for 1909.

Ice Cream and Ice Cream Substitutes.

According to the Standards fixed by the U. S. Secretary of Agriculture and adopted by the Director of the Maine Agricultural Experiment Station (Bulletin 135, Maine Station):

Ice Cream is made from cream and sugar with or without a natural flavoring and contains not less than 14 per cent of milk fat.

Fruit ice cream is made from cream, sugar and fruit and contains not less than 12 per cent of milk fat.

Nut ice cream is made from cream, sugar and nuts and contains not less than 12 per cent of milk fat.

Until further notice 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.

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 label 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.

It is unlawful to sell even a properly labeled imitation ice cream for ice cream. If a customer calls for ice cream and an imitation ice cream is supplied without a full and clear explanation of what the goods are, the sale is unlawful.

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.

Flavoring Extracts.

In the fall of 1908 quite a number of samples of flavoring extracts, for the most part manufactured outside of the State, were collected. The results of the analyses are given in the tables which follow. There were comparatively little differences in the apparent size of the bottles, but as will be noted in the table, there were great difference in the actual capacity. A two ounce bottle should carry not quite 60 cubic centimeters. It will be noted that some of the 10 cent bottles were down to about half the capacity of a two-ounce bottle. The reduced capacity of the bottle was obtained by having the glass sides very much thicker and the panels in the sides of the bottle much deeper. With the exception of four or five samples, which are not reported, and were found on investigation to be old goods, the extracts were for the most part up to strength and frequently were very much stronger than the standards. Sample 7775 was collected and examined in the summer of 1908. The case was settled by affidavit.

TABLE SHOWING RESULTS OF ANALYSES OF SAMPLES OF FLAVORING EXTRACTS COLLECTED IN THE FALL OF 1908.

Station number.	Name, Maker and Dealer.	Price per bottle.	Capacity per bottle.	Oil per cent.	Remarks.
	PURE ALMOND EXTRACT				
7907	Colonial Mfg. Co., Detroit, Mich E. A. Whitney, Portland..	25c	63 cc.	1.9	Nearly double standard.
	CINNAMON EXTRACT				
7906	"Pure Concentrated." Colonial Mfg. Co., Detroit, Mich. E. A. Whitney, Portland..	25c	55 cc.	4.4	Double standard strength.
	LEMON EXTRACT				
7913	"Butterfly Pure Extract." Bastine & Co., New York. V. G. Gardiner, Cherryfield.......	22c	59 cc.	7.6	One and one-half standard strength.
7771	City Drug Store, Hallowell....	10c	58 cc.	5.5	Above standard strength.
7886	"Mayflower Extract." A. Colburn & Co., Philadelphia. N. H. Hall, Brewer...........	10c	28 cc.	5.4	Artifically colored. Above standard strength.
7904	"Pure Concentrated." Colonial Mfg. Co., Detroit, Mich. E. A. Whitney, Portland...	25c	56 cc.	7.0	One and one-third standard strength.
7894	"Harris Pure Extract." Frank E. Harris, Binghampton, N. Y. Brennon & Curran, Bangor.....................	20c	55 cc.	6.05	Above standard.
7912	"Hartshorn's Pure Extract." E. Hartshorn & Sons, Boston. Peter Smith, Cherryfield.....................	20c	56 cc.	6.1	Above standard.
7775	"Spaulding's Pure Extract." Spaulding's Drug Store, Hallowell....................	10c	58 cc.	1.7	One-third strength. Adulterated.
7915	"Stickney & Poor's Best." Stickney & Poor Spice Co., Boston. L. C. Atwood, Eastport................	10c	37 cc.	6.3	Above standard.
7888	"Highly Concentrated." Van Duzer Extract Co. F. W. Wentworth, So. Brewer....	20c	66 cc.	10.0	Double standard strength.
7910	"Forest City Brand." A. R. Verrill, Portland...........	10c	33 cc.	5.0	Standard strength.
7893	"Worth's Pure." Worth Extract Co., New York. J. F. O'Connell, Bangor.........	15c	60 cc.	5.8	Above standard.
	ORANGE EXTRACT				
7949	Joseph Burnett Co., Boston. Geo. S. Inch, Wytopitlock..	25c	62 cc.	11.2	Double standard strength.

TABLE SHOWING RESULTS OF ANALYSES OF SAMPLES OF FLAVORING EXTRACTS COLLECTED IN THE FALL OF 1908—*Concluded.*

Station number.	Name, Maker and Dealer	Price per bottle.	Capacity of bottle.	Oil per cent.	Remarks
	PEPPERMINT EXTRACT				
7903	"Pure Concentrated." Colonial Mfg. Co., Detroit, Mich. E. A. Whitney, Portland . . .	25c	53 cc.	14.5	Five times standard strength.
7916	"Forest City Brand." 27-29 Hampden St., Springfield, Mass. A. M. Gilpatrick, W. Pembroke	10c	37 cc.	4.4	A little below standard strength.
7918	"Harris Pure." Frank E. Harris, Binghamton, N. Y C. E. Beane, Calais	15c	57 cc.	7.7	One and one-half standard strength.
7776	Spaulding's Drug Store, Hallowell	10c	58 cc.	9.2	Nearly double standard strength.
	WINTERGREEN EXTRACT				
7908	"Pure Concentrated." Colonial Mfg. Co., Detroit. E. A. Whitney, Portland	25c	55 cc.	5.3	Nearly double standard strength.
7917	"Harris Pure." Frank E. Harris, Binghampton, N. Y. C. E. Beane, Calais	20c	58 cc.	5.0	Nearly double standard strength.
	SPIRIT OF WINTERGREEN				
7766	James A. Murphy, Hallowell . .	10c	58 cc.	3.8	Strength of extract. About two-thirds strength of spirit of wintergreen.
7770	City Drug Store, Hallowell	10c	58 cc.	6.2	Above standard strength.
	SPIRIT OF PEPPERMINT				
7769	City Drug Store, Hallowell	10c	58 cc.	12.2	Above standard strength.
7765	James A. Murphy, Hallowell . .	10c	58 cc.	3.3	Strength of extract; one-half strength of spirit of peppermint.

EXTRACTS OF VANILLA COLLECTED IN THE FALL OF 1908; ARRANGED ALPHABETICALLY BY THE NAMES OF THE MANUFACTURERS.

Station number.	Name, Maker and Dealer	Price per bottle.	Capacity per bottle.	Remarks
	VANILLA EXTRACT			
7899	"Bastine's Pure." Bastine & Co., New York. S. H. Robinson & Son, Bangor	25c	58 cc.	Not found adulterated.
7885	"Burnett's Superior." Jos. Burnett & Co., Boston. Kenney & McMahon, Brewer	30c	58 cc.	Not found adulterated.
7895	"Mayflower Extract." The A. Colburn Co., Philadelphia. Brennon & Curran, Bangor	10c	27 cc.	Not found adulterated.
7905	"Pure Concentrated." Colonial Mfg. Co., Detroit. E. A. Whitney, Portland	25c	60 cc.	Not found adulterated.
7890	"Harris Pure." Frank E.Harris,Binghampton, N. Y. Daniel Rooney,Jr. Brewer	25c	61 cc.	Not found adulterated.
7914	"Hartshorn's Pure." E. Hartshorn & Sons, Boston. M. Gardner & Son, Machias	25c	61 cc.	Not found adulterated.
7900	"Good Value." Frank E.Harris,Binghampton, N. Y. F. S. Jones & Co., Bangor	10c	38 cc.	Not found adulterated.
7938	"Kimball's Pure." Kimball Bros. & Co., Enosburg Falls, Vt. J. Dow, Smyrna Mills	25c	57 cc.	Not found adulterated.
7911	"Forest City Brand." E. O. Parker & Co., Portland	10c	35 cc.	Not found adulterated.
7896	"Stickney & Poor's Best." Stickney & Poor, Boston. A. E. Baker, Bangor	20c	62 cc.	Not found adulterated.
7889	"Van Duzer's High Concentrated." Van Duzer Extract Co., New York. F. W. Wentworth, So. Brewer	25c	58 cc.	Not found adulterated.
7892	"Worth's Pure." Worth Extract Co., New York. J. F. O'Connell, Bangor	20c	53 cc.	Not found adulterated.

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Both the spirit and the letter of the Maine Inspection laws demand freedom from adulteration and truthful labeling.

FERTILIZER INSPECTION.

The law regulating the sale of commercial fertilizers has been modified by the present legislature so that after the present year it is not expected to publish the spring bulletin which, like the present, contains the analyses of samples received from the manufacturer, guaranteed to represent, within reasonable limits, the goods to be placed upon the market later. The bulletin which contains the analyses of the samples collected in the open market by a representative of the Station is a more reliable guide to the quality of the fertilizers as actually sold than is that containing the analysis of samples submitted by the manufacturers.

ANALYSES OF MANUFACTURERS' SAMPLES.

In the tables there are given the results of the analyses of the manufacturers' samples of licensed brands. The tables include all the brands which were licensed to March, 1909. Dealers are cautioned against handling any brands not given in this list without first writing the Station.

The figures which are given as the percentages of valuable ingredients guaranteed by the manufacturers are the minimum percentages of the guarantee. If, for instance, the guarantee is 2 to 3 per cent of nitrogen, it is evident that the dealer cannot be held to have agreed to furnish more than 2 per cent, and so this percentage is taken as actual guarantee. The figures under the head of "found" are those showing the actual composition of the samples.

VALUATION OF FERTILIZERS.

The chief use of fertilizers is to supply plant-food. It is good farming to make the most of the natural resources of the soil and of the manures produced on the farm, and to depend upon artificial fertilizers only to furnish what more is needed. It is not good economy to pay high prices for materials which the soil may itself yield, but it is good economy to supply the lacking ones in the cheapest way. The rule in the purchase of costly commercial fertilizers should be to select those that supply, in the best forms and at the lowest cost, the plant-food which the crop needs and the soil fails to furnish.

Plants differ widely with respect to their capacities for gathering their food from soil and air; hence the proper fertilizer in a given case depends upon the crop as well as upon the soil. The fertility of the soil would remain practically unchanged if all the ingredients removed in the various farm products were restored to the land. This may be accomplished by feeding the crops grown on the farm to animals, carefully saving the manure and returning it to the soil. If it is practicable to pursue a system of stock feeding in which those products of the farm which are comparatively poor in fertilizing constituents are exchanged in the market for feeding stuffs of high fertilizing value, the loss of soil fertility may be reduced to a minimum, or there may be an actual gain in fertility.

The agricultural value of any fertilizing constituent is measured by the value of the increase of the crop produced by its use, and is, of course, a variable factor, depending upon the availability of the constituent, and the value of the crop produced. The form of the materials used must be carefully considered in the use of manures. Slow-acting materials cannot be expected to give profitable returns upon quick growing crops, nor expensive materials profitable returns when used for crops of relatively low value.

The agricultural value is distinct from what is termed "commercial value," or cost in market. This last is determined by market and trade conditions, as cost of production of the crude material, methods of manipulation required, etc. Since there is no strict relation between agricultural and commercial or market value, it may happen that an element in its most available form, and under ordinary conditions of high agricultural value, costs less in market than the same element in less available forms and of a lower agricultural value. The commercial value has reference to the material as an article of commerce, hence commercial ratings of various fertilizers have reference to their relative cost and are used largely as a means by which the different materials may be compared.

The commercial valuation of a fertilizer consists in calculating the retail trade-value or cash-cost at freight centers (in raw materials of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer. Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates, and similar articles, for which $20 to $75 per ton are paid, depend for their trade value exclusively on the substances, nitrogen, phosphoric acid and potash, which are comparatively costly and steady in price. The trade-value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce. The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the trade-value of the above named ingredients a suitable margin for the expenses of

[Continued on page 30.]

Descriptive List of Manufacturers' Samples, 1909.

Station number.	Manufacturer, Place of Business and Brand.
	AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y.
1751	A. A. C. Co's Aroostook Complete Manure
1752	A. A. C. Co's Aroostook High Grade
1753	A. A. C. Complete Manure with 10% Potash
1754	A. A. C. Grass and Lawn Top Dressing
1755	A. A. C. Grass and Oats Fertilizer
1756	A. A. C. High Grade Fertilizer with 10% Potash
1757	A. A. C. Co's Northern Maine Potato Special
1758	A. A. C. Co's Peerless Potato Manure
1759	A. A. Potato Grower
1760	Bradley's Alkaline Bone with Potash
1761	Bradley's Complete Manure for Potatoes and Vegetables
1762	Bradley's Complete Manure with 10% Potash
1763	Bradley's Corn Phosphate
1764	Bradley's Eureka Fertilizer
1765	Bradley's Niagara Phosphate
1766	Bradley's Potato Fertilizer
1767	Bradley's Potato Manure
1768	Bradley's XL Superphosphate of Lime
1769	Clark's Cove Bay State Fertilizer
1770	Clark's Cove Bay State Fertilizer G. G
1771	Clark's Cove Bay State Fertilizer for Seeding Down
1772	Clark's Cove Defiance Complete Manure
1773	Clark's Cove Great Planet Manure A. A
1774	Clark's Cove King Philip Alkaline Guano
1775	Clark's Cove Potato Fertilizer
1776	Clark's Cove Potato Manure
1777	Cleveland Fertilizer for all Crops
1778	Cleveland High Grade Complete Manure
1779	Cleveland Potato Phosphate
1780	Cleveland's Superphosphate
1781	Crocker's Ammoniated Corn Phosphate
1782	Crocker's Aroostook Potato Special
1783	Crocker's New Rival Ammoniated Superphosphate
1784	Crocker's Potato Hop and Tobacco
1785	Crocker's Special Potato Manure
1786	Cumberland Potato Fertilizer
1787	Cumberland Superphosphate
1788	Darling's Blood, Bone and Potash
1789	Dissolved Bone Black
1790	Fine Ground Bone
1791	Great Eastern General
1792	Great Eastern High Grade Potato Manure
1793	Great Eastern Northern Corn Special
1794	Great Eastern Potato Manure
1795	High Grade Sulphate of Potash

Analysis of Manufacturers' Samples, 1909.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
	Soluble in water.	Insoluble in water.	Total.		Soluble.	Reverted.	Insoluble.	Available.		Total.		Found.	Guaranteed.
			Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.		
%	%	%	%	%	%	%	%	%	%	%	%	%	%
1751	0.01	1.40	2.41	2.47	3.08	3.20	2.00	6.28	6.00	8.28	......	10.04	10.00
1752	2.88	1.62	4.50	4.12	4.31	2.21	2.83	6.52	7.00	9.35	......	7.60	7.00
1753	1.99	1.46	3.45	3.30	4.31	1.95	2.07	6.26	6.00	8.33	7.00	9.55	10.00
1754	4.44	0.08	4.52	3.91	1.03	5.16	0.97	7.69	5.00	8.66	6.00	3.56	2.00
1755	.....	.....	.....	.....	11.10	0.44	3.06	11.54	11.00	14.60	......	1.91	2.00
1756	1.50	1.03	2.53	2.40	5.82	1.76	2.63	7.58	6.00	10.21	7.00	10.44	10.00
1757	2.42	1.98	4.40	3.70	5.31	2.09	1.53	7.40	7.00	8.93	......	9.85	10.00
1758	1.73	2.05	3.78	3.29	6.46	1.61	3.22	8.07	8.00	11.29	......	7.01	7.00
1759	1.70	2.64	4.34	3.70	3.78	3.25	1.85	7.03	7.00	8.88	9.00	10.60	10.00
1760	.....	.....	.....	.....	5.34	4.18	3.64	9.52	11.00	13.16	12.00	2.49	2.00
1761	2.57	1.37	3.94	3.30	5.49	2.08	2.72	7.57	8.00	10.29	9.00	6.52	7.00
1762	1.99	1.31	3.30	3.30	3.59	3.19	2.44	6.78	6.00	9.22	7.00	11.20	10.00
1763	0.66	1.42	2.08	2.06	7.05	2.55	2.56	9.60	8.00	11.16	10.00	2.01	1.50
1764	0.11	1.06	1.17	1.03	5.93	2.35	1.55	8.28	8.00	11.16	10.00	2.01	2.00
1765	0.40	0.64	1.04	0.82	5.41	3.15	1.38	8.56	7.00	9.94	8.00	1.49	1.00
1766	1.64	0.62	2.26	2.06	5.85	1.89	2.67	7.74	8.00	10.41	10.00	3.13	3.00
1767	1.29	1.44	2.73	2.50	5.42	0.79	2.48	6.21	6.00	8.69	8.00	4.96	5.00
1768	1.45	1.13	2.58	2.50	6.62	2.54	3.25	9.16	9.00	12.41	11.00	2.34	2.00
1769	1.45	1.07	2.52	2.50	6.67	2.39	3.59	9.06	9.00	12.65	11.00	2.34	2.00
1770	1.58	0.74	2.32	2.06	5.42	2.39	3.32	7.81	8.00	11.13	10.00	1.85	1.50
1771	0.41	0.74	1.45	1.03	5.93	2.80	2.42	8.73	8.00	11.15	10.00	2.57	2.00
1772	0.40	0.68	1.08	0.82	5.24	2.74	1.48	7.98	7.00	9.46	8.00	1.59	1.00
1773	1.88	1.52	3.40	3.30	5.20	3.01	1.96	8.21	8.00	10.17	9.00	7.43	7.00
1774	0.43	0.68	1.11	1.03	5.71	2.67	1.47	8.38	8.00	9.85	10.00	2.12	2.00
1775	1.76	0.56	2.32	2.06	5.92	1.98	2.74	7.90	8.00	10.64	10.00	3.30	3.00
1776	0.56	2.11	2.67	2.50	3.96	3.03	3.49	6.99	6.00	10.48	8.00	5.59	5.00
1777	0.34	0.72	1.06	1.03	5.50	2.87	2.60	8.37	8.00	10.97	10.00	2.30	2.00
1778	2.32	1.33	3.65	3.30	5.63	2.11	2.69	7.74	8.00	10.43	9.00	6.74	7.00
1779	1.63	0.56	2.19	2.06	6.06	1.74	2.73	7.80	8.00	10.53	10.00	3.17	3.00
1780	0.66	1.40	2.06	2.06	7.17	2.35	2.62	9.52	8.00	12.14	10.00	2.03	1.50
1781	0.26	2.06	2.32	2.06	4.52	3.65	3.87	8.17	8.00	12.04	......	2.26	1.50
1782	0.81	1.29	2.10	2.06	5.17	3.33	2.03	8.50	8.00	10.53	......	6.61	6.00
1783	0.23	1.14	1.27	1.03	4.82	3.70	2.47	8.52	8.00	10.90	......	2.12	2.00
1784	1.10	1.10	2.20	2.06	5.98	2.07	2.68	8.05	8.00	10.73	......	3.34	3.00
1785	2.01	1.30	3.31	3.29	3.84	3.29	2.34	7.13	6.00	9.47	......	10.80	10.00
1786	0.72	1.34	2.06	2.06	6.13	4.17	2.33	10.30	8.00	12.63	10.00	3.38	3.00
1787	1.64	0.74	2.38	2.06	5.30	2.56	3.18	7.86	8.00	11.04	10.00	1.89	1.50
1788	2.76	1.40	4.16	4.10	4.98	1.90	2.48	6.88	7.00	9.36	8.00	7.16	7.00
1789	.....	.....	.....	.....	13.61	2.58	0.38	16.19	15.00	16.57	......	......	......
1790	.....	.....	2.50	2.47	.....	.....	.....	.....	.....	25.31	22.80	......	......
1791	0.52	0.96	1.48	0.82	5.17	2.42	3.05	7.59	8.00	10.64	......	4.73	4.00
1792	2.38	1.00	3.38	3.29	4.87	3.25	1.86	8.12	6.00	9.98	......	10.64	10.00
1793	0.42	1.84	2.26	2.06	5.02	4.60	2.35	9.62	8.00	11.98	......	2.26	1.50
1794	0.85	1.23	2.08	2.06	5.92	2.31	2.76	8.23	8.00	10.99	......	3.37	3.00
1795	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	......	49.80	48.00

Descriptive List of Manufacturers' Samples, 1909.

Station number.	Manufacturer, Place of Business and Brand.
1796	Lazaretto Aroostook Potato Guano
1797	Lazaretto Corn Guano
1798	Lazaretto High Grade Potato Guano
1799	Lazaretto Propellor Potato Guano
1800	Muriate of Potash
1801	Nitrate of Soda
1802	Otis' Potato Fertilizer
1803	Otis' Superphosphate
1804	Pacific Dissolved Bone and Potash
1805	Pacific Grass & Grain Fertilizer
1806	Pacific High Grade General Fertilizer
1807	Pacific Nobsque Guano
1808	Pacific Potato Special
1809	Packer's Union Animal Corn Fertilizer
1811	Packer's Union Gardners' Complete Manure
1812	Packer's Union Potato Manure
1813	Packer's Union Universal Fertilizer
1814	Plain Superphosphate
1815	Quinnipiac Climax Phosphate for all Crops
1816	Quinnipiac Corn Manure
1817	Quinnipiac Market Garden Manure
1818	Quinnipiac Potato Manure
1819	Quinnipiac Potato Phosphate
1820	Read's Farmers' Friend
1821	Read's High Grade Farmers' Friend
1822	Read's Potato Manure
1823	Read's Practical Potato Special
1824	Read's Standard Superphosphate
1825	Read's Sure Catch Fertilizer
1826	Read's Vegetable & Vine Fertilizer
1827	Soluble Pacific Guano
1828	Standard A. Brand
1829	Standard Bone & Potash
1830	Standard Complete Manure
1831	Standard Fertilizer
1832	Standard Guano for all Crops
1833	Standard Special for Potatoes
1834	Williams & Clark Americus Ammoniated Bone Superphosphate
1835	Williams & Clark Americus Corn Phosphate
1836	Williams & Clark Americus High Grade Special
1837	Williams & Clark Americus Potato Manure
1838	Williams & Clark Royal Bone Superphosphate for all Crops
	ARMOUR FERTILIZER WORKS, BALTIMORE, MD.
1839	All Soluble
1840	Armour's Complete Potato
1841	Bone, Blood & Potash

Analysis of Manufacturers' Samples, 1909.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
	Soluble in water.	Insoluble in water.	Total.		Soluble.	Reverted.	Insoluble.	Available.		Total.		Found.	Guaranteed.
			Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.		
%	%	%	%	%	%	%	%	%	%	%	%	%	%
1796	0.19	0.78	0.97	0.82	5.69	3.36	2.11	9.05	8.00	11.16	......	4.57	4.00
1797	0.95	1.02	1.97	1.64	4.47	3.20	2.74	7.67	8.00	10.41	......	2.53	2.00
1798	1.21	1.82	3.03	3.29	4.00	1.90	2.27	5.90	6.00	8.17	......	10.60	10.00
1799	0.70	1.30	2.00	2.06	5.69	2.56	2.88	8.25	8.00	11.13	......	6.52	6.00
1800	......	......	......	......	......	......	......	......	......	......	......	49.63	49.00
1801	15.12	......	15.12	15.00	......	......	......	......	......	......	......	......	......
1802	1.74	0.58	2.32	2.06	5.74	2.28	2.46	8.02	8.00	10.48	10.00	3.05	3.00
1803	0.68	1.38	2.06	2.06	6.94	2.92	2.43	9.86	8.00	12.29	10.00	2.16	1.50
1804	......	......	......	......	5.98	4.81	1.91	10.70	10.00	12.70	11.00	2.43	2.00
1805	0.42	0.64	1.06	0.82	5.46	3.01	1.43	8.47	7.00	9.90	8.00	2.99	1.00
1806	2.13	1.41	3.54	3.30	5.15	2.92	2.14	8.07	8.00	10.21	9.00	7.18	7.00
1807	0.45	0.80	1.25	1.03	5.53	2.31	2.73	7.81	8.00	10.57	10.00	2.14	2.00
1808	0.76	1.34	2.10	2.06	5.69	4.27	2.70	9.96	8.00	12.66	10.00	3.15	3.00
1809	0.31	2.10	2.41	2.47	5.64	3.22	3.46	8.86	8.00	12.32	......	1.91	6.00
1811	1.38	1.16	2.54	2.47	5.58	0.47	2.06	6.05	6.00	8.11	......	10.99	10.00
1812	0.96	1.10	2.06	2.06	4.85	3.16	1.85	8.01	8.00	9.86	......	6.54	6.00
1813	0.25	0.96	1.21	0.82	6.05	3.22	1.46	9.27	8.00	10.73	......	5.04	4.00
1814	......	......	......	......	10.21	3.91	1.30	14.12	14.00	15.42	15.00	......	......
1815	0.39	1.06	1.45	1.03	5.10	3.54	1.63	8.64	8.00	10.27	10.00	2.91	2.00
1816	0.67	1.38	2.05	2.06	6.69	2.63	2.41	9.32	8.00	11.73	10.00	1.95	1.50
1817	2.19	1.08	3.58	3.30	4.23	4.67	1.47	8.90	8.00	10.37	9.00	7.57	7.00
1818	1.03	1.50	2.53	2.50	2.55	4.03	3.06	6.58	6.00	9.64	8.00	5.15	5.00
1819	0.74	1.30	2.04	2.06	5.61	4.71	2.36	10.32	8.00	12.68	10.00	3.34	3.00
1820	1.57	0.62	2.19	2.06	5.84	2.08	2.59	7.92	8.00	10.51	10.00	3.11	3.00
1821	2.23	1.48	3.71	3.30	3.96	2.13	2.08	6.09	6.00	8.17	7.00	9.59	10.00
1822	0.42	2.28	2.70	2.40	4.59	1.89	1.25	6.48	6.00	7.73	7.00	10.94	10.00
1823	0.42	0.74	1.16	0.82	1.64	2.56	1.99	4.20	4.00	6.19	5.00	8.03	8.00
1824	0.10	0.94	1.04	0.82	5.87	2.89	2.23	8.76	8.00	10.99	10.00	4.81	4.00
1825	......	......	......	......	5.42	3.90	3.09	9.32	10.00	12.41	11.00	2.59	2.00
1826	0.32	1.80	2.12	2.06	5.94	2.25	1.38	8.29	8.00	9.67	10.00	6.35	6.00
1827	1.58	0.80	2.38	2.06	5.18	2.81	3.01	8.09	8.00	11.10	10.00	1.89	1.50
1828	0.31	0.90	1.21	0.82	3.64	4.10	2.08	7.74	7.00	9.82	8.00	1.56	1.00
1829	......		......	......	7.66	2.60	1.96	10.26	10.00	12.22	11.00	2.08	2.00
1830	2.40	0.90	3.30	3.30	7.02	1.99	1.04	8.81	8.00	9.85	9.00	7.56	7.00
1831	1.60	0.78	2.38	2.06	5.14	2.41	3.36	7.55	8.00	10.91	10.00	1.70	1.50
1832	0.37	0.70	1.07	1.03	5.31	3.03	1.44	8.34	8.00	9.74	10.00	2.10	2.00
1833	1.68	0.62	2.30	2.06	5.82	2.22	2.45	8.04	8.00	10.49	10.00	3.17	3.00
1834	1.40	1.35	2.75	2.50	5.52	2.65	3.44	8.17	9.00	11.61	11.00	2.78	2.00
1835	1.35	0.76	2.11	2.06	5.58	2.78	3.04	8.36	8.00	11.40	10.00	1.99	1.50
1836	2.36	1.33	3.69	3.30	5.57	2.56	2.48	8.13	8.00	10.61	9.00	6.54	7.00
1837	1.68	0.60	2.28	2.06	6.17	2.02	2.48	8.19	8.00	10.67	10.00	3.28	3.00
1838	0.29	0.82	1.11	1.03	5.47	3.14	2.55	8.61	8.00	11.16	10.00	2.59	2.00
1839	1.93	1.64	3.57	2.88	7.70	1.19	0.54	8.89	8.00	9.43	9.00	4.40	4.00
1840	1.56	2.06	3.62	3.29	5.85	1.67	0.57	7.52	6.00	8.09	7.00	10.94	10.00
1841	2.34	2.21	4.55	4.11	6.67	1.47	1.01	8.24	8.00	9.25	9.00	8.40	7.00

Descriptive List of Manufacturers' Samples, 1909.

Station number.	Manufacturer, Place of Business and Brand.
1842	Fruit and Root Crop Special
1843	Grain Grower
1844	High Grade Potato
1845	Wheat, Corn & Oats Special
	BOWKER FERTILIZER CO., BOSTON, MASS.
1846	Bowker's Blood, Bone & Potash
1847	Bowker's Bone & Potash, Square Brand
1848	Bowker's Complete Manure for Potatoes and Vegetables
1849	Bowker's Corn Phosphate
1850	Bowker's Early Potato Manure
1851	Bowker's Farm and Garden Phosphate
1852	Bowker's Fresh Ground Bone
1853	Bowker's Hill & Drill Phosphate
1854	Bowker's Market Garden Fertilizer
1855	Bowker's Potash Bone
1856	Bowker's Potash or Staple Phosphate
1857	Bowker's Potato & Vegetable Fertilizer
1858	Bowker's Potato & Vegetable Phosphate
1859	Bowker's Six Percent Potato Fertilizer
1860	Bowker's Superphosphate with Potash
1861	Bowker's Sure Crop Phosphate
1862	Bowker's Ten Percent Manure
1864	Stockbridge's Manure A for Potatoes
1865	Stockbridge's Special Complete Manure for Corn and all Grain Crops
1863	Stockbridge's Complete Manure for Potatoes & Vegetables
1866	Stockbridge's Special Complete Manure for Quick Growth and Forcing
1867	Stockbridge's Special Complete Manure for Seeding Down, Permanent Dressing and Legumes
	BUFFALO FERTILIZER CO., BUFFALO, N. Y.
1868	Buffalo "Four-Six-Ten"
1869	Buffalo "587"
	COE-MORTIMER CO., NEW YORK.
1870	E. Frank Coe's Celebrated Special Potato Fertilizer
1871	E. Frank Coe's Columbian Corn and Potato Fertilizer
1872	E. Frank Coe's Columbian Potato Fertilizer
1873	E. Frank Coe's Double Strength Potato Manure
1874	E. Frank Coe's Excelsior Potato Fertilizer
1875	E. Frank Coe's Famous Prize Brand Grass & Grain Fertilizer
1876	E. Frank Coe's High Grade Ammoniated Bone Superphosphate
1877	E. Frank Coe's High Grade Potato Fertilizer
1878	E. Frank Coe's New Englander Corn & Potato Fertilizer
1879	E. Frank Coe's Red Brand Excelsior Guano
1880	E. Frank Coe's Special Grass & Grain Fertilizer
1881	E. Frank Coe's Standard Potato Fertilizer
	DEEP COVE MANUFACTURING CO., EASTPORT, ME.
1961	Fish and Potash
	ESSEX FERTILIZER CO., BOSTON, MASS.
1882	Essex Complete Manure for Potatoes, Roots and Vegetables
1883	Essex Market Garden & Potato Manure
1884	Essex Potato Grower

Analysis of Manufacturers' Samples, 1909.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
	Soluble in water.	Insoluble in water.	Total.		Soluble.	Reverted.	Insoluble.	Available.		Total.		Found.	Guaranteed.
			Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.		
	%	%	%	%	%	%	%	%	%	%	%	%	%
1842	0.75	1.06	1.81	1.65	7.78	0.35	0.47	8.13	8.00	9.60	9.00	5.93	5.00
1843	0.94	0.72	1.60	1.65	5.61	2.35	1.26	7.96	8.00	9.22	9.00	2.51	2.00
1844	0.94	0.96	1.90	1.65	8.05	1.08	0.50	9.13	8.00	9.63	9.00	10.70	10.00
1845	0.22	0.60	0.82	0.82	5.04	2.24	2.02	7.28	7.00	9.30	8.00	1.24	1.00
1846	2.59	2.02	4.61	4.11	6.28	1.47	1.37	7.75	7.00	9.12	9.00	6.67	7.00
1847	1.03	0.81	1.84	1.65	1.04	3.68	7.10	4.72	6.00	11.82	7.00	2.34	2.00
1848	1.59	1.64	3.23	3.29	4.66	1.58	2.58	6.24	6.00	8.82	7.00	10.51	10.00
1849	0.40	1.14	1.54	1.65	2.27	5.90	2.19	8.17	8.00	10.36	9.00	2.52	2.00
1850	2.32	0.94	3.26	3.29	6.78	1.40	1.02	8.18	8.00	9.20	9.00	7.60	7.00
1851	0.52	1.16	1.68	1.65	2.20	6.62	2.50	8.92	8.00	11.42	9.00	2.80	2.00
1852	......	......	2.53	2.47	......	......	......	......	......	21.42	22.80	......	......
1853	0.71	1.73	2.44	2.47	3.27	5.48	2.76	8.75	9.00	11.51	10.00	2.16	2.00
1854	1.59	0.79	2.38	2.47	5.55	2.12	1.34	7.67	6.00	9.01	7.00	9.85	10.00
1855	0.90	......	0.90	0.82	3.05	1.93	3.03	4.98	6.00	8.01	8.00	2.10	2.00
1856	0.18	0.74	0.92	0.82	1.69	6.43	2.15	8.12	8.00	10.27	9.00	3.37	3.00
1857	0.61	1.73	2.34	2.47	7.26	2.32	0.83	9.58	8.00	10.41	9.00	4.30	4.00
1858	0.30	1.18	1.48	1.65	2.28	6.79	2.31	9.07	8.00	11.38	9.00	2.32	2.00
1859	0.35	0.65	1.00	0.82	1.39	4.82	3.05	6.21	6.00	9.26	7.00	6.48	6.00
1860	......	......	......	......	4.39	5.30	1.71	9.69	10.00	11.40	11.00	2.84	2.00
1861	0.35	0.72	1.07	0.82	4.93	3.50	2.42	8.43	8.00	10.88	9.00	2.37	2.00
1862	0.17	0.69	0.86	0.82	1.29	3.92	1.99	5.21	5.00	7.20	6.00	10.34	10.00
1864	1.60	2.64	4.24	4.11	4.31	2.77	1.93	7.08	7.00	9.01	8.00	11.11	10.00
1865	1.93	1.40	3.30	3.29	7.89	2.30	0.91	10.19	10.00	11.10	11.00	7.39	7.00
1863	1.32	1.88	3.20	3.29	2.57	3.54	2.27	6.11	6.00	8.38	7.00	10.34	10.00
1866	3.18	1.88	5.06	4.93	3.01	2.69	2.26	5.70	4.00	7.96	6.00	6.11	6.00
1867	0.79	1.59	2.38	2.47	2.97	2.88	4.24	5.85	6.00	10.00	9.00	10.04	10.00
1868	1.69	1.97	3.66	3.28	3.96	2.59	2.65	6.55	6.00	9.20	7.00	10.54	10.00
1869	2.22	1.99	4.21	4.10	5.02	3.11	3.59	8.13	8.00	11.72	9.00	8.02	7.00
1870	1.26	0.62	1.88	1.65	7.34	1.19	2.71	8.53	8.00	11.24	9.00	4.73	4.00
1871	0.60	0.74	1.34	1.23	7.29	2.77	2.53	9.46	8.50	12.01	9.50	2.98	2.50
1872	0.54	0.80	1.34	1.23	6.30	2.16	2.49	9.46	8.50	11.95	9.50	3.08	2.50
1873	2.62	1.14	3.76	3.70	4.88	2.37	2.40	7.25	7.00	9.65	8.50	11.75	10.00
1874	1.46	0.96	2.41	2.47	6.03	1.97	2.22	8.00	7.00	10.22	8.00	9.35	8.00
1875	......	......	......	......	6.64	3.96	3.06	10.55	10.00	13.61	11.00	2.59	2.00
1876	......	......	1.98	1.85	5.53	2.25	1.15	7.78	8.00	8.93	9.00	3.28	3.00
1877	1.68	0.92	2.60	2.47	7.15	1.53	2.76	8.68	8.00	11.44	9.00	6.48	6.00
1878	0.63	0.70	1.33	0.80	7.15	2.42	2.60	9.57	7.50	12.17	8.50	3.11	3.00
1879	......	......	3.54	3.30	7.13	1.59	0.79	8.72	8.00	9.51	9.00	7.21	7.00
1880	0.07	0.73	0.80	0.80	6.73	2.57	2.81	9.30	8.50	12.11	10.00	2.28	1.50
1881	......	......	3.71	3.30	5.17	1.56	1.40	6.73	6.00	8.13	7.00	10.72	10.00
1961	......	......	3.62	3.29	3.04	3.35	0.85	6.39	6.00	7.24	......	12.79	10.00
1882	1.98	1.38	3.36	3.25	4.31	2.70	1.20	7.01	6.00	8.21	7.00	10.06	10.00
1883	0.38	1.80	2.18	2.00	4.47	3.63	5.22	8.10	8.00	13.22	9.00	5.71	5.00
1884	1.66	1.10	2.76	2.46	4.86	1.78	1.02	6.64	6.00	7.66	7.00	10.57	10.00

Descriptive List of Manufacturers' Samples, 1909.

Station number.	Manufacturer, Place of Business and Brand.
1885	Essex XXX Fish & Potash
	HUBBARD FERTILIZER CO., BALTIMORE, MD.
1886	Hubbard's Blood, Bone & Potash
1887	Hubbard's Bone and Potash 10 and 2
1888	Hubbard's Farmers' IXL Superphosphate
1889	Hubbard's Five Percent Royal Seal Compound
1890	Hubbard's Royal Ensign
1891	Hubbard's Special Potato Compound
	LISTER'S AGRICULTURAL CHEMICAL WORKS, NEWARK, N. J.
1892	Lister's Animal Bone & Potash
1960	*** Lister's Bone Meal**
1893	Lister's High Grade Special
1894	Lister's Oneida Special
1895	Lister's Potato Manure
1896	Lister's Special Corn Fertilizer
1897	Lister's Special Potato Fertilizer
1898	Lister's Success
1961	**† Lister's 10% Potato Grower**
	MERROW BROTHERS CO., AUBURN, ME.
1962	Merrow's Bone Meal
	MORRISON BROTHERS, BANGOR, ME.
1899	"A" Brand Potato Fertilizer
1900	Acid Phosphate
1901	"C" Brand Fertilizer for all Crops
1902	Muriate of Potash
1903	Nitrate of Soda
1904	Sulphate of Potash
	NATIONAL FERTILIZER CO., BOSTON, MASS.
1905	Chittenden's Ammoniated Bone Phosphate
1906	Chittenden's Aroostook Special
1907	Chittenden's Complete Root Fertilizer
1908	Chittenden's Eureka Potato Fertilizer
1909	Chittenden's Excelsior Potato Fertilizer
1910	Chittenden's Market Garden Fertilizer
	NEW ENGLAND FERTILIZER CO., BOSTON, MASS.
1911	New England Complete Manure
1912	New England Corn & Grain Fertilizer
1913	New England Corn Phosphate
1914	New England High Grade Potato Fertilizer
1915	New England High Grade Special
1916	New England Market Garden Manure
1917	New England Potato Fertilizer
1918	New England Potato Grower
1919	New England Superphosphate
	PARMENTER & POLSEY FERTILIZER CO., BOSTON, MASS.
1920	A. A. Brand
1921	Aroostook Special
1922	Maine Potato Fertilizer
1923	Plymouth Rock Brand
1924	P. & P. Potato Grower
1925	Special Potato Fertilizer
	PORTLAND RENDERING CO., PORTLAND, MAINE.
1926	Bone Dust Tankage

*** Sample taken from ware house at Portland.**
† Sample taken from ware house at Bangor.

Analysis of Manufacturers' Samples, 1909.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
	Soluble in water.	Insoluble in water.	Total. Found.	Total. Guaranteed.	Soluble.	Reverted.	Insoluble.	Available. Found.	Available. Guaranteed.	Total. Found.	Total. Guaranteed.	Found.	Guaranteed.
%	%	%	%	%	%	%	%	%	%	%	%	%	%
1885	0.40	2.22	2.62	2.00	6.54	2.44	1.91	8.98	8.00	10.89	9.00	3.95	3.00
1886	2.02	1.10	3.12	3.32	6.62	2.14	1.21	8.76	8.00	9.97	9.00	7.20	7.00
1887	......	......	......	......	......	......	......	......	10.00	......	11.00	......	2.00
1888	1.06	0.90	1.96	1.66	7.35	1.43	0.96	8.78	8.00	9.74	9.00	2.53	2.00
1889	2.70	1.66	4.36	4.15	4.31	2.48	1.34	6.79	6.00	8.13	7.00	6.42	5.00
1890	1.58	1.36	2.94	2.49	8.80	1.08	0.55	9.88	8.00	10.43	9.00	4.55	4.00
1891	2.01	1.30	3.31	3.32	3.96	3.01	1.40	6.97	6.00	8.37	7.00	10.14	10.00
1892	......	......	......	......	3.30	6.81	4.12	10.11	10.00	14.23	11.00	2.17	2.00
1960	......	......	2.90	2.68	......	......	......	......	......	24.67	23.00	......	......
1893	0.45	1.50	1.95	1.65	3.75	4.34	3.07	8.09	8.00	11.16	9.00	11.16	10.00
1894	0.34	0.83	1.17	0.83	4.42	3.71	2.48	8.13	7.00	10.61	8.00	1.16	1.00
1895	1.92	1.25	3.17	3.30	5.50	2.46	3.09	7.96	8.00	11.05	9.00	7.22	7.00
1896	0.70	1.12	1.82	1.65	5.63	3.72	2.39	9.35	8.00	11.74	9.00	3.66	3.00
1897	0.64	1.22	1.86	1.65	5.66	3.94	2.19	9.60	8.00	11.79	9.00	3.52	3.00
1898	0.31	0.99	1.30	1.23	6.16	3.02	2.58	9.18	9.00	11.76	11.00	2.37	2.00
1961	......	......	......	3.30	......	......	......	......	6.00	......	7.00	......	10.00
1962	......	......	1.38	1.25	......	......	......	......	......	31.51	31.00	......	......
1899	2.19	1.13	3.32	3.00	7.97	1.20	0.48	9.17	8.00	9.65	......	9.61	10.00
1900	......	......	......	......	14.29	1.54	0.19	15.83	16.00	16.02	......	......	......
1901	1.71	0.46	2.17	2.20	9.35	1.31	0.50	10.66	10.00	11.16	......	6.45	6.00
1902	......	......	......	......	......	......	......	......	......	......	......	50.00	50.00
1903	......	......	15.32	15.00	......	......	......	......	......	......	......	......	......
1904	......	......	......	......	......	......	......	......	......	......	......	50.66	48.00
1905	......	......	1.85	1.65	6.23	2.78	3.33	9.01	8.00	12.34	10.00	2.34	2.00
1906	2.46	1.72	4.18	4.11	5.77	2.60	1.39	8.37	7.00	9.76	8.00	7.89	7.00
1907	1.71	1.73	3.44	3.30	6.51	1.49	1.78	8.00	8.00	9.78	10.00	6.01	6.00
1908	0.85	1.78	2.63	2.40	4.19	1.46	1.75	5.65	6.00	7.40	7.00	10.48	10.00
1909	1.80	1.76	3.56	3.30	4.08	1.88	1.85	5.96	6.00	7.81	7.00	10.56	10.00
1910	1.16	1.26	2.42	2.40	3.70	2.49	2.17	6.19	6.00	8.36	8.00	5.63	5.00
1911	1.91	1.48	3.39	3.28	3.45	3.14	3.57	6.59	6.00	10.16	7.00	10.04	10.00
1912	0.44	0.76	1.20	1.22	5.66	1.40	0.55	7.06	7.00	7.61	8.00	2.05	2.00
1913	0.76	1.02	1.78	1.64	3.85	4.93	1.33	8.78	8.00	10.11	9.00	3.23	3.00
1914	1.28	1.20	2.48	2.46	5.65	2.38	2.16	8.03	8.00	10.19	9.00	6.18	6.00
1915	2.32	1.40	3.72	3.69	5.38	3.53	1.17	8.91	7.00	9.08	8.00	10.54	10.00
1916	2.07	2.22	4.29	4.10	5.95	1.16	1.91	7.11	7.00	9.02	8.00	7.91	7.00
1917	0.88	0.88	1.76	1.64	3.46	4.89	0.98	8.35	7.00	9.33	8.00	4.28	4.00
1918	1.38	1.16	2.54	2.46	3.45	2.59	2.40	6.04	6.00	8.44	7.00	10.33	10.00
1919	0.88	1.60	2.48	2.46	5.66	1.93	3.77	7.59	8.00	11.36	10.00	4.34	4.00
1920	2.11	2.44	4.55	4.10	5.93	1.86	1.67	7.79	7.00	9.46	8.00	7.64	8.00
1921	2.70	1.26	3.96	3.69	5.33	1.95	2.64	7.28	7.00	9.92	8.00	10.18	10.00
1922	2.38	1.26	3.64	3.20	5.10	0.90	1.85	6.09	6.00	7.94	7.00	10.90	10.00
1923	0.96	1.62	2.58	2.47	4.86	2.75	3.67	7.61	8.00	11.28	9.00	4.11	4.00
1924	......	......	......	2.46	......	......	......	......	6.00	......	7.00	......	10.00
1925	2.00	1.36	3.36	3.29	6.09	1.04	1.53	7.13	8.00	8.66	9.00	7.06	7.00
1926	......	......	5.83	5.75	......	......	......	......	......	16.91	14.50	......	......

Descriptive List of Manufacturers' Samples, 1909.

Station number.	Manufacturer, Place of Business and Brand.
	PROVINCIAL CHEMICAL FERTILIZER CO., ST. JOHN, N. B.
1928	10% Complete Aroostook Potato
1929	Special Potato Phosphate
	P. H. REED, FT. FAIRFIELD, MAINE.
1960	Reed's Potato Grower
	SAGADAHOC FERTILIZER CO., BOWDOINHAM, MAINE.
1930	Acid Phosphate
1931	Aroostook Potato Manure
1932	Dirigo Fertilizer
1933	Muriate of Potash
1934	Nitrate of Soda
1935	Sagadahoc High Grade Superphosphate
1936	Sagadahoc Special Potato Fertilizer
1939	XX Chemical Fertilizer
1938	Yankee Fertilizer
1939	3-6 and 10 Fertilizer
1940	4-6 and 10 Fertilizer
	SWIFT'S LOWELL FERTILIZER CO., BOSTON, MASS.
1941	Acid Phosphate
1942	Muriate of Potash
1943	Nitrate of Soda
1944	Swift's Lowell Animal Brand
1945	Swift's Lowell Bone Fertilizer
1946	Swift's Lowell Cereal Fertilizer
1947	Swift's Lowell Dissolved Bone and Potash
1948	Swift's Lowell Empress Brand
1949	Swift's Lowell Potato Grower
1950	Swift's Lowell Potato Manure
1951	Swift's Lowell Potato Phosphate
1952	Swift's Lowell Superior Fertilizer
1953	Swift's Special Corn & Vegetable Manure
1954	Swift's Special Potato Fertilizer
	TUSCARORA FERTILIZER CO., BALTIMORE, MD.
1955	Tuscarora Aroostook Special
1956	Tuscarora Complete Potato
1957	Tuscarora Fruit and Potato
1958	Tuscarora Trucker
	JOHN WATSON & CO., HOULTON, MAINE.
1959	Watson's Improved Potato Fertilizer
	WHITMAN & PRATT RENDERING CO., LOWELL, MASS.
1963	Whitman & Pratt's Corn Success
1964	Whitman & Pratt's Potash Special
1965	Whitman & Pratt's Potato Manure
1966	Whitman & Pratt's Potato Plowman
1967	Whitman & Pratt's Vegetable Grower
1968	Whitman & Pratt's All Crop Brand

Analysis of Manufacturers' Samples, 1909.

Station number.	Nitrogen. Soluble in water.	Nitrogen. Insoluble in water.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
%	%	%	%	%	%	%	%	%	%	%	%	%	%
1928	......	......	3.24	3.29	5.76	0.90	0.64	6.66	8.00	7.30	......	10.01	10.00
1929	1.06	1.08	2.14	2.06	7.73	1.13	4.30	8.86	8.00	13.16	......	6.15	6.00
1960	2.01	1.80	3.81	3.30	6.31	1.11	0.65	7.42	7.00	8.07	8.50	8.55	8.00
1930	......	......	......	......	13.48	2.52	0.83	16.00	15.00	16.83	14.00	......	......
1931	0.92	0.08	1.00	1.00	7.11	1.44	0.45	8.55	6.00	9.00	7.00	4.97	4.00
1932	1.02	1.78	2.80	1.00	3.19	2.01	1.34	5.20	4.00	6.54	6.00	4.75	2.00
1933	......	......	......	......	......	......	......	......	......	......	......	53.20	50.00
1934	15.58	......	15.58	14.00	......	......	......	......	......	......	......	......	......
1935	1.54	0.38	1.92	1.50	6.86	1.14	3.50	8.00	6.00	11.50	7.00	4.37	3.00
1936	1.33	0.58	1.91	2.00	4.63	1.66	4.54	6.29	7.00	10.83	8.00	9.83	8.00
1937	7.03	1.07	8.10	7.00	......	......	3.76	4.29	4.00	8.05	6.00	10.05	8.00
1938	0.35	0.41	0.76	0.40	7.30	2.73	1.04	10.03	7.00	11.07	8.00	3.05	2.00
1939	1.73	0.80	2.53	2.47	3.11	1.56	1.98	4.67	6.00	6.65	7.00	10.18	10.00
1940	2.65	0.80	3.45	3.29	3.19	3.75	1.70	6.94	6.00	8.64	7.00	10.57	10.00
1941	......	......	......	......	10.05	2.76	2.42	12.81	12.00	15.23	13.00	......	......
1942	......	......	......	......	......	......	......	......	......	......	......	51.80	50
1943	......	......	15.72	15.00	......	......	......	......	......	......	......	......	......
1944	1.04	1.54	2.58	2.46	4.60	4.69	3.97	9.35	8.00	13.32	10.00	4.19	4.00
1945	0.73	0.94	1.67	1.64	5.26	2.76	1.79	8.02	8.00	9.81	9.00	3.20	3.00
1946	0.34	0.50	0.84	0.82	5.22	1.76	1.32	6.98	7.00	8.30	8.00	1.18	1.00
1947	0.72	1.04	1.76	1.64	8.21	1.80	1.15	10.01	9.00	11.16	10.00	2.35	2.00
1948	0.87	0.54	1.41	1.23	4.85	2.50	2.32	7.35	7.00	9.67	8.00	2.15	2.00
1949	2.14	1.42	3.56	3.28	4.99	1.51	1.35	6.50	6.00	7.85	7.00	10.53	10.00
1950	0.69	0.94	1.63	1.64	4.55	2.10	2.17	6.65	7.00	8.82	8.00	4.07	4.00
1951	1.31	1.16	2.47	2.46	5.66	2.49	1.71	8.15	8.00	9.86	9.00	6.35	6.00
1952	2.52	1.28	3.80	3.69	5.60	1.98	1.30	7.58	7.00	8.88	8.00	10.23	10.00
1953	1 88	1.48	3.36	3.28	5.95	1.38	1.68	7.33	8.00	9.01	9.00	7.10	7.00
1954	1.71	0.88	2.59	2.46	5.34	1.77	1.02	7.11	6.00	8.13	7.00	10.51	10.00
1955	1.45	1.16	2.61	2.47	6.94	1.18	0.89	8.12	7.00	9.01	8.00	9.23	8.00
1956	1.66	1.96	3.62	3.29	5.73	1.04	1.06	6.77	6.00	7.83	7.00	10.78	10.00
1957	0.74	1.02	1.76	1.65	7.89	0.98	1.08	8.87	8.00	9.95	9.00	11.40	10.00
1958	2.64	2.12	4.76	4.11	7.93	0.93	0.63	8.86	8.00	9.49	9.00	7.35	7.00
1959	0.09	2.00	4.62	4.12	7.55	1.00	0.66	8.55	8.00	9.21	10.00	7.68	7.00
1963	0.90	0.87	1.77	1.64	4.61	3.26	2.54	7 87	8.00	10.41	10.00	3.30	3.00
1964	1.47	1.26	2.73	2.87	3.32	3.02	2.89	6.34	6.00	9.23	8.00	10.85	10.00
1965	1.34	0.01	2.35	2.46	2.44	4.81	1.28	7.25	7.00	8.53	9.00	5.41	5.00
1966	......	......	......	3.29	......	......	......	......	7.00	......	9.00	......	6.00
1967	......	......	......	3.29	......	......	......	......	8.00	......	10.00	......	7.00
1868	......	......	......	2.46	......	......	......	......	9.00	......	11.00	......	4.00

[Continued from page 19.]

manufacturer, etc., and for the convenience or other advantage incidental to their use.

For many years this Station has not printed an estimate of the commercial value of the different brands licensed in the State. If anyone wishes to calculate the commercial value he can do so by using the trade values adopted for 1909 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, 1909, in ton lots at tide water in the states named. 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 1909.

	Cents per pound.
Nitrogen in nitrates	16½
in ammonia salts	17
Organic nitrogen in dry and fine ground fish, meat and blood, and in mixed fertilizers	19
in fine bone and tankage	19
in coarse bone and tankage	14
Phosphoric acid, water-soluble	4
citrate-soluble	3½
in fine ground bone and tankage	3½
in coarse bone and tankage	3
in cotton seed meal, castor pomace and ashes	3
in mixed fertilizers, if insoluble in ammonium citrate	2
Potash as high grade sulphate and in forms free from muriate or chlorides	5
as muriate	4¼

RULES FOR CALCULATING VALUATION OF FERTILIZERS.

The commercial valuation will be accurate enough as a means of comparison if the following rule is adopted:

Multiply 3.8 by the percentage of nitrogen.

Multiply 0.7 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,	3.8 × 3.30,	$12 54
Available phosphoric acid,	0.7 × 8.00,	5 60
Insoluble phosphoric acid,	0.4 × 1.00,	40
Potash,	1.0 × 6.00,	6 00
		$24 54

Since this rule assumes all the nitrogen to be organic and all the potash to be in the form of the sulphate, it is evident that the valuations thus calculated must not be taken as the only guide in the choice of a fertilizer. In every case the farmer should consider the needs of his soil before he begins to consider the cost. In many instances a little careful experimenting will show him that materials containing either nitrogen, potash, or phosphoric acid alone will serve his purpose as fully as a "complete fertilizer," in which he must pay for all three constituents, whether needed or not.

AGRICULTURAL SEED INSPECTION.

During the year 1908, the chief work in connection with seed inspection was to make it possible for wholesale dealers in Maine to place proper guarantees on their seeds. Seed houses outside of the State will not sell guaranteed seeds. It is therefore necessary, in order that the wholesale trade in Maine shall know the quality of the seeds which they are handling to have them examined. It was believed that by making these examinations free for dealers that greater advances would be made in the quality of the seeds handled in Maine than in any other way; consequently during the spring months a large number of samples (291) were examined for dealers in Maine. About 432 official samples were collected and quite a large percentage of these have been examined. The official samples, for the most part, corresponded fairly closely with the guaranties which the dealers had placed upon the goods. Because of a defect in the law the opinion was held that prosecutions could not be maintained and therefore no attempt was made during the season of 1908 to follow up the violations of the seed law. This matter has been amended by the present legislature so that it is believed that the requirements of the seed law can be enforced.

Quite a large number of samples have been examined for dealers thus far in 1909. It is proposed during the months of April and May to collect samples and compare them with their guaranties. Dealers will take notice that many excuses that have been accepted in the past, will no longer be accepted as valid reasons for not bringing a case to trial. Neglect to conform to the requirements of the law will be considered as though they were wilful violations. It is now 12 years that the seed law has been upon the statute books. While dealers cannot buy guaranteed seeds outside of the State, they have no excuse for not knowing the purity of the seeds which they handle, as the Station has offered to make free examination of all samples taken and submitted in accordance with its directions. Maine wholesale dealers are prepared to supply retailers with guaranteed seeds.

[344-4-09]

MAINE

AGRICULTURAL EXPERIMENT STATION

ORONO, MAINE.

CHAS. D. WOODS, Director.

Official Inspections.

10

Both the spirit and the letter of the Maine Inspection laws demand freedom from adulteration and truthful labeling.

FEEDING STUFF INSPECTION.

CHIEF REQUIREMENTS OF THE LAW.

The points of the law of most interest both to the dealer and consumer concisely stated, follow.

Kinds of Feed Exempt Under the Law. The law applies to all feeding stuffs *except* the following: hays and straws; whole seeds, meals, brans and middlings of wheat, rye, barley, oats, Indian corn, buckwheat and broom corn, sold separately; wheat bran and middlings mixed together and pure grains ground together.

Kinds of Feed Coming within the Law. The principal feeds coming under the provisions of the law are linseed meals, cottonseed meals, cottonseed feeds, pea meals, cocoanut meals, gluten meals, gluten feeds, maize feeds, starch feeds, sugar feeds, dried brewer's grains, dried distiller's grains, malt sprouts, hominy feeds, cerealine feeds, rice meals, oat feeds, corn and oat chops, corn and oat feeds, corn bran, ground beef or fish scraps, foods, poultry foods, stock foods, patented, proprietary and trademark stock and poultry foods, mixed feeds other than those composed solely of wheat bran and middlings mixed together or pure grains ground together, and all other materials of similar nature.

The Brand. Each package of feeding stuffs coming within the law shall bear, conspicuously printed, the following statements:

The number of net pounds contained in the package.

The name or trade-mark under which it is sold.

The name of the manufacturer or shipper.

The place of manufacture.

The place of business of manufacturer or shipper.

The percentage of crude protein.

The percentage of crude fat.

The Adulteration of Feeding Stuffs. If any foreign substances are added to whole or ground grain or wheat offals, the true mixture must be plainly marked upon the packages.

Penalties. The sale or offering for sale of feeding stuffs not properly branded, or containing a smaller percentage of protein and fat than are guaranteed, or of adulterated feeding stuffs, is punishable by a fine not exceeding $100 for the first, and $200 for each subsequent offense.

THE GUARANTY.

No prosecution will be made against any handler of feeding stuffs within the State provided he obtain at the time of purchase a *written guaranty* that the goods are in conformity with the law regulating their sale. Failure to obtain such a guaranty on the part of the dealer will be presumptive evidence that he is not sufficiently interested in the purity of the goods which he handles, and unless there are especially extenuating circumstances, the Director will feel it his duty to begin prosecution for a violation of the laws regulating the sale of concentrated commercial feeding stuffs.

Any form of guaranty covering the facts may be used. The *printed matter on the bag or the tags* accompanying the feeding stuff *will not be considered as a guaranty*. The guaranty to be valid must be signed in ink. The guaranty should identify and may be attached to the bill of sale, invoice, Bill of Lading or other schedule giving the name and amount of feed stuff. In case of car load lots, the car number should appear.

In case a dealer cannot obtain a written guaranty from the parties from whom he purchases, the only safe thing is to take a sample from the car immediately on its arrival and before it is accepted, and send to the Experiment Station. A prompt free analysis will be made and results reported.

RESULTS OF THE INSPECTION FOR 1908-9.

The last bulletin on feeding stuff inspection was published in April, 1908. The present report gives the analyses of about 800 samples of feeding stuffs that have been collected by the inspector and sent in by correspondents since that bulletin was issued. This includes samples that were taken up to about March 18, 1909, at which time the copy for the tables was sent to the printer.

DATE OF RECEIPT OF SAMPLES.

The time of drawing the samples is not given in the tables showing the results of the analyses but can be readily ascertained by comparing the sample number with the following list which shows the dates of receipt of the sample.

Samples 2088 to 2125 received in March, April and May, 1908.

Samples 2122 to 2153 received in June, July and August, 1908.

Samples 2154 to 2173 received in September and October, 1908.

Samples 2174 to 2249 received in November, 1908.

Samples 2250 to 2532 received in December, 1908.

Samples 2533 to 2686 received in January, 1909.

Samples 2687 to 2821 received in February, 1909.

Samples 2822 to 2869 received in March, 1909.

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein.		Fat.		Station number.
		Found—per cent.	Guaranteed—per cent.	Found—per cent.	Guaranteed per cent.	
COTTON SEED MEAL.						
Cotton Seed Meal....................	*D	45.69	41.00	–	9.00	2112
American Cotton Oil Co., Greenville, Miss	D	39.38	41.00	–	9.00	2147
	D	43.00	41.00	–	9.00	2162
	D	41.40	41.00	–	9.00	2171
	D	40.75	41.00	–	9.00	2562
	D	42.50	41.00	–	9.00	2566
	D	41.82	41.00	–	9.00	2578
	D	40.75	41.00	–	9.00	2593
	O	38.69	41.00	9.97	9.00	2799
	D	42.00	41.00	–	9.00	2834
Battle Brand Choice Cotton Seed Meal..	O	44.81	41.00	8.56	8.00	2234
W. P. Battle & Co., Memphis, Tenn...	O	42.81	41.00	–	8.00	2354
	O	41.87	41.00	–	8.00	2407
	D	41.87	41.00	–	8.00	2480
	D	41.50	41.00	–	8.00	2481
	D	41.13	41.00	–	8.00	2519
	O	41.63	41.00	–	8.00	2606
Buck Eye Cotton Seed Meal...........	O	38.50	39.00	9.19	–	2282
Buckeye Cotton Oil Co..............	D	42.00	41.00	–	–	2750
	D	41.17	41.00	6.75	–	2751
	D	39.71	41.00	–	–	2771
	D	41.25	41.00	–	–	2774
	O	40.54	41.00	–	–	2791
	D	40.75	39.00	–	–	2822
	D	42.00	41.00	–	–	2869
Cotton Seed Meal.....................	D	41.13	41.00	–	9.00	2114
H. E. Bridges & Co., Memphis, Tenn.	D	41.94	41.00	–	9.00	2124
	O	41.25	41.00	4.10	7.00	2371
	O	42.87	41.00	–	7.00	2424
	O	41.13	41.00	–	7.00	2445
	D	40.63	41.00	–	7.00	2535
	D	43.37	41.00	–	7.00	2853
	D	41.25	41.00	–	7.00	2861
Dixie Brand Cotton Seed Meal..........	D	43.13	41.00	–	9.00	2095
Humphreys, Godwin & Co., Memphis, Tenn.............................	D	40.25	41.00	–	9.00	2107
	C	43.56	41.00	–	9.00	2153
	D	44.50	41.00	–	9.00	2167
	D	43.06	41.00	–	8.00	2181
	O	36.25	41.00	–	8.00	2192
	O	40.87	41.00	–	8.00	2208
	O	40.38	41.00	–	8.00	2219
	O	41.25	41.00	8.76	8.00	2228
	D	40.25	41.00	–	8.00	2231
	D	33.38	41.00	–	8.00	2232
	D	43.19	41.00	–	8.00	2233
	O	42.62	41.00	–	8.00	2246
	O	37.37	41.00	–	8.00	2289
	D	42.25	41.00	–	8.00	2299
	O	39.63	41.00	–	8.00	2307
	O	38.25	41.00	–	8.00	2311
	O	42.94	41.00	–	8.00	2337

* C, from the feeder; D. from the dealer; M, from the manufacturer; and O, the inspector's sample.

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
COTTON SEED MEAL—Continued.						
Dixie Brand Cotton Seed Meal —Continued.	O	41.12	41.00	–	8.00	2341
	O	41.94	41.00	–	9.00	2351
	D	38.25	41.00	–	8.00	2360
	D	39.63	41.00	–	8.00	2361
	O	42.00	41.00	–	8.00	2364
	D	39.00	41.00	–	8.00	2379
	D	41.50	41.00	–	7.00	2380
	D	38.06	41.00	–	7.00	2382
	O	44.87	41.00	–	9.00	2386
	O	41.37	41.00	–	8.00	2390
	O	43.18	41.00	–	7.00	2392
	O	41.94	41.00	–	8.00	2419
	D	43.69	41.00	–	7.00	2429
	D	42.25	41.00	–	8.00	2436
	D	38.75	41.00	–	8.00	2437
	O	41.13	41.00	–	8.00	2439
	O	38.25	41.00	–	7.00	2472
	M	42.25	41.00	–	8.00	2482
	D	42.37	41.00	–	8.00	2483
	D	37.81	41.00	–	8.00	2486
	O	41.87	41.00	–	8.00	2490
	O	40.25	41.00	–	7.00	2496
	O	40.38	41.00	–	8.00	2521
	D	40.69	41.00	–	9.00	2559
	D	41.57	41.00	–	8.00	2561
	D	38.69	41.00	–	7.00	2569
	D	40.50	41.00	–	8.00	2570
	D	41.93	41.00	–	7.00	2572
	D	40.38	41.00	–	8.00	2579
	O	37.44	41.00	–	8.00	2580
	D	38.31	41.00	–	8.00	2611
	D	42.75	41.00	–	8.00	2619
	D	39.25	41.00	–	8.00	2620
	D	40.69	41.00	–	9.00	2627
	D	40.61	41.00	–	9.00	2628
	M	39.00	41.00	–	8.00	2631
	D	40.25	41.00	–	9.00	2636
	D	39.13	41.00	–	8.00	2650
	D	42.37	41.00	–	8.00	2651
	D	43.16	41.00	–	8.00	2655
	D	43.50	41.00	–	8.00	2657
	D	45.19	41.00	–	9.00	2664
	O	39.13	39.00	–	8.00	2671
	O	39.93	41.00	–	8.00	2682
	O	37.75	41.00	–	9.00	2706
	O	41.75	41.00	–	8.00	2710
	O	42.00	41.00	–	8.00	2713
	O	42.68	41.00	–	8.00	2715
	O	39.87	41.00	–	7.00	2721
	O	41.50	41.00	–	8.00	2722
	O	40.88	41.00	–	7.00	2724
	O	39.63	41.00	–	7.00	2725
	O	42.37	41.00	–	9.00	2745
	D	41.43	41.00	–	8.00	2772
	O	40.44	41.00	–	8.00	2776
	O	41.75	41.00	–	8.00	2785
	D	41.87	41.00	–	7.00	2788
	D	43.00	41.00	–	7.00	2812
	D	40.81	41.00	–	7.00	2846

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
COTTON SEED MEAL—Continued.						
Dove brand Pure Cotton Seed Meal.... F. W. Brode & Co., Memphis.	O	39.13	38.00	7.82	7.00	2753
Eagle Brand Cotton Seed Meal..........	D	37.75	41.00	–	9.00	2536
American Brokerage Co..............	D	36.75	41.00	–	9.00	2616
Cotton Seed Meal, Georgia, Registered..	D	45.20	–	–	–	2159
Madison, Oil Co., Madison, Ga........	D	43.81	–	–	–	"
	D	47.87	–	–	–	"
Good Luck Cotton Seed Meal........... S. P. Davis, Littlerock, Ark.	O	39.62	38.00	10.52	9.00	2344
Green Diamond Cotton Seed Meal.......	D	43.88	41.00	–	9.00	2250
Chapin & Co., Boston, Mass...........	O	42.94	41.00	8.92	9.00	2254
	O	42.50	41.00	–	9.00	2366
	O	43.87	41.00	–	9.00	2373
	O	43.12	41.00	–	9.00	2394
	D	42.50	41.00	–	9.00	2431
	D	41.75	41.00	–	9.00	2564
	O	44.19	41.00	–	9.00	2586
	D	42.71	41.00	–	9.00	2743
	D	40.50	41.00	–	9.00	2789
Cotton Seed Meal......................	C	37.63	38.50	–	7.50	2183
Hunter Bros. Milling Co.,St. Louis, Mo.	O	37.37	38.50	–	8.00	2195
	O	42.87	41.00	9.32	7.00	2247
	O	44.13	41.00	–	7.50	2271
	O	43.50	41.00	–	9.00	2287
	D	35.25	41.00	–	9.00	2571
	O	43.88	41.00	8.03	9.00	2415
	D	41.87	41.00	–	9.00	2252
	C	40.63	41.00	–	7.50	2614
	C	42.37	41.00	–	7.50	2615
	D	39.87	41.00	–	7.50	2638
	D	37.50	41.00	–	9.00	2646
	O	37.42	41.00	–	9.00	2705
	D	42.00	41.00	–	7.50	2832
	D	41.06	41.00	–	7.50	2839
	D	38.50	41.00	–	7.50	2845
	D	41.50	41.00	–	7.50	2847
Cotton Seed Meal......................	O	39.44	41.00	8.78	8.00	2203
C. C. Johnson Co., Memphis, Tenn.....	O	37.62	41.00	9.04	8.00	2349
Cotton Seed Meal...................... H. B. Johnson & Co., Memphis, Tenn..	O	41.63	41.00	–	9.00	2088
Old Gold Brand Cotton Seed Meal.......	D	42.63	41.00	–	9.00	2097
T. H. Bunch, Littlerock, Ark.........	O	40.38	41.00	–	9.00	2270
	O	42.87	41.00	9.21	9.00	2281
	D	38.25	41.00	–	9.00	2563
	D	38.25	41.00	–	9.00	2577
	D	39.63	41.00	–	9.00	2618
	D	39.87	41.00	–	9.00	2630

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
COTTON SEED MEAL.—Continued.						
Old Gold Brand Cotton Seed Meal —Continued.	O	40.50	41.00	–	9.00	2702
	D	39.25	41.00	–	8.00	2786
	D	39.50	41.00	–	8.00	2787
	D	37.90	41.00	–	8.00	2793
	D	41.75	41.00	–	9.00	2824
	D	40.70	41.00	–	9.00	2827
	D	39.75	41.00	–	9.00	2837
	C	39.63	41.00	–	9.00	2841
	D	40.09	41.00	–	9.00	2849
	D	41.19	41.00	–	9.00	2859
	D	40.13	41.00	–	9.00	2865
	D	37.63	41.00	–	9.00	2866
Owl Brand Cotton Seed Meal...........	D	45.69	41.00	–	7.00	2094
F. W. Brode & Co., Memphis, Tenn...	D	44.69	41.00	–	7.00	2098
	D	42.75	41.00	–	7.00	2100
	D	43.94	41.00	–	7.00	2104
	D	45.00	41.00	–	7.00	2105
	D	44.44	41.00	–	7.00	2108
	D	43.07	41.00	–	7.00	2109
	D	42.44	41.00	–	7.00	2110
	D	41.07	41.00	–	7.00	2130
	D	42.31	41.00	–	7.00	2132
	D	44.25	41.00	–	7.00	2172
	D	43.25	41.00	–	7.00	2179
	D	40.13	41.00	–	7.00	2180
	O	43.50	41.00	–	7.00	2187
	O	43.25	41.00	9.50	7.00	2214
	O	40.56	41.00	–	7.00	2257
	O	41.69	41.00	–	7.00	2275
	D	42.56	41.00	–	7.00	2278
	O	39.81	41.00	–	7.00	2322
	O	42.75	41.00	–	7.00	2325
	O	42.25	41.00	–	7.00	2368
	D	41.13	41.00	–	7.00	2378
	D	43.12	41.00	–	7.00	2409
	O	42.00	41.00	–	7.00	2410
	D	43.00	41.00	–	7.00	2432
	D	41.25	41.00	–	7.00	2433
	O	43.18	41.00	–	7.00	2442
	O	42.25	41.00	–	7.00	2463
	O	40.69	41.00	–	7.00	2474
	D	35.62	41.00	–	7.00	2520
	O	43.50	41.00	–	7.00	2529
	O	40.25	41.00	–	7.00	2544
	O	41.87	41.00	–	7.00	2596
	D	41.75	41.00	–	6.00	2645
	D	42.62	41.00	–	6.00	2652
	D	42.32	41.00	–	6.00	2656
	O	41.37	41.00	–	6.00	2674
	O	42.50	41.00	–	6.00	2683
	O	43.06	41.00	–	7.00	2708
	O	41.06	41.00	–	7.00	2712
	O	39.00	41.00	–	7.00	2718
	O	43.06	41.00	–	7.00	2730
	D	42.06	41.00	–	6.00	2736

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
COTTON SEED MEAL—Continued.						
Owl Brand Cotton Seed Meal —Continued.	D	42.42	41.00	–	6.00	2740
	O	41.19	41.00	–	6.00	2744
	O	44.31	41.00	–	7.00	2758
	D	43.06	41.00	–	6.00	2766
	O	43.12	41.00	–	7.00	2754
	D	44.13	41.00	–	6.00	2781
	O	41.37	41.00	–	7.00	2782
	O	41.25	41.00	–	6.00	2803
	O	42.13	41.00	–	7.00	2820
	D	41.94	41.00	–	6.00	2823
	D	41.63	41.00	–	6.00	2826
	D	42.62	41.00	–	7.00	2828
	D	41.69	41.00	–	6.00	2829
	D	43.63	41.00	–	6.00	2830
	D	44.37	41.00	–	7.00	2844
	D	41.50	41.00	–	7.00	2858
	D	40.88	41.00	–	6.00	2860
	D	42.00	41.00	–	6.00	2863
Peacock Cotton Seed Meal............. Peacock Cotton Seed Meal Co., Memphis, Tenn.	D	43.75	41.00	–	9.00	2741
Purity Brand Cotton Seed Meal.........	D	41.50	41.00	–	5.00	2175
Blackstone Smith, New Orleans, La....	D	40.88	41.00	–	5.00	2176
	D	42.06	41.00	–	9.00	2185
	D	42.13	41.00	–	9.00	2253
	O	40.81	41.00	–	5.00	2256
	O	40.87	41.00	8.32	5.00	2267
	D	39.63	41.00	–	5.00	2276
	O	39.00	41.00	–	9.00	2323
	O	40.65	41.00	–	5.00	2338
	O	39.13	41.00	–	5.00	2350
	O	41.00	41.00	–	5.00	2402
	D	37.50	41.00	–	5.00	2533
	O	40.75	41.00	–	5.00	2585
	D	41.63	41.00	–	5.00	2644
	D	40.25	41.00	–	5.00	2653
	D	44.00	41.00	–	5.00	2654
	D	41.50	41.00	–	5.00	2659
	D	43.94	41.00	–	9.00	2666
	O	40.00	41.00	–	5.00	2667
	D	41.63	41.00	–	9.00	2692
	D	44.75	41.00	–	9.00	2696
	O	40.56	41.00	–	5.00	2728
	D	44.37	41.00	–	9.00	2735
	D	41.33	41.00	–	9.00	2767
	D	42.00	41.00	–	9.00	2794
	D	42.69	41.00	–	9.00	2796
	D	42.19	41.00	–	9.00	2811
	D	41.50	41.00	–	9.00	2838
	D	41.66	41.00	–	9.00	2840
	D	42.37	41.00	–	9.00	2842
	D	40.00	41.00	–	5.00	2851

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
COTTON SEED MEAL—Concluded.						
Soper's Choice Cotton Seed Meal	C	44.87	41.00	–	8.00	2163
J. E. Soper & Co., Boston, Mass.	D	41.00	41.00	–	8.00	2178
	O	45.00	41.00	9.35	8.00	2237
	D	39.19	38.50	–	5.00	2632
	D	40.05	38.50	–	5.00	2687
Star Brand Cotton Seed Meal	D	42.38	41.00	–	9.00	2090
J. Lindsey Wells Co., Memphis, Tenn.	D	45.69	41.00	–	9.00	2101
	D	35.82	41.00	–	9.00	2115
	D	39.06	41.00	–	9.00	2131
	D	39.07	41.00	–	9.00	2133
	D	39.06	41.00	–	9.00	2279
	D	38.12	41.00	–	9.00	2300
	O	38.87	41.00	10.27	9.00	2334
	O	39.37	41.00	–	9.00	2414
	D	39.65	41.00	–	9.00	2560
	O	37.81	41.00	–	9.00	2648
	D	44.25	41.00	–	9.00	2689
Sun Brand Choice Cotton Seed Meal	D	43.25	41.00	–	7.00	2170
J. Lindsey Wells Co., Memphis, Tenn.	O	43.50	41.00	9.45	9.00	2209
	C	44.37	41.00	–	9.00	2251
	O	42.37	41.00	–	9.00	2405
	O	42.75	41.00	–	9.00	2470
	O	37.87	36.00	–	6.00	2779
COTTON SEED FEED.						
Fox Brand Standard Cotton Seed Feed Meal	D	24.94	22.00	–	5.00	2113
F. W. Brode & Co., Memphis, Tenn.						
Star Cotton Feed	O	12.50	10.00	6.86	6.50	2363
Toledo Elevator Co., Toledo, Ohio	O	12.44	10.00	–	6.50	2401
	O	11.56	10.00	–	6.50	2408
	O	11.94	10.00	–	6.50	2456
Cremo Brand Cotton Seed Feed Meal	O	24.50	22.00	6.58	5.00	2731
Tennessee Fiber Co.						
LINSEED OIL MEAL.						
Linseed Oil Meal	O	36.25	36.00	3.74	1.00	2205
American Linseed Co., Chicago, Ill.	D	39.13	36.00	–	1.00	2484
	D	38.87	36.00	–	1.00	2487
	D	37.63	36.00	–	1.00	2573
	O	40.13	36.00	–	1.00	2792
Old Process Oil Meal	O	37.37	32.00	6.17	5.00	2240
American Linseed Co., Chicago, Ill.	O	34.63	34.00	8.37	6.50	2291
	O	37.44	32.00	–	5.00	2296
	O	36.75	32.00	–	5.00	2438
	O	36.63	32.00	–	5.00	2466
	D	37.50	32.00	–	5.00	2855

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
GLUTEN FEED.						
Gluten Feed American Corn Products Co.	D	28.94	23.00	–	2.50	2568
Cream of Corn Gluten Feed	O	24.75	23.00	4.26	2.50	2193
American Maize Products Co.	O	24.87	23.00	–	2.50	2420
	O	23.50	23.00	–	2.50	2443
	D	23.62	23.00	–	2.50	2617
	O	29.50	23.00	–	2.50	2800
Clinton Gluten Feed Clinton Sugar Refining Co., Clinton, Iowa	O	24.12	23.00	4.08	3.00	2464
Buffalo Gluten Feed	C	25.63	24.75	–	–	2103
Corn Products Mfg. Co., Chicago, Ill.	O	25.50	23.00	–	2.50	2220
	O	28.38	23.00	–	2.50	2197
	O	25.62	23.00	–	2.50	2207
	O	25.06	23.00	–	2.50	2210
	O	26.00	23.00	–	2.50	2212
	O	25.62	23.00	–	2.50	2245
	O	25.12	23.00	4.13	2.50	2259
	O	25.62	23.00	–	2.50	2280
	O	24.87	23.00	–	2.50	2290
	O	23.88	23.00	–	2.50	2295
	O	24.69	23.00	–	2.50	2309
	O	25.62	23.00	–	2.50	2362
	O	24.12	23.00	–	2.50	2374
	O	25.31	23.00	–	2.50	2389
	O	25.31	23.00	–	2.50	2475
	O	26.25	23.00	–	2.50	2498
	D	26.75	23.00	–	2.50	2574
	O	25.75	23.00	–	2.50	2590
	O	25.62	23.00	–	2.50	2594
	D	26.75	23.00	–	2.50	2625
	D	25.88	23.00	–	2.50	2635
	D	26.94	23.00	–	2.50	2662
	D	26.88	23.00	–	2.50	2665
	O	28.75	23.00	–	2.50	2670
	O	26.62	23.00	–	2.50	2675
	O	26.25	23.00	–	2.50	2681
	O	26.00	23.00	–	2.50	2697
	O	27.87	23.00	–	2.50	2709
	D	27.33	23.00	–	2.50	2749
	D	26.25	23.00	–	2.50	2795
	O	27.81	23.00	–	2.50	2804
	D	27.63	23.00	–	2.50	2831
Diamond Gluten Feed	O	22.94	23.00	5.19	2.50	2356
Corn Products Rfg. Co., Chicago, Ill.	O	24.75	23.00	–	2.50	2446
	O	25.13	23.00	–	2.50	2506
	O	25.50	23.00	–	2.50	2530
Globe Gluten Feed Corn Products Rfg. Co., Chicago, Ill.	O	27.25	24.00	3.70	2.50	2522
Gluten Feed J. C. Hubinger Bros. Co., Keokuk, Iowa.	O	23.50	23.50	3.91	2.60	2396

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
GLUTEN FEED—Continued.						
Jenks Gluten Feed	D	28.13	27.00	–	7.50	2161
Huron Milling Co., Harbor Beach, Mich.	D	26.94	27.00	–	7.50	2277
	O	30.00	27.00	9.78	7.50	2326
	O	27.87	27.00	–	7.50	2543
	O	26.87	27.00	–	2.50	2605
	D	23.63	27.00	–	2.50	2609
	D	29.19	27.00	–	2.50	2647
	D	25.44	27.00	–	2.50	2663
	O	27.37	27.00	–	7.50	2746
Bay State Gluten Feed	O	21.00	23.00	4.60	4.00	2340
J. E. Soper & Co., Boston, Mass.						
New England Gluten Feed	D	25.94	24.00	–	3.00	2151
J. E. Soper & Co., Boston, Mass.	O	25.19	24.00	5.43	3.00	2293
Western Gluten Feed	O	23.75	23.00	4.03	2.50	2200
Western Glucose Co., Chicago, Ill.	O	23.87	23.00	–	2.50	2230
	O	22.25	23.00	–	2.50	2426
	O	24.50	23.00	–	2.50	2441

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

WEED SEEDS IN FEEDING STUFFS.

The oil meals and gluten feeds, the analyses of which preceed, have never been found to contain weed seeds of any amount. The analyses of the feeding stuffs which are more or less likely to carry weed seeds, follow. In most cases the official samples have been tested for weed seeds, but rarely have the samples which have been sent in by correspondents been so tested. In case the feeds have not been tested, the fact is indicated by ** referring to the foot note. In no case was there an exact quantitative analysis made, but a general estimate of the number of the seeds were formed by the analyst. In no case were the weed seeds tested for vitality.

In the winter of 1908 quite an extended investigation was made relative to weed seeds in feeding stuffs in Maine. These results were published at considerable length in bulletin 156. It is not purposed to discuss only in a very general way, the matter of weed seeds in the present report.

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Weed seeds found—per cent.	Station number.
DISTILLERS GRAINS.							
Ajax Flakes	O	29.75	31.00	-	12.00	None.	2191
Ajax Milling & Feed Co.	O	30.20	31.00	-	12.00	**	2199
	O	28.19	31.00	-	12.00	None.	2211
	O	30.75	31.00	14.30	12.00	None.	2215
	O	29.37	31.00	-	12.00	None.	2355
	D	31.38	31.00	-	12.00	**	2633
Continental Gluten Feed	O	30.25	33.00	15.48	14.00	None.	2241
Continental Cereal Co.							
"Climax" Distillers Corn Grains	D	30.32	34.00	13.62	11.00	**	2121
Deutsch & Sickert Co., Milwaukee, Wis.	O	29.87	34.00	12.11	11.00	None.	2202
	D	33.75	34.00	-	11.00	**	2622
"Corn Protegran" Distillers Corn Grains	D	27.38	33.00	12.73	12.00	**	2106
Dewey Brothers, Blanchester, Ohio.							
Fourex Grains	O	30.50	33.00	13.47	11.00	None.	2239
J. W. Biles Co., Cincinnati, Ohio	O	30.31	33.00	-	11.00	None.	2330
	O	31.25	31.00	-	12.00	None.	2399
	D	32.13	31.00	-	12.00	**	2576
	D	30.75	33.00	-	11.00	**	2621
	O	30.19	33.00	-	11.00	**	2733
	D	34.37	31.00	-	12.00	**	2825
Onex "X" Distillers Dried Grains	O	22.56	22.00	10.81	8.00	None.	2305
J. W. Biles Co., Cincinnati, Ohio.							
Proteina	D	27.50	31.00	-	9.00	**	2634
C. F. Keck & Co., Milwaukee, Wis.							
Unicorn Dairy Ration	O	27.75	26.00	-	6.00	Few.	2190
Ajax Milling and Feed Co	O	27.75	26.00	-	6.00	None.	2218
	O	27.06	26.00	-	6.00	Few.	2266
	O	26.37	26.00	6.72	6.00	Few.	2235
	O	25.50	26.00	-	6.00	Few.	2526
	O	26.75	26.00	-	6.00	Few.	2600
Unicorn Dairy Ration	D	28.88	26.00	-	6.00	**	2126
Chapin & Co., Boston, Mass.	D	30.31	26.00	-	6.00	**	2149
	C	25.62	26.00	-	6.00	**	2610
	D	27.31	26.00	-	6.00	**	2742
MISCELLANEOUS REINFORCED FEEDS.							
Badger Dairy Feed	C	17.32	18.00	-	4.50	**	2089
Chas. A. Krause Milling Co., Milwaukee, Wis	O	18.00	18.00	5.38	4.50	5	2182
	O	17.50	18.00	-	4.50	8	2188
	O	17.75	18.00	-	4.50	5	2201
	O	16.13	18.00	-	4.50	25	2213
	O	16.99	18.00	-	4.50	10	2227

** Not tested for weeds.

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Weed seeds found—per cent.	Station number.
MISCELLANEOUS REINFORCED FEEDS—Continued.							
Badger Dairy Feed—Continued.	O	15.63	18.00	–	4.50	None.	2249
	O	17.63	18.00	–	4.50	10	2306
	O	15.63	18.00	–	4.50	8	2347
	O	17.38	18.00	–	4.50	Few.	2422
	O	18.06	18.00	–	4.50	8	2430
	D	16.00	18.00	–	4.50	**	2435
	D	18.75	18.00	6.06	4.50	**	2507
	D	17.00	18.00	–	4.50	**	2508
	D	17.00	18.00	–	4.50	**	2509
	D	16.75	18.00	–	4.50	**	2510
	D	17.81	18.00	–	4.50	**	2511
	D	15.63	18.00	6.88	4.50	**	2512
	D	15.94	18.00	–	4.50	**	2513
	D	15.32	18.00	–	4.50	**	2514
	D	15.88	18.00	–	4.50	**	2515
	D	16.38	18.00	–	4.50	**	2516
	D	15 63	18.00	–	4.50	**	2517
	D	15.00	18.00	–	4.50	**	2518
	D	16.63	17.00	–	4.50	**	2661
	D	17.44	18.00	–	4.50	**	2690
	O	17.63	18.00	–	4.50	15	2734
	D	17.77	16.00	–	3.50	**	2864
Daisy Dairy Feed	D	13.44	16.00	–	3.00	**	2092
Great Western Cereal Co., Chicago	D	14.00	14.00	–	3.00	**	2093
	O	15.13	14.00	–	3.00	8	2186
	O	15.13	14.00	–	3.00	10	2204
	O	13.56	14.00	–	3.00	8	2243
	O	14.00	14.00	3.61	3.00	Few.	2255
	O	15.19	14.00	–	3.00	Few.	2264
	O	13.88	14.00	–	3.00	8	2318
	O	14.88	14.00	–	3.00	Many.	2365
	O	16.13	14.00	–	3.00	Few.	2452
	O	18.56	14.00	–	3.00	Few.	2524
	O	16.38	14.00	–	3.00	Few.	2582
	O	10.38	14.00	–	3.00	Many.	2591
	O	15.44	14.00	–	3.00	**	2759
	D	17.63	14.00	–	3.00	**	2773
	O	18.00	14.00	–	3.00	8	2810
Hammond Dairy Feed	M	17.63	17.00	5.79	3.00	8	2119
Western Grain Products Co., Hammond, Ind.							
H. J. Flax Feed	D	16.44	17.34	–	17.87	**	2096
Henry Jennings, Boston, Mass	D	13.57	14.00	–	14.00	15	2120
	O	14.38	17.34	8.24	17.37	50	2608
	O	15.13	17.34	–	17.37	50	2679
	D	15.25	17.84	–	17.37	**	2694
Calf Meal	D	18.81	19.00	–	8.00	**	2623
Quaker Oats Co.							
Schumaker's Calf Meal	O	19.38	19.00	9.24	8.00	None.	2274

** Not tested for weeds.

C, from the feeder; D, from the dealer; M, from the manufacturer; and O. the inspector's sample.

ANALYSES OF SAMPLES OF FEEDING STUFFS.

MICELLANEOUS REINFORCED FEEDS—Concluded.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Weed seeds found—per cent.	Station number.
Union Grains	D	25.00	24.00	–	7.00	**	2152
J. W. Biles Co., Cincinnati, Ohio	O	24.50	24.00	–	7.00	None.	2194
	O	24.44	24.00	8.27	7.00	Few.	2198
	O	24.63	24.00	–	7.00	1	2206
	O	24.63	24.00	–	7.00	Few.	2216
	O	24.38	24.00	7.79	7.00	Few.	2418
	O	24.00	24.00	–	4.00	Few.	2221
	O	23.63	24.00	–	7.00	Few.	2226
	O	23.75	24.00	–	7.00	5	2244
	O	24.75	24.00	–	7.00	Few.	2297
	O	24.38	24.00	–	7.00	Few.	2321
	O	24.25	24.00	–	7.00	Few.	2327
	O	24.13	24.00	–	7.00	Many.	2403
	O	23.88	24.00	–	7.00	Many.	2416
	D	25.12	27.00	–	7.00	**	2434
	O	24.50	24.00	–	7.00	Few.	2604
	O	24.00	24.00	–	7.00	Few.	2649
	D	23.50	24.00	–	7.00	**	2695

MOLASSES AND SUGAR FEEDS.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Weed seeds found—per cent.	Station number.
Husted's Molasses Corn Flake	D	10.25	8.00	–	4.00	**	2738
Husted Milling Co	D	10.25	8.00	–	4.00	**	2857
Husted Molasses Feed	D	17.25	18.00	–	4.00	**	2737
Husted Milling Co	D	19.63	18.00	–	4.00	**	2836
	D	20.88	18.00	–	4.00	**	2854
International Sugared Feed for Milch Cows	O	16.94	16.50	5.61	3.50	10	2284
International Sugar Feed Co., Minneapolis, Minn.							
International Sugared Feed for Horses	O	13.56	12.50	4.31	5.00	Many.	2285
International Sugar Feed Co.							
Molac Molasses Feed	O	15.25	15.50	5.10	3.00	10	2314
Quaker Oats Co., Chicago, Ill.							
Sucrene Dairy Feed	O	18.25	16.50	5.34	3.50	10	2346
American Milling Co., Chicago, Ill.	O	17.38	16.50	–	3.50	15	2504
	O	18.69	16.50	–	3.50	10	2525
	O	16.63	16.50	–	3.50	10	2527
	D	19.25	16.50	–	3.50	**	2556
	O	18.75	16.50	–	3.50	10	2777
Sucrene Horse and Mule Feed	O	12.00	10.00	3.84	3.00	15	2778
American Milling Co.							
Sugarota Dairy Feed	O	18.50	18.00	5.99	4.50	10	2265
Northwest Mills Co., Winona, Minn.	O	17.50	18.00	–	4.50	15	2358
	M	18.38	18.00	–	4.50	**	2381
	O	19.38	18.00	–	4.50	10	2406
	O	18.82	18.00	–	4.50	**	2720
Sugarota Horse Feed	O	15.62	12.00	4.24	3.50	Few.	2398
Northwest Mills Co., Winona, Minn.	O	17.63	12.00	–	3.50	**	2729

** Not tested for weeds.
C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Weed seeds found—per cent.	Station number.
CORN, OAT AND BARLEY FEED.							
Corn, Oat and Barley Feed. Oscar Holway Co., Auburn.	D	11.69	11.00	–	4.00	**	2790
CORN AND OAT FEEDS.							
Empire Feed for Stock	O	7.75	7.63	3.70	3.97	Few.	2352
Empire Mills, Orlean, N. Y.	O	7.13	7.63	–	3.97	Few.	2489
	D	8.13	7.63	–	3.97	**	2693
	O	8.63	7.63	–	3.97	None.	2707
	O	8.63	7.63	–	3.97	None.	2723
Gilt Edge Flakes. Chapin & Co., Boston.	O	15.75	–	–	–	Few.	2684
Haskell's Stock Feed	O	8.88	8.00	6.43	4.00	Few.	2189
W. H. Haskell & Co., Toledo, Ohio	O	9.31	8.00	–	4.00	None.	2229
	O	10.06	8.00	–	4.00	Few.	2331
	O	9.50	8.00	–	4.00	None.	2493
	O	9.63	8.00	–	4.00	None.	2685
	O	9.31	8.00	–	4.00	None.	2747
	O	9.44	8.00	–	4.00	**	2756
	O	9.13	8.00	–	4.00	None.	2798
Horse Feed. Buffalo Cereal Co.	O	11.25	12.00	5.70	4.50	Few.	2492
Husted Germanline	D	9.81	9.00	–	3.00	**	2739
Husted Milling Co., Buffalo, N. Y.	D	7.63	8.00	–	3.00	**	2856
Husted Stock Feed	O	8.75	8.00	5.75	4.00	None.	2273
Husted Milling Co., Buffalo, N. Y.	O	9.69	8.00	–	4.00	Few.	2335
King Feed. R. P. Moore Milling Co., Princeton, Ind.	O	15.88	15.00	–	4.00	None.	2801
Monarch Chop. Husted Milling Co.	D	8.25	7.00	–	4.00	**	2835
Pearl Horse and Cow Feed	O	8.13	6.00	–	3.00	None.	2669
Chapin & Co., Boston	O	8.35	6.00	3.37	3.00	**	2783
Schumakers Stock Feed	O	11.25	10.00	–	4.00	None.	2236
Quaker Oats Co., Chicago, Ill	O	11.25	10.00	–	4.00	None.	2238
	O	10.31	10.00	4.39	4.00	None.	2272
	D	11.87	10.00	–	4.00	**	2298
	O	10.88	10.00	–	4.00	None.	2400
	O	9.75	10.00	–	4.00	None.	2467
	O	10.81	10.00	–	4.00	None.	2491
	O	10.75	10.00	–	4.00	None.	2523
	O	10.75	10.00	–	4.00	None.	2538
	O	10.63	10.00	–	4.00	None.	2549

** Not tested for weeds.

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Weed seeds found—per cent.	Station number.
CORN AND OAT FEEDS—Concluded.							
Scnumakers Stock Feed—Continued	O	10.25	10.00	–	4.00	None.	2602
	D	11.13	10.00	–	4.00	**	2660
	O	10.25	10.00	–	4.00	None.	2672
	O	11.25	10.00	–	4.00	None.	2678
	O	12.25	10.00	–	4.00	None.	2698
	O	11.75	10.00	–	4.00	None.	2701
	O	11.00	10.00	–	4.00	None.	2732
	O	11.44	10.00	–	4.00	None.	2760
	D	10.38	10.00	–	4.00	**	2764
	O	10.69	10.00	–	4.00	None.	2802
Star Feed	D	8.37	7.00	–	6.50	**	2168
Toledo Elevator Co., Toledo, Ohio	O	8.50	7.00	–	6.50	None.	2217
	O	8.31	7.00	7.07	6.50	None.	2294
	O	9.13	7.00	–	6.50	None.	2348
	O	8.44	7.00	–	6.50	None.	2369
	O	8.82	7.00	–	6.50	None.	2421
	O	8.81	7.00	–	6.50	None.	2473
Sterling Stock Feed	O	9.69	11.00	4.73	4.00	Many.	2263
Great Western Cereal Co., Chicago	O	10.00	11.00	–	4.00	Few.	2319
Victor Feed	O	7.31	7.50	3.93	3.00	Few.	2292
Quaker Oats Co., Chicago	O	7.50	7.50	–	3.00	None.	2601
Winner Chop Feed	O	7.75	8.00	3.82	4.00	Few.	2258
David Stott, Detroit, Mich.							
Wirthmore Stock Feed	D	9.44	10.00	–	4.00	**	2624
Chas. M. Cox Co., Boston, Mass.							
HOMINY FEEDS.							
Hominy Feed	D	11.19	9.00	–	6.00	**	2862
M. F. Baringer, Phila.							
Hominy Feed	M	12.50	–	7.34	–	**	2138
Buffalo Cereal Co., Buffalo, N. Y.							
Fine Hominy Feed	D	10.94	8.00	–	6.00	**	2122
A. B. Porter & Co., Phila., Pa.							
WHEAT OFFALS.							
Acme Feed	O	15.31	15.00	–	4.00	None.	2262
Acme Milling Co., Indianapolis, Ind.	O	16.50	15.00	–	4.00	Few.	2449
Trojan Mixed Feed	O	16.13	15.00	–	4.00	Few.	2283
Allen & Wheeler Co., Troy, Ohio.							

** Not tested for weeds.

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Weed seeds found—per cent.	Station number.
WHEAT OFFALS—Continued.							
Bran	O	15.00	14.00	–	3.00	Few.	2343
Ansted & Burke Co., Springfield, Ohio	O	14.56	14.00	–	3.00	None.	2459
	O	14.75	14.00	–	3.00	None.	2584
Middlings	O	17.00	14.50	–	4.00	None.	2184
Ansted & Burke Co., Springfield, Ohio	O	17.25	14.50	–	4.00	None.	2333
	O	17.00	14.50	–	4.00	None.	2359
	O	16.56	14.50	–	4.00	None.	2395
	O	17.38	14.50	–	4.00	None.	2531
	O	16.69	14.50	–	4.00	None.	2588
	O	16.88	14.50	–	4.00	None.	2607
	O	16.75	14.50	–	4.00	None.	2704
Mixed Feed	O	16.31	14.50	–	4.00	None.	2260
Ansted & Burke Company	O	16.25	14.50	–	3.50	None.	2372
	O	16.19	14.50	–	4.00	None.	2458
	O	16.43	14.50	–	4.00	None.	2468
	O	16.06	14.50	–	4.00	Few.	2583
	O	16.13	14.50	–	4.00	Few.	2587
Ballard's Warranted Pure Wheat Ballard & Ballard Co., Louisville, Ky.	O	16.63	15.69	4.86	3.75	None.	2329
Winona Bran Bay State Milling Co., Winona, Minn.	O	15.63	15.00	–	4.75	Few.	2703
Blish Bulls Eye Mixed Feed	O	16.25	15.80	–	4.70	Few.	2310
Blish Milling Co., Saymore, Ind	O	15.88	15.80	–	4.70	Few.	2453
	O	16.13	15.80	–	4.70	Few.	2597
Bran Cain Milling Co., Atchison, Kans.	C	16.07	13.50	–	–	**	2085
Bon Ton Bran Carr Milling Co., Hamilton, Ohio.	O	14.88	–	–	–	None.	2375
Mixed Feed Chapin & Co., Boston, Mass.	D	17.38	–	–	–	**	2129
Ozark Brand Mixed Feed Chapin & Co., Boston, Mass.	O	17.50	14.00	–	3.00	None.	2320
Vermont Brand Mixed Feed	O	16.63	14.00	–	4.00	Few.	2357
Chapin & Co., Boston, Mass	O	16.13	14.00	–	4.00	Few.	2388
	O	16.75	14.00	–	4.00	Few.	2528
White Middlings No. 8 Chapin & Co.	O	17.88	14.00	–	3.00	None.	2471
Jersey Bran Geo. C. Christain, Minneapolis.	O	14.69	13.00	–	4.00	Few.	2598
Indiana Mixed Feed F. L. Cressey, Boston, Mass.	O	11.94	10.00	–	2.00	Few.	2425

** Not tested for weeds.

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ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein.		Fat.		Weed seeds found—per cent.	Station number.
		Found—per cent.	Guaranteed—per cent.	Found—per cent.	Guaranteed—per cent.		
WHEAT OFFALS—Continued.							
Henkel's Bran Feed	O	15.94	14.79	–	3.30	Many.	2288
Commercial Milling Co., Detroit, Mich.							
Mixed Feed	O	15.56	15.00	–	3.00	Few.	2376
Wm. A. Coombs Milling Co., Coldwater, Mich.	O	15.13	15.00		3.00	Few.	2542
Fancy White Middlings	O	14.38	–	–	–	None.	2377
Wm. A. Coombs Milling Co.							
Winter Wheat Middlings	O	16.31	18.00	–	5.00	**	2748
Detroit Milling Co.							
Bran	O	15.88	–	–	–	None.	2225
Dow & King, Pittsfield, Ill.	O	17.13	–	–	–	None.	2223
Boston Mixed Feed	O	16.44	16.00	5.68	4.50	Few.	2478
Duluth Superior Mill Co., Duluth	O	16.00	16.00	–	4.50	Many.	2545
Acme Mixed Feed	D	15.38	–	–	–	**	2640
Edwardsville Milling Co.							
Hoosier Mill Feed	D	16.44	15.00	–	4.00	**	2157
Geo. T. Evans & Son, Indianapolis, Ind.							
Garland Mixed Feed	O	15.94	15.25	–	3.75	**	2797
Garland Milling Co., Greensburg, Ind.							
Mixed Feed	D	18.50	–	–	–	**	2154
W. H. Gardner Grain & Milling Co., Bellevue, O.							
Xtra good Mixed Feed	M	16.00	–	4.78	–	**	2141
Griswold & Mackinnon, St. Johnsbury, Vt	O	15.63	–	–	–	**	2726
Xtra good Stock Feed	O	8.25	7.63	3.82	2.97	None.	2714
Griswold & Mackinnon.							
Red Star Soft Wheat Mill Run Mixed Feed	O	16.31	14.00	–	4.00	Few.	2440
Hannibal Milling Co., Hannibal, Mo.							
Bran	O	15.00	13.00	–	4.00	Few.	2385
Hicks, Brown Milling Co., Mansfield, Ohio	O	16.00	14.00	–	4.00	Few.	2387
	O	15.25	14.00	–	4.00	None.	2391
Pure Winter Wheat Bran	O	16.63	14.00	–	3.50	**	2761
Hunter Bros. Milling Co.							
Hunter's Mill Sunshine Feed	O	17.50	15.00	4.89	4.00	Few.	2469
Hunter Bros. Milling Co., St. Louis.							
Winter Wheat Mixed Feed	D	15.44	–	–	–	**	2156
Huron Milling Co., Harbor Beach, Mich.	O	15.50	–	–	–	**	2755
Climax Wheat Bran	O	17.38	15.50	–	4.00	None.	2501
Kansas Milling Co.							

** Not tested for weeds.

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ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Weed seeds found—per cent.	Station number.
WHEAT OFFALS—Continued.							
Mixed Feed—Bran and Shorts Kelley Milling Co., Kansas City, Mo.	O	17.38	–	–	–	Few.	2546
Peerless Mill Feed Kelhor Flour Mills Co., St. Louis, Mo.	O	18.38	14.00	–	4.00	Few.	2819
Diamond Bran Kemper Mill & Elevator Co., Kansas City, Mo.	O	16.31	14.50	–	4.00	None.	2393
Snow Flake Bran Lawrenceburg Roller Mills Co.	O	15.00	–	–	–	**	2808
Snow Flake Middlings Lawrenceburg Roller Mills Co.	O	18.50	–	–	–	None.	2762
Mixed Feed Lexington Roller Mills Co., Lexington, Ky.	C	17.69	–	–	–	**	2084
Elmeo Wheat Standard Middlings Listman Mill Co., LaCrosse, Wis.	O	19.00	18.32	–	5.21	**	2807
Bran Lyon & Greenleaf, Wauseon, Ohio.	O	15.50	–	–	–	Few.	2224
Mixed Feed Lyon & Greenlief, Ligonia, Ind.	D	15.19	–	–	–	**	2160
Middlings Lyon & Greenleaf, Wauseon, Ohio.	O	15.69	–	–	–	None.	2367
Uniform Mixed Feed	M	14.82	–	3.76	–	**	2127
D. L. Marshall Milling Co., Buffalo, N. Y.	D	15.38	–	–	–	**	2135
Milbourne Wheat Feed Milbourne Mills, Phila., Pa.	O	17.25	13.00	–	3.00	None.	2312
Gold Heart Mixed Feed	O	18.75	16.50	–	5.30	Few.	2423
Missouri Valley Milling Co.	O	18.50	16.50	5.97	5.30	Few.	2479
	O	18.38	16.50	–	5.30	Few.	2497
	O	18.00	16.50	–	5.30	Few.	2552
	O	19.00	16.50	–	5.30	Few.	2727
	O	19.00	16.50	–	5.30	Many.	2821
Bran Missouri Valley Milling Co.	O	16.75	–	–	–	Few.	2784
King Feed	O	15.63	15.00	–	5.00	None.	2261
R. P. Moore Milling Co., Princeton, Ind.	O	16.38	15.00	–	5.00	Few.	2328
Alora Middlings	O	16.44	16.00	–	5.00	None.	2448
New Occidental Milling Co., Minneapolis, Minn.	O	16.75	16.00	–	5.00	None.	2500
Middlings Northwestern Consolidated Milling Co.	O	17.25	15.75	–	5.25	None.	2345

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ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Weed seeds found—per cent.	Station number.
WHEAT OFFALS—Continued.							
Esmeralda Mixed Feed	O	16.75	15.20	–	4.00	Few.	2551
Ohio Cereal Co., Circleville, O.							
Pure Winter Wheat Bran	O	15.94	14.00	–	4.00	None.	2589
Thomas Page, Topeka, Kansas.							
Bran	O	15.63	13.00	–	4.00	Few.	2447
Pillsbury, Minneapolis	O	12.38	12.00	–	4.00	Few.	2532
	O	15.44	13.00	–	4.00	Few.	2555
Middlings	O	17.13	14.00	–	4.50	None.	2384
Pillsbury, Minneapolis	O	14.88	14.00	–	4.50	Few.	2503
	O	16.75	14.00	–	4.50	None.	2539
	O	16.50	14.00	–	4.50	None.	2599
	O	17.25	14.00	–	4.50	None.	2677
Bran	D	14.69	–	–	–	Few.	2557
A. B. Porter & Co., Phila., Pa.							
Champion Mixed Feed	O	15.75	–	4.95	–	Few.	2413
	O	16.00	–	–	–	Few.	2717
Portland Milling Co.							
Middlings	O	20.63	16.65	–	4.75	None.	2554
Quality Mills, Enterprise, Kans.							
Standard Middlings	O	18.06	17.25	–	6.25	Few.	2457
James Quirk Milling Co., Montgomery, Minn.							
Colonial Mixed Feed	D	15.25	16.10	–	4.20	**	2765
James Quirk Milling Co., Montgomery, Minn.							
Occident Mixed Feed	O	17.63	15.00	6.02	4.00	None.	2222
Russell-Miller Milling Co.	O	17.50	15.00	–	4.00	Few.	2332
	O	17.56	15.00	–	4.00	Few.	2370
	O	17.88	15.00	–	4.00	Few.	2412
	O	17.25	15.00	–	4.00	Few.	2581
	O	17.88	15.00	–	4.00	Few.	2668
	D	17.56	16.00	–	4.00	**	2833
Gold Mine Mixed Feed	O	17.13	17.00	–	4.50	Few.	2308
Sheffield-King Milling Co., Minneapolis, Minn.	O	15.94	17.00	–	4.50	Few.	2353
Mixed Wheat Feed	D	14.25	–	6.47	–	**	2485
Sleepy Eye Milling Co.	D	14.50	12.08	–	5.03	**	2639
Monarch Ground Wheat Feed	O	17.13	–	6.80	–	Many.	2450
F. W. Stock & Son, Hillsdale, Mich.							
Stock's Monarch Mixed Feed	O	16.81	–	–	–	Few.	2711
F. W. Stock & Sons.							
Middlings	O	16.63	–	–	–	None.	2404
F. W. Stock & Son, Hillsdale, Mich.							

** Not tested for weeds.

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ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed per cent.	Weed seeds found—per cent.	Station number.
WHEAT OFFALS—Concluded.							
Pure Wheat Bran W. H. Stokes Milling Co., Watertown, S. D.	O	14.63	15.00	–	4.00	Few.	2548
Stotts Honest Mixed Feed	O	15.88	–	–	–	Few.	2411
David Stott, Detroit, Mich	O	15.38	–	–	–	Few.	2541
Stotts Climax Middlings David Stott.	O	16.50	–	–	–	Many.	2540
Mixed Wheat Feed Thornton & Chester Milling Co., Buffalo, N.Y.	O	16.75	15.00	–	3.00	Few.	2550
Unicorn Bran Valley City Milling Co.	O	14.63	17.75	–	10.93	Some.	2699
Valier's Mixed Feed Valier & Spies Milling Co., Marine, Ill.	O	16.25	–	5.58	–	None.	2477
Bran	O	15.13	14.00	–	4.00	Many.	2342
Washburn-Crosby Co., Minneapolis	O	14.75	14.00	–	4.00	Few.	2451
	O	15.44	15.00	–	4.00	Few.	2505
Standard Middlings	O	17.63	15.00	–	4.00	None.	2444
Washburn-Crosby Co.	O	16.56	15.00	–	4.00	None.	2495
	O	16.81	15.00	–	4.00	None.	2547
	O	16.94	15.00	–	4.00	None.	2603
U-Knead It High Patent Wheat Bran Watson Mill Co., Wichita.	O	17.75	14.96	–	3.75	Few.	2499
Mixed Feed Webster Mill Co., Webster, S. D.	O	15.38	–	–	–	Many.	2680
Kent Mixed Feed	O	15.38	12.00	–	2.00	Few.	2719
The Williams Bros. Co.	O	15.88	12.00	–	2.00	Few.	2806
Kent Middlings and Bran	O	15.44	14.00	–	3.00	Few.	2454
William Bros. Co., Kent, Ohio	O	15.00	12.00	–	2.00	Few.	2494
Snow's Flaky Bran E. S. Woodworth & Co., Minneapolis.	O	16.63	–	–	–	None.	2502
ADULTERATED WHEAT OFFALS.							
Blue Grass Mixed Feed	O	10.63	10.00	–	2.50	Few.	2313
A. Waller & Co., Henderson, Ky	O	10.88	10.00	–	2.50	Few.	2324
	O	10.56	9.00	–	2.00	Few.	2336
	O	11.13	9.00	–	2.00	None.	2397
	O	11.25	9.00	–	2.00	Few.	2455
	O	10.94	10.00	3.20	2.50	Few.	2752
Jersey Middlings Indiana Milling Co.	O	10.25	10.00	3.89	2.00	None.	2476
Jersey Mixed Feed	O	12.25	10.00	3.70	2.00	Few.	2196
Indiana Milling Co.	O	12.00	10.00	–	2.00	Few.	2339

** Not tested for weeds.
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ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Weed seeds found—per cent.	Station number.
POULTRY FEEDS.							
Dry Mash Feed Park and Pollard Co.	O	18.25	20.00	–	3.00	**	2843
Gritless Chick Food Park & Pollard Co.	O	12.19	13.77	3.02	2.77	Few.	2269
Growing Feed Park & Pollard Co.	O	18.63	14.00	5.42	3.50	5	2700
Intermediate Growing Feed Park & Pollard Co.	O	11.50	10.00	3.14	3.00	**	2757
Scratch Feed	O	10.69	10.00	3.82	3.00	None.	2268
Park & Pollard Co.	O	10.88	10.00	–	3.00	Few.	2460
Schumakers Scratching Grains Quaker Oats Co.	O	11.06	10.50	–	3.00	Few.	2465
BEEF SCRAPS.							
Meat and Bone Meal The Beach Soap Co., Lawrence, Mass.	D	32.69	30.00	9.07	10.00	**	2626
Beef Scrap The Beach Soap Co.	D	37.75	40.00	19.53	20.00	**	2629
Dow's Ground Beef Scraps John C. Dow Co.	O	43.12	43.00	14.89	12.00	None.	2242
Beef Scraps Merrow Bros. & Co.	D	36.82	–	25.48	–	**	2116
Bone Meal Merrow Bros. & Co.	D	8.50	--	8.53	–	**	2117
Beef Scraps Merrow Bros. & Co.	D	36.37	–	25.69	–	**	2768
Alprotein Beef Scraps Park & Pollard Co.	D	81.56	74.00	–	–	**	2150
Beef Scraps	D	39.25	40.00	–	8.00	**	2102
Portland Rendering Co., Portland, Me.	O	38.94	40.00	–	15.00	None.	2248
	O	38.63	40.00	12.89	15.00	None.	2417
	O	41.13	40.00	–	15.00	None.	2461
	O	44.37	40.00	–	15.00	None.	2553
	O	40.38	40.00	–	15.00	None.	2592
	O	42.13	40.00	–	15.00	None.	2595
Beef Scraps	O	38.50	40.00	–	15.00	**	2676
Portland Rendering Co.	O	41.31	40.00	–	10.00	None.	2780
Pure Beef Scraps Whitman & Pratt Rendering Co.	O	46.87	40.00	10.62	10.00	None.	2686

** Not tested for weeds.

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

RESULTS OF FEEDING STUFF INSPECTION.

The present report gives the analyses of the samples of feeding stuffs which were collected by the inspector and that have been sent in by correspondents since bulletin 156 was published in the spring of 1908. This includes samples which were taken up to about March 15, at which time the copy for these tables was sent to the printer. The analyses for the most part tell their own story.

It will be noted that occasional samples of *cottonseed meal* fell one, two and three, and in one instance 5 per cent below the guaranty. While this deficiency in protein is small compared to what it was a few years ago, earnest endeavor is being made to take this matter up with the mills and prevent these low grade meals coming into the State. The present season this is due to what would seem to be an adulteration. From reliable sources it would seem that most of the cottonseed meal, if it were properly bolted, would carry from 44 to 48 per cent protein, but the highest grade recognized by the Inter-State Cottonseed Crushers' Association is choice cottonseed meal which carries 8 per cent ammonia, or the equivalent of 41.2 per cent protein. When the mills sell choice cottonseed meal, they are penalized for meal that falls below the guaranty, but are not allowed any premium for meal that runs above the requirements of choice cottonseed meal. This has apparently led to either deliberate introduction of cottonseed hull to the meal or inefficient bolting, with the idea of producing a cottonseed meal that should carry about 41 per cent protein. In some instances and with some mills there has been a large amount of carelessness so that it has not been uncommon to find meals running as low as prime which has been sold as choice.

Cottonseed meal is a by-product; the mills which grind it being primarily engaged in the manufacture of cottonseed oil. Almost none of the cottonseed meal is sold under the name of the mill which produces it. Shippers in St. Louis, Memphis, Little Rock and other points contract with these mills for the delivery of cottonseed meal which they have purchased either under a guaranty or per sample. The shipper sends his tags to the mill and the cars are distributed to points where sales have been made without the shipper ever having seen the meal. It frequently happens that the meal thus shipped will go through 3, 4 or more dealers before it finally reaches the retailer who distributed the meal.

It has become customary for the shippers to make refund all the way through to the retailer on the basis of 50 cents per protein unit. One shipper prints a contract something like the following, and the same agreement is lived up to by practically all reputable shippers,—"The actual protein is guaranteed in the contract and if on analysis of the meal in this shipment, does not equal within one unit of protein guaranteed, we agree to refund on a basis of 50 cents per unit protein." "Such claims supported by proper samples to be made within 10 days after the arrival of the car." From the shippers standpoint, this would seem to be a fair proposition. From the standpoint of the consumer, however, it ordinarily is not of much value. For example,—The Station received a sample from a car of cottonseed meal through a certain retailer in Maine. On analysis it was found that this meal was considerably below the guaranty. It happened, however, that most of this car was distributed before the results of the analysis were reported. A claim was put in on the basis of the analysis and was allowed by the shipper and a refund of $40 was made to the retailer. None of this money, however, reached the consumer as the goods were scattered and the retailer claimed that he did not know to whom this particular car of goods was sold. Hence in this particular case the retailer in addition to making the ordinary profits on a car of cottonseed meal, received and kept a premium of $40 for having handled cottonseed meal deficient in protein. Practically no instance has come to the writers' knowledge of the refund reaching the consumer. This method of refund is also a wrong one, as it enables a mill to send out inferior goods and only make a refund in the case they are caught. For example,—if a shipper contracts for 40 cars of meal of 41 per cent protein and they ship out 38 per cent protein instead of 41, on all cars in which they are detected, they are penalized, but after they have paid the refund because of the deficiency in protein they still have sold the car for all that the meal was worth and in the case of the cars in which they have not been detected, they have made an actual profit because of its low grade above the contract price.

This whole matter of the shipments of cottonseed meal has been given very careful attention. At a conference of the directors of the New England Experiment Stations held in Boston, it was the chief topic discussed. The Director of the Maine Station is the executive officer of the Maine food and drug law, as well as of the feeding stuffs law; in the former capacity he holds from the U. S. Secretary of Agriculture a commission whereby he can enforce the provisions of the National food and drug act. As this Act regulates interstate trade, it is hoped that this gives a method of dealing directly with the mills who are at fault in this matter.

The *cottonseed feeds* were all above their guaranties, but they are not economical feeds at any price which they have been or are likely to be offered. As a source of protein, a choice cottonseed meal is equal to two pounds of the best cottonseed feed, and 4 pounds of the Star Cotton Feed.

Both the *Old and New Process Linseed Oil* Meals are well up to the guaranty and at the prices which they have been selling, are economical feeds.

The *Gluten Feeds* which are largest sold in this State, are well up to their guaranty and have been much more free from seeds than in years past. Many of them are still artificially colored; they are frequently labeled to that effect. The coloring which is used is probably harmless, but it does not add anything to the quality of the feed.

The *Dried Distillers Grains* more or less resemble gluten products in their composition. They are chiefly made from corn from which the starch has been removed by fermentation. Goods of this class run somewhat uneven because of the difference in weight and bulk of different parts of the residues. A process has been invented whereby all the distillery slop is now dessicated. In order to overcome mechanical difficulties, it is necessary to add a drying material and it has been reported that corn cob meal has been used for this purpose. In none of the samples here reported has corn cob meal been detected.

Strictly speaking the *Badger Dairy Feed* should have been classed under the molasses feeds and not under the *Reinforced* *feeds,* although the distinction between the molasses feeds and the reinforced feeds is very slight. Most of these mixed reinforced feeds, as well as the molasses feeds, contain waste products of doubtful feeding value, since they frequently are largely loaded with weed seeds. Not only is there danger from live weed seeds germinating and thus introducing dangerous plants, but there is practically nothing known of their feeding value. Some of the weed seeds are undoubtedly poisonous. Many of the weed seeds in these feeds pass through the digestive tract of the animal unchanged, even germinating after passing through the digestive tract. Obviously there is no nutritive value derived from such seeds. It would not seem good economy to purchase meals of this doubtful nature. Some of the makers of these goods, however, are claiming that they are now using only good nutritive materials for their absorbents. There are also practical feeders that claim valuable results from the use of molasses feeds, but it is very doubtful if exact feeding experiments would show them to have any such claims for consideration as the agents testify.

In general all of the oat, barley and hominy feeds are fairly well up to their guaranty, and few or no claims are made for nutrients which the goods do not actually carry. The feeder has only himself to blame if with barns filled with hay, corn stalks and silage, he buys feeds low in protein instead of those high in protein. Economical animal production in Maine would seem to depend upon the farmer growing the largest possible amount of feed for his stock and since he can grow the carbohydrates much more abundantly and cheaply than he can grow the nitrogenous constituents, when he goes to purchase it should be the highly concentrated protein carrying feeding stuffs.

READ THE LABELS.

Practically all of the feeding stuffs and mill refuses even when they do not come under the requirements of the feeding stuffs law now come labeled showing the percentages of protein and fat. It is important to both the dealer and the consumer that he study these labels and know as near as possible what the goods are. It would also be advisable to compare the analyses given on the tag with analyses of standard goods as reported by the Station. The following are illustrations of the need of studying labels.

Most of the cottonseed meal which comes into the State is guaranteed 41 per cent protein. There are an increasing number of cars that are guaranteed only 38 per cent protein. So far as the writers can learn there is practically no difference in selling price between the 41 per cent or choice cottonseed meal and the 38 per cent or prime cottonseed meal. Even allowing the protein in cottonseed meal in Maine to be worth only 50 cents per ton unit, according to the rebate which some of the companies allow for shortage there is a difference of $1.25 in value between a 41 and a 38 per cent meal. There is a much greater actual difference to the Maine feeder because 50 cents a ton per protein unit is based on what the goods are worth at Mississippi Valley points.

The name gluten feed is somewhat of a misnomer but it has come by common consent to be applied to the refuse of corn from starch and glucose factories. A gluten feed of good quality will come guaranteed 23 per cent protein and will usually analyze 25 per cent and will not carry more than 8 1-2 per cent of the indigestible crude fiber. There are upon the market so-called gluten feeds which while containing some corn product are made up of various other compounds. One recently examined carried cottonseed meal, malt sprouts, barley, peanut shells and some corn product. Such goods will carry half as much again indigestible crude fiber as a straight gluten feed.

High grade middlings carry 16 to 18 per cent protein and are usually so labeled. A good bran will carry 15 or more per cent of protein. Wheat middlings will carry about 5 per cent and wheat bran not more than 9 per cent crude fiber. There are upon the market adulterated middlings and mixed feeds which frequently retail at the price of straight middlings and wheat bran, and rarely more than a dollar a ton below the straight wheat refuse. These goods are plainly labeled under the law and yet they find people to purchase them. For instance, "Jersey Middlings," according to its label is composed of low grade flour, winter wheat middlings and ground corn cobs. Its protein is guaranteed 10 per cent instead of the 16 per cent carried by good middlings, and the indigestible crude fiber is

14 per cent instead of the 5 per cent. "Indiana Mixed Feed" according to its label is composed of winter wheat bran, winter wheat ship stuff, and corn cob meal. It is guaranteed to carry 10 per cent protein instead of 15 per cent in a good bran, and carries 14 per cent of indigestible crude fiber instead of the 9 per cent in bran.

THE WEIGHT OF FEEDING STUFFS.

Practically all of the feeding stuffs are weighed into packages automatically and run fairly uniform. It is very seldom that the Station hears complaints of short weight. Something over 50 lots of the different standard feeding stuffs were weighed by the Station representatives the present season and were found for the most part to be approximately correct as regards net weight. In some cases there is apparently no allowance made for the weight of the sack and a purchaser pays for the sack at the same rate that he pays for the feeding stuffs that it contains. In a great majority of cases however a tare of one or two pounds is allowed and the package marked 100 pounds weighs 101 or 102 pounds. There is some trouble in connection with cottonseed meal which is probably due not so much to shortage when the goods are put up at the mills as to the fact that they are put into poor sacks and more or less meal sifts out. While in some instances cottonseed meal was found to weigh 101, 102 or even 103 pounds, in other cases it dropped to 95 pounds or less. As a rule, however, the dealers are pretty alert to matters of this kind and report shortages and obtain rebates from the shippers. It is to be hoped that these rebates are passed on to their customers or that the packages are opened and filled. This is a matter which any dealer or user can readily verify for himself and it would be in the line of self interest to occasionally weigh the packages and thus make sure that they are full weight.

[350-5-09.]

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

Official Inspections.

11

Both the spirit and the letter of the Maine Inspection laws demand freedom from adulteration and truthful labeling.

Official Inspections 9 and 10.

Official Inspections 9 containing results of analyses of manufacturers's samples of fertilizers licensed to be sold in the year 1909, and Official Inspections 10, which contains the results of the analyses of the concentrated commercial feeding stuffs collected during a year ending about April 1 were sent to the general mailing list and to dealers in fertilizers, feeding stuffs and seeds. Copies of these will be sent to any citizen of the State on request.

Soda and Cream of Tartar.

A few samples of soda and cream of tartar have been examined, chiefly sent in by correspondents. These have all been found to be practically pure. The following brands of soda were sampled: Wyandotte Bicarbonate of Soda, Michigan Alkali Co., Wyandotte, Mich. Success Soda, Moorehouse Manfg. Co., Savannah, Ga.

With two exceptions, the cream of tartars were bulk goods. A sample of Slades Grape Cream of Tartar, packed by D. & L. Slade Co., Boston, Mass., and the Stickney & Poor's Warranted Pure Cream of Tartar, packed by Stickney & Poor, Boston, were pure and full weight packages.

EXTRACT OF PEPPERMINT.

There was an error in the remarks in the case of three extracts of peppermint reported in Official Inspections 8. The analyses were correctly given. The comments should have read in the case of the Forest City Brand made at 27, 29 Hampden St., Springfield, Mass., "1 1-2 times standard strength;" and the Harris Pure made by Frank E. Harris, Binghampton, N. Y., should have been "2 1-2 times standard strength;" and that at Spaulding's drug store, Hallowell, should have read "3 times standard strength."

SWEET CORN.

The sweet corn industry is a very important one in Maine and the quality of the corn grown in Maine had led to labeling corn as Maine corn that was grown in other states. Because of this practice the National food and drug act which forbids the use of erroneous geographical names, has greatly helped the corn packing industry in this State. In order to ascertain whether the corn offered in Maine was really Maine grown, samples purporting to be Maine packed were collected in retail stores in different parts of the State. By correspondence each lot of corn was traced back to the factory and found to be strictly Maine produced.

There is but little in the chemical analysis that can show the quality of a corn other than its purity. It will be noted that some samples of corn had considerably more dry matter than others, but that does not necessarily mean that they were better flavored. In fact a corn with some of the lower percentages of dry matter might be more palatable than the one with the higher percentage of solids.

There is no evidence of adulteration in these corns. Probably most of them had been sweetened with cane sugar and it may have been that corn starch had been added to thicken some but this fact cannot be proven by chemical analysis. Sweet corn naturally carries sugar and corn starch and small amounts of these may be added without the fact being proven by analysis. It is gratifying to note that none of the samples contained saccharine or preservatives. In one case, however, sulphites were apparently found but the examination of six other cans from the same pack failed to disclose any sulphurous acid.

Table showing results of analyses of Maine packed sweet corn collected in February, 1909; arranged alphabetically by packers' towns. All samples tested for saccharine, preservatives and sulphites.

Number.	Retailer and Town Dealer and Town Brand and Packer.	Price per can.	Net weight.	Dry Matter.	Foreign matter.
		cts.	ounce	Perct.	
7990	C. A. Pierce & Son, Brunswick. Shaw, Hammond & Carney, Portland. White Cross Maine Sugar Corn, Bethel Packing Co., Bethel.	12	20.3	21.6	None
8028	F. E. Webber, Richmond. Pine Grove Packing Co., Bowdoinham, Maine Crosby Sugar Corn.	12	20.5	22.9	None
7991	J. W. McMillin, Topsham. Kimball Bros., Bath. Red Dragon Sugar Corn, Louisa Canning Co., Brunswick.	10	20.8	26.2	None
7987	C. A. Lemieux, Brunswick. C. A. Weston, Portland. Raven Brand Maine Sugar Corn packed at Canton.	10	20.4	24.1	None
8009	Cole Bros., South Portland. J. B. Donnell & Co., Portland. Casco Poppy Brand Sweet Corn. J. N. Eastman & Co., Casco.	12	20.2	20.3	None
7994	S. Mitchell, Freeport. Hannaford Bros. Co., Portland. Summit Brand Sugar Corn. F. H. Hayes, Dexter.	10	19.6	24.5	None
8017	H. E. Woster, Camden. John Bird Co., Rockland. Hayes Fancy Maine Sugar Corn. F. H. Hayes, Dexter.	10	20.8	25.9	None
8000	Libby & Etchell, Biddeford. Steadman & Hawkes, Portland. Pine Cone Brand Maine Sugar Corn. Fryeburg Canning Co., Fryeburg.	10	20.2	23.5	None
8016	H. J. Fitch, Rockland. L. P. True, Hope. Knox Pioneer Brand Sugar Corn. L. P. True, Hope.	12	17.7	23.5	None
8020	Larrabee Bros., Rockland. L. P. True & Co., Hope. Tit Willow Brand Sugar Corn. True, Spear & Co., Hope.	13	19.6	26.5	None
8021	W. I. Ayer, Rockland. Francis Cobb & Co., Rockland. Queen's Taste Fancy Maine Corn. Minot Packing Co., Mechanic Falls.	13	19.5	25.1	None

Table showing results of analyses of Maine packed sweet corn collected in February, 1909—Continued.

Number.	Retailer and Town Dealer and Town Brand and Packer.	Price per can.	Net weight.	Dry matter.	Foreign matter.
		cts.	ounce	Perct.	
8015	Shaw's Cash Market, Yarmouth. Davis, Baxter & Co., Portland. Honey Drop Sugar Corn. Davis Baxter & Co., Portland.	10	20.3	25.2	None
8001	J. B. E. Tartre, Biddeford. B. F. Littlefield, Saco. Fancy Crosby Golden Royal Brand Sweet Corn. Boothby & Tucker Co., Portland.	10	20.0	25.8	None
7992	A. Melcher Graves, Topsham. Conant, Patrick Co., Portland. Perfection Brand Sweet Corn packed for Conant, Patrick Co. by E. S. Dingley Co., W. Farmington.	10	20.8	25.2	None
8012	J. B. Pare & Sons, Biddeford. Conant, Patrick Co., Portland. Daisy Brand Maine Sweet Corn packed for Conant, Patrick Company.	12	20.0	24.4	*Sulphurous acid present
8122	Conant, Patrick Co., Portland. Daisy Brand Maine Sweet Corn.	12	21.1	–	None
8027	F. L. Rogers, Richmond. H. S. Melcher Co., Portland. Sunland Brand Maine Sugar Corn. H. S. Melcher Co., Portland.	10	21.0	22.9	None
7985	H. T. Nason, Brunswick. Milliken-Tomlinson Co., Portland. Manx Brand Maine Corn. Highland Canning Co., Portland.	10	21.1	21.8	None
8008	So. Portland Co-op. Store, So. Portland. Milliken-Tomlinson Co., Portland. Superba Maine Sugar Corn packed for Milliken-Tomlinson Co.	13	19.6	21.8	None
8010	Casco Feed & Grocery Co., So. Portland. C. A. Weston & Co., Portland. Early Crosby Extra Sugar Corn. New Gloucester Packing Co., Portland.	10	21.1	18.2	None
7997	John F. Hannaway, Biddeford. Twitchell-Champlin Co., Portland. Hatchet Brand Sugar Corn. Twitchell-Champlin Co.	10	20.2	25.2	None
7993	A. Derosier, Freeport. Shaw, Hammond & Carney, Portland. Maine Sugar Corn. H. F. Webb Co., Portland.	9	20.2	22.1	None
8019	S. E. & H. L. Shepherd Co., Rockport. L. P. True, Hope. Maine Sugar Corn. S. E. & H. L. Shepherd Co.	10	19.9	26.9	None

*Six other cans from the same pack were examined and no sulphurous acid was found.

Table showing results of analyses of Maine packed sweet corn collected in February, 1909—Concluded.

Number.	Retailer and Town Dealer and Town Brand and Packer.	Price per can.	Net weight.	Dry matter.	Foreign matter.
		cts.	ounce	Perct.	
8014	B. D. Day, Yarmouth H. S. Melcher Co., Portland. Ossipee Brand Maine Sweet Corn. Carll Canning Co., Waterboro, Maine	10	20.4	24.1	None
7986	A. T. Snow, Brunswick Sturdivant & Norton, Portland. Maine Sugar Corn, Royalls River. A. F. York, Yarmouthville.	10	20.6	21.9	None
7999	S. K. Ames, Biddeford Ames Quality Brand Cream Corn. S. K. Ames Distributors, Boston, Mass.	9	21.1	23.1	None

Maple Sugar.

There has been a marked improvement in the quality of maple sirups on sale in Maine so that one may be reasonably sure of what they purchase. The situation as regards maple sugar is not as good. While most of the maple sugar that is sold in the State comes to the retailer properly labeled, the consumer in many instances, is apparently not notified by the dealer as to the quality of the goods. The inspector went into many different retail stores and inquired if they had maple sugar and when he found that they did, purchased half a pound of maple sugar. At 53 different places he was given what purported to be maple sugar without any comment or any markings upon the package to indicate the nature of the goods. Twenty-seven, or practically 50 per cent of these dealers gave adulterated goods. A few hours after the deputy had left the store with the sample, he returned and explained who he was and asked to see the box from which the sugar was taken that was sold to him; in the great majority of cases it was found that the box was correctly labeled. Hearings have been appointed for all of these violations and the matter will be thoroughly investigated and if the parties are believd to be guilty the cases will be brought to trial.

Table showing results of analyses of goods delivered to the Station Inspector when he bought Maple Sugar from the retailer; arranged alphabetically by towns in which purchased.

Station number.	Name of Dealer and Town.	Price paid per pound.	Remarks.
		cents.	
8177	Stevens & Robinson, Auburn	.30	Passed.
8190	Augusta Fruit Co., 218 Water St., Augusta	.20	Adulterated.
8191	Augusta Fruit Co., 296 Water St., Augusta	.20	Adulterated.
8189	W. W. Morse, Augusta	.30	Passed.
8154	C. E. Hilton & Son, Berwick	.20	Passed.
8155	E. E. Snow, North Berwick	.20	Adulterated.
8152	J. A. Maddox, So. Berwick	.25	Passed.
8153	G. A. Mathes, South Berwick	.25	Adulterated.
8149	Katherine Doyle, Biddeford	.20	Adulterated.
8148	Chas. H. Innes, Biddeford	.20	Adulterated.
8164	C. E. Holt, Fairfield	.20	Adulterated.
8181	I. Baitler, Corner Fruit Store. Gardiner	.20	Adulterated.
8184	I. Baitler, 310 Water St., Gardiner	.20	Adulterated.
8179	A. W. Cunningham, Gardiner	.20	Passed.
8186	J. E. Cunningham, Gardiner	.20	Passed.
8178	E. P. Dill, Gardiner	.36	Passed.
8183	R. E. Harmon & Co., Gardiner	.25	Passed.
8185	Miller's Fruit Store, Gardiner	.20	Adulterated.
8180	F. M. Noyes, Gardiner	.20	Passed.
8182	Joseph Woldman, Gardiner	.20	Adulterated.
8187	J. Arata, Hallowell	.20	Adulterated.
8188	C. B. Hobbs, Hallowell	.20	Passed.
8129	Anthony Brountas, Houlton	.20	Passed.
8131	McGary Bros., Houlton	.20	Passed.
8130	John A. Miller	.30	Passed.
8150	Kittery Grocery Co., Kittery	.22	Passed.
8151	C. M. Prince, Kittery	.24	Passed.
8168	Atwood's Market, Lewiston	.20	Adulterated.
8170	Bagley & Small, Lewiston	.20	Passed.
8173	Grant's Confectioner & Caterer, Lewiston	.30	Adulterated.
8172	A. E. Harlow, Lewiston	.25	Passed.
8169	Leadbetter's Drug Store, Lewiston	.25	Adulterated
8174	Chas. Morneau, Jr., Lewiston	.18	Passed.
8171	Lewiston Fruit Market, Lewiston	.20	Adulterated.
8176	The Northern Fruit Co., Lewiston	.20	Passed.
8175	W. H. Teague, Lewiston	.30	Passed.
8165	F. W. Smith, Oakland	.20	Adulterated.
8143	P. P. Bonfilio, Portland	.24	Passed.
8141	Chas. K. D. Chase, Portland	.20	Adulterated.
8136	H. Dalton Fruit Co., Portland	.20	Passed.
8140	C. Garbarina, Portland	.20	Adulterated.
8142	George Labares, Portland	.25	Adulterated.
8139	D. K. Macris, Portland	.20	Adulterated.
8137	Geo. E. Sawyer, Portland	.24	Passed.
8138	Geo. F. Soule, Portland	.16	Adulterated.
8144	F. H. Verrill, Portland	.14	Passed.
8147	Fred A. Burnham, Saco	.20	Adulterated.
8146	H. D. Davis, Saco	.20	Adulterated.
8163	E. Marchette & Son, Waterville	.20	Adulterated.
8162	E. Q. Simpson, Waterville	.20	Passed.
8145	S. F. Hopkinson, Westbrook	.10	Adulterated.
8167	A. M. Calzolari, Winthrop	.20	Adulterated,
8166	Levi Jones & Sons, Winthrop	.18	Passed.

Prepared Flours.

A half dozen samples of specially prepared flours which were on sale in Maine were examined and found as shown in the following table to be true to name and correctly labeled.

Results of Analyses of Special and Prepared Flour collected March, 1909.

Number.	Brand, Name of Retailer and Town.	Found.
8067	Old Grist Mill Self Raising Biscuit Flour manufactured by Potter & Wrightington, Boston, Mass E. Janelle & Co., Lewiston.	Wheat only.
8038	Reliable Self Raising Prepared Flour, Reliable Flour Co., Boston, Mass. S. H. Robinson & Sons, Bangor.	Wheat flour only.
8045	Pure Franklin Self Raising Entire Wheat Flour, Franklin Mills Co., Lockport, N. Y. F. H. Drummond, Bangor.	Apparently true to name.
8080	Aunt Jemima's Pancake Flour for griddle cakes, muffins and gems. Registered U. S. Patent Office Guarantee No. 51056 Serial No. 1462. Davis Milling Co., St. Joseph, Mo. Barrett's Market, Portland.	Mostly wheat and corn with small amount of rice. Contains some cerealstarch which has apparently been modified by heat.
8039	Hecker's Self Raising Buckwheat and Wheat Flour Compound. S. H. Robinson & Son, Bangor.	Buckwheat and wheat flour.
8092	Health Brand Potato Flour. Scandanavian Importing Co., Boston, Mass. F. H. Verrill, Portland.	Potato starch only.

Spices and Pepper.

Samples of spices and pepper put up in packages were purchased in different places during the month of March. These were subjected to a full chemical analysis and microscopical examination. The chemical results are not given here but they show that the goods were all in conformity with the standards. The microscopical examination shows, as indicated under "Remarks," that in the case of one sample of allspice and one sample of cloves that there were rather more stems present than should be in first-class goods.

Table showing results of analyses of spices and pepper purchased in packages in March, 1909.

Number.	Manufacturer, Name of Dealer and Brand.	Price cents.	Net weight lb.	Remarks.
	ALLSPICE.			
8088	Brownelle & Field Co., Providence. A. D. Lovell, Portland. Autocrat Pure Allspice.	.10	–	Slight excess of stems. Passed.
8081	D. & L. Slade Co. Servian AmericanCo.,Portland. Slade's Absolutely Pure.	.10	–	Passed.
8070	Stickney & Poor, Boston. O. Roger, Lewiston. Stickney &Poor's Pure Allspice.	.08	–	Passed.
8044	Stickney & Poor, Boston. F. H. Drummond, Bangor. Stickney & Poor's Absolutely Pure Allspice.	.07	–	Passed.
	CINNAMON.			
8062	D. & L. Slade Co., Boston. C. H. Cloutier & Co., Lewiston. Slade's Cinnamon, absolutely pure.	.08	–	Passed.
8049	Stickney & Poor, Boston. J. F. O'Connell, Bangor. Stickney & Poor's Absolutely Pure Cassia.	.08	–	Passed.
	CLOVES.			
8206	Brownell & Field, Providence, R. I. A. D. Lowell, Portland. Autocrat Spices.	.10	–	Considerable amount stems present. Passed.
8040	Martin L. Hall Co., Boston. T. J. Daley & Co., Bangor. Preferred Stock Cloves.	.10	.26	Small amount of stems present. Passed.
8061	D. & L. Slade Co., Boston. C. H. Cloutier & Co., Lewiston. Slades Cloves, absolutely pure.	.08	.26	Small amount stems present. Passed.
8050	Stickney & Poor, Boston, Mass. R. E. Harvey & Co., Bangor. Stickney & Poor's Absolutely Pure Cloves.	.08	–	Very small amount stems present. Passed.
	GINGER.			
8090	B. Fischer & Co., New York. M. J. Flaherty, Portland. Fischer's Pure Ginger.	.05	.09	Passed.
8073	D. & L. Slade Co., Boston. J. Bowker, Lewiston. Slades Ginger Absolutely Pure.	.08	.25	Passed.
8041	Stickney & Poor, Boston. T. J. Daley, Bangor. Stickney & Poor's Absolutely Pure Ginger.	.10	.26	Passed.

Table showing results of analyses of spices and pepper purchased in packages in March, 1909—Continued.

Number.	Manufacturer, Name of Dealer and Brand.	Price cents.	Net weight lb.	Remarks.
	MUSTARD.			
8113	D. & L. Slade Co., Boston. B. D. Field, Belfast. Oxford mustard.	.10	.25	Some hulls. White mustard. Passed.
8112	S. S. Pierce & Co., Boston. Ben D. Field, Belfast. Keen's Mustard.	.28	.50	White mustard. Passed.
8111	Stickney & Poor, Boston. Dutch Bros. Belfast. Stickney & Poor's Extra Fine Mustard.	.10	.30	Black and white mustard; few foreign seeds. Passed.
	MACE.			
8072	Stickney & Poor, Boston, Mass. J. Bowker, Lewiston. Stickney & Poor's Pure Mace.	.10	.08	Passed.
	NUTMEG.			
8056	D. & L. Slade Co., Boston. Boston Tea Store, Lewiston. Slade's Absolutely Pure Nutmeg.	.18	.24	Passed.
8089	Stickney & Poor, Boston. A. F. Archibald, Portland. Stickney & Poor's Nutmegs.	.10	.09	Passed.
8099	Swan, Earle & Co., Boston. Brown & Sturtevant, Waterville. Reception Brand Nutmeg.	.10	.13	Passed.
	BLACK PEPPER.			
8085	B. Fischer & Co., New York. E. F. Hillman, Portland. Pure Black Pepper.	.05	.05	Excess pepper hulls. Passed.
8053	O'Donohue's Spices, New York. G. H. Stiles, Bangor. O'Donohue's 5th Ave. Spices, Pepper.	.10	.13	Passed.
8058	D. & L. Slade Co., Boston. Boston Tea Store, Lewiston. Slades Pure Extra Strong Pepper.	.12	.14	Passed.
8071	D. & L. Slade Co., Boston. J. E. Pelletier, Lewiston. Slades Pepper, absolutely pure.	.08	.23	Passed.
8036	Stickney & Poor, Boston. S. H. Robinson & Son. Bangor. Stickney & Poor's Absolutely Pure Pepper.	.08	.23	Passed.

Table showing results of analyses of spices and pepper purchased in packages in March, 1909—Concluded.

Number.	Manufacturer, Name of Dealer and Brand.	Price cents.	Net weight lb.	Remarks.
	CAYENNE PEPPER.			
8091	E. F. Fischer & Co., New York. M. J. Flaherty, Portland. Fischer's Pure Cayenne.	.05	.11	Passed.
8057	D. & L. Slade Co., Boston. Boston Tea Store, Lewiston. Slades Pure Extra Strong Pepper.	.12	.11	Passed.
8066	Stickney & Poor, Boston, Mass. E. Janelle & Co., Lewiston. Stickney & Poor's Pure Cayenne.	.10	.13	Passed.
	WHITE PEPPER.			
8084	B. Fischer & Co., New York. E. F. Hillman, Portland. Pure White Pepper.	.05	.06	Passed.
8035	Stickney & Poor, Boston. S. H. Robinson & Son, Bangor. Stickney & Poor's Absolutely Pure White Pepper.	.08	.24	Passed.

Sweet Spirit of Nitre.

Twenty-eight samples of sweet spirit of nitre were purchased at as many different drug stores during the month of April and the results of the analyses are here reported. Hearings were appointed in all of these cases which ran below 80 per cent U. S. P. standard and after investigation it was deemed necessary to prosecute some of the cases. Three cases have been brought to trial, conviction obtained and fine paid. The trials of others are pending.

At least one wholesale druggist and manufacturing chemist within the State has adopted that which seems to be a reprehensible, although lawful practice, of furnishing to the druggists of the State a below-standard spirit of nitre marked to carry 2 1-2 per cent of ethyl nitrite instead of the minimum of 4 per cent which is U. S. P. standard. They explain "we send 62 per cent alcohol and 2 1-2 per cent ethyl nitrite because this is the strength that our trade paid for before the pure food law came into force."

Table showing the results of analyses of sweet spirit of nitre purchased in April, 1909; arranged alphabetically by towns in which purchased.

No.	Name of Dealer.	Nitrous ether per cent.	Per cent U. S. P. minimum strength.
8199	Charles S. Bartlett, Auburn	3.61	91.0
8200	Bumpus & Getchell, Auburn	3.69	92.4
8202	John Coughlin, Augusta	3.74	94.0
8193	Swett Drug Store, Bath	3.31	83.0
7996	J. Crowley, Biddeford	3.20	81.0
7995	Elm St. Drug Store, Biddeford	2.01	50.6
7998	J. B. Morin & Co., Biddeford	3.28	82.2
8002	A. B. Smith Co., Biddeford	3.73	93.2
8201	L. D. Small, Bowdoinham	2.00	50.0
7988	Drapeau's Pharmacy, Brunswick	1.62	41.0
8103	Drapeau's Pharmacy, Brunswick	3.74	93.4
8195	Drapeau's Pharmacy, Brunswick	4.34	108.0
8194	F. H. Wilson, Brunswick	2.90	72.5
8018	Chandler's Pharmacy, Camden	1.99	50.0
8133	The Cochran Drug Store, Houlton	3.27	83.0
8132	M. J. Hathaway Co., Houlton	3.62	91.0
8197	Martel's Pharmacy, Lewiston	2.25	54.3
8196	South End Pharmacy, Lewiston	2.14	53.5
8198	Warren E. Riker, Lewiston	2.68	67.1
8031	A. M. Gerry, Lisbon Falls	0.89	22.0*
7902	Horgan & Abbott, Portland	3.90	98.0
8029	E. A. Mansir, Richmond	3.74	94.0
8011	Thos. F. Devine, So. Portland	3.45	86.0
8022	Chas. C. McDonald & Co., Thomaston	2.10	53.0
8033	Warren Drug Store, Warren	0.19	5.0**
8204	Geo. A. Daviau, Waterville	4.81	120.0
8203	George W. Dorr, Waterville	2.10	53.0
8205	Willard R. Jones, Waterville	4.00	100.0

*Labelled "Not U. S. P."

**Labelled "Below Standard Strength." "2½ per cent ethyl nitrite."

Table showing analyses of samples of cider vinegar all found to be pure and of lawful strength.

Sta. No.	Retail Dealer, Maker or Wholesale Dealer and Brand.	Total Acid.	Total Solids	Ash.
		%	%	%
7953	Twitchell-Champlin Co., Portland. Cider vinegar.	4.61	1.95	0.31
7954	Twitchell-Champlin Co., Portland. Cider vinegar.	5.03	3.11	0.40
7972	C. F. Dearth, Foxcroft. W. S. Ham, Foxcroft. Cider vinegar.	5.07	2.10	0.35
8030	H. E. Houdlette, Richmond. C. S. Libby, Richmond. Country cider vinegar.	4.47	1.25	0.43

Rice.

In December when Official Inspections 6 was published, the statement therein made that there was practically not a pound of rice produced in or imported into the United States without its being coated with glucose and talc, was true. Fortunately this condition is being changed and it is now possible to buy rice that is neither coated with glucose and talc or artificially colored, but is a straight natural head rice. If the housewife will insist that her dealer furnish her with uncoated rice, and if the dealer demand uncoated rice from his jobber, it will only be a short time before the adulteration of this staple will have ceased.

Alcohol.

In order to prepare many of the pharmaceutical preparations, it is necessary for the druggists to use alcohol. It has been suggested by a Maine chemist that because of the fact that the alcohol thus handled was more or less contraband that it was possible that the houses that were furnishing the Maine druggists with alcohol were not giving them alcohol of U. S. P. quality. Through the courtesy of some Maine druggists, we were supplied with samples of alcohol which they are using. This alcohol furnished by 5 supply houses was tested to see how closely it corresponded to the U. S. P. standards. While practically all of it carried traces of aldehyde when delicate tests were applied, it was all of such quality as to meet the U. S. P. requirements.

[352-6-09.]

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

Official Inspections.

12

THE TEXT OF THE LAWS.

The text of the laws of which the Director of the Maine Agricultural Experiment Station is the executive office are here printed as revised and effective July, 1909, per the following list:

AGRICULTURAL SEEDS.

Kind of Seeds Coming Under the Law. The law applies to every lot of seeds, containing one pound or more, of cereals, grasses, forage plants, vegetable and garden plants, but does not apply to sweet corn, trees, shrubs and ornamental plants.

The Guarantee. Every lot sold, offered or exposed for sale must be accompanied by a written or printed guaranty of the percentage of purity.

CHAPTER 39, REVISED STATUTES.

SEC. 27. Every lot of seeds of agricultural plants, whether in bulk or in package, containing one pound or more, and including the seeds of cereals, except sweet corn, grasses, forage plants, vegetables and garden plants but not including those of trees, shrubs and ornamental plants, which is sold, offered or exposed for sale for seed by any person in the state shall be accompanied by a written or printed guaranty of its percentage of purity and freedom from foreign matter; *provided*, that mixtures may be sold as such when the percentages of the various constituents are stated.

SEC. 28. Dealers may base their guaranties upon tests conducted by themselves, their agents or by the director of the Maine Agricultural Experiment Station; *provided*, that such tests shall be made under such conditions as the said director may prescribe.

SEC. 29. The results of all tests of seeds made by said director shall be published by him in the bulletins or reports of the experiment station, together with the names of the persons from whom the samples of seeds were obtained. The said director shall also publish equitable standards of purity, together with such other information concerning agricultural seeds as may be of public benefit.

* SEC. 30. Whoever sells, offers or exposes for sale or for distribution, in the state, any agricultural seeds without complying with the requirements of sections twenty-seven and twenty-eight, or whoever, wrongly marks or labels any package or bag containing garden or vegetable seeds or any other agricultural seeds, not including those of trees, shrubs and ornamental plants, shall be punished by a fine not exceeding one hundred dollars for the first offense and not exceeding two hundred dollars for each subsequent offense. Municipal and police courts and trial justices are hereby vested with original jurisdiction concurrent with the supreme judicial and superior courts, to try, and, upon conviction, to punish, for offenses against the provisions of this act.

SEC. 31. The provisions of the four preceding sections shall not apply to any person growing or selling cereals and other seeds for food.

* SEC. 33. The director of the Maine Agricultural Experiment Station shall diligently enforce the provisions of sections twenty-seven and thirty, of this chapter, and, in his discretion, prosecute offenses against the same.

CHAPTER 66 OF THE PUBLIC LAWS OF 1905.

SEC. 1. The director of the Maine Agricultural Experiment Station shall analyze, or cause to be analyzed, samples of agricultural seeds sold or offered for sale under the provisions of chapter thirty-nine of the revised statutes. He shall take in person or by deputy, a sample, not exceeding four ounces in weight, for said analysis, from any lot or package of agricultural seeds which may be in the possession of any grower,, importer, agent or dealer in the state.

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* The matter not relevant to seeds is omitted.

APPLES, GRADING, PACKING, AND BRANDING.

Grading. The law requires that all apples shall be graded into 4 classes. These are defined in sections 2 to 6.

Branding. The requirements of branding are given in section 1, 5 and 6.

Size of Package. A lawful apple barrel shall contain 3 bushels and a lawful apple box one bushel. The dimensions of the apple barrel and the apple box are given in section 7. Smaller barrels or boxes can be used if they are plainly marked "short barrel" or "short box" with figures indicating the fraction part of a barrel or box therein contained.

THE UNIFORM GRADING, PACKING AND BRANDING OF APPLES.

CHAPTER 247, PUBLIC LAWS, 1909.

SEC. 1. All barrels, boxes, crates and other closed packages of apples intended or offered for sale in the state of Maine, or for shipment outside of the state, shall be marked on the end in plain letters not less than five-eighths of one inch in length with the name and address of the purchaser or owner of said apples at the time of packing, the true name of the variety, if known, and the class or grade as defined as follows.

SEC. 2. Fancy apples shall consist of apples of one variety above the average size and color for the variety, sound and free from worm holes, bruises, scab or any other defect that materially injures the appearance or useful quality of the apples, and shall be properly packed in clean, strong packages.

Any package, barrel or box of apples containing more than ten per cent of apples below this standard shall not be marked as fancy apples.

SEC. 3. Number one, or class one, shall consist of well matured apples of one variety of normal shape and good color for the variety, not less than two and one-quarter inches in diameter, sound and free from all defects such as worm holes, bruises, scab or any other defect that materially injures the appearance or useful quality of the apple, and shall be properly packed in clean, strong packages.

Any package, barrel or box of apples containing more than ten per cent of apples below this standard shall not be marked as number one or class one.

SEC. 4. Number two or class two, shall consist of well matured apples of one variety, not less than two inches in diameter, of medium color for the variety and normal shape. Apples two and one-quarter inches in diameter or less, must be sound. Apples more than two and one-quarter inches in diameter may have one defect such as a worm hole or a bruise if the skin is not broken and shall be properly packed in clean, strong packages.

Any package, barrel or box of apples containing more than ten per cent of apples below this standard shall not be marked number two or class two.

SEC. 5. All of the three foregoing classes of apples grown in the state of Maine and packed in closed packages for shipment or sale outside of the state of Maine shall be marked on the outside in plain letters not less than seven-eighths of one inch long with the word Maine in such manner as to plainly designate that they were grown in the state of Maine.

SEC. 6. All apples grown in the state of Maine and offered for sale or shipment outside of the state of Maine in closed packages, not conforming to the foregoing conditions as to variety, size or other conditions, shall be marked "Unclassified."

SEC. 7. The standard measure of capacity for all apple barrels shall be three bushels, the barrel shall be of no less dimensions than seventeen and one-eighth inches for the head diameter, length of stave twenty-eight and one-half inches, with bilge circumference not less than sixty-four inches outside measurement, and shall be plainly marked, "standard barrel." Barrels of less dimensions and capacity shall be plainly marked on end and side, "short barrel" with the figures indicating the fractional part of a "standard barrel," therein contained.

The standard bushel box shall be twenty inches by eleven by ten inches, inside measurement, or of such dimensions as shall contain two thousand two hundred and fifty cubic inches and marked "standard bushel box."

Any box of less dimensions than the above mentioned shall be plainly marked on the top and side, "short box," and with the fractional part of a bushel therein contained.

SEC. 8. Any person, corporation, or firm who sells or offers for sale barrels, boxes, crates and other closed packages of apples, not conforming to the provisions of this act; or any person, corporation or firm who manufactures barrels, boxes, crates or other closed packages for the apple or fruit trade, not conforming to the provisions of this act, shall be punished by a fine not exceeding one hundred dollars for the first offense and not exceeding two hundred dollars for each subsequent offense. Trial justices and municipal and police courts are hereby vested with original jurisdiction concurrent with the supreme judicial and superior courts, to try, and, upon conviction, to punish, for offenses against the provisions of this act.

SEC. 9. When the director of the Maine agricultural experiment station becomes cognizant of the violation of any of the provisions of this act he shall cause notice of such fact, together with a copy of the findings, to be given to the party or parties concerned. The parties so notified shall be given an opportunity to be heard under such rules and regulations as may be prescribed as aforesaid. Notices shall specify the date, hour and place of the hearing. The hearing shall be private and the parties interested therein may appear in person or by attorney.

SEC. 10. No dealer shall be prosecuted under the provisions of this act when he can establish a guaranty signed by the wholesaler, jobber, manufacturer or other party residing in the United States, from whom he received such articles, to the effect that the same is not adulterated or misbranded, within the meaning of this act, designating it. Said guaranty, to afford protection, shall contain the name and address of the party or parties making the sale of such articles to said dealer, and in such case said party or parties shall be amenable to the prosecutions, fines and other penalties which would attach, in due course, to the dealer under the provisions of this act.

SEC. 11. The director of the Maine agricultural experiment station shall diligently enforce all the provisions of this act, and when after due hearing he is convinced that the provisions of this act have been violated he shall, in his discretion, prosecute all offenses against the same.

SEC. 12. Nothing in this act shall in any way be construed as debarring the so called flour barrel from being considered a standard barrel.

CREAMERY GLASSWARE.

Requirements of the Law. The law requires that all glassware used in creameries for the determination of butter fat shall be tested for accuracy by the Director of the Maine Agricultural Experiment Station. In practice this regulates the sale as for the most part the glassware is tested before it is sold to the creameries. It is not the duty of the Director of the Station to see that creameries and dealers comply with the requirements of this law.

CHAPTER 39, REVISED STATUTES.

SEC. 12. All bottles, pipettes or other measuring glasses used by any person, firm or corporation, or their agents or employes, at any creamery, butter factory, cheese factory, condensed milk factory or elsewhere in this state, in determining by the Babcock test, or any other test, the value of milk or cream received from different persons at such creameries or factories, shall be tested before such use, for accuracy of measurement and for accuracy of the per cent scale marked thereon. Such bottles, pipettes or measuring glasses shall bear in marks or characters ineffaceable the evidence that such test has been made by the authority named in the following section. No inaccurate bottles, pipettes or other glasses shall bear such marks or characters.

SEC. 13. The director of the Maine Agricultural Experiment Station, or some competent person designated by him, shall test the accuracy of all bottles, pipettes or other measuring glasses used by persons, firms or corporations in the state buying or pooling milk or cream, or apportioning butter or cheese, made from the same, by the contents of butter far contained therein. The said director, or the person designated by him, shall mark such bottles, pipettes or other measuring glasses as are found correct, with marks or characters which cannot be erased, and which marks or characters shall stand as proof that they have been so tested. The said director shall receive for such service no more than the actual cost incurred, which shall be paid by the persons or corporations for whom it is done.

COMMERCIAL FEEDING STUFFS.

Kinds of Feed coming within the Law. The law applies to all feeding stuffs *except* hays and straws; whole seeds and meals of wheat, rye, barley, oats, Indian corn, buckwheat and broom corn; brans and middlings. The principal feeds coming under the provisions of the law are linseed meals, cottonseed meals, cottonseed feeds, pea meals, cocoanut meals, gluten meals, gluten feeds, maize feeds, starch feeds, sugar feeds, dried brewer's grains, dried distiller's grains, malt sprouts, hominy feeds, cerealine feeds, rice meals, oat feeds, corn and oat chops, corn and oat feeds, corn bran, ground beef or fish scraps, condimental foods, poultry foods, stock foods, patented proprietary and trade mark stock and poultry foods, mixed feeds other than those composed solely of wheat bran and middlings mixed together or pure grains ground together, and all other materials of similar nature. It is unlawful to mix any thing with whole or ground grain or with bran or middlings unless the true composition is "plainly marked or indicated upon the packages."

The Brand. Each package of feeding stuff shall bear, conspicuously printed, the following statements:

The number of net pounds contained in the package.

The name or trade-mark under which it is sold.

The name of the manufacturer or shipper.

The place of manufacture.

The place of business of manufacturer or shipper.

The percentage of crude protein.

The percentage of crude fat.

CHAPTER 39, REVISED STATUTES.

SEC 22. Every package of any concentrated commercial feeding stuff, as defined in section twenty-four, used for feeding farm livestock, sold, offered or exposed for sale in the state, shall have affixed in a conspicuous place on the outside thereof, a plainly printed statement clearly and truly certifying the number of net pounds in the package, the name, brand or trade-mark under which the article is sold, the name and address of the manufacturer or importer, and a chemical analysis stating the percentage of crude protein, allowing one per cent of nitrogen to equal six and one-fourth per cent of protein, and of crude fat which it contains, both constituents to be determined by the methods adopted at the time by the association of official agricultural chemists. If the feeding stuff is sold in bulk or put up in packages belonging to the purchaser, the agent or dealer shall, upon request of the purchaser, furnish him with the certified statement named in this section.

SEC. 23. The term "concentrated commercial feeding stuff," as here used, shall not include hays and straws, the whole seeds nor the unmixed meals made directly from the entire grains of wheat, rye, barley, oats, Indian corn, buckwheat and broom corn. Neither shall it include wheat, rye and buckwheat brans or middlings, not mixed with other substances, but sold separately, as distinct articles of commerce, nor wheat bran and middlings mixed together, nor pure grains ground together.

SEC. 24. The term "concentrated commercial feeding stuff," as here used, shall include linseed meals, cottonseed meals, cottonseed feeds, pea meals, cocoanut meals, gluten meals, gluten feeds, maize feeds, starch feeds, sugar feeds, dried brewers' grains, dried distillers' grains, malt sprouts, hominy feeds, cerealine feeds, rice meals, oat feeds, corn and oat chops, corn and oat feeds, corn bran, ground beef or fish scraps, condimental foods, poultry foods, stock foods, patented proprietary or trade-marked stock and poultry foods, mixed feeds other than those composed solely of wheat bran and middlings mixed together, or pure grains ground together, and all other materials of similar nature not included in the preceding section.

SEC. 26. The director of the Maine Agricultural Experiment Station annually shall analyze, or cause to be analyzed, at least one sample of every concentrated commercial feeding stuff sold or offered for sale under the provisions of this chapter. He shall take in person or by deputy, a sample, not exceeding two pounds in weight, for said analysis, from any lot or package of concentrated commercial feeding stuff which may be in the possession of any manufacturer, importer, agent or dealer in the state. The result of the analyses of all samples of concentrated commercial feeding stuffs together with such additional information as may be of public benefit shall be published in reports or bulletins of the station.

* SEC. 30. Whoever sells, offers or exposes for sale or for distribution, in the state, any concentrated commercial feeding stuffs as defined in section twenty-four without complying with the requirements of section twenty-two, or any feeding stuff which contains a smaller percentage of constituents than are certified to be contained, shall be punished by a fine not exceeding one hundred dollars for the first offense and not exceeding two hundred dollars for each subsequent offense. Municipal and police courts and trial justices are hereby vested with original jurisdiction concurrent with the supreme judicial and superior courts, to try, and, upon conviction, to punish, for offenses against the provisions of this act.

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* The matter not relevant to feeding stuff is omitted.

SEC. 32. Whoever adulterates any whole or ground grain with milling or manufactured offals or with any foreign substance whatever, or any bran or middlings made from the several grains with any foreign substance whatever, for the purpose of sale, unless the true composition, mixture or adulteration thereof is plainly marked or indicated upon the packages containing the same, or in which it is offered for sale; or whoever sells or offers for sale any whole or ground grain, bran or middlings which have been so adulterated, unless the true composition, mixture or adulteration is plainly marked or indicated upon the package containing the same, or in which it is offered for sale, shall be fined not exceeding one hundred dollars for the first offense, and not exceeding two hundred dollars for each subsequent offense. Municipal and police courts and trial justices are hereby vested with original jurisdiction concurrent with the supreme judicial and superior courts, to try, and, upon conviction, to punish, for offenses against the provisions of this act.

* SEC. 33. The director of the Maine Agricultural Experiment Station shall diligently enforce the provisions of sections twenty-two, thirty and thirty-two, of this chapter, and, in his discretion, prosecute offenses against the same.

FEEDING STUFFS AND THE FOOD AND DRUG LAW.

In the Food and Drug Law the term "food" as defined includes "all articles used for food, drink, confectionery or condiment by man or other animals whether simple, mixed or compound." Therefore, in a general way, commercial feeding stuffs are included under the Food and Drug Law as well as under the special law regulating the sale of concentrated commercial feeding stuffs. The following are cited as illustrations of the special bearings of the Food and Drug Law on the sale of feeding stuffs:

Whole grains do not come under the requirements of the law regulating the sale of commercial feeling stuffs. Hence, so far as the feeding stuffs law goes, oats badly adulterated with weed seeds or with other grains could be sold with impunity. If, however, the oats are sold for oats and are not true to grade or true to name, the sale is made in violation of the Maine Food and Drug Law as well as the United States Food and Drugs Act.

* The matter not relevant to feeding stuff is omitted.

There is nothing in the Maine feeding stuffs law which prohibits weeds in feeds. Under the Food and Drug Law, however, poisonous weeds as corn cockle and jimson weeds are excluded and the sale of feeding stuffs carrying these poisonous weed seeds is unlawful.

Food Inspection Decision 90 of the U. S. Board of Food and Drug Inspection bearing on the sale of commercial feeding stuffs is reprinted here.

THE LABELING OF FOODS AND MEDICINAL MIXTURES FOR STOCK AND POULTRY.

The Department has frequently received inquiries in regard to the labeling of bran, of which the following is a fair sample:

Can the screenings of wheat, consisting principally of shrunken seed, etc., be put in the bran and it still be called bran, etc.

Since the above is clearly in violation of those provisions of the law requiring that a food product be true to label, the Department is of the opinion that it will be necessary to label such a mixture as "Bran and Screenings."

It has recently come to the attention of the Department that a number of the cattle and poultry foods sold on the American market contain enough poisonous weed seeds, such as corn cockle and jimson weed (Jamestown weed), to have a more or less toxic effect on poultry, cattle, etc. Poultry and cattle foods which contain poisonous weed seeds in appreciable quantities will be considered as adulterated in accordance with those provisions of the food and drugs act, June 30, 1906, forbidding the presence of poisonous or deleterious ingredients.

The Department has been asked by the manufacturers of medicinal mixtures for poultry, cattle, etc., whether such mixtures may, under the law, be labeled respectively as cattle and poultry foods. It is thought, first, that the words "Cattle Food" or "Poultry Food" should apply to cattle or poultry foods which are not mixed with any condimental or medicinal substance or substances; second, that mixtures of cattle and poultry food materials, with small quantities of condiments, such as anise seed, ginger, capsicum, etc., should be labeled as "Condimental Cattle Food," or "Condimental Poultry Food;" and third, that mixtures of cattle-food materials with medicinal substances, such as arsenic, sulphate of iron (copperas), etc., should not be labeled as foods, but as medicines, or remedies. For example, under the latter ruling, a cattle food mixed with medicinal substances, such as arsenic, copperas, etc., should be plainly labeled as a remedy, or medicine, so as to differentiate clearly such a substance from a cattle food material unmixed with medicinal agents.

COMMERCIAL FERTILIZERS.

The Brand. Each package shall bear, conspicuously printed. the following statements:

The number of net pounds contained in each package.

The name or trade mark under which it is sold.

The name of the manufacturer or shipper.

The place of manufacture.

The place of business of manufacturer or shipper.

The percentage of nitrogen or its equivalent in ammonia.

The percentage of potash soluble in water.

The percentage of phosphoric acid in available form.

The percentage of total phosporic acid.

The Certificate. There shall be filed annually between Nov. 15 and Dec. 15 with the Director of the Station a certificate containing an accurate statement of the brand. This certificate applies to the next succeeding calendar year.

Analysis Fee. For each brand of fertilizer sold or offered for sale in the State there shall be paid annually to the Treasurer of State "an analysis fee as follows: Ten dollars for the phosphoric acid and five dollars each for the nitrogen and potash, contained or said to be contained in the fertilizer."

The License. Upon the payment of the fee and receipt of the certificate the Director of the Station "shall issue a certificate of compliance."

CHAPTER 39, REVISED STATUTES.

Regulation of Sale of Commercial Fertilizers.

SEC. 16. Every manufacturer, company or person, who shall sell, offer or expose for sale in the state any commercial fertilizer or any material used for fertilizing purposes, the price of which exceeds ten dollars a ton, shall affix to every package of such fertilizer, in a conspicuous place on the outside thereof, a plainly printed statement clearly and truly certifying the number of net pounds in the package sold or offered for sale, the name or trade mark under which the article is sold, the name of the manufacturer or shipper, the place of manufacture, the place of business and a chemical analysis stating the percentage of nitrogen, or its equivalent in ammonia in available form, of potash soluble in water, and of phosphoric acid in available form, soluble and reverted, and also the total phosphoric acid.

SEC. 17. Every manufacturer, company or person, who shall sell, offer or expose for sale in the state any commercial fertilizer or material used for fertilizing purposes, the price of which exceeds ten dollars a ton, shall file annually between the fifteenth day of November and the fifteenth day of December with the director of the Maine Agricultural Experiment Station, a certified copy of the statement named in the preceding section, for each and every fertilizer bearing a distinguishing name or trade mark. Such certificate shall apply to the entire calendar year next succeeding the date upon which said certificate is made. The manufacturer, company or person who shall file said certificate shall pay annually to the treasurer of state an analysis fee as follows: Ten dollars for the phosphoric acid, and five dollars each for the nitrogen and potash, contained or said to be contained in the fertilizer, this fee to be assessed on any brand sold in the State. Upon receipt of the treasurer's receipt for such fee and of the certified statement, said director shall issue a certificate of compliance with this chapter. Whenever the manufacturer or importer of a fertilizer shall have filed the statement and paid the analysis fee, no agent or seller of said manufacturer, importer or shipper shall be required to file such statement or pay such fee.

SEC. 20. The director of the Maine Agricultural Experiment Station annually shall analyze, or cause to be analyzed, at least one sample of every fertilizer sold or offered for sale under the provisions of this chapter. Said director shall take, in person or by deputy, a sample, not exceeding two pounds in weight, for said analysis, from any lot or package of fertilizer, or any material used for manurial purposes which may be in the possession of any manufacturer, importer, agent or dealer in the state. The results of the analyses of all samples of commercial fertilizers together with such additional information as may be of public benefit shall be published in reports or bulletins of the station.

* SEC. 30. Whoever sells, offers or exposes for sale or for distribution, in the state, any commercial fertilizer without complying with the requirements of sections sixteen and seventeen, or any fertilizer which contains a smaller percentage of constituents than are certified to be contained, shall be punished by a fine not exceeding one hundred dollars for the first offense and not exceeding two hundred dollars for each subsequent offense. Municipal and police courts and trial justices are hereby vested with original jurisdiction concurrent with the supreme judicial and superior courts, to try, and, upon conviction, to punish, for offenses against the provisions of this act.

* SEC. 33. The director of the Maine Agricultural Experiment Station shall diligently enforce the provisions of sections sixteen, seventeen, and thirty of this chapter, and, in his discretion, prosecute offenses against the same.

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* The matter not relevant to fertilizers is omitted.

FOOD AND DRUGS.

The Maine Food and Drug Law is in accord with the National Food and Drug Act, June 30, 1906, and demands freedom from adulteration and truthful labeling. The standards and regulations are too long to be here printed.

CHAPTER 124 OF THE PUBLIC LAWS OF 1907.

SEC. 1. It shall be unlawful for any person within this state to manufacture, sell, transport, or offer for sale or transportation, any article of food or drug which is adulterated or misbranded within the meaning of this act.

SEC. 2. The term 'drug,' as used in this act, shall include all medicines and preparations recognized in the United States pharmacopœia or national formulary for internal or external use, and any substance or mixture of substances intended to be used for the cure, mitigation, or prevention of disease of either man or other animals. The term 'food,' as used herein, shall include all articles used for food, drink, confectionery, or condiment by man or other animals, whether simple, mixed or compound.

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

In case of drugs:

First. If when a drug is sold under or by a name recognized in the United States pharmacopœia or national formulary, it differs from the standard of strength, quality or purity, as determined by the test laid down in the United States pharmacopœia or national formulary official at the time of investigation: Provided, that no drug defined in the United States pharmacopœia or national formulary shall be deemed to be adulterated under this provision if the standard of strength, quality, or purity be plainly stated upon the bottle, box or other container thereof although the standard may differ from that determined by the test laid down in the United States pharmacopœia or national formulary.

Second. If its strength or purity fall below the professed standard or quality under which it is sold.

In the case of confectionery:

If it contains terra alba, barytes, talc, chrome yellow, or other mineral substances or poisonous color or flavor, or other ingredient deleterious or detrimental to health, or any vinous, malt, or spirituous liquor or compound or narcotic drug.

In the case of food:

First. If any substance has been mixed and packed with it so as to reduce or lower or injuriously affect its quality or strength.

Second. If any substance has been substituted wholly or in part for the article.

Third. If any valuable constituents of the article have been wholly or in part abstracted.

Fourth. If it be mixed, colored, powdered, coated, or stained in a manner whereby damage or inferiority is concealed.

Fifth. If it contain any added poisonous or other added deleterious ingredient which may render such article injurious to health; Provided, that when in the preparation of food products for shipment they are preserved by any external application applied in such manner that the preservative is necessarily removed mechanically, or by maceration in water, or otherwise, and directions for the removal of said preservative shall be printed on the covering of the package, the provisions of this act shall be construed as applying only when said products are ready for consumption.

Sixth. If it consists in whole or in part of a filthy, decomposed, or putrid animal or vegetable substance, or any portion of an animal unfit for food, whether manufactured or not, or if it is the product of a diseased animal, or one that has died otherwise than by slaughter.

SEC. 4. The term 'misbranded,' as used herein, shall apply to all drugs, or articles of food, or articles which enter into the composition of food, the package or label of which shall bear any statement, design, or device regarding such article, or the ingredients or substances contained therein which shall be false or misleading in any particular and to any food or drug product which is falsely branded as to the state, territory, or country in which it is manufactured or produced.

For the purpose of this act an article shall also be deemed to be misbranded:

In case of drugs:

First. If it be an imitation of or offered for sale under the name of another article.

Second. If the contents of the package as originally put up shall have been removed, in whole or in part, and other contents shall have been placed in such package, or, except in the case of a physician's prescription compounded by a physician or a registered pharmacist, if the package fail to bear a statement on the label of the quantity or proportion of any alcohol, morphine, opium, cocaine, heroin, alpha or beta eucaine, chloroform, cannabis indica, chloral hydrate or acetanilide or any derivative or any preparation of any such substances contained therein.

In the case of food:

First. If it be an imitation of or offered for sale under the distinctive name of another article.

Second. If it be labeled or branded so as to deceive or mislead the purchaser, or purport to be a foreign product when not so, or if the contents of the package as originally put up shall have been removed in whole or in part and other contents shall have been placed in such package, or if it fail to bear a statement on the label of the quantity or proportion of any morphine, opium, cocaine, heroin, alpha, or beta eucaine, chloroform, cannabis indica, chloral hydrate, or acetanilide, or any derivative or preparation of any of such substances contained therein.

Third. If in package form, and the contents are stated in terms of weight or measure, they are not plainly and correctly stated on the outside of the package.

Fourth. If the package containing it or its label shall bear any statement, design, or device regarding the ingredients or the substances contained therein, which statement, design, or device shall be false or misleading in any particular: Provided, that an article of food which does not contain any added poisonous or deleterious ingredients shall not be deemed to be adulterated or misbranded in the following cases:

First. In the case of mixtures or compounds which may be now or from time to time hereafter known as articles of food, under their own distinctive names, and not an imitation of or offered for sale under the distinctive name of another article, if the name be accompanied on the same label or brand with a statement of the place where said article has been manufactured or produced.

Second. In the case of articles labeled, branded, or tagged so as to plainly indicate that they are compounds, imitations, or blends, and the word 'compound,' 'imitation,' or 'blend,' as the case may be, is plainly stated on the package in which it is offered for sale: Provided, that the term 'blend' as used herein shall be construed to mean a mixture of like substances, not excluding harmless coloring or flavoring ingredients used for the purpose of coloring and flavoring only: And provided further, that nothing in this act shall be construed as requiring or compelling proprietors or manufacturers of proprietary foods which contain no unwholesome added ingredient to disclose their trade formulas except in so far as the provisions of this act may require to secure freedom from adulteration or misbranding.

SEC. 5. The director of the Maine Agricultural Experiment Station shall make uniform rules and regulations for carrying out the provisions of this act, including the collection and examination of specimens of foods and drugs manufactured, sold, transported, or offered for sale or transportation within this state, or which may be submitted for examination by any health, food or drug officer of any town, city or county within this state. The said director may also adopt or fix standards of purity, quality or strength when such standards are not specified or fixed by law and shall publish them together with such other information concerning articles of food and drugs as may be of public benefit. Such rules, regulations and standards shall, where possible, conform to and be the same as the rules and regulations adopted from time to time for the enforcement of act of congress approved June thirtieth, nineteen hundred and six, and known as 'The Food and Drugs Act.'

SEC. 6. The director of the Maine Agricultural Experiment Station shall analyze, or cause to be analyzed, samples of articles of food and drugs on sale in Maine, and at such times and to such extent as said director may determine. And said director, in person or by deputy, shall have free access at all reasonable hours to any place wherein articles of food or drugs are offered for sale, and upon tendering the market price of any such article may take from any person samples for analysis. The results of all analyses of articles of food and drugs made by said director shall be published by him in the bulletins or reports of the experiment station, together with the names of the persons from whom the samples were obtained, and the names of the manufacturers thereof.

SEC. 7. When the said director becomes cognizant of the violation of any of the provisions of this act he shall cause notice of such fact, together with a copy of the findings, to be given to the party or parties concerned, including those from whom the sample was obtained, and to the party, if any, whose name appears upon the label as manufacturer, packer, wholesaler, retailer or other dealer. The parties so notified shall be given an opportunity to be heard under such rules and regulations as may be prescribed as aforesaid. Notices shall specify the date, hour and place of the hearing. The hearing shall be private and the parties interested therein may appear in person or by attorney. If the party whose name appears upon the label resides without the state he shall be entitled to reasonable notice by mail at such address as may, with due diligence, be obtained.

SEC. 8. Any person who adulterates or misbrands, within the meaning of this act, any article of food or drugs, or any person who sells, transports, offers or exposes for sale or transportation any adulterated or misbranded article of food or drugs, shall be punished by a fine not exceeding one hundred dollars for the first offense and not exceeding two hundred dollars for each subsequent offense. Trial justices and municipal and police courts are hereby vested with original jurisdiction concurrent with the supreme judicial and superior courts, to try, and, upon conviction, to punish, for offenses against the provisions of this act.

SEC. 9. No dealer shall be prosecuted under the provisions of this act when he can establish a guaranty signed by the wholesaler, jobber, manufacturer, or other party residing in the United States, from whom he purchased such articles, to the effect that the same is not adulterated or misbranded within the meaning of this act, designating it. Said guaranty, to afford protection, shall contain the name and address of the party or parties making the sale of such articles to such dealer, and in such case said party or parties shall be amenable to the prosecutions, fines and other penalties which would attach, in due course, to the dealer under the provisions of this act.

SEC. 10. The director of the Maine Agricultural Experiment Station shall diligently enforce all the provisions of this act, and when after due hearing he is convinced that the provisions of this act have been violated he shall, in his discretion prosecute all offenses against the same.

SEC. 12. The word 'person' as used in this act shall be construed to import both the plural and the singular, as the case demands, and shall include corporations, companies, societies and associations. When construing and enforcing the provisions of this act, the act, omission, or failure of any officer, agent or other person acting for or employed by any corporation, company, society, or association, within the scope of his employment or office, shall in every case be also deemed to be the act, omission, or failure of such corporation, company, society, or association as well as that of the person.

Food and Drug Regulations and Decisions.

The following list includes the more important of the National regulations and Food Inspection Decisions (F. I. D.) and the Maine Food and Drug Regulations (M. F. D. R.):

REGULATIONS.

(Circular 21, Office of Secretary.)

7. Standards for Drugs.
8. Formulas—Proprietary Foods.
9. Form of Guaranty.
10. Confectionery.
11. Substances Mixed and Packed with Foods.
12. Coloring, Powdering, Coating and Staining.
13. Natural Poisonous or Deleterious Ingredients.
14. External Application of Preservatives.
15. Wholesomeness of Colors and Preservatives.
16. Character of the Raw Materials.
17. Label.
18. Name and Address of Manufacturer.
19. Character of Name.
20. Distinctive Name.
21. Compounds, Imitations, or Blends without Distinctive Name.
22. Articles without a Label.
24. Incompleteness of Branding.
25. Substitution.
26. Waste Materials.
27. Mixtures of Compounds with Distinctive Names.
28. Substances named in Drugs or Foods.
29. Statement of Weight or Measure.
30. Method of Stating Quantity or Proportion.

FOOD INSPECTION DECISIONS (F. I. D.).

42. Mixing Flours.
47. Flavoring Extracts.
48. Substances used in the Preparation of Foods.
50. Imitation Coffee.
51. Coloring of Butter and Cheese.
52. Form of Label.
53. Formula on the Label of Drugs.

54. Declaration of the Quantity or Proportion of Alcohol.
56. Names to be Employed in Declaring the Amount of the Ingredients.
58. The Labeling of Products Used as Food and Drugs as well as for Technical Purposes.
59. National Formulary Appendix.
61. Cocoa Butter Substitutes.
63. Use of the word "Compound" in Names of Drug Products.
64. Labeling Sardines.
66. The Use of Sugar in Canned Foods.
67. Polishing and Coating Rice.
71. Labeling of Succotash.
72. Use of Guaranties and Serial Numbers.
75. Labeling Mixtures of Cane and Maple Syrups.
76. Dyes, Chemicals and Preservatives in Foods.
77. Certificate and Control of Permissible Dyes.
80. Glazed Coffee.
81. Labeling Caramels.
82. Labeling Coffee Prodrced in the Dutch East Indies.
85. Labeling Bitters.
87. Labeling Corn Syrup.
89. Benzoate of Soda and Sulphur Dioxid.
90. Foods and Medicinal Mixtures for Stock.
91. Labeling Mocha Coffee.
92. Use of Copper Salts in the Greening of Foods.
94. Labeling of Medicinal and Table Waters.
96. Serial Number Guaranty.
97. "Soaked Curd" Cheese.
99. Change in Form of Guaranty.
100. Bleached Flour.
101. Benzoate of Soda.
104. Benzoate of Soda.
105. Labeling of Salmon and White Fish.

MAINE FOOD AND DRUG REGULATIONS.

M. F. D. R. 1. Text of Law.
M. F. D. R. 4. Food Standards.
M. F. D. R. 5. Standards for Drugs.
M. F. D. R. 8. Vinegar.
M. F. D. R. 10. Sirup Standards.
M. F. D. R. 11. A written guaranty.
M. F. D. R. 12 Selling Goods Removed from the Original Package.
M. F. D. R. 13. Substitution.
M. F. D. R. 14. The Guaranty.
M. F. D. R. 15. Labeling Drugs and Medicines.
M. F. D. R. 16. Labeling Shelf Bottles.

O. I. 3. Sweet Spirit of Nitre.
O. I. 4. Misbranding goods from open packages.
O. I. 6. Extracts.
O. I. 7. Standards for Liquors.
O. I. 7. Carbonated Beverages.
O. I. 8. Benzoate of Soda.
O. I. 8. Ice Cream and Ice Cream Substitutes.

INCOME FOR WORK OF INSPECTION.

Chapter 115 of the Public Laws of 1909.

Sec. 1. There shall be appropriated annually from the state treasury the sum of nine thousand dollars in favor of the Maine Agricultural Experiment Station, and the same shall be expended by the director of said station in executing the provisions of the laws relating to the collection, examination, inspection and analysis of agricultural seeds, concentrated commercial feeding stuffs, commercial fertilizer, and foods and drugs. Payments of said appropriation shall be made quarterly upon the order of the governor and council, who shall draw a warrant for that purpose. The director of said station shall annually publish in the reports or bulletins of the station a classified account of all receipts and expenditures under this act.

Sec. 2. Section nineteen of chapter thirty-nine of the Revised Statutes is hereby amended so that as amended said section shall read as follows: *

'All fines paid under section thirty, chapter thirty-nine of the Revised Statutes and under section eight of chapter one hundred twenty-four of the Public Laws of nineteen hundred and seven may be used for the enforcement of the laws regulating the sale and analysis of agricultural seeds, commercial fertilizers, concentrated commercial feeding stuffs and food and drugs, and shall be paid over by the several county treasurers to whom they shall be paid to the officer charged by law with the enforcement of the laws regulating the same.'

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* The matter not relevant to income is omitted.

[357-7-09.]

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

Official Inspections.

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Both the spirit and the letter of the Maine Inspection Laws demand freedom from adulteration and truthful labeling.

COFFEE.

Table showing results of analyses of samples of coffee purchased in March, 1909.

Station No.	Name of Maker, Brand and Dealer.	Price per pound.	Weight.		Results of microscopic examination.
			Claimed	Found	
		Cts.		Ozs.	
8095	Chase & Sanborn, Boston, Mass. "Choice Blended Coffee" Edward McLaughlin, Waterville	20	16	16.3	No adulteration.
8076	Delano, Potter & Co., Boston, Mass. "Bay State Coffee" C. O. Scribner, Portland	25	16	16.3	Some coffee hulls, but probably not more than is to be expected in a low priced coffee.
8098	Swain, Earle & Co., Boston, Mass. "Silver Quarter Coffee" Brown & Sturtevant, Waterville	25	16	16.1	Very few hulls, but not enough to suspect intended adulteration.
8093	Brownelle & Field Co., Providence, R. I. "One pound Autocrat Pure Coffee" E. L. Cove, Waterville	25	16	16.1	Some sticks and very few hulls. Probably not intentional.
8094	Berry-Hall Co., Burlington, Vt. "Reputation Coffee" Edward McLaughlin, Waterville	25	16	16.0	No adulteration.

GELATINE.

Samples of the leading brands of gelatine, simple and compounded, that were upon the Maine market were collected in June. The chief results of the examinations are given in the table which follows. As was to be expected there was a great difference in the price per ounce, although it is to be remembered that where they contain sugar that they will not make nearly as much of the product ready for the table as a like amount of gelatine free from sugar. Nitrogen was determined in the samples which did not contain sugar or much of other foreign materials. Chemically pure and water free gelatine carries about 18.3 per cent nitrogen. The percentage of nitrogen (see table) is a reasonable measure as to the strength. Of course, the adding of any foreign material such as sugar, acid or flavoring extracts will all tend to reduce the percentage of nitrogen and the jelly making power of the gelatine. Air dried gelatine will always carry some water and naturally the greater the percentage of water the lower the percentage of nitrogen.

In the case of flavoring materials, the purity of the flavoring extracts were not tested. It is probable that in such materials as strawberry, wild cherry, etc., that the flavors are imitation and not fruit flavors. The coloring matters were for the most part either vegetable or the permissible coal tar colors. In the case of samples which are marked with double asterisks (**) in the table, we were unable to identify the dye that was used, although they were not coal tar colors.

In the case of three samples it was found necessary to appoint hearings. The notes given below were too long to be included under "Remarks" in the table.

8320. Misbranded by using word "Concentrated" also marked "Plain" when it contains sugar. Hearing was appointed. Company explained that word "Plain" was used to distinguish from their flavored and that the word "Concentrated" did not refer to nitrogen content but to the amount of gelatine required to make a given amount of product ready for the table.. Both will be corrected on new labels for all goods to be shipped. Case not prosecuted.

8329. Misbranded. Statement on package "Colored with a harmless vegetable color." The color was found to be amaranth one of the permissable coal tar colors. Hearing appointed.

8336. The package carried extravagant and misleading and false statements such as "whitest and purest gelatine," "most economical for family use," "giving to the system just what it needs." Hearing appointed.

8338. Not properly labeled although by careful reading all needed facts could be found. Company are preparing a new label that will conform to requirements of National and Maine food and drug laws. Contained sugar and vegetable acid.

Table showing the results of analyses of samples of gelatine purchased in June, 1909. The samples are arranged alphabetically by states and towns within the state in which manufactured. See discussion page 94.

Station No.	Maker, Brand and Retailer.	Price.	Weight.	Foreign matters.†	Color.	Nitrogen.	Remarks.
		Cts.	Ozs.				
8387	Geo. C. Shaw Co., Portland, Me...... "Silver Thread Refining Gelatine." Geo. C. Shaw Co., Portland, Me.	12	1.69	None	None	14.76	
8388	National Cocoanut Co., Baltimore, Md. "National Double Refined Gelatine". John W. Deering & Son, Portland, Me.	10	0.63	None	None	14.34	
8398	Crystal Gelatine Co., Boston, Mass. "Crystal Gelatine." Geo. C. Shaw Co., Portland, Me......	10	1.06	None	None	14.88	
8324	Plymouth Rock Gelatine Co., Boston "Plymouth Rock Phosphated Granulated Gelatine." Brown & Sturtevant, Waterville......	13	1.90	None	None	13.70	
8321	Plymouth Rock Gelatine Co., Boston. "Plymouth Rock Plain Granulated Gelatine." Brown & Sturtevant, Waterville......	13	1.41	None	*	14.90	*
8328	Swampscott Gelatine Co., Boston. "Swampscott Brand Sparkling Gelatine." Whitcomb & Cannon, Waterville.....	10	1.16	None	*	14.88	
8320	Minute Tapioca Co., Orange, Mass. "Minute Plain Gelatine Concentrated" Brown & Sturtevant, Waterville......	10	1.65	None	*	12.74	See 8320 above.
8338	Whitman Grocery Co., Orange, Mass. "Minute Gelatine, flavored Wild Cherry." Nealey & Miller, Lewiston...........	10	3.38	None	Cudbear	–	See 8338 above.

Table showing results of the examination of goods purchased as sweet oil in June, 1909. The samples are arranged alphabetically by towns in which purchased.—Continued.

Station No.	Makers, Brand and Retailer.	Price.	Weigh.	Foriegn matters.†	Color.	Nitrogen.	Remarks.
8329	Michigan Carbon Works, Detroit, Mich. "Keystone Silver White Gelatine." Whitcomb & Cannon, Waterville.....	12	1.51	None	Amaranth	14.80	See 8329 above.
8322	Chas. B. Knox, Johnstown, N. Y. "Knox's No. 3 Improved Package Acidulated Gelatine." Brown & Sturtevant, Waterville, Me.	13	1.20	None	*	14.78	
8323	Chas. B. Knox, Johnstown, N. Y. "Knox's Sparkling Gelatine No. 1." Brown & Sturtevant, Waterville......	13	1.23	None	*	15.14	
8352	The Genesee PureFoodCo.,LeRoy,N.Y. "Jell-O." J. T. Dougherty, Portland	10	3.53	None	**Dye	–	Sugar.acid.
8368	The Genesee PureFoodCo.,LeRoy,N.Y. "Jell-O." H. P. Gillise, Portland.............	10	3.53	None	**Dye	–	Sugar.acid.
8355	E. S. Burnham Co., New York City,N.Y "Burnham's Jellycon, Raspberry." Libby & Chipman, Portland.........	10	3.84	None	**Dye	–	Sugar.acid.
8357	E. S. Burnham Co., New York City. "Burnham's Jellycon, Strawberry." Russell-Webber Co., Portland........	10	3.95	None	**Dye	–	Sugar.acid.
8376	The Stern & Sallberg Co., N. Y. City. "Bromangelon." S. F. Wood, Portland...............	10	4.37	None	**Dye	–	Sugar.acid.
8336	Chalmers, Williamsville, N. Y. "Chalmers' Granulated Gelatine." W. P. Stewart Co., Waterville........	10	1.80	None	*	14.70	See 8336 above.
8354	James Chalmers Sons, Williamsville, N. Y. "James Chalmers Sons' Sour Transparent Gelatine." Libby & Chipman, Portland.........	10	1.87	None	*	14.74	
8386	G. Nelson, Dale & Co., Ld., Emscote Mills, Warwick, England.......... "Nelson's ImprovedBrilliantGelatine" W. L. Wilson & Co., Portland........	17	1.62	None	None	14.62	
8325	I. & G. Cox Gelatine Works, Gorgie Mills, Edinburg, Scotland. "Cox Instant Powdered Gelatine." Brown & Sturtevant, Waterville......	17	1.66	None	None	15.10	

*Separate package of permissable color.

†Only includes materials found by microscope.

**Unidentified. Not a coal tar color.

SWEET OIL.

A few samples of sweet oil were purchased in drug stores and grocery stores in the month of June. Many of these samples were purchased from bulk. These samples are indicated by an asterisk (*) in the table. All the samples were tested for cotton seed and sesame oils. In no instance was sesame oil found but in several cases the sample consisted entirely of cotton seed oil. Most of the goods that were in bottles were not marked to show content. In two instances there was short measure. While there was a marked difference in the quality of the olive oil no attempt is made in the table to distinguish as to quality as th requirements of the law only extend to purity.

Samples about which no questions were raised are marked "Passed" in the table. The other samples are discussed in the following notes:

8229. Wrongly sold and labeled. As it was plainly labeled "cotton seed oil (sweet oil)" the dealer was cautioned and the case was not prosecuted.

8230. Unlawfully sold. Misbranded and adulterated. Cotton seed oil instead of olive oil. Hearing appointed.

8231. Unlawfully sold. Misbranded and adulterated. Cotton seed oil instead of olive oil. Hearing appointed.

8232. Eight ounces of sweet oil was asked for. Unlabeled bottle containing 7.12 ounces instead of 8 ounces was delivered. Short measure. Hearing appointed.

8233. Unlawfully sold. Misbranded and adulterated. Cotton seed oil instead of olive oil. Hearing appointed.

8268. Unlawfully sold. Adulterated and misbranded. Sample consisted of a box containing 12 bottles labeled "1 doz. 1 1-2 oz. Daisy pure sweet oil for family use, manufactured by Thurston and Kingsbury, Bangor, Maine." The bottles were on the average a little under measure and contained cotton seed oil instead of olive oil. Hearing appointed.

8308. This was wrongly sold, but the dealer evidently intended to follow the law as evidenced by putting the words "for technical use only" on the label. This phrase takes a material out of the requirements of the food and drug law.

The dealer was at fault in thus selling and labeling without calling the attention of the purchaser. The dealer was cautioned and the case was not prosecuted.

8309. Unlawfully sold. Misbranded and adulterated. Cotton seed oil instead of olive oil. Also slightly short measure. Hearing appointed.

8311. Unlawfully sold. Misbranded and adulterated. Cotton seed oil instead of olive oil. Hearing appointed.

Table showing results of the examination of goods purchased as sweet oil in June, 1909. The samples are arranged alphabetically by towns in which purchased. For settlement of violations, see discussion.

Station No.	Retailer, Maker and Brand.	Price.	Volume.	Ref. index.	Iodine No.	Remarks.
		Cts.	Ozs.			
8229	* Buckley Drug Store, Bangor, "Cotton Seed Oil (Sweet Oil)".......	20	8.31	1.4691	108.1	Unlawful. See 8229 above.
8232	* Chick's Drug Store, Bangor..........	25	7.12	1.4646	82.7	Short measure. See 8232 above.
8228	* C. A. Fowler & Co., Bangor, "Olive Oil.".........................	35	7.89	1.4658	76.6	Passed.
8216	F. L. Frank & Co., Bangor, Jas. J. Loughery & Co., Boston. "De Rago Brand Finest Sublime Olive Oil".............................	25	4.41	1.4688	83.5	Passed.
8218	Gallagher Bros., Bangor, Callisto Francesconi, Lucca, Italy. "Specialty Lucca Olive Oil"..........	85	3.33	1.4654	81.6	Passed.
8212	Fred T. Hall & Co., Bangor, S. Rae & Co., Leghorn. "Finest Sublime Lucca Oil"...........	35	8.81	1.4664	81.6	Passed.
8213	Fred T. Hall & Co., Bangor, S. S. Pierce Co., Boston, Mass. "One full half pint pure Olive Oil"....	40	9.06	1.4656	83.7	Passed.
8231	* Carl S. Preble, Bangor, "Sweet Oil"........................	35	8.53	1.4678	110.0	Unlawful. See 8231 above.
8230	* Alex. M. Robinson, Bangor, "Sweet Oil"........................	20	8.39	1.4680	108.3	Unlawful. See 8230 above.
8222	James H. Snow & Co., Bangor, Los. Angeles Olive Growers' Association, Los. Angeles, Calif. "Sylman Brand Pure California Olive Oil	25	4.48	1.4688	84.3	Passed.

Table showing results of the examination of goods purchased as sweet oil in June, 1909. The samples are arranged alphabetically by towns in which purchased.—Continued.

Station No.	RETAILER, MAKER AND BRAND.	Price.	Volume.	Ref. index.	Iodine No.	Remarks.
8268	Thurston & Kingsbury, Bangor, "Daisy Pure Sweet Oil"	10	1.51	-	–	Unlawful. See 8268 above.
8233	* Ara Warren, Bangor, "Sweet Oil"	20	8.07	1.4708	107.0	Unlawful. See 8233 above.
8257	Delmont Emerson, Island Falls, Libby, McNeil & Libby, Chicago. "Libby's Pure Olive Oil"	30	4.44	1.4664	82.8	Passed.
8310	* Brown & Turner, Portland, "Olive Oil"	35	8.07	1.4659	81.4	Passed.
8307	* Wm. J. Flanigan, Portland, "Olive Oil"	35	8.49	1.4670	82.1	Passed.
8314	* Edward L. Foss, Portland, "Olive Oil"	35	8.28	1.4613	79.9	Passed.
8308	* Horgan & Abbott, Portland, "Sweet Oil. For technical use only."	20	7.93	1.4696	106.0	Unlawful. See 8308 above.
8311	* John D. Keefe, Portland, "Sweet Oil"	25	8.14	1.4693	106.2	Unlawful. See 8311 above.
8313	* Frank D. McCarthy, Portland, "Sweet Oil"	35	8.21	1.4656	82.4	Passed.
8309	* Smith & Broe., Portland, "Sweet Oil"	35	7.82	1.4695	108.7	Unlawful. See 8309 above.
8312	* Chas. E. Wheeler, Portland, "Olive Oil"	25	8.07	1.4657	86.2	Passed.

* Bulk goods. Eight ounces called for.

HONEY.

A few samples of honey were collected by the deputy during the spring of 1909. With one exception these were unquestionably pure honey, although one was misbranded These two samples that were not passed are discussed below.

8052 and 8342. This was labeled as pure clover honey. As sample 8052, consisting of a single bottle, was found to be a mixture of honeys from different plants, a case of the same brand was purchased from the jobbing house who supplied the retailer. This also proved to be a mixture of honey obtained from different plants. The microscope while showing some clover pollen disclosed it to carry pollen from many other kinds of flowers including composites, eucalyptus, grass and a number of unidentified grains as well as traces of starch and alfalfa tissue. As this was sold under a serial number the matter is being taken up under the National law.

8059. This honey carried an excess of sucrose and was unlawfully sold. Correspondence with Bishop and Company developed the fact that another lot of their honey found in Virginia was abnormal in its sucrose content. They had investigated the matter and were unable to account for this abnormality. As the goods were sold under a serial number there was no case against the Maine dealer and the whole matter was referred to the U. S. Board of Food and Drug Inspection.

HONEY.

Table showing results of samples of honey purchased in the spring of 1909. The samples are arranged alphabetically by states in which they were packed. All samples were tested for glucose and invert sugar. For violations see discussion page 99.

Station No.	Name of Maker, Brand and Dealer.	Water.	Ash.	Sucrose.*	Remarks.
		%	%	%	
8059	Bishop & Co., Los Angeles, Calif. "California Pure Honey" Boston Tea Store, Lewiston	19.95	0.19	9.45**	
8219	Geo. S. Graffam & Bros., Bangor, "Black Diamond Brand" J. F. O'Connell, Bangor	22.75	0.16	3.50	Passed.
8074	Jas. J. Loughery & Co., Boston, Mass. "LeRoy extra Quality Pure Honey" Napoleon Bouldoc, Lewiston	23.75	0.37	6.07	Passed.
8052 & 8342	New England Maple Syrup Co., Boston. "Golden Tree Pure Clover Honey" C. C. Cloudman & Co., Bangor. T. R. Savage & Co., Bangor	18.65	0.34	2.77	
8064	Huntington Maple Syrup and Sugar Co., East Providence, R. I. "Gold Leaf Brand Pure Honey" Frank Minmont, Lewiston	19.90	0.45	4.34	Passed.
8069	J. E. Crane & Son, Middlebury, Vt. "Pure Extracted Honey" O. Roger, Lewiston	19.85	0.28	3.66	Passed.

* By polariscope.

** By direct determination.

[358-9-09.]

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

Official Inspections.

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MAINE FOOD AND DRUG REGULATIONS.
(M. F. D. R. 20.)

CONTENTS.

This publication contains the full text of the Maine Food and Drug Law as amended, the standards and definitions of foods and drugs and the regulations that have been adopted as revised to September, 1909.

An index is given on pages 139 and 140.

FOOD AND DRUGS.

The Maine Food and Drug Law is in accord with the National Food and Drug Act, June 30, 1906, and demands freedom from adulteration and truthful labeling. The text of the law as amended and the standards and regulations revised to July, 1909, follow.

M. F. D. R. I.

MAINE FOOD AND DRUG LAW.

CHAPTER 124 OF THE PUBLIC LAWS OF 1907.

SEC. 1. It shall be unlawful for any person within this state to manufacture, sell, transport, or offer for sale or transportation, any article of food or drug which is adulterated or misbranded within the meaning of this act.

SEC. 2. The term 'drug,' as used in this act, shall include all medicines and preparations recognized in the United States pharmacopœia or national formulary for internal or external use, and any substance or mixture of substances intended to be used for the cure, mitigation, or prevention of disease of either man or other animals. The term 'food,' as used herein, shall include all articles used for food, drink, confectionery, or condiment by man or other animals, whether simple, mixed or compound.

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

In case of drugs:

First. If when a drug is sold under or by a name recognized in the United States pharmacopœia or national formulary, it differs from the standard of strength, quality or purity, as determined by the test laid down in the United States pharmacopœia or national formulary official at the time of investigation: Provided, that no drug defined in the United States pharmacopœia or national formulary shall be deemed to be adulterated under this provision if the standard of strength, quality, or purity be plainly stated upon the bottle, box or other container thereof although the standard may differ from that determined by the test laid down in the United States pharmacopœia or national formulary.

Second. If its strength or purity fall below the professed standard or quality under which it is sold.

In the case of confectionery:

If it contains terra alba, barytes, talc, chrome yellow, or other mineral substances or poisonous color or flavor, or other ingredient deleterious or detrimental to health, or any vinous, malt, or spiritous liquor or compound or narcotic drug.

In the case of food:

First. If any substance has been mixed and packed with it so as to reduce or lower or injuriously affect its quality or strength.

Second. If any substance has been substituted wholly or in part for the article.

Third. If any valuable constituents of the article have been wholly or in part abstracted.

Fourth. If it be mixed, colored, powdered, coated, or stained in a manner whereby damage or inferiority is concealed.

Fifth. If it contain any added poisonous or other added deleterious ingredient which may render such article injurious to health: Provided, that when in the preparation of food products for shipment they are preserved by any external application applied in such manner that the preservative is necessarily removed mechanically, or by maceration in water, or otherwise, and directions for the removal of said preservative shall be printed on the covering of the package, the provisions of this act shall be construed as applying only when said products are ready for consumption.

Sixth. If it consists in whole or in part of a filthy, decomposed, or putrid animal or vegetable substance, or any portion of an animal unfit for food, whether manufactured or not, or if it is the product of a diseased animal, or one that has died otherwise than by slaughter.

SEC. 4. The term 'misbranded,' as used herein, shall apply to all drugs, or articles of food, or articles which enter into the composition of food, the package or label of which bear any statement, design, or device regarding such article, or the ingredients or substances contained therein which shall be false or misleading in any particular and to any food or drug product which is falsely branded as to the state, territory, or country in which it is manufactured or produced.

For the purpose of this act an article shall also be deemed to be misbranded:

In case of drugs:

First. If it be an imitation of or offered for sale under the name of another article.

Second. If the contents of the package as originally put up shall have been removed, in whole or in part, and other contents shall have been placed in such package, or, except in the case of a physician's prescription compounded by a physician or a registered pharmacist, if the package fail to bear a statement on the label of the quantity or proportion of any alcohol, morphine, opium, cocaine, heroin, alpha or beta eucaine, chloroform, cannabis indica, chloral hydrate or acetanilide or any derivative or any preparation of any such substances contained therein.

In the case of food:

First. If it be an imitation of or offered for sale under the distinctive name of another article.

Second. If it be labeled or branded so as to deceive or mislead the purchaser, or purport to be a foreign product when not so, or if the contents of the package as originally put up shall have been removed in whole or in part and other contents shall have been placed in such package, or if it fail to bear a statement on the label of the quantity or proportion of any morphine, opium, cocaine, heroin, alpha or beta eucaine, chloroform, cannabis indica, chloral hydrate, or acetanilide, or any derivative or preparation of any of such substances contained therein.

Third. If in package form, and the contents are stated in terms of weight or measure, they are not plainly and correctly stated on the outside of the package.

Fourth. If the package containing it or its label shall bear any statement, design, or device regarding the ingredients or the substances contained therein, which statement, design, or device shall be false or misleading in any particular: Provided, that an article of food which does not contain any added poisonous or deleterious ingredients shall not be deemed to be adulterated or misbranded in the following cases:

First. In the case of mixtures or compounds which may be now or from time to time hereafter known as articles of food, under their own distinctive names, and not an imitation of or offered for sale under the distinctive name of another article, if the name be accompanied on the same label or brand with a statement of the place where said article has been manufactured or produced.

Second. In the case of articles labeled, branded, or tagged so as to plainly indicate that they are compounds, imitations, or blends, and the word 'compound,' 'imitation,' or 'blend,' as the case may be, is plainly stated on the package in which it is offered for sale: Provided, that the term 'blend' as used herein shall be construed to mean a mixture of like substances, not excluding harmless coloring or flavoring ingredients used for the purpose of coloring and flavoring only: And provided further, that nothing in this act shall be construed as requiring or compelling proprietors or manufacturers of proprietary foods which contain no unwholesome added ingredient to disclose their trade formulas except in so far as the provisions of this act may require to secure freedom from adulteration or misbranding.

SEC. 5. The director of the Maine Agricultural Experiment Station shall make uniform rules and regulations for carrying out the provisions of this act, including the collection and examination of specimens of foods and drugs manufactured, sold, transported, or offered for sale or transportation within this state, or which may be submitted for examination by any health, food or drug officer of any town, city or county within this state. The said director may also adopt or fix standards of purity, quality or strength when such standards are not specified or fixed by law and shall publish them together with such other information concerning articles of food and drugs as may be of public benefit. Such rules, regulations and standards shall, where possible, conform to and be the same as the rules and regulations adopted from time to time for the enforcement of act of congress approved June thirtieth, nineteen hundred and six, and known as 'The Food and Drugs Act.'

SEC. 6. The director of the Maine Agricultural Experiment Station shall analyze, or cause to be analyzed, samples of articles of food and drugs on sale in Maine, and at such times and to such extent as said director may determine. And said director, in person or by deputy, shall have free access at all reasonable hours to any place wherein articles of food or drugs are offered for sale, and upon tendering the market price of any such article may take from any person samples for analysis. The results of all analyses of articles of food and drugs made by said director shall be published by him in the bulletins or reports of the experiment station, together with the names of the persons from whom the samples were obtained, and the names of the manufacturers thereof.

SEC. 7. When the said director becomes cognizant of the violation of any of the provisions of this act he shall cause notice of such fact, together with a copy of the findings, to be given to the party or parties concerned, including those from whom the sample was obtained, and to the party, if any, whose name appears upon the label as manufacturer, packer, wholesaler, retailer or other dealer. The parties so notified shall be given an opportunity to be heard under such rules and regulations as may be prescribed as aforesaid. Notices shall specify the date, hour and place of the hearing. The hearing shall be private and the parties interested therein may appear in person or by attorney. If the party whose name appears upon the label resides without the state he shall be entitled to reasonable notice by mail at such address as may, with due diligence, be obtained.

SEC. 8. Any person who adulterates or misbrands, within the meaning of this act, any article of food or drugs, or any person who sells, transports, offers or exposes for sale or transportation any adulterated or misbranded article of food or drugs, shall be punished by a fine not exceeding one hundred dollars for the first offense and not exceeding two hundred dollars for each subsequent offense. Trial justices and municipal and police courts are hereby vested with original jurisdiction concurrent with the supreme judicial and superior courts, to try, and, upon conviction, to punish, for offenses against the provisions of this act.

SEC. 9. No dealer shall be prosecuted under the provisions of this act when he can establish a guaranty signed by the wholesaler, jobber, manufacturer, or other party residing in the United States, from whom he purchased such articles, to the effect that the same is not adulterated or misbranded within the meaning of this act, designating it. Said guaranty, to afford protection, shall contain the name and address of the party or parties making the sale of such articles to such dealer, and in such case said party or parties shall be amenable to the prosecutions, fines and other penalties which would attach, in due course, to the dealer under the provisions of this act.

SEC. 10. The director of the Maine Agricultural Experiment Station shall diligently enforce all the provisions of this act, and when after due hearing he is convinced that the provisions of this act have been violated he shall, in his discretion prosecute all offenses against the same.

SEC. 12. The word 'person' as used in this act shall be construed to import both the plural and the singular, as the case demands, and shall include corporations, companies, societies and associations. When construing and enforcing the provisions of this act, the act, omission, or failure of any officer, agent or other person acting for or employed by any corporation, company, society, or association, within the scope of his employment or office, shall in every case be also deemed to be the act, omission, or failure of such corporation, company, society, or association as well as that of the person.

M. F. D. R. 2.

SHORT TITLE OF FOOD AND DRUG LAW.

The act to regulate the sale and analysis of food and drugs, chapter 124 of the Public Laws of 1907, printed in full in M. F. D. R. 1 shall be known and referred to as the Maine Food and Drug Law.

M. F. D. R. 3.

SCOPE OF THE REGULATIONS.

Section 5 of the Maine Food and Drug Law directs the Director to make uniform rules and regulations for carrying out the provisions of the law and permits him to fix and adopt standards of purity. The rules, regulations and standards are, when possible, to be the same as those adopted by the executive officer of the National Food and Drugs Act, June 30, 1906. These rules, regulations and standards,* become when published a part of the law.

In addition to these, the Director of the Station will publish from time to time expressions of opinion which are not to be considered in the light of rules and regulations and are not part of the law. These opinions are and will be in accord with the Food Inspection Decisions of the U. S. Secretary of Agriculture and express his attitude and that of the Station Director in the interpretation of the law. They are issued in an advisory spirit and are not mandatory. It may occur that such an opinion is not that of the manufacturer, jobber, or dealer. Each one is entitled to his own opinion and interpretation, and to assume the responsibility of acting in harmony therewith. The opinion of the Director is not the law. The courts are the final authority as to what the law means. It is clear, however, that if the manufacturers, jobbers, and dealers interpret the law including the rules and regulations in the same manner as they are interpreted by the Director and follow that interpretation in their business transactions, no prosecution will lie against them.

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*Doubt has been expressed as to the power of the legislature to delegate the authority to fix standards. This matter has been taken to the Supreme Court in the states of Indianna and New York and the court findings in both cases were that a law providing for the fixing of standards is constitutional and that "the law took effect because of the power that made the law and that the taking effect was only delayed till the standard was made."

M. F. D. R. 4.

STANDARDS FOR FOODS.*

As empowered in Section 5, Chapter 124 of the public laws of 1907, Charles D. Woods, the director of the Maine Agricultural Experiment Station hereby adopts and fixes the following together with their definitions as the official standards of these food products for the State of Maine. These standards and definitions supersede all previously published standards for the State of Maine.

A food product bearing a name recognized in the following standards and branded so as to plainly show to the non-professional person a different standard of strength, quality or purity shall not be regarded as adulterated or misbranded if it conforms to its declared standard.

I. ANIMAL PRODUCTS.

A. Meats and the Principal Meat Products.

a. MEATS.

1. *Meat, flesh,* is any clean, sound, dressed, and properly prepared edible part of animals in good health at the time of slaughter, and if it bears a name descriptive of its kind, composition, or origin, it corresponds thereto. The term "animals," as herein used, includes not only mammals, but fish, fowl, crustaceans, mollusks, and all other animals used as food.

2. *Fresh meat* is meat from animals recently slaughtered and properly cooled until delivered to the consumer.

3. *Cold storage meat* is meat from animals recently slaughtered and preserved by refrigeration until delivered to the consumer.

4. *Salted, pickled,* and *smoked meats* are unmixed meats preserved by salt, sugar, vinegar, spices, or smoke, singly or in combination, whether in bulk or in suitable containers.*

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* Suitable containers for keeping moist food products such as sirups, honey, condensed milk, soups, meat extracts, meats, manufactured meats, and undried fruits and vegetables, and wrappers in contact with food products, contain on their surfaces, in contact with the food product, no lead, antimony, arsenic, zinc or copper or any compounds thereof or any other poisonous or injurious substance. If the containers are made of tin plate, they are outside-soldered and the plate in no place contains less than one hundred and thirteen (113) milligrams of tin on a piece five (5) centimeters square or one and eight-tenths (1.8) grains on a piece two (2) inches square.

The inner coating of the containers is free from pin holes, blisters, and cracks.

If the tin plate is lacquered, the lacquer completely covers the tinned surface within the container and yields to the contents of the container no lead, antimony, arsenic, zinc or copper or any compounds thereof, or any other poisonous or injurious substance.

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* See foot note page 106.

b. MANUFACTURED MEATS.

1. *Manufactured meats* are meats not included in paragraphs 2, 3, and 4, whether simple or mixed, whole or comminuted, in builk or in suitable containers,* with or without the addition of salt, sugar, vinegar, spices, smoke, oils, or rendered fat. If they bear names descriptive of kind, composition, or origin, they correspond thereto and when bearing such descriptive names, if force or flavoring meats are used, the kind and quantity thereof are made known.

2. *Sausage, sausage meat* is a comminuted meat from neat cattle or swine, or a mixture of such meats, either fresh, salted, pickled or smoked, with added salt and spices and with or without the addition of edible animal fats, blood and sugar, or subsequent smoking. It contains no larger amount of water than the meats from which it is prepared, contain when in their fresh condition, and if it bears a name descriptive of kind, composition, or origin, it corresponds to such descriptive name. All animal tissues used as containers, such as casings, stomachs, etc., are clean and sound and impart to the contents on other substance than salt.

3. *Blood sausage* is sausage to which has been added clean, fresh blood from neat cattle or swine in good health at the time of slaughter.

4. *Canned meat* is the cooked, fresh meat of fowl, neat cattle, or swine, preserved in hermetically sealed packages.

5. *Corned or cured meat* is meat, cured or pickled with dry salt or in brine, with or without the addition of sugar or sirup and (pending further inquiry) saltpeter.

6. *Potted meat* is comminuted and cooked meat from those parts of the animal ordinarily used for food in the fresh state, with or without salt and spices, and enclosed in suitable containers hermetically sealed.

7. *Meat loaf* is a mixture of comminuted cooked meat, with or without spices, cereals, milk, and eggs, and pressed into a loaf. If it bears a descriptive name, it corresponds thereto.

8. *Mince, mince meat,* is a mixture of not less than ten (10) per cent of cooked, comminuted meat, with chopped suet, apple and other fruit, salt and spices, and with sugar, sirup, or molasses, and with or without vinegar, fresh, concentrated, or fermented fruit juices, or spirituous liquors.

c. MEAT EXTRACTS, MEAT PEPTONES, GELATIN, ETC.

1. *Meat extract* is the product obtained by extracting fresh meat with boiling water and concentrating the liquid portion by evaporation after the removal of fat, and contains not less than seventy-five (75) per cent of total solids, of which not over twenty-seven (27) per cent is ash, and not over twelve (12) per cent is sodium chlorid (calculated from the total chlorin present), not over six-tenths (0.6) per cent is fat, and not less than eight (8) per cent is nitrogen. The nitrogenous compounds contain not less than forty (40) per cent of meat bases and not less than ten (10) per cent of kreatin and kreatinin.

2. *Fluid meat extract* is identical with meat extract except that it is concentrated to a lower degree, and contains not more than seventy-five (75) and not less than fifty (50) per cent of total solids.

3. *Bone extract* is the product obtained by extracting clean, fresh, trimmed bones of animals in good health at the time of slaughter with boiling water and concentrating the liquid portion by evaporation, after removal of fat, and contains not less than seventy-five (75) per cent of total solids.

4. *Fluid bone extract* is identical with bone extract except that it is concentrated to a lower degree, and contains not more than seventy-five (75) and not less than fifty (50) per cent of total solids.

5. *Meat juice* is the fluid portion of muscle fiber, obtained by pressure or otherwise, and may be concentrated by evaporation at a temperature below the coagulating point of the soluble proteids. The solids contain not more than fifteen (15) per cent of ash, not more than two and five-tenths (2.5) per cent of sodium chlorid (calculated from the total chlorin present), not more than four (4) nor less than two (2) per cent of phosphoric acid (P_2O_5), and not less than twelve (12) per cent of nitrogen. The nitrogenous bodies contain not less than thirty-five (35) per cent of coagulable proteids and not more than forty (40) per cent of meat bases.

6. *Peptones* are products prepared by the digestion of proteid material by means of enzymes or otherwise, and contain not less than ninety (90) per cent of proteoses and peptones.

7. *Gelatin* (*edible gelatin*) is the purified, dried, inodorous product of the hydrolysis, by treatment with boiling water, of certain tissues, as skin, ligaments, and bones, from sound animals, and contains not more than two (2) per cent of ash and not less than (15) per cent of nitrogen.

d. LARD.

1. *Lard* is the rendered fresh fat from hogs in good health at the time of slaughter, is clean, free from rancidity, and contains, necessarily incorporated in the process of rendering, not more than one (1) per cent of substances, other than fatty acids and fat.

2. *Leaf lard* is lard rendered at moderately high temperature from the internal fat of the abdomen of the hog, excluding that adherent to the intestines, and has an iodin number not greater than sixty (60).

3. *Neutral lard* is lard rendered at low temperatures.

B. Milk and Its Products.

a. MILKS.

1. *Milk* * is the fresh, clean, lacteal secretion obtained by the complete milking of one or more healthy cows, properly fed and kept, excluding that obtained fifteen days before and ten days after calving, and contains not less than 8.5 per cent of solids not fat, and not less than 3.25 per cent of milk fat.

2. *Blended milk* is milk modified in its composition so as to have a definite and stated percentage of one or more of its constituents.

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* These standards, fixed by statute, are the same as the standards adopted by the U. S. Secretary of Agriculture.

3. *Skim milk* is milk which a part or all of the cream has been removed and contains not less than nine and one-quarter (9.25) per cent of milk solids.

4. *Pasteurized milk* is milk that has been heated below boiling but sufficiently to kill most of the active organisms present and immediately cooled to 50° Fahr. or lower.

5. *Sterilized milk* is milk that has been heated at the temperature of boiling water or higher for a length of time sufficient to kill all organisms present.

6. *Condensed milk, evaporated milk,* is milk from which a considerable portion of water has been evaporated and contains not less than twenty-eight (28) per cent of milk solids of which not less than twenty-seven and five-tenths (27.5) per cent is milk fat.

7. *Sweetened condensed milk* is milk from which a considerable portion of water has been evaporated and to which sugar (sucrose) has been added, and contains not less than twenty-eight (28) per cent of milk solids, of which not less than twenty-seven and five-tenths (27.5) per cent is milk fat.

8. *Condensed skim milk* is milk from which a considerable portion of water has been evaporated.

9. *Buttermilk* is the product that remains when butter is removed from milk or cream in the process of churning.

10. *Goat's milk, ewe's milk, et cetera,* are the fresh, clean, lacteal secretions, free from colostrum, obtained by the complete milking of healthy animals other than cows, properly fed and kept, and conform in name to the species of animal from which they are obtained.

b. CREAM.

1. *Cream* is that portion of milk, rich in milk fat, which rises to the surface of milk on standing, or is separated from it by centrifugal force, is fresh and clean and contains not less than eighteen (18) per cent of milk fat.

2. *Evaporated cream, clotted cream,* is cream from which a considerable portion of water has been evaporated.

c. MILK FAT OR BUTTER FAT.

1. *Milk fat, butter fat,* is the fat of milk and has a Reichert-Meisse number not less than twenty-four (24) and a specific gravity not less than 0.905 $\left(\frac{40^0\ C.}{40^0\ C.}\right)$

d. BUTTER.

1. *Butter* is the clean, non-rancid product made by gathering in any manner the fat of fresh or ripened milk or cream into a mass, which also contains a small portion of the other milk constituents, with or without salt, and contains not less than eighty-two and five-tenths (82.5) per cent of milk fat.

2. *Renovated butter, process butter,* is the product made by melting butter and reworking, without the addition or use of chemicals or any

substances except milk, cream, or salt, and contains not more than sixteen (16) per cent of water and at least eighty-two and five-tenths (82.5) per cent of milk fat.

e. CHEESE.

1. *Cheese* is the sound, solid, and ripened product made from milk or cream by coagulating the casein thereof with rennet or lactic acid, with or without the addition of ripening ferments and seasoning, and contains, in the water-free substance, not less than fifty (50) per cent of milk fat.

2. *Skim milk cheese* is the sound, solid, and ripened product, made from skim milk by coagulating the casein thereof with rennet or lactic acid, with or without the addition of ripening ferments and seasoning.

3. *Goat's milk cheese, ewe's milk cheese, et cetera,* are the sound, ripened products made from the milks of the animals specified, by coagulating the casein thereof with rennet or lactic acid, with or without the addition of ripening ferments and seasoning.

f. ICE CREAMS.*

1. *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.

2. *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.

3. *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.

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.

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* *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 label 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.

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.

g. MISCELLANEOUS MILK PRODUCTS.

1. *Whey* is the product remaining after the removal of fat and casein from milk in the process of cheese-making.

2. *Kumiss* is the product made by the alcoholic fermentation of mare's or cow's milk.

II. VEGETABLE PRODUCTS.

A. GRAIN PRODUCTS.

a. GRAINS AND MEALS.

1. *Grain* is the fully matured, clean, sound, air-dry seed of wheat, maize, rice, oats, rye, buckwheat, barley, sorghum, millet, or spelt.

2. *Meal* is the clean, sound product made by grinding grain.

3. *Flour* is the fine, clean, sound product made by bolting wheat meal and contains not more than thirteen and one-half (13.5) per cent of moisture, not less than one and twenty-five hundredths (1.25) per cent of nitrogen, not more than one (1) per cent of ash, and not more than fifty hundredths (0.50) per cent of fiber.

4. *Graham flour* is unbolted wheat meal.

5. *Gluten flour* is the clean, sound product made from flour by the removal of starch and contains not less than five and six-tenths (5.6) per cent of nitrogen and not more than ten (10) per cent of moisture.

6. *Maize meal, corn meal, Indian corn meal,* is meal made from sound maize grain and contains not more than fourteen (14) per cent of moisture, not less than one and twelve hundredths (1.12) per cent of nitrogen, and not more than one and six-tenths (1.6) per cent of ash.

7. *Rice* is the hulled, or hulled and polished grain of *Oryza sativa.*

8. *Oatmeal* is meal made from hulled oats and contains not more than twelve (12) per cent of moisture, not more than one and five-tenths (1.5) per cent of crude fiber, not less than two and twenty-four hundredths (2.24) per cent of nitrogen, and not more than two and two-tenths (2.2) per cent of ash.

9. *Rye flour* is the fine, clean, sound product made by bolting rye meal and contains not more than thirteen and one-half (13.5) per cent of moisture, not less than one and thirty-six hundredths (1.36) per cent of nitrogen, and not more than one and twenty-five hundredths (1.25) per cent of ash.

10. *Buckwheat flour* is bolted buckwheat meal and contains not more than twelve (12) per cent of moisture, not less than one and twenty-eight hundredths (1.28) per cent of nitrogen, and not more than one and seventy-five hundredths (1.75) per cent of ash.

B. Fruit and Vegetables.

a. fruit and fruit products.

(Except fruit juices, fresh, sweet, and fermented, and vinegar.)

1. *Fruits* are the clean, sound, edible, fleshy fructifications of plants, distinguished by their sweet, acid, and ethereal flavors.

2. *Dried fruit* is the clean, sound product made by drying mature, properly prepared, fresh fruit in such a way as to take up no harmful substance, and conforms in name to the fruit used in its preparation; *sun-dried fruit* is dried fruit made by drying without the use of artificial means; *evaporated fruit* is dried fruit made by drying with the use of artificial means.

3. *Evaporated apples* are evaporated fruit made from peeled and cored apples, and contain not more than twenty-seven (27) per cent of moisture determined by the usual commercial method of drying for four (4) hours at the temperature of boiling water.

(Standards for other dried fruits are in preparation.)

4. *Canned fruit* is the sound product made by sterilizing clean, sound, properly matured and prepared fresh fruit, by heating, with or without sugar (sucrose) and spices, and keeping in suitable, clean, hermetically sealed containers and conforms in name to the fruit used in its preparation.

5. *Preserve* † is the sound product made from clean, sound, properly matured and prepared fresh fruit and sugar (sucrose) sirup, with or without spices or vinegar, and conforms in name to that of the fruit used, and in its preparation not less than forty-five (45) pounds of fruit are used to each fifty-five (55) pounds of sugar.

6. *Honey preserve* † is preserve in which honey is used in place of sugar (sucrose) sirup.

7. *Glucose preserve* † is preserve in which a glucose product is used in place of sugar (sucrose) sirup.

8. *Jam, marmalade* † is the sound product made from clean, sound, properly matured and prepared fresh fruit and sugar (sucrose), with or without spices or vinegar, by boiling to a pulpy or semisolid consistence, and conforms in name to the fruit used, and in its preparation not less than forty-five (45) pounds of fruit are used to each fifty-five (55) pounds of sugar.

9. *Glucose jam, glucose marmalade,* † is jam in which a glucose product is used in place of sugar (sucrose).

10. *Fruit butter* † is the sound product made from fruit juice and clean, sound, properly matured and prepared fruit, evaporated to a semi-solid mass of homogeneous consistence, with or without the addition of sugar and spices or vinegar, and conforms in name to the fruit used in its preparation.

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† Products made with mixtures of sugar, glucose, and honey, or any two thereof, are reserved for future consideration.

11. *Glucose fruit butter* † is fruit butter in which a glucose product is used in place of sugar (sucrose).

12. *Jelly* † is the sound, semisolid, gelatinous product made by boiling clean, sound, properly matured and prepared fresh fruit with water, concentrating the expressed and strained juice, to which sugar (sucrose) is added, and conforms in name to the fruit used in its preparation.

13. *Glucose jelly* † is jelly in which a glucose product is used in place of sugar (sucrose).

b. VEGETABLES AND VEGETABLE PRODUCTS.

1. *Vegetables* are the succulent, clean, sound, edible parts of herbaceous plants used for culinary purposes.

2. *Dried vegetables* are the clean, sound products made by drying properly matured and prepared vegetables in such a way as to take up no harmful substance, and conform in name to the vegetables used in their preparation; *sun-dried vegetables* are dried vegetables made by drying without the use of artificial means; *evaporated vegetables* are dried vegetables made by drying with the use of artificial means.

3. *Canned vegetables* are sound, properly matured and prepared fresh vegetables, with or without salt, sterilized by heat, with or without previous cooking in vessels from which they take up no metallic substance, kept in suitable, clean, hermetically sealed containers, are sound and conform in name to the vegetables used in their preparation.

4. *Pickles* are clean, sound, immature cucumbers, properly prepared, without taking up any metallic compound other than salt, and preserved in any kind of vinegar, with or without spices; *pickled onions, pickled beets, pickled beans,* and other pickled vegetables are vegetables prepared as described above, and conform in name to the vegetables used.

5. *Salt pickles* are clean, sound, immature cucumbers, preserved in a solution of common salt, with or without spices.

6. *Sweet pickles* are pickled cucumbers or other vegetables in the preparation of which sugar (sucrose) is used.

7. *Sauerkraut* is clean, sound, properly prepared cabbage, mixed with salt, and subjected to fermentation.

8. *Catchup* (*ketchup, catsup*) is the clean, sound product made from the properly prepared pulp of clean, sound, fresh, ripe tomatoes, with spices and with or without sugar and vinegar; *mushroom catchup, walnut catchup, et cetera,* are catchups made as above described, and conform in name to the substances used in their preparation.

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† Products made with mixtures of sugar, glucose, and honey, or any two thereof, are reserved for future consideration.

C. Sugars and Related Substances.

a. SUGAR AND SUGAR PRODUCTS.

Sugars.

1. *Sugar* is the product chemically known as sucrose (saccharose) chiefly obtained from sugar cane, sugar beets, sorghum, maple, and palm.

2. *Granulated, loaf, cut, milled,* and *powdered sugars* are different forms of sugar and contain at least ninety-nine and five-tenths (99.5) per cent of sucrose.

3. *Maple sugar* is the solid product resulting from the evaporation of maple sap, and contains, in the water-free substance, not less than sixty-five one-hundredths (0.65) per cent of maple sugar ash.

4. *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 semisolid consistence, and in which the sugar chiefly exists in a crystalline state.

Molasses and Refiners' Sirup.

1. *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.

2. *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.

Sirups.

1. *Sirup* is the sound product made by purifying and evaporating the juice of a sugar-producing plant without removing any of the sugar.

2. *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.

3. *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.

4. *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.

5. *Sugar sirup* is the product made by dissolving sugar to the consistence of a sirup and contains not more than thirty-five (35) per cent of water.

b. GLUCOSE PRODUCTS.

1. *Starch sugar* is the solid product made by hydrolyzing starch or a starch-containing substance until the greater part of the starch is converted into dextrose. Starch sugar appears in commerce in two

forms, anhydrous starch sugar and hydrous starch sugar. The former, crystallized without water of crystallization, contains not less than ninety-five (95) per cent of dextrose and not more than eight-tenths (0.8) per cent of ash. The latter, crystallized with water of crystallization, is of two varieties—70 sugar, also known as brewers' sugar, contains not less than seventy (70) per cent of dextrose and not more than eight-tenths (0.8) per cent of ash; 80 sugar, climax or acme sugar, contains not less than eighty (80) per cent of dextrose and not more than one and one-half (1.5) per cent of ash.

The ash of all these products consists almost entirely of chlorids and sulphates.

2. *Glucose, mixing glucose, confectioners' glucose, corn sirup,* is a thick, sirupy, colorless product made by incompletely hydrolyzing starch, or a starch-containing substance, and decolorizing and evaporating the product. It varies in density from forty-one (41) to forty-five (45) degrees Baumé at a temperature of 100° Fahr. (37.7° C.), and conforms in density, within these limits, to the degree Baumé it is claimed to show, and for a density of forty-one (41) degrees Baumé contains not more than twenty-one (21) per cent and for a density of forty-five (45) degrees not more than fourteen (14) per cent of water. It contains on a basis of forty-one (41) degrees Baumé not more than one (1) per cent of ash, consisting chiefly of chlorids and sulphates.

c. CANDY.

1. *Candy* is a product made from a saccharine substance or substances with or without the addition of harmless coloring, flavoring, or filling materials and contains no terra alba, barytes, talc, chrome yellow, or other mineral substances or poisonous colors or flavors, or other ingredients deleterious or detrimental to health, or any vinous, malt, or spirituous liquor or compound, or narcotic drug.

d. HONEY.

1. *Honey* is the nectar and saccharine exudations of plants gathered, modified, and stored in the comb by honey bees (*Apis mellifica* and *A. dorsata*); is lævo-rotatory, contains not more than twenty-five (25) per cent of water, not more than twenty-five hundredths (0.25) per cent of ash, and not more than eight (8) per cent of sucrose.

2. *Comb honey* is honey contained in the cells of comb.

3. *Extracted honey* is honey which has been separated from the uncrushed comb by centrifugal force or gravity.

4. *Strained honey* is honey removed from the crushed comb by straining or other means.

D. CONDIMENTS (EXCEPT VINEGAR AND SALT).

a. SPICES.

1. *Spices* are aromatic vegetable substances used for the seasoning of food and from which no portion of any volatile oil or other flavoring principle has been removed and which are clean, sound, and true to name.

2. *Allspice, pimento,* is the dried fruit of the *Pimenta pimenta* (L.) Karst, and contains not less than eight (8) per cent of quercitannic acid *; not more than six (6) per cent of total ash, not more than five-tenths (0.5) per cent of ash insoluble in hydrochloric acid, and not more than twenty-five (25) per cent of crude fiber.

3. *Anise* is the fruit of the *Pimpinella anisum* L.

4. *Bay leaf* is the dried leaf of *Laurus nobilis* L.

5. *Capers* are the flower buds of *Capparis spinosa* L.

6. *Caraway* is the fruit of *Carum carvi* L.

Cayenne and Red Peppers.

7. *Red pepper* is the red, dried, ripe fruit of any species of *Capsicum.*

8. *Cayenne papper, cayenne,* is the dried ripe fruit of *Capsicum frutescens* L., *Capsicum baccatum* L., or some other small-fruited species of *Capsicum,* and contains not less than fifteen (15) per cent of non-volatile ether extract; not more than six and five-tenths (6.5) per cent of total ash; not more than five-tenths (0.5) per cent of ash insoluble in hydrochloric acid; not more than one and five-tenths (1.5) per cent of starch, and not more than twenty-eight (28) per cent of crude fiber.

9. *Paprika* is the dried ripe fruit of *Capsicum annuum* L., or some other large-fruited species of *Capsicum,* excluding seeds and stems.

10. *Celery seed* is the dried fruit of *Apium graveolens* L.

11. *Cinnamon* is the dried bark of any species of the genus *Cinnamomum* from which the outer layers may or may not have been removed.

12. *True cinnamon* is the dried inner bark of *Cinnamomum zeylanicum* Breyne.

13. *Cassia* is the dried bark of various species of *Cinnamomum,* other than *Cinnamomum zeylanicum,* from which the outer layers may or may not have been removed.

14. *Cassia buds* are the dried immature fruit of species of *Cinnamomum.*

15. *Ground cinnamon, ground cassia,* is a powder consisting of cinnamon, cassia, or cassia buds, or a mixture of these spices, and contains not more than six (6) per cent of total ash and not more than two (2) per cent of sand.

16. *Cloves* are the dried flower buds of *Caryophyllus aromaticus* L., which contain not more than five (5) per cent of clove stems; not less than ten (10) per cent of volatile ether extract; not less than twelve (12) per cent of quercitannic acid *; not more than eight (8) per cent of total ash; not more than five-tenths (0.5) per cent of ash insoluble in hydrochloric acid, and not more than ten (10) per cent of crude fiber.

17. *Coriander* is the dried fruit of *Coriandrum sativum* L.

18. *Cumin seed* is the fruit of *Cuminum cyminum* L.

19. *Dill seed* is the fruit of *Anethum graveolens* L.

20. *Fennel* is the fruit of *Foeniculum foeniculum* (L.) Karst.

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* Calculated from the total oxygen absorbed by the aqueous extract.

21. *Ginger* is the washed and dried or decorticated and dried rhizome of *Zinziber zinziber* (L) Karst., and contains not less than forty-two (42) per cent of starch; not more than eight (8) per cent of crude fiber, not more than six (6) per cent of total ash, not more than one (1) per cent of lime, and not more than three (3) per cent of ash insoluble in hydrochloric acid.

22. *Limed ginger, bleached ginger,* is whole ginger coated with carbonate of lime and contains not more than ten (10) per cent of ash, not more than four (4) per cent of carbonate of lime, and conforms in other respects to the standard for ginger.

23. *Horse-radish* is the root of *Roripa armoracia* (L.) Hitchcock, either by itself or ground and mixed with vinegar.

24. *Mace* is the dried arillus of *Myristica fragrans* Houttuyn, and contains not less than twenty (20) nor more than thirty (30) per cent of nonvolatile ether extract, not more than three (3) per cent of total ash, and not more than five-tenths (0.5) per cent of ash insoluble in hydrochloric acid, and not more than ten (10) per cent of crude fiber.

25. *Macassar mace, Papua mace,* is the dried arillus of *Myristica argentea* Warb.

26. *Bombay mace* is the dried arillus of *Myristica malabarica* Lamarck.

27. *Marjoram* is the leaf, flower and branch of *Majorana majorana* (L.) Karst.

28. *Mustard seed* is the seed of *Sinapis alba* L. (white mustard), *Brassica nigra* (L.) Koch (black mustard), or *Brassica juncea* (L.) Cosson (black or brown mustard).

29. *Ground mustard* is a powder made from mustard seed, with or without the removal of the hulls and a portion of the fixed oil, and contains not more than two and five-tenths (2.5) per cent of starch and not more than eight (8) per cent of total ash.

30. *Prepared mustard, German mustard, French mustard, mustard paste,* is a paste composed of a mixture of ground mustard seed or mustard flour with salt, spices and vinegar, and, calculated free from water, fat and salt, contains not more than twenty-four (24) per cent of carbohydrates calculated as starch, determined according to the official methods, not more than twelve (12) per cent of crude fiber nor less than thirty-five (35) per cent of protein, derived solely from the materials named.

31. *Nutmeg* is the dried seed of the *Myristica fragrans* Houttuyn, deprived of its testa, with or without a thin coating of lime, and contains not less than twenty-five (25) per cent of nonvolatile ether extract, not more than five (5) per cent of total ash, not more than five-tenths (0.5) per cent of ash insoluble in hydrochloric acid, and not more than ten (10) per cent of crude fiber.

32. *Macassar nutmeg, Papua nutmeg, male nutmeg, long nutmeg,* is the dried seed of *Myristica argentea* Warb, deprived of its testa.

Pepper.

33. *Black pepper* is the dried immature berry of *Piper nigrum* L. and contains not less than six (6) per cent of nonvolatile ether extract, not less than twenty-five (25) per cent of starch, not more than seven (7) per cent of total ash, not more than two (2) per cent of ash insoluble in hydrochloric acid, and not more than fifteen (15) per cent of crude fiber. One hundred parts of the nonvolatile ether extract contain not less than three and one-quarter (3.25) parts of nitrogen. *Ground black pepper* is the product made by grinding the entire berry and contains the several parts of the berry in their normal proportions.

34. *Long pepper* is the dried fruit of *Piper longum* L.

35. *White pepper* is the dried mature berry of *Piper nigrum* L. from which the outer coating or the outer and inner coatings have been removed and contains not less than six (6) per cent of nonvolatile ether extract, not less than fifty (50) per cent of starch, not more than four (4) per cent of total ash, not more than five-tenths (0.5) per cent of ash insoluble in hydrochloric acid, and not more than five (5) per cent of crude fiber. One hundred parts of the nonvolatile ether extract contain not less than four (4) parts of nitrogen.

36. *Saffron* is dried stigma of *Crocus sativus* L.

37. *Sage* is the leaf of *Salvia officinalis* L.

38. *Savory, summer savory*, is the leaf, blossom, and branch of *Satureja hortensis* L.

39. *Thyme* is the leaf and tip of blooming branches of *Thymus Vulgaris* L.

b. FLAVORING EXTRACTS.

For suggestions as to labeling imitations or below standard goods see M. F. D. R. 15, 16 and 17 pp. 134 to 137.

1. *A flavoring extract** is a solution in ethyl alcohol of proper strength of the sapid and odorous principles derived from an aromatic plant, or parts of the plant, with or without its coloring matter, and conforms in name to the plant used in its preparation.

2. *Almond extract* is the flavoring extract prepared from oil of bitter almonds, free from hydrocyanic acid, and contains not less than one (1) per cent by volume of oil of bitter almonds.

2a. *Oil of bitter almonds,* commercial, is the volatile oil obtained from the seed of the bitter almond (*Amygdalus communis* L.), the apricot (*Prunus armeniaca* L.), or the peach (*Amygdalus persica* L.)

3. *Anise extract* is the flavoring extract prepared from oil of anise, and contains not less than three (3) per cent by volume of oil or anise.

3a. *Oil of anise* is the volatile oil obtained from the anise seed.

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* The flavoring extracts herein described are intended solely for food purposes and are not to be confounded with similar preparations described in the Pharmacopœia for medicinal purposes.

4. *Celery seed extract* is the flavoring extract prepared from celery seed or the oil of celery seed or both, and contains not less than three-tenths (0.3) per cent by volume of oil of celery seed.

4a. *Oil of celery seed* is the volatile oil obtained from celery seed.

5. *Cassia extract* is the flavoring extract prepared from oil of cassia and contains not less than two (2) per cent by volume of oil of cassia.

5a. *Oil of cassia* is the lead-free volatile oil obtained from the leaves or bark of *Cinnamomum cassia* Bl., and contains not less than seventy-five (75) per cent by weight of cinnamic aldehyde.

6. *Cinnamon extract* is the flavoring extract prepared from oil of cinnamon, and contains not less than two (2) per cent by volume of oil of cinnamon.

6a. *Oil of cinnamon* is the lead-free volatile oil obtained from the bark of the Ceylon cinnamon (*Cinnamomum zeylanicum* Breyne), and contains not less than sixty-five (65) per cent by weight of cinnamic aldehyde and not more than ten (10) per cent by weight of eugenol.

7. *Clove extract* is the flavoring extract prepared from oil of cloves, and contains not less than two (2) per cent by volume of oil of cloves.

7a. *Oil of cloves* is the lead-free, volatile oil obtained from cloves.

8. *Ginger extract* is the flavoring extract prepared from ginger and contains in each one hundred (100) cubic centimeters, the alcohol-soluble matters from not less than twenty (20) grams of ginger.

9. *Lemon extract* is the flavoring extract prepared from oil of lemon, or from lemon peel, or both, and contains not less than five (5) per cent by volume of oil of lemon.

9a. *Oil of lemon* is the volatile oil obtained by expression or alcoholic solution, from the fresh peel of the lemon (*Citrus limonum* L.), has an optical rotation (25° C.) of not less than +60° in a 100-millimeter tube, and contains not less than four (4) per cent by weight of citral.

10. *Terpeneless extract of lemon* is the flavoring extract prepared by shaking oil of lemon with dilute alcohol, or by dissolving terpeneless oil of lemon in dilute alcohol, and contains not less than two-tenths (0.2) per cent by weight of citral derived from oil of lemon.

10a. *Terpeneless oil of lemon* is oil of lemon from which all or nearly all of the terpenes have been removed.

11. *Nutmeg extract* is the flavoring extract prepared from oil of nutmeg, and contains not less than (2) per cent by volume of oil of nutmeg.

11a. *Oil of nutmeg* is the volatile oil obtained from nutmegs.

12. *Orange extract* is the flavoring extract prepared from oil of orange, or from orange peel, or both, and contains not less than five (5) per cent by volume of oil of orange.

12a. *Oil of orange* is the volatile oil obtained, by expression of alcoholic solution, from the fresh peel of the orange (*Citrus aurantium* L.) and has an optical rotation (25° C.) of not less than +95° in a 100-millimeter tube.

13. *Terpeneless extract of orange* is the flavoring extract prepared by shaking oil of orange with dilute alcohol, or by dissolving terpeneless

oil of orange in dilute alcohol, and corresponds in flavoring strength to orange extract.

13a. Terpeneless oil of orange is oil of orange from which all or nearly all of the terpenes have been removed.

14. *Peppermint extract* is the flavoring extract prepared from oil of peppermint, or from peppermint, or both, and contains not less than three (3) per cent by volume of oil of peppermint.

14a. Peppermint is the leaves and flowering tops of *Mentha piperita* L.

14b. Oil of peppermint is the volatile oil obtained from peppermint and contains not less than fifty (50) per cent by weight of menthol.

15. *Rose extract* is the flavoring extract prepared from otto of roses, with or without red rose petals, and contains not less than four-tenths (0.4) per cent by volume of otto of roses.

15a. Otto of roses is the volatile oil obtained from the petals of *Rosa damascena* Mill., *R. centifolia* L., or *R. moschata* Herrm.

16. *Savory extract* is the flavoring extract prepared from oil of savory, or from savory, or both, and contains not less than thirty-five hundredths (0.35) per cent by volume of oil of savory.

16a. Oil of savory is the volatile oil obtained from savory.

17. *Spearmint extract* is the flavoring extract prepared from oil of spearmint, or from spearmint, or both, and contains not less than three (3) per cent by volume of oil of spearmint.

17a. Spearmint is the leaves and flowering tops of *Mentha spicata* L.

17b. Oil of spearmint is the volatile oil obtained from spearmint.

18. *Star anise extract* is the flavoring extract prepared from oil of star anise, and contains not less than three (3) per cent by volume of oil of star anise.

18a. Oil of star anise is the volatile oil distilled from the fruit of the star anise (*Illicium verum* Hook).

19. *Sweet basil extract* is the flavoring extract prepared from oil of sweet basil, or from sweet basil, or both, and contains not less than one-tenth (0.1) per cent by volume of oil of sweet basil.

19a. Sweet basil, basil is the leaves and tops of *Ocymum basilicum* L.

19b. Oil of sweet basil is the volatile oil obtained from basil.

20. *Sweet marjoram extract, marjoram extract,* is the flavoring extract prepared from the oil of marjoram, or from marjoram, or both, and contains not less than one (1) per cent by volume of oil of marjoram.

20a. Oil of marjoram is the volatile oil obtained from marjoram.

21. *Thyme extract* is the flavoring extract prepared from oil of thyme, or from thyme, or both, and contains not less than two-tenths (0.2) per cent by volume of oil of thyme.

21a. Oil of thyme is the volatile oil obtained from thyme.

22. *Tonka extract* is the flavoring extract prepared from tonka bean, with or without sugar or glycerin, and contains not less than one-tenth (0.1) per cent by weight of coumarin extracted from the tonka bean, together with a corresponding proportion of the other soluble matters thereof.

22a. *Tonka bean* is the seed of *Coumarouna odorata* Aublet (*Dipteryx odorata* (Aubl.) Willd.).

23. *Vanilla extract* is the flavoring extract prepared from vanilla bean, with or without sugar or glycerin, and contains in one hundred (100) cubic centimeters the soluble matters from not less than ten (10) grams of the vanilla bean.

23a. *Vanilla bean* is the dried, cured fruit of *Vanilla planifolia* Andrews.

24. *Wintergreen extract, checkerberry extract,* is the flavoring extract prepared from oil of wintergreen, oil of birch, or methyl salicylate, and contains not less than three (3) per cent by volume of the oil or of the ester.

24a. *Oil of wintergreen* is the volatile oil distilled from the leaves of the *Gaultheria procumbens* L.

C. EDIBLE VEGETABLE OILS AND FATS.

1. *Olive oil* is the oil obtained from the sound, mature fruit of the cultivated olive tree (*Olca curopoea* L.) and subjected to the usual refining processes; is free from rancidity; has a refractive index (25° C) not less than one and forty-six hundred and sixty ten-thousandths (1.4660) and not exceeding one and forty-six hundred and eighty ten-thousandths (1.4680); and an iodin number not less than seventy-nine (79) and not exceeding ninety (90).

2. *Virgin olive oil* is olive oil obtained from the first pressing of carefully selected, hand-picked olives.

3. *Cotton-seed oil* is the oil obtained from the seeds of cotton plants (*Gossypium hirsutum* L., *G. barbadense* L., or *G. herbaceum* L.) and subjected to the usual refining processes; is free from rancidity; has a refractive index (25° C.) not less than one and forty-seven hundred ten-thousandths (1.4700) and not exceeding one and forty-seven hundred and twenty-five ten-thousandths (1.4725); and an iodin number not less than one hundred and four (104) and not exceeding one hundred and ten (110).

4. *"Winter-yellow" cotton-seed oil* is expressed cotton-seed oil from which a portion of the stearin has been separated by chilling and pressure, and has an iodin number not less than one hundred and ten (110) and not exceeding one hundred and sixteen (116).

5. *Peanut oil, arachis oil, carthnut oil,* is the oil obtained from the peanut (*Arachis hypogœa* L.) and subjected to the usual refining processes; is free from rancidity; has a refractive index (25° C.) not less than one and forty-six hundred and ninety ten-thousandths (1.4690) and not exceeding one and forty-seven hundred and seven ten-thousandths (1.4707); and an iodin number not less than eighty-seven (87) and not exceeding one hundred (100).

6. *"Cold-drawn" peanut oil* * is a peanut oil obtained by pressure without heating.

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* The fixing of limits for chemical and physical properties is reserved for future consideration.

7. *Sesame oil, gingili oil, teel oil,* is the oil obtained from the seeds of the sesame plants (*Sesamum orientale* L. and *S. radiatum* Schum. and Thonn.) and subjected to the usual refining processes; is free from rancidity; has a refractive index (25° C.) not less than one and forty-seven hundred and four ten-thousandths (1.4704) and not exceeding one and forty-seven hundred and seventeen ten-thousandths (1.4717); and an iodin number not less than one hundred and three (103) and not exceeding one hundred and twelve (112).

8. *"Cold-drawn" sesame oil* * is sesame oil obtained by pressure without heating.

9. *Poppy-seed oil* * is the oil obtained from the seed of the poppy (*Papaver somniferum* L.) subjected to the usual refining processes and free from rancidity.

10. *White poppy-seed oil, "cold-drawn" poppy-seed oil,** is poppy-seed oil of the first pressing without heating.

11. *Coconut oil* * is the oil obtained from the kernels of the coconut (*Cocos nucifera* L.) and subjected to the usual refining processes and free from rancidity.

12. *Cochin oil* is coconut oil prepared in Cochin (Malabar).

13. *Ceylon oil* is coconut oil prepared in Ceylon.

14. *Copra oil* is coconut oil prepared from copra, the dried kernels of the coconut.

15. *Rape-seed oil, colza oil,** is the oil obtained from the seeds of the rape plant (*Brassica napus* L.) and subjected to the usual refining processes and free from rancidity.

16. *"Cold-drawn" rape-seed oil* is rape-seed oil obtained by the first pressing without heating.

17. *Sunflower oil* * is the oil obtained from the seeds of the sunflower (*Helianthus annus* L.) and subjected to the usual refining processes and free from rancidity.

18. *"Cold-drawn" sunflower oil* * is sunflower oil obtained by the first pressure without heating.

19. *Maize oil, corn oil,** is the oil obtained from the germ of the maize (*Zea mays* L.) and subjected to the usual refining processes and free from rancidity.

20. *Cocoa butter, cacao butter,* is the fat obtained from roasted, sound cocoa beans, and subjected to the usual refining processes; is free from rancidity; has a refractive index (40° C.) not less than one and forty-five hundred and sixty-six ten-thousandths (1.4566) and not exceeding one and forty-five hundred and ninety-eight ten-thousandths (1.4598); an iodin number not less than thirty-three (33) and not exceeding thirty-eight (38); and a melting-point not lower than 30° C. nor higher than 35° C.

21. *Cotton-seed oil stearin* is the solid product made by chilling cotton-seed oil and separating the solid portion by filtration, with or without pressure, and having an iodin number not less than eighty-five (85) and not more than one hundred (100).

E. Tea, Coffee, and Cocoa Products.

a. tea.

1. *Tea* is the leaves and leaf buds of different species of *Thea*, prepared by the usual trade processes of fermenting, drying, and firing; meets the provisions of the act of Congress approved March 2, 1897, and the regulations made in conformity therewith (Treasury Department Circular 16, February 6, 1905); conforms in variety and place of production to the name it bears; and contains not less than four (4) nor more than seven (7) per cent of ash.

b. coffee.

1. *Coffee* is the seed of *Coffea arabica* L. or *Coffea liberica* Bull., freed from all but a small portion of its spermoderm, and conforms in variety and place of production to the name it bears.

2. *Roasted coffee* is coffee which by the action of heat has become brown and developed its characteristic aroma, and contains not less than ten (10) per cent of fat and not less than three (3) per cent of ash.

c. cocoa and cocoa products.

1. *Cocoa beans* are the seeds of the cacao tree, *Theomroma cacao* L.

2. *Cocoa nibs, cracked cocoa,* is the roasted, broken cocoa bean freed from its shell or husk.

3. *Chocolate, plain chocolate, bitter chocolate, chocolate liquor, bitter chocolate coatings,* is the solid or plastic mass obtained by grinding cocoa nibs without the removal of fat or other constituents except the germ, and contains not more than three (3) per cent of ash insoluble in water, three and fifty hundredths (3.50) per cent of crude fiber, and nine (9) per cent of starch, and not less than forty-five (45) per cent of cocoa fat.

4. *Sweet chocolate, sweet chocolate coatings,* is chocolate mixed with sugar (sucrose), with or without the addition of cocoa butter, spices, or other flavoring materials, and contains in the sugar- and fat-free residue no higher percentage of either ash, fiber, or starch than is found in the sugar- and fat-free residue of chocolate.

5. *Cocoa, powdered cocoa,* is cocoa nibs, with or without the germ, deprived of a portion of its fat and finely pulverized, and contains percentages of ash, crude fiber, and starch corresponding to those in chocolate after correction for fat removed.

6. *Sweet cocoa, sweetened cocoa,* is cocoa mixed with sugar (sucrose), and contains not more than sixty (60) per cent of sugar (sucrose), and in the sugar- and fat-free residue no higher percentage of either ash, crude fiber, or starch than is found in the sugar- and fat-free residue of chocolate.

F. Beverages.

a. FRUIT JUICES—FRESH, SWEET, AND FERMENTED.

1. *Fresh Fruit Juices.*

1. *Fresh fruit juices* are the clean unfermented liquid products obtained by the first pressing of fresh, ripe fruits, and correspond in name to the fruits from which they are obtained.

2. *Apple juice, apple must, sweet cider,* is the fresh fruit juice obtained from apples, the fruit of *Pyrus malus,* has a specific gravity (20° C.) not less than 1.0415 nor greater than 1.0690; and contains in one hundred (100) cubic centimeters (20° C.) not less than six (6) grams, and not more than twenty (20) grams of total sugars, in terms of reducing sugars, not less than twenty-four (24) centigrams nor more than sixty (60) centigrams of apple ash, which contains not less than fifty (50) per cent of potassium carbonate.

3. *Grape juice, grape must,* is the fresh fruit juice obtained from grapes (*Vitis* species), has a specific gravity (20° C.) not less than 1.0400 and not exceeding 1.1240; and contains in one hundred (100) cubic centimeters (20° C.) not less than seven (7) grams nor more than twenty-eight (28) grams of total sugars, in terms of reducing sugars, not less than twenty (20) centigrams and not more than fifty-five (55) centigrams of grape ash, and not less than fifteen (15) milligrams nor more than seventy (70) milligrams of phosphoric acid (P_2O_5).

4. *Lemon juice* is the fresh fruit juice obtained from lemon, the fruit of *Citrus limonum* Risso, has a specific gravity (20° C.) not less than 1.030 and not greater than 1.040; and contains not less than ten (10) per cent of solids, and not less than seven (7) per cent of citric acid.

5. *Pear juice, pear must, sweet perry,* is the fresh fruit juice obtained from pears, the fruit of *Pyrus communis* or *P. sinensis.*

2. *Sterilized Fruit Juices.*

1. *Sterilized fruit juices* are the products obtained by heating fresh fruit juices sufficiently to kill all the organisms present, and correspond in name to the fruits from which they are obtained.

3. *Concentrated Fruit Juices.*

1. *Concentrated fruit juices* are clean, sound fruit juices from which a considerable portion of the water has been evaporated, and correspond in name to the fruits from which they are obtained.

4. *Sweet Fruit Juices, Sweetened Fruit Juices, Fruit Sirups.*

1. *Sweet fruit juices, sweetened fruit juices, fruit sirups,* are the products obtained by adding sugar (sucrose) to fresh fruit juices, and correspond in name to the fruits from which they are obtained.

2. *Sterilized fruit sirups* are the products obtained by the addition of sugar (sucrose) to fresh fruit juices and heating them sufficiently to

kill all the organisms present, and correspond in name to the fruits from which they are obtained.

5. *Fermented Fruit Juices.*

9. *Cider, hard cider,* is the product made by the normal alcoholic fermentation of apple juice, and the usual cellar treatment, and contains not more than seven (7) per cent by volume of alcohol, and, in one hundred (100) cubic centimeters of the cider, not less than two (2) grams nor more than twelve (12) grams of solids, not more than eight (8) grams of sugars, in terms of reducing sugars, and not less than twenty (20) centigrams nor more than forty (40) centigrams of cider ash.

10. *Sparkling cider, champagne cider,* is cider in which the after part of the fermentation is completed in closed containers, with or without the addition of cider or sugar liquor, and contains, in one hundred (100) cubic centimeters, not less than twenty (20) centigrams of cider ash.

b. MEAD, ROOT BEER, ETC.

(Schedule in preparation. See M. F. D. R. 19 p —)

c. MALT LIQUORS.

1. *Malt liquor* is a beverage made by the alcoholic fermentation of an infusion, in potable water, of barley malt and hops, with or without unmalted grains or decorticated and degerminated grains.

2. *Beer* is a malt liquor produced by bottom fermentation, and contains, in one hundred (100) cubic centimeters (20° C.), not less than five (5) grams of extractive matter and sixteen one-hundredths (0.16) gram of ash, chiefly potassium phosphate, and not less than two and twenty-five one-hundredths (2.25) grams of alcohol.

3. *Lager beer, stored beer,* is beer which has been stored in casks for a period of at least three months, and contains, in one hundred (100) cubic centimeters (20° C.), not less than five (5) grams of extractive matter and sixteen one-hundredths (0.16) gram of ash, chiefly potassium phosphate, and not less than two and fifty one-hundredths (2.50) grams of alcohol.

4. *Malt beer* is beer made of an infusion, in potable water, of barley malt and hops, and contains, in one hundred (100) cubic centimeters (20° C.), not less than five (5) grams of extractive matter, not less than two-tenths (0.2) gram of ash, chiefly potassium phosphate, nor less than two and twenty-five one-hundredths (2.25) grams of alcohol, nor less than four-tenths (0.4) gram of crude protein (nitrogen X 6.25).

5. *Ale* is a malt liquor produced by top fermentation and contains, in one hundred (100) cubic centimeters, (20° C.) not less than two and seventy-five one-hundredths (2.75) grams of alcohol, nor less than five (5) grams of extract, and not less than sixteen one-hundredths (0.16) gram of ash, chiefly potassium phosphate.

6. *Porter* and *stout* are varieties of malt liquor made in part from highly roasted malt.

d. Spirituous Liquors.

1. *Distilled spirit* is the distillate obtained from a fermented mash of cereals, molasses, sugars, fruits, or other fermentable substances, and contains all the volatile flavors, essential oils, and other substances derived directly from the materials used, and the higher alcohols, ethers, acids, and other volatile bodies congeneric with ethyl alcohol produced during fermentation, which are carried over at the ordinary temperature of distillation and the principal part of which are higher alcohols estimated as amylic.

2. *Alcohol, cologne spirit, neutral spirit, velvet spirit, or silent spirit* is distilled spirit from which all, or practically all, of its constituents except ethyl alcohol and water are separated, and contains not less than ninety-four and nine-tenths (94.9) per cent (189.8 proof) by volume of ethyl alcohol.

3. *New whisky* is the properly distilled spirit from the properly prepared and properly fermented mash of malted grain, or of grain the starch of which has been hydrolyzed by malt; it has an alcoholic strength corresponding to the excise laws of the various countries in which it is produced, and contains in one hundred (100) liters of proof spirit not less than one hundred (100) grams of the various substances other than ethyl alcohol derived from the grain from which it is made, and of those produced during fermentation, the principal part of which consists of higher alcohols estimated as amylic.

4. *Whisky (potable whisky)* is new whisky which has been stored in wood not less than four (4) years without any artificial heat save that which may be imparted by warming the storehouse to the usual temperature, and contains in one hundred (100) liters of proof spirit not less than two hundred (200) grams of the substances found in new whisky save as they are changed or eliminated by storage and of those produced as secondary bodies during aging; and, in addition thereto, the substances extracted from the casks in which it has been stored. It contains, when prepared for consumption as permitted by the regulations of the Bureau of Internal Revenue, not less than forty-five (45) per cent by volume of ethyl alcohol, and, if no statement is made concerning its alcoholic strength, it contains not less than fifty (50) per cent of ethyl alcohol by volume, as prescribed by law.

5. *Rye whisky* is whisky in the manufacture of which rye, either in a malted condition, or with sufficient barley or rye malt to hydrolyze the starch, is the only grain used.

6. *Bourbon whisky* is whisky made in Kentucky from a mash of Indian corn and rye, and barley malt, of which Indian corn forms more than fifty (50) per cent.

7. *Corn whisky* is whisky made from malted Indian corn, or of Indian corn, the starch of which has been hydrolyzed by barley malt.

8. *Blended whisky* is a mixture of two or more whiskies.

9. *Scotch whisky* is whisky made in Scotland solely from barley malt, in the drying of which peat has been used. It contains in one

hundred (100) liters of proof spirit not less than one hundred and fifty (150) grams of the various substances prescribed for whisky exclusive of those extracted from the cask.

10. *Irish whisky* is whisky made in Ireland, and conforms in the proportions of its various ingredients to Scotch whisky, save that it may be made of the same materials as prescribed for whisky, and the malt used is not dried over peat.

11. *New rum* is properly distilled spirit made from the properly fermented, clean, sound juice of the sugar-cane, the clean, sound massecuite made therefrom, clean, sound molasses from the massecuite, or any sound, clean, intermediate product save sugar, and contains in one hundred (100) liters of proof spirit not less than one hundred (100) grams of the volatile flavors, oils, and other substances derived from the materials of which it is made, and of the substances congeneric with the ethyl alcohol produced during fermentation, which are carried over at the ordinary temperatures of distillation, the principal part of which is higher alcohols estimated as amylic.

12. *Rum (potable rum)* is new rum stored not less than four (4) years in wood without any artificial heat save that which may be imparted by warming the storehouse to the usual temperature, and contains in one hundred (100) liters of proof spirit not less than one hundred and seventy-five (175) grams of the substances found in new rum save as they are changed or eliminated by storage, and of those produced as secondary bodies during aging; and, in addition thereto, the substances extracted from the casks. It contains, when prepared for consumption as permitted by the regulations of the Bureau of Internal Revenue, not less than forty-five (45) per cent by volume of ethyl alcohol, and, if no statement is made concerning its alcoholic strength, it contains not less than fifty (50) per cent by volume of ethyl alcohol as prescribed by law.

13. *New brandy* is a properly distilled spirit made from wine, and contains in one hundred (100) liters of proof spirit not less than one hundred (100) grams of the volatile flavors, oils, and other substances derived from the material from which it is made, and of the substances congeneric with ethyl alcohol produced during fermentation and carried over at the ordinary temperature of distillation, the principal part of which consists of the higher alcohols estimated as amylic.

14. *Brandy (potable brandy)* is new brandy stored in wood for not less than four (4) years without any artificial heat save that which may be imparted by warming the storehouse to the usual temperature, and contains in one hundred (100) liters of proof spirit not less than one hundred and fifty (150) grams of the substances found in new brandy save as they are changed or eliminated by storage, and of those produced as secondary bodies during aging; and, in addition thereto, the substances extracted from the casks in which it has been stored. It contains, when prepared for consumption as permitted by the regulations of the Bureau of Internal Revenue, not less than forty-five (45)

per cent by volume of ethyl alcohol, and, if no statement is made concerning its alcoholic strength, it contains not less than fifty (50) per cent by volume of ethyl alcohol as prescribed by law.

15. *Cognac, cognac brandy* is brandy produced in the department of the Charente and Charente Inferieure, France, from wine produced in those departments.

e. CARBONATED WATERS, ETC.

(Schedule in preparation. See M. F. D. R. 19 p. 138.)

G. VINEGAR.

Attention is especially called to the fact that as defined in paragraph one the word vinegar means in Maine vinegar made from apple cider and cannot be used by itself to designate any other kind of vinegar. It is lawful to sell all other kinds but they must be called by their proper names. Vinegar not up to the standards can be lawfully sold if it is plainly marked "Below standard strength."

1. *Vinegar, cider vinegar, apple vinegar,* is the product made by the alcoholic and subsequent acetous fermentations of the juice of apples, is lævo-rotatory, and contains not less than four (4) grams of acetic acid, not less than one and six-tenths (1.6) grams of apple solids, of which not more than fifty (50) per cent are reducing sugars, and not less than twenty-five hundredths (0.25) gram of apple ash in one hundred (100) cubic centimeters (20° C.); and the water-soluble ash from one hundred (100) cubic centimeters (20° C.) of the vinegar contains not less than ten (10) milligrams of phosphoric acid ($P_2 O_5$), and requires not less than thirty (30) cubic centimeters of decinormal acid to neutralize its alkalinity.

2. *Wine vinegar, grape vinegar,* is the product made by the alcoholic and subsequent acetous fermentations of the juice of grapes and contains, in one hundred (100) cubic centimeters (20° C.) not less than four (4) grams of acetic acid, not less than one (1.0) gram of grape solids, and not less than thirteen hundredths (0.13) gram of grape ash.

3. *Malt vinegar* is the product made by the alcoholic and subsequent acetous fermentations, without distillation, of an infusion of barley malt or cereals whose starch has been converted by malt, is dextro-rotatory, and contains, in one hundred (100) cubic centimeters (20° C.), not less than four (4) grams of acetic acid, not less than two (2) grams of solids, and not less than two-tenths (0.2) gram of ash; and the water-soluble ash from one hundred (100) cubic centimeters (20° C.) of the vinegar contains not less than nine (9) milligrams of phosphoric acid ($P_2 O_5$), and requires not less than four (4) cubic centimeters of decinormal acid to neutralize its alkalinity.

4. *Sugar vinegar* is the product made by the alcoholic and subsequent acetous fermentations of solutions of sugar, sirup, molasses, or refiners' sirup, and contains, in one hundred (100) cubic centimeters (20° C.) not less than four (4) grams of acetic acid.

5. *Glucose vinegar* is the product made by the alcoholic and subsequent acetous fermentations of solutions of starch sugar or glucose,

is dextro-rotatory, and contains, in one hundred (100) cubic centimeters (20° C.), not less than four (4) grams of acetic acid.

6. *Spirit vinegar, distilled vinegar, grain vinegar,* is the product made by the acetous fermentation of dilute distilled alcohol, and contains, in one hundred (100) cubic centimeters (20° C.), not less than four (4) grams of acetic acid.

III. SALT.

1. *Table salt, dairy salt,* is fine-grained crystalline salt containing on a water-free basis, not more than one and four-tenths (1.4) per cent of calcium sulphate ($CaSO_4$), nor more than five-tenths (0.5) per cent of calcium and magnesium chlorids ($CaCl_2$ and $MgCl_2$), nor more than one-tenth (0.1) per cent of matters insoluble in water.

IV. PRESERVATIVES AND COLORING MATTERS.

a. PRESERVATIVES.

Standard preservatives are salt, sugar, vinegar, spices and their essential oils, wood smoke, edible oils and fats, and alcohol.

The use, in food products, of any other preservative or antiseptic, or of any substance is not permitted:

1. If it is poisonous or injurious to health under the conditions of its use in foods.

Among such substances are fluorides, beta-naphtol, formaldehyde, salts of copper, salicylic acid and its salts, boric acid and its salts.

2. If it has not been proved beyond reasonable doubt by scientific investigation to be harmless to health. When its use is not in conflict investigation to be harmless to health. Among such substances are abrastol saccharin and benzoic acid and its salts. When its use is not in conflict with 3 benzoate of soda may for the present be used in foods provided its presence and amount are plainly stated on the label. Alum may be used in limited amount in the pack of pickles for the year 1909 provided its presence is plainly stated on the label. Sulphur may be used in the preparation of molasses and dried fruits for the present.

3. If it conceals in any way inferiority of the product or counterfeits or enhances a natural color.

b. COLORING MATTERS.

The schedule for definitions and standards for coloring matters is in preparation. For the present the use of colors in foods will be governed by Food Inspection Decision 76, the chief points of which are:

The use of any dye, harmless or otherwise, to color or stain a food in a manner whereby damage or inferiority in concealed is specifically prohibited by law. The use in food for any purpose of any mineral dye or any coal-tar dye, except those coal-tar dyes hereinafter listed, will be grounds for prosecution. Pending further investigations now under way and the announcement thereof, the coal-tar dyes hereinafter named, made specifically for use in foods,, and which bear a guaranty from the manufacturer that they are free from subsidiary products and represent the actual substance the name of which they bear, may be used in foods. In every case a certificate that the dye in question has been tested by competent experts and found to be free from harmful constituents must be filed with the Secretary of Agriculture and approved by him.

The following coal-tar dyes which may be used in this manner are given numbers, the numbers preceding the names referring to the number of the dye in question as listed in A. G. Green's edition of the Schultz-Julius Systematic Survey of the Organic Coloring Matters, published in 1904.

The list is as follows:

Red shades:

107. Amaranth.
56. Ponceau 3 R.
517. Erythrosin.

Orange shade:

85. Orange I.

Yellow shade:

4. Naphthol yellow S.

Green shade:

435. Light green S. F. yellowish.

Blue shade:

692. Indigo disulfoacid.

Each of these colors shall be free from any coloring matter other than the one specified and shall not contain any contamination due to imperfect or incomplete manufacture.

M. F. D. R. 5.

STANDARDS FOR DRUGS.

As empowered in Section 5, Chapter 124, Public Laws 1907, Charles D. Woods, the Director of the Maine Agricultural Experiment Station hereby adopts and fixes the following as the standards of purity, quality and strength of drugs in the State of Maine.

A drug, including beverages, bearing a name recognized in the United States Pharmacopœia or National Formulary including the appendix, without any further statement respecting its character, shall be required to conform in strength, quality, and purity to the standards prescribed or indicated for a drug of the same name recognized in the United States Pharmacopœia or National Formulary including the appendix, official at the time.

A drug including beverages, bearing a name recognized in the United States Pharmacopoeia or National Formulary, and branded so as to plainly show to the non-professional person a different standard of strength, quality, or purity, shall not be regarded as adulterated or misbranded if it conforms to its declared standard.

A beverage for medicinal purposes, not bearing a name recognized in the United States Pharmacopoeia or National Formulary shall conform to the standard of strength, quality and purity named in the food standards adopted at the time for the State of Maine.

M. F. D. R. 6.

The regulations published in Circular 21 of the Office of The U. S. Secretary of Agriculture are, so far as they pertain to commerce within a state, adopted as part of the regulations under the Maine Food and Drug Law.

M. F. D. R. 7.

The Food Inspection Decisions that have been and shall be made by the U. S. Secretary of Agriculture under the National Food and Drugs act, June 30, are and will be construed as applying to the Maine Food and Drug Law.

M. F. D. R. 8.

Superseded.

M. F. D. R. 9.

SAMPLES FOR ANALYSIS.

The Station will so far as circumstances may allow, make free of charge and as promptly as possible, analysis of samples of foods and drugs coming under the requirements of the Maine Food and Drug Law. As a protection to the dealers and to the Station the following conditions respecting samples must be observed.

Original unbroken packages will be accepted for analysis when sent prepaid and accompanied by the name and postoffice address of the sender and the dealer.

Samples from opened or bulk goods must be taken, sealed and packed in the presence of a witness, preferably the dealer, and forwarded by prepaid express. Usually not less than 8 ounces of a material should be sent as a sample. The sample must be accompanied by (1) an exact copy of the principal label or marks on the package from which the sample is taken; (2) the name and address of the dealer; (3) the signed statement of the witness that the sample was taken, sealed and packed in his presence; and (4) the signed statement of the sender that in his judgment the sample fairly represents the goods and that the accompanying statements are accurate.

M. F. D. R. 10 AND 11.

Superseded.

M. F. D. R. 12.

SELLING GOODS THAT HAVE BEEN REMOVED FROM THE PACKAGE.

There are occasional unwitting violations of the law on the part of dealers by removing the contents of a package into some other receptacle before selling. This is perfectly proper in the case of goods that are exactly what they appear to be, but goods that require branding cannot be lawfully removed from the original packages before being sold unless they are still correctly labeled. For example—adulterated maple sugar may be sent out in boxes that are properly labeled; it is unlawful for the dealer to remove it from the package in which it was received and expose it for sale unless it shall be plainly marked adulterated maple sugar or maple sugar and cane sugar or whatever is necessary to accord with the fact. Pork sausage as put up by many manufacturers contains some cereal and is properly labeled "Pork sausage, cereal added." The removal of such sausage from the original package and exposure for sale without proper labeling is unlawful. An imitation cream of tartar sold in bulk, may be properly labeled in its original package but it is unlawful to remove it from that package and expose it for sale unless it shall be properly labeled.

M. F. D. R. 13.

Superseded.

M. F. D. R. 14.

THE GUARANTY.

Section 9 of the Maine Food and Drug Law reads as follows: "No dealer shall be prosecuted under the provisions of this act when he can establish a guaranty signed by the wholesaler, jobber, manufacturer, or other party residing in the United States, from whom he purchased such articles, to the effect that the same is not adulterated or misbranded within the meaning of this act, designating it. Said guaranty, to afford protection, shall contain the name and address of the party or parties making the sale of such articles to such dealer, and in such case said party or parties shall be amenable to the prosecutions, fines and other penalties which would attach, in due course, to the dealer under the provisions of this Act."

The object of the Legislature in enacting this section was two-fold; to offer adequate protection to the honest dealer and throw the responsibility for adulterations back where it belongs, upon the manufacturer. It is earnestly recommended that every dealer in the state, whenever he shall purchase any article of food or drugs, feeding stuffs, fertilizers or agricultural seeds coming under the requirements of the inspection laws, insist upon and obtain from the person from whom he purchases, a written guaranty in accord with the law above cited.

No prosecutions will lie against any handler of food or drugs within the state provided the goods carry the U. S. serial number or he obtains at the time of purchase a *written guaranty* that the goods are in conformity with the law regulating their sale. Failure to obtain such a guaranty on the part of the dealer will be presumptive evidence that he is not sufficiently interested in the purity of the goods which he handles, and unless there are especially extenuating circumstances, the Director will feel it his duty to begin prosecution for violations of the law regulating the sale of food and drugs.

Any form of guaranty covering the facts may be used. Forms are suggested below. The guaranty must be signed in ink. The signature of a corporation should be made in the following form. First the legal corporate title of the company, second the autograph of a duly authorized officer of the company; third the title or designation of his office. For example—The Smith-Jones Company, *Chas. R. Doe*, Member of firm.

The following three classes of guarantees cover the cases about which questions have arisen.

(1) *A guaranty filed with the United States Secretary of Agriculture* by the manufacturer or dealer and given a serial number, which number shall appear on each and every package of goods sold under such guaranty together with the words "Guaranteed by .... under the Food and Drug Act, June 30.

(2) If a *guaranty* is *not filed* and the serial number not printed as above stated, the guaranty should identify and may be atached to the bill of sale, invoice, bill of lading or other schedule giving the names and quantities of the articles sold.

"I (we) the undersigned do hereby guarantee that the following articles, packed, distributed or sold by me (us) (specify the same as fully as possible) are in conformity with the requirements of the Maine Food and Drug law."

(Signed in ink.)

....

(Name and place of business of wholesale dealer, manufacturer, jobber, or other party.)"

(3) A *general guaranty* may be given by a manufacturer or dealer for a period of time and the following form may be used.

("I (we) the undersigned do hereby guarantee that the articles of foods and drugs packed, distributed or sold by me (us) (state name of consignee) during the year 19— shall be in conformity with the requirements of the Maine Food and Drug Law."

To be signed, etc., as under (2).

M. F. D. R. 15 AND 16.

LABELING DRUGS AND MEDICINES.

United States Pharmacopea and National Formulary preparations as well as other medicinal preparations (except physicians prescriptions) must "bear a statement on the label of the quantity or proportion of any alcohol, morphine, opium, cocaine, heroin, alpha or beta eucaine, chloroform, cannabis indica, chloral hydrate or acetanilide or any derivative or any preparation of any such substances contained therein." This applies to all containers including shelf bottles in which the preparations are stored as well as to the package which is given to the customer.

The statements can be made in quantity, as grains per ounce, etc., or in percentages. Until further notice, the percentage of the above named materials in the U. S. P. and N. F. preparations may be stated as given in the Era Dose Book *, Fifth Edition, or other reliable authority such as the American Pharmaceutical table.

U. S. P. and N. F. preparations must be in exact accord with the standards in the last edition of U. S. P. and N. F. or else be branded so as to plainly show to the non-professional person that they differ and how.

The following are illustrations of proper branding,—Tincture of benzoin must be of the strength named in the U. S. P. and would be properly labeled:—

TINCTURE OF BENZOIN

Alcohol 90 per cent.

If less benzoin is used the label should read;—

TINCTURE OF BENZOIN BELOW STANDARD STRENGTH

Alcohol 90 per cent.

In the same way if the amount of alcohol be varied the label should show the fact, as;—

TINCTURE OF BENZOIN BELOW STANDARD STRENGTH

Alcohol per cent.

Ginger extract to be used as a food and made of the strength called for in the Food Standards adopted for Maine does not need to carry a statement of the amount of alcohol and may be lawfully labeled GINGER EXTRACT, or EXTRACT OF GINGER. If below strength called for by the Food Standards, it should be labeled so as to indicate that fact, as GINGER EXTRACT BELOW STRENGTH.

Ginger extract or ginger tincture, if sold as a medicine must be of the strength named in the U. S. P. for fluid extract or for the tincture and should be labeled accordingly. The extract should be labeled;—

FLUID EXTRACT OF GINGER

Alcohol 94.9 per cent.

The tincture should be labeled;—

TINCTURE OF GINGER

Alcohol 93 per cent.

If the extract or the tincture is not exactly in accord with the U. S. P., the label should show the fact, as;—

FLUID EXTRACT OF GINGER BELOW (OR ABOVE) STRENGTH

Alcohol per cent.

or

TINCTURE OF GINGER BELOW (OR ABOVE) STRENGTH

Alcohol per cent.

The Maine Food and Drug Law in no way changes the laws regulating the sale of poisons.

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* Published by D. O. Haynes & Co., New York, price 50 cents.

M. F. D. R. 17.

LABELING.

To put into a clear concise statement the labeling requirements involved under the law is perhaps impossible. The labeling requirments apply to everyone making or selling any article of food or drugs and applies to any package in which these materials may be put as well as to the original package. Goods that need to be labeled must be plainly labeled from the time they leave the manufacturer until they reach the consumer. It is as necessary for the retailer to plainly label the package that he gives to a customer as it is for the maker to label the original package in which the goods are shipped. The law is for the protection and the label is for the information of the consumer.

Regulations 17 to 30 of the rules and regulations under the National law adopted for Maine in April, 1907, have to do with the section of the law that defines misbranding. In general it is only goods that are adulteration or in imitation of other goods that need labeling. Goods that are exactly what their names * imply do not need labels; all other articles need to be labeled to show what they are. For instance,—such articles as flour, corn meal, sugar, eggs, tea, coffee, beans, molasses, etc., do not need to be labeled if they are exactly what their names imply. Articles of food and drugs that are not exactly in accord with the name applied to them must be labeled. E. g., flour to which corn starch has been added, molasses mixed with glucose, coffee containing chicory, etc. must be labeled to show exactly what they are.

When goods are sold in imitation of other goods or of a different strength or purity than the genuine they must be plainly labeled so that the exact nature of the goods can be readily understood by a non-professional person. The words that are used to explain the departure from the genuine must be in the same sized type as that used for the name of the article and must be printed on a background uniform with that on which the name is printed. Goods that differ from the standards in any particular must be plainly marked with the words above or below standard strength as the case may be must be uniform in size and background with the name of the goods. In the case of goods put up by the retailer for direct sale to the consumer they may be labeled by the use of a gummed label, or a tag, or if put up in a package that will admit of it the package itself may be directly labeled. The label may be printed from type or a rubber stamp, or it may be written with ink. The only requirment is that it be *plainly* marked and the type used can not be smaller than 8 point capitals.

The distinction between misbranding and adulteration must be kept in mind. Correct branding is not a remedy for adulteration or for substitution. Goods must be sold for exactly what they are. If, for instance, a customer asks for maple sirup and the dealer supplies a

* Except in the case of articles containing alcohol, morphine, opium, etc.

bottle containing a mixture of cane and maple, the fact that the bottle is correctly labeled does not protect the dealer from prosecution for adulteration. It even makes the case against him stronger. For he has knowingly, as evidenced by the label, sold an imitation for the real. If a customer asks for molasses and the dealer fills the jug with a mixture of glucose and molasses, putting a label on the jug that it is compound molasses, in no wise lessens the sale of adulterated goods. It is perfectly lawful to sell these goods for just what they are but they cannot be lawfully substituted for the article they imitate.

M. F. D. R. 18.

SPIRIT OF NITROUS ETHER.

(Sweet Spirit of Nitre.)

The following precautions in handling concentrated nitrous ether, preparing, keeping and dispensing the spirit of nitrous ether, if observed, should prevent undue deterioration and if they are followed in every respect, druggists will not be prosecuted under the Maine Food and Drug Law if on analysis the spirit of nitrous ether dispensed should yield "less than 4 per cent ethyl nitrite."

Spirit of nitrous ether may be prepared according to the U. S. P. Eighth Edition or may be made from concentrated nitrous ether. If the latter method is used purchase concentrated nitrous ether from a reliable house. If the label does not carry the U. S. serial number, obtain a written guaranty from the seller as to its strength.

Buy in small sealed packages so that the spirit of nitrous ether made therefrom will under ordinary conditions be sold inside of one month.

Follow directions for preparation as given by the manufacturer as regards the proportions of concentrated nitrous ether and alcohol to be used. Thoroughly chill both the concentrated nitrous ether and the alcohol. Use a towel or other non-conducting material in handling the concentrated nitrous ether container. Do not pour through the air more than absolutely necessary.

Store in amber colored, glass bottle, stoppered with tight fitting cork stopper. Do not use a ground glass stopper.

Keep the bottle in a cool place. Room temperature is not cool enough.

Put the date of manufacture on the bottle.

Do not sell after six weeks from preparation without testing strength by assay. If weak bring up to strength by adding concentrated nitrous ether q. s. and put new date on bottle.

Put date of manufacture on bottle given to customer.

A cautionary statement on the label of the dispensing bottle advising the customer of the volatile nature of sweet spirit of nitre and that it should be kept tightly stoppered in a cool place and not used more than 12 weeks after date of manufacture is suggested.

All persons retailing sweet spirit of nitrous ether in bottles as put up by manufacturers should buy these goods under special guaranty as to date of their manufacture, their being of U. S. P. strength, and length of time which they are guaranteed to remain U. S. P. strength. At expiration of this time, they should be withdrawn from sale.

M. F. D. R. 19.

CARBONATED BEVERAGES.

The standards for carbonated beverages, roots beers and similar beverages have not yet been determined upon. For the present these goods may be sold in Maine under the following general regulations.

Goods true to name need no label. Hence sirups made from cane sugar and flavored with extracts made from pure fruit oils or with pure fruit juices, without added coloring matter can be lawfully sold without label of any kind.

Carbonated water flavored with extract made from pure fruit oils or with pure fruit juices, without any added coloring matter and sweetened with cane sugar can be lawfully sold in bottles or from fountains as "soda water" or "soda" without label of any kind.

Sirups or soda waters flavored with imitation flavors must be so labeled.

Sirups flavored with imitation flavors cannot be lawfully drawn from soda water fountains unless the fact is conspicuously stated upon labels attached to the fountain.

If coloring matter is used, that fact must be stated. Food Inspection Decision 76 names the colors which may be lawfully used.

The words "imitation and colored" when used must be the same size and plainness of type as the name of the flavor, except that, for the present, in the case of bottled soda water where the label is upon the crown cap, the words "imitation flavor and color" may be in smaller letters than the flavor but they must be sufficiently large and plain as to be readily noted.

Benzoate of soda may be used in fruit sirups if the fact of its presence and amount is stated on the label. No other preservatives or chemicals (except as stated on page 1, F. I. D. 76) can be lawfully used under any circumstances.

Sirups containing benzoate of soda may be used in soda fountains

Sirups containing benzoate of soda may be used in soda fountains provided a conspicuous sign is shown stating that fact, including its amount.

Sirups containing benzoate of soda may be used in bottled sodas, provided the fact and amount is stated on the label.

Trade marked or proprietary beverages sold under a descriptive name must be true to name.

For the present root beer, birch beer and ginger ale may be sold without a statement on the label that they are artificially colored and flavored.

If there is more than one label on imitation goods, the secondary label must correspond in fact with the principal label. Goods carrying "imitation flavor and color" on the crown cap, will not permit the use of a side label bearing a name unless it also carries "imitation flavor and color."

It is unlawful to substitute an imitation or adulterated article of food or drugs without calling attention to the fact of the substitution even if the goods are properly and correctly labeled. For example, if Pineapple soda is asked for, it is unlawful to sell a soda that contains an artificial flavor and color even though it be labeled "Pineapple soda imitation flavor and color," without calling attention to the fact that it is an imitation.

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[361-10-09.]

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

Official Inspections.

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Both the spirit and the letter of the Maine Inspection laws demand freedom from adulteration and truthful labeling.

THE SALE OF APPLES.

VERY IMPORTANT TO DEALERS.

A dealer who is not posted on the requirements of Chapter 247 of the Public Laws of 1909 on the uniform grading, packing and branding of apples should at once send to the Station for a copy of the law (ask for Official Inspections 12) and give it careful study. The law has to do with the sale of all apples, whether grown in the State or out, that are in closed packages. The law is explicit but it needs to be well understood in order to avoid its violation. It covers two pages of fine print and can hardly be abstracted. Its chief features are: The grading of all apples as to size and imperfections; the size of the barrel or bushel box, and the way it must be labeled if not of standard size; and the way all closed packages must be labeled so as to state their content. The Director of the Experiment Station is the executive officer, and the penalties and methods of handling violations are similar to those of the Maine Food and Drug Law.

CATCHUP.

As defined in the Maine food standards catchup, catsup or ketchup is the clean, sound product made from the properly prepared pulp of clean, sound, fresh, ripe tomatoes, with spices and with or without sugar and vinegar. Also benzoate of soda may be used provided its presence and amount are plainly stated upon the label. A number of samples of the leading brands of catchup on sale in Maine were collected with the particular purpose of ascertaining whether the requirements relative to the use of benzoate of soda were being complied with. The quality of the catchups in other particulars were left for later investigation.

The results of the examination are given in the tables on pages 144 and 145. In no instance was a preservative found in the goods unless the fact of its presence was stated. Hearings were appointed in all cases in which the percentage of benzoate of soda materially exceeded the amount stated upon the label. The hearings developed the following facts:

8135. This was sold to The Twitchell Champlin Company under written guaranty by the makers as containing .1 per cent benzoate of soda. The makers claim that in the tomato season they get stock faster than they can use it and add benzoate of soda to keep it. The goods are made later and as they do not have the product analyzed it would seem they know practically nothing of the amount of benzoate of soda it may carry. Twitchell-Champlin were innocent and are protected by a written guaranty. The case has been referred to the U. S. Board of Food and Drug Inspection for prosecution.

8214. The manufacturers made affidavit that they had not labeled any goods as "Snider's Home Made Catsup" since 1906, and that they had used no preservatives since July, 1908. Affidavit accepted in settlement of case.

8227 and 8371. From goods packed in 1907 and from stock purchased from other manufacturers. This practice of buying stock has been discontinued. Affidavit accepted in settlement of case.

8221. Hearing not yet held.

8223. Investigation showed that these goods were shipped into the State prior to 1906. While this does not excuse the dealer the case was not prosecuted. The goods were withdrawn from sale.

8224, 8246, and 8258. These goods were sold under guarantees by the E. D. Pettingill Sons' Company. The company made an assignment in 1908. The goods were purchased by them from manufacturers outside of the State. The cases were dropped as the company responsible for them no longer exists.

8225. The makers presented affidavit that the benzoate of soda was added to the finished product and accurately weighed in. They account for the excess in this sample by faulty mixing which involves the assumption that other part of the same batch would show less than .1 per cent benzoate of soda. As the excess was only .07 per cent the affidavit was accepted in settlement.

8226. The makers made affidavit that the excess of sodium benzoate was due to faulty mixing. Examination of goods in their stock by their chemists showed some to run over and others to run under and in one lot no benzoate of soda was found. Affidavit accepted in settlement of case.

8401. Makers made affidavit that they had used no preservative since 1906 in their catchup and that these goods must have been made prior to 1906. Other samples of their goods were found (see 8399) to contain no preservative. Affidavit was accepted in settlement of the case.

The differences in price between the different catchups may be due to the retailer from whom the goods were bought but the marked differences in the weight of the contents of the bottles is due to the makers. In general no weights are given upon the bottles. Pint bottles which should hold 16 ounces of water are what the makers seem to desire to make the buyer think he is getting. These "pint" bottles hold all the way from 13 to 19 ounces of catchup. The smaller bottles in many instances are so fluted and shaped as to appear full size. In one case the half pint bottle was plainly labeled to show the weight to be 7 1-2 ounces which it over ran as the contents weighed 8.2 ounces.

Table showing the analyses of official samples of catchups purchased in the spring of 1909. The samples are arranged alphabetically by states and towns within the state in which manufactured. Hearings appointed for all violations.

Station No.	Manufacturer, Dealer and Brand.	Price.	Contents.	Benzoate of Soda. Claimed.	Benzoate of Soda. Found.
		Cts.	Ozs.		
8225	Libby, McNeill & Libby, Chicago, Ill. Staples' Cash Market, Bangor, "Libby's Tomato Catsup"	25	15.5	.10	.17
8265	Frazier's Packing Co., Elwood, Ind. Thurston & Kingsbury, Bangor, "Royal Red Brand Tomato Catsup"	–	13.0	.10	None.
8248	**Columbia Conserve Co., Indianapolis, Ind. S. W. Collins & Son, Caribou, "Columbia Catsup"	25	19.3	.10	.25
8401	Columbia Conserve Co., Indianapolis, Ind.† E. F. Hillman, Portland. "Columbia Catsup"	25	18.9	.10	.16
8399	Columbia Conserve Co., Indianapolis, Ind. Geo. C. Shaw, Co., Portland. "Tomato Catsup"	–	18.9	None.	None.
8220	*Van Camp Packing Co., Indianapolis, Ind. J. F. O'Connell, Bangor, "Van Camp's Tomato Catsup"	20	17.1	.10	.31
8371	*Van Camp Packing Co., Indianapolis, Ind. A. R. Verrill, Portland. "Van Camp's Tomato Catsup"	20	17.4	.10	.33
8258	Thurston & Kingsbury, Bangor, M. J. Watson, Patten, "Purity Catsup"	25	15.8	.10	.29
8247	Milliken-Tomlinson Co., Portland, Geo. O. Smith, Caribou, "Golden Rod Catsup"	12	16.0	.10	.10
8224	E. D. Pettingill Sons Co., Portland, Staples' Cash Market, Bangor, "Eastern Star Brand Tomato Catsup"	10	18.8	.10	.32
8246	Shaw, Hammond & Carney, Portland, R. J. Kimball, Bridgewater, "Mt. Kineo Catsup"	10	18.4	.10	.36
8242	Twitchell-Champlin Co., Portland, H. N. Goodhue, Ft. Fairfield, "Hatchet Brand Tomato Catsup"	20	17.8	–	None.
8221	Jas. J. Loughery & Co., Boston, Mass. J. F. O'Connell, Bangor, "LeRoy Extra Quality Tomato Catsup"	10	13.5	.10	.20
8396	Jas. J. Loughery & Co., Boston, Mass. Geo. C. Shaw Co., Portland. "LeRoy Extra Quality Tomato Catsup"	10	13.2	.10	.31
8226	A. F. Ross & Co., Ins., Newburyport, Mass. Penobscot Cafe, F. D. Daley, Prop., Bangor. "Peerless Tomato Ketchup"	10	12.8	.10	.26

Table showing the analyses of official samples of catchups purchased in the spring of 1909. The samples are arranged alphabetically by states and towns within the state in which manufactured. Hearings appointed for all violations.—Continued.

Station No.	Manufacturer, Dealer and Brand.	Price.	Contents.	Benzoate of Soda.	
				Claimed.	Found.
8223	Horton-Cato Mfg. Co., Detroit, Mich. Staples Cash Market, Bangor. "Royal Brand Tomato Catsup"†	20	16.9	.10	.38
8215	Joseph Campbell Co., Camden, N. J. J. C. Norton & Co., Bangor, "Campbell's Tomato Ketchup"	10	8.2	–	None.
8134	Curtice Bros. Co., Rochester, N. Y. A. H. Berry & Son Co., Houlton, "Curtice Bros. Blue Label Tomato Ketchup"	25	17.7	.10	.12
8250	Jersey Packing Co., Cincinnati, O. Watson Bros., Van Buren, "Newport Tomato Ketchup"	10	13.0	–	None.
8227	Jersey Packing Co., Cincinnati, O. Staples & Griffin, Bangor, "Sunny Side Tomato Ketchup"	10	16.1	–	None.
8214	T. A. Snider Preserve Co., Cincinnati, O. Fred T. Hall & Co., Bangor, "Snider's Home Made Catsup"†	20	18.7	.10	.44
8217	J. Weller Co., Cincinnati, Ohio. F. L. Frank & Co., Bangor, "Fort Pitt Tomato Catsup"	10	14.6	.10	.115
8256	J. Weller Co., Cincinnati, Ohio. Houlton Grange Store, Houlton, "Hoffman House Ketchup"	9	15.8	.10	.12
8251	Lutz & Schramm Co., Pittsburg, Pa. L. W. Dyer, Houlton, "Lutz & Schramm Tomato Catsup"	15	8.4	–	None.
8135	E. C. Flaccus Co., Wheeling, W. Va. A. H. Berry & Sons Co., Houlton, "The Champion Catsup"	10	15.6	.10	.20

* Packed in 1907. Settled by affidavit.
** Sold S. W. Collins & Son in 1904.
† Packed before 1906.

COCOA.

Cocoa is made from cocoa nibs with or without the germ and is deprived of a portion of the fat. Cocoa nibs is the roasted broken cocoa bean freed from its shell or husk. Consequently there should be no cocoa shells or other foreign matter present in cocoa. Several samples of the brands of cocoa found on sale in the State were collected in the late spring and early summer of 1909. The results of the examination are given in the table which follows.

For the most part the cocoas were found to be good and free from all adulteration. Three samples, 8060, 8083 and 8086, contained some shells ground very fine. But as the amount present was small and probably accidental they were passed. Sample 8083 however carried misleading statements on the package and a hearing was appointed. It developed that the company making the cocoa failed in 1902 hence the goods were made at least 3 years before the enactment of the first Maine food law and at least 4 years before the National law. While this fact is no real excuse for the dealer it was decided not to prosecute the dealer with whom the goods were found. The remainder of the lot was destroyed.

Table showing results of analyses of samples of cocoa purchased in March, 1909. The samples are arranged alphabetically by states and towns within the state in which manufactured.

Station No.	Manufacturer, Dealer and Brand.	Price.	Weight.	Ash.	Fat.	Under microscope
			Oz.	%	%	
8055	Stephen L. Bartlett, Boston, Mass. Boston Tea Store, Lewiston, "Bensdorp's Royal Dutch Cocoa".......	.30	8.2	7.31	30.41	No foreign materials found.
8097	Stephen L. Bartlett, Boston, Mass. Brown & Sturtevant, Waterville, "Ralston Health Club Cocoa"...........	35	8.0	3.39	14.20	No foreign materials found.
8086	Melbourne Trading Co., Boston, Mass. John D. Johnson, Portland, "Empire Brand Compound Lunch Cocoa"	20	8.2	4.66	14.03	Some shells ground fine.
8051	Walter Baker & Co., Dorchester, Mass. R. E. Harvey & Co., Bangor, "Walter Baker & Co., Breakfast Cocoa"..	25	8.1	5.23	29.67	No foreign materials found.

Table showing results of analyses of samples of cocoa purchased in March, 1909. The samples are arranged alphabetically by states and towns within the state in which manufactured.—Continued.

Station No.	Manufacturer, Dealer and Brand.	Price.	Weight.	Ash.	Fat.	
			Oz.	%	%	
8083	New England Chocolate Co., *Winthrop, Mass. James Conellan, Portland, "New England Breakfast Cocoa"	10	3.5	8.74	23.93	Some shells ground fine.
8065	Houton Cocoa & Chocolate Co., Newark, N. J. E. Janelle & Co., Lewiston, "Houton's Amazon Breakfast Cocoa"	25	8.9	5.17	27.12	No foreign materials found.
8043	Huyler, New York. F. H. Drummond, Bangor, "Huyler's Caracas Cocoa"	25	7.9	5.10	34.33	No foreign materials found.
8096	Chas. H. Phillips Chemical Co., N. Y. Brown & Sturtevant, Waterville, "Phillips Digestible Cocoa"	40	7.7	3.69	30.66	No foreign materials found.
8037	Rockwood & Co., New York. S. H. Robinson & Sons, Bangor, "Rockwood & Co., Breakfast Cocoa"	25	8.0	5.56	19.46	No foreign materials found.
8042	Runkel Bros., New York. F. H. Drummond, Bangor, "Pure Breakfast Cocoa"	25	8.1	5.46	25.52	No foreign materials found.
8079	Runkel Bros., New York. Philip J. Ward, Portland, "Runkel's Pure Breakfast Cocoa"	10	3.5	5.88	24.63	No foreign materials found.
8075	Stollwerck Bros., New York. C. O. Scribner, Portland, "Stollwerck Cocoa"	25	8.0	4.60	26.71	No foreign materials found.
8077	Stollwerck Bros., New York. Chas. H. Lombard, Portland, "Stollwerck's Milk Cocoa"	10	2.8	5.76	21.91	No foreign materials found.
8060	Ideal Cocoa Co., Lititz, Pa. C. H. Cloutier & Co., Lewston, "Ideal Breakfast Cocoa"	25	8.2	9.64	22.65	Few cocoa shells present, ground fine.
8078	Brownelle & Field Co., Providence, R. I. Philip J. Ward, Portland, "Autocrat Cocoa"	25	8.2	4.42	33.12	No foreign materials found.
8068	W. H. Baker, Winchester, Va. O. Roger, Lewiston, "W. H. Baker's Best Cocoa"	25	8.2	6.37	30.22	No foreign materials found.
8063	C. Y. Van Houten Royal Cocoa Factory, Weesp-Holland. C. H. Cloutier & Co., Lewiston, "Van Houten's Pure Soluble Cocoa"	30	4.2	8.71	29.11	No foreign materials found.
8054	G. H. Stiles, Bangor, "Lowney's Breakfast Cocoa"	25	8.3	5.15	24.23	No foreign materials found.

*Company failed in 1902 hence these goods were at least 7 years old.

EXTRACTS.

SHORT MEASURE.

In the early summer of 1909 the inspector was sent to wholesale houses with instructions to weigh and measure the different kinds of package and bottle goods in stock. Among other things it was found that the goods of three manufacturers of extracts were uniformly short measure. Original boxes of these goods were purchased, the contents of the bottles were carefully measured at the laboratory and analyzed. Hearings were appointed and as complete an investigation made as practicable. No prosecutions have been begun as yet against the Maine firms, and it may be that the short measure cases will not be carried further. The results of the examination are given in the table on page 150.

It would seem that manufacturers have been in the habit of ordering two or four ounce bottles as the case may be. The makers send bottles that will hold the desired amount when full. If a bottle is completely filled with a liquid an increase in temperature blows the cork out of the bottle. Makers of extracts therefore leave an air bubble of greater or less amount in the top. This brings it about that unless the precaution has been taken of ordering a bottle larger than required to hold the amount there has been a 5 to 15 per cent shortage. Most makers do not label the bottles to show the measure they are expected to hold. The Schlotterbeck and Foss Company mark the measure on the box but put no statement of measure on the carton or the bottle that is given to the customer. The Dolan and Furnival Company put no statement of measure on the bottle except that which is implied in the name of the goods "Four ounce brand." Both of these companies are at fault in what has been their practice and both claim that it shall not occur in future output. The goods made by Frank E. Harris were sold into the State under written guaranty and the cases were reported to the U. S. Board of Food and Drug Inspection. The other samples reported were of only single bottles. As the goods were above strength no pains were taken to find unbroken lots.

BELOW STANDARD.

8292. Foss' Pure Spirits Camphor. These goods were 70 per cent of the U. S. P. strength in both alcohol and camphor. There was nothing to indicate to the purchaser that the goods were deficient in camphor and only one familiar with the formula for camphor would have obtained any information from the label as to this shortage in alcohol. The goods were short measure, and below strength in the two particulars. The case of the goods being below standard will be prosecuted.

8276. Our Special Brand Essence Checkerberry. These goods were two-thirds the standard strength in checkerberry. It is impracticable to distinguish between an extract made from oil of wintergreen, oil of birch or the synthetical ester. The company claim that their goods are made from the high priced oil of wintergreen. The goods were labeled "Oil CHECKERBERRY 10m" on one line and on the next "75% ALCOHOL-1oz." To perhaps one person in ten thousand in the State that may have conveyed the information that these goods were below standard strength as the Company claim they meant should be the case. The plainly printed statement that "This essence is of high grade, strictly pure, and is prepared especially for the family trade," in connection with the statement on the other side of the carton that "customers will find to be of superior quality, strong in flavor and perfectly pure" would certainly lead nearly every one to think the goods were of lawful strength. The benefit of the doubt is given to the Company and on their promise to correct these matters the case is allowed to rest.

8277. Our Special Brand Essence Peppermint. All the statements made with reference to 8276 hold with these goods. They were short measure, below strength and with misleading statements. No prosecution will be made as explained above.

8290 and 8291. McAndrews Four Ounce Brand Lemon and McAndrews Four Ounce Brand Peppermint. Both of these were short measure and somewhat below strength. Hearings were appointed. They explain the slight deficiency in the lemon by a loss in filtering and the shortage in the peppermint by a misunderstanding of a formula. As the goods were so nearly of lawful strength the cases were not followed up on the agreement of the Company to make all goods full measure and full strength.

Table showing results of analyses of extracts purchased in the early summer of 1909. Hearings were appointed for the violations of law both in short measure and low strength. See discussion which preceeds on pages 148 and 149.

Station number.	Name of Maker Brand and Dealer.	Measure.		Oil.		Per cent of standard strength.
		Claimed.	Found.	Found.	Standard.	
	Camphor.	Ozs.	Ozs.	%	%	
8292	Schlotterbeck & Foss Co., Portland "Foss' Pure Spirits Camphor." John Cassidy Co., Bangor	2	1.86*	†	†	70
	Checkerberry.					
8276	Schlotterbeck & Foss Co., Portland. "Foss' Special Brand Essence Checkerberry." Arthur Chapin & Co., Bangor	2	1.82*	2.0	3.0	67
7941	E. Hartshorn & Sons, Boston, Mass. "Hartshorn's Pure Extract Checkerberry." W. J. Wiley, Monticello	–	1.76	4.50	3.0	150
	Lemon.					
8290	Dolan & Furnival Co., Portland, Me. "McAndrews Four-Ounce Brand Colored Lemon." John Cassidy Co., Bangor	–	3.71*	4.9	5.0	98
8282	Frank E. Harris, Binghampton, N. Y. "Harris Pure Extract of Lemon." John Cassidy Co., Bangor	2	1.75*	5.9	5.0	118
	Peppermint.					
8291	Dolan & Furnival Co., Portland, Me. "McAndrews Four Ounce Brand Peppermint." John Cassidy Co., Bangor	–	3.60*	2.7	3.0	90
8277	Schlotterbeck & Foss Co., Portland. "Foss' Special Brand Essence Peppermint." Arthur Chapin & Co., Bangor	2	1.81*	1.65	3.0	55
7939	E. Hartshorn & Sons, Boston, Mass. "Hartshorn's Pure Extract Peppermint." J. H. McGowan, Ashland	–	1.93	4.00	3.0	133
8283	Frank E. Harris, Binghampton, N. Y. "Harris' Concentrated Extract of Peppermint." John Cassidy Co., Bangor, Me.	2	1.79*	7.00	3.0	233
7940	Van Duzer Extract Co., N. Y. City, N. Y. "Van Duzer's Fruit Extracts Highly Concentrated Peppermint." J. H. O'Donnell, Presque Isle	–	2.10	7.16	3.0	239

*Average of 12 bottles.

†Contained 7 grams camphor per 100 cubic centimeters and the standard is 10 grams.

SPIRIT OF NITROUS ETHER.

June 3, 1909, there was made up from a Smith, Kline & French Company's tube of concentrated nitrous ether about one pint of sweet spirit of nitre. Care was taken to follow exactly the directions upon the tube. As soon as prepared this was analyzed and found to carry 4.06 per cent ethyl nitrite or equal to 101.5 per cent U. S. P. standard. This was, in accordance with the directions in Official Inspections 3, stored in an amber bottle, stoppered with a cork stopper and kept in the dark in a refrigerator. At intervals during three months samples were drawn and tested. Each time a test was made about two ounces were poured out and thrown away in imitation of a sale of that amount. The bottle was full when the test began and was about half empty at the end of 90 days. The results were as follows:

Table showing changes in composition of properly stored sweet spirit of nitre tested at intervals during three months.

		Ethyl nitrite.	Per cent U. S. P. standard.	Days kept.
1909.		%		
June 3	Made and tested	4.06	101.5	0
June 16	Tested	4.06	101.5	13
	Two ounces poured out.			
July 17	Tested	4.06	101.5	44
	Two ounces poured out.			
August 3	Tested	4.06	101.5	61
	Two ounces poured out.			
August 18	Tested	3.97	99.3	76
	Two ounces poured out.			
Sept. 1	Tested	3.83	95.8	90

It will be seen that under conditions that can be readily imitated in any drug store sweet spirit of nitre may, even in summer, be kept perfectly for 60 days, and in good condition for 90 days. *If sweet spirit of nitre is prepared and kept in accordance with the directions in Official Inspections 3 it will be of perfect strength when dispensed.*

STANDARD FOR OYSTERS.

IMPORTANT TO DEALERS, SHIPPERS AND TRANSPORTATION COMPANIES.

The Maine Food and Drug Law forbids the addition of any substance to a food which shall "reduce or lower or injuriously affect its quality or strength." By actual examination it has been found that in the case of solid pack oysters the percentage of free liquid that will drain off will not exceed 15 per cent while in the case of opened oysters shipped with ice in the container the liquid ran as high as 65 per cent and in 24 samples the liquid averaged 56 per cent. But this is not the whole of the story. The iced (watered) oysters had taken in the fresh water and increased in volume so that the meat of the solid pack had 13.4 per cent of dry solids and the meat of the watered stock only 8.6 per cent. Not only is there a less percentage of meats in the watered stock but the meats themselves are only two-thirds as good in the watered stock as in the solid pack.

The U. S. Board of Food and Drug Inspection have the matter of shipment of opened oysters under advisement. Until further notice the following is the standard for opened oysters in Maine.

Opened oysters sold in bulk shall not contain ice or added water; nor more than 17 per cent by weight of free liquid; nor less than 10 per cent by weight of total dry solids.

This standard does not apply to oysters sold in the shell nor to oysters opened at time of sale.

The attention of public carriers is called to the fact that it is unlawful to transport within the State oysters that do not meet the requirements of the standard.

[365-11-09.]

MAINE
AGRICULTURAL EXPERIMENT STATION,
ORONO, MAINE.

Official Inspections.

16

Both the spirit and the letter of the Maine Inspection laws demand freedom from adulteration and truthful labeling.

Lest You Forget.

After three years investigation of the retail food trade in Maine it seemed necessary, in order to protect the consumer, that the label provisions of the law be enforced so that they shall be observed by the retailer who handles bulk goods as well as by the manufacturer. In consequence a ruling was issued and the trade notified that beginning with April 1, 1909, the labeling requirements of the food and drug law would be enforced on goods put up by the retailer and delivered by him to his customers. This applies to every article of food and drug ordinarily sold. It is not enough that the box in which the retailer keeps an article in stock be properly branded, but the package he gives to his customer must be similarly branded. It is to be noted, however, that goods that are exactly what their names imply and that are exactly what they seem to be, do not need to be labeled. *All goods that are not strictly true to name require labeling.*

Commercial Thickeners for Ice Cream.

Ice cream manufacturers usually use more or less of starch, gelatine, gum tragacanth, egg or other similar material in the manufacture of ice cream even when they use a heavy cream that would make a perfect product for immediate use. It is claimed that if ice cream has to be kept several hours that the presence of these materials assist in its retaining its shape and increases the smoothness of the product. Their use in moderate quantites is permitted in Maine without statement of fact.* There are upon the market preparations specially made as thickeners for ice cream. These are sold at rather high prices and it was deemed important to know something of their content. A few of the more common ones that came to our attention were examined as reported below. They are arranged alphabetically by the names under which they are sold.

The results of the analyses show that these materials contain no injurious materials. They consist for the most part of starchy materials or gelatin with very liberal amounts of sugar. They are evidently prepared chiefly because of the high price at which comparatively inexpensive materials can be sold. The intelligent maker of ice cream will buy starch, gelatine or whatever he prefers to use in his cream direct at what the goods are really worth in the market. There will always however be some people who will be induced to purchase these prepared materials because of the special claims made for them without much consideration of what they are or at what price they are sold.

Creamoline (No. 7694). This was received by Geo. W. Austin and Company of Bar Harbor from H. A. Johnson and Company of Boston in a box labeled corn starch and nothing upon it to indicate that it was Creamoline. The Maine firm claim that they purchased Creamoline. On examination by chemical tests no starch was found. Under the microscope a few corn starch grains were found. These probably came from the starch originally packed in the box. No preservatives were found. It carried .32 per cent nitrogen and contained a material resembling slipery elm, which may have been gum tragacanth. The goods were sold at 35 cents a pound.

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* See Official Inspections 8, pages 12 and 13.

Flake (No. 7686). From Burke's drug store, Main St., Gardiner. It was labeled: Flake. Flake is a pure, wholesome vegetable powder, which can always be relied upon and is essential in making an exquisitely smooth ice cream. Prepared by The Murray Co., 210 State St., Boston, Mass. Guaranteed under the Food & Drugs Act, June 30, 1906, Serial No. 1876. The price was $8.25 per hundred pounds.

The sample of Flake carried .26 per cent nitrogen. Starch was present. No preservatives were found.

Kymo (No. 7712). From S. J. Foster, Main St., Oakland. The package bore the following statement: We hereby guarantee this package of Kymo under the Food and Drugs Act of June 30, 1906. Serial No. 3946. Size C Kymo. Manufactured by Kymo Co., Little Falls, N. Y. The price was about one dollar a pound. It carried 6.56 per cent of nitrogen and contained starch. It probably consists of a cereal product and gelatine.

Jell-o Ice Cream Powder—Chocolate (No. 7696). From F. J. Nash, Bar Harbor. Made by The Genesee Pure Food Co., Le Roy, N. Y. Ten cents per small package. It carried .36 per cent nitrogen, and was free from preservatives. It was apparently a gelatine product free from starch and carrying flavoring material and sugar.

Jell-o Ice Cream Powder—Vanilla (No. 7695). This was also from F. J. Nash, Bar Harbor. It was old goods and the barrel in which it was kept was not labeled. It carried .05 per cent of nitrogen and was free from preservatives. It contained no starch and was practically granulated sugar with a little gelatine and flavoring material. Its cost was not learned.

Selaw (No. 7687). From Vose and Luques, Waterville. Made by Joseph Middleby, Jr., Inc., Boston, Mass. The goods carried .52 per cent of nitrogen and were free from preservatives. Starch was present. The price was 30 cents a pound.

Tri-Krema (No. 7685). From E. P. Farrar, Richmond. Prepared by Curtis & Moore Co., Boston, Mass. U. S. Serial No. 2833. The label stated that it was for perfecting ice cream, sherbets, and frosting of all kinds. It carried .34 per cent of nitrogen and was free from preservatives. Starch was present. The price was 45 cents per pound.

An Unlawful Maple Sugar Made Exclusively From Maple Sap.

The sugar of the maple, the beet, and the sugar cane are chemically identical. The maple sugar of commerce owes its value to certain flavoring constituents which are in a sense impurities. If maple sugar is refined so that these flavoring materials are removed the product will not conform to the definition and standards fixed for Maine and would therefore be classed as an adulterated product. In the spring of 1909 the inspector purchased maple sugar at Grant's confectionery store in Lewiston, which on analysis was found to be deficient in the matters characteristic of maple sugar. The results of the examination were published as No. 8173 on page 66 of Official Inspections 11, and the goods were reported as adulterated and a hearing appointed. At the hearing it developed that Mr. Grant purchased from a handler of maple sirup, the sugar that had crystalized out and remained in the bottom of the cans. Mr. Grant's candy maker melted this sugar with the addition of water and it was sold as maple sugar. Because the sugar had lost its maple characteristics through crystalization the sugar was the same as would be produced by mixing granulated sugar with a little pure maple sugar. The sugar was unlawful but the case was not prosecuted as all concerned in the matter had evidently acted in good faith.

Jams, Jellies and Preserves.

In the summer of 1909 the deputy purchased at different places in Maine fruit jams, jellies and preserves which were put up by companies outside of the State. Most of the goods proved to be correctly labeled. Where they were not, hearings were appointed and in every instance the company was able to make satisfactory explanations; usually that the goods were old goods and that they had corrected the troubles which we found in the goods on sale in Maine. The cases were settled by affidavits. The local dealers were notified relative to the goods and either they were withdrawn from sale or the labels changed so as to accord with fact.

Table showing results of examination of jams, jellies and preserves purchased in the summer of 1909. Samples arranged alphabetically by states and towns within the state where the goods were made.

Station No.	Brand, Maker and Dealer.	Results of Examination.*
8383	Strawberry Jam, Medallion. Made by Bishop & Co. Los Angeles, Calif. Dealer, O. C. Elwell, Portland.	No preservative, artificial color foreign matter or glucose found.
8393	Guava Jelly. Made by Lillian M. Blake, Miami, Fla. Dealer, Geo. C. Shaw Co., Portland.	No preservative, artificial color, glucose, or foreign matter found.
8385	Pure Guava Jelly. Baker Extract Co., Springfield, Mass., New England Selling Agents. Made by Jas. Carnell, Ormond, Fla. Dealer, Geo. C. Shaw Co., Portland.	No preservative, artificial color, foreign matter, or glucose found.
8326	Pure Fruit Jelly, Quince Flavor. Made by Emery Food Co., Chicago, Ill. Dealer, Elmer L. Craig, Waterville.	No preservative, artificial color, foreign matter, or glucose found.
8337	Libby's Preserved Raspberries. Made by Libby, McNeill & Libby, Chicago, Ill. Dealer, Spear & Webster, Lewiston.	No preservative, foreign matter, or artificial color found.
8345	Libby's Preserved Strawberries. Made by Libby, McNeill & Libby, Chicago, Ill. Dealer, Atwood's Market, Lewiston.	No artificial color or foreign matter found.
8332	Rex Imitation Fruit Jelly. Made by the Corn Products Mfg. Co., Davenport, Iowa. Dealer, Belleveau Bros., Waterville.	No preservative or foreign matter found. Glucose 71.7 per cent. Colored with amaranth
8350	Crescent Imitation Fruit Jelly. Made by Corn Products Mfg. Co., Davenport, Iowa. Dealer, Napoleon Buldoc, Lewiston.	Glucose 74.5 per cent.
8374	Pure Crab Apple Jelly. 1-10 Sodium Benzoate. Made by F. P. Adams & Co., Boston, Mass. Dealer, S. F. Wood, Portland.	No artificial color, foreign matter, or glucose found. Preserved with .08 per cent Sodium Benzoate. Sucrose 44.3 per cent.
8392	Red Currant Jelly. E. T. Comdrey, Boston, Mass. Dealer, Geo. C. Shaw Co., Portland.	No preservative, artificial color, foreign matter, or glucose found.
8339	Red Raspberry. Red Lily. Made by Martin L. Hall & Co., Boston, Mass. Dealer, E. J. Roche, Lewiston.	No preservative, artificial color, foreign matter, or glucose found.
8343	Apple Jelly, Crabapple Flavor Compound. 1-25 of 1 per cent Benzoate of Soda. Made by A. A. Knights & Son, Boston, Mass. Dealer, Josiah Bowker, Lewiston.	No artificial color or foreign matter found. Preserved with .04 per cent Sodium Benzoate. Glucose 30.2 per cent.
8331	Ideal Raspberry and Apple Compound. Artificially Colored. Made by Logan, Johnson & Co., Boston, Mass. Dealer, O. J. Pelletier, Waterville.	No foreign matter found. Preserved with .09 per cent Sodium Benzoate. Glucose 59.5 per cent. Colored with amaranth. Misbranded.

*Made prior to January 1, 1906.

Table showing results of examination of jams, jellies and preserves purchased in the summer of 1909. Samples arranged alphabetically by states and towns within the state where the goods were made—Continued.

Station No.	Brand, Maker and Dealer.	Results of Examination.*
8367	Strawberry and Apple. Sodium Benzoate 1-30 of 1 per cent. Artificially colored. No. 1509. Guaranteed under the Food and Drugs Act, etc. Made by Logan, Johnson & Co., Boston, Mass. Dealer, J. M. Edwards & Son, Portland.	Preserved with .05 per cent Sodium Benzoate. Glucose 58.5 per cent. Colored with Ponceau 3R or a mixture, probably of allowed colors. No other fruits found.
8330	Imitation Current Jelly. Apple Juice .500, glucose .499, Tartaric Acid .001, Artificially colored. Made by Jos. Middleby, Jr., Inc., Boston, Mass. Dealer, O. J. Pelletier, Waterville.	No foreign matter found. Preserved with Sodium Benzoate. Glucose 64.9 per cent. Colored with coal tar color. Probably Ponceau 3R or a mixture of allowed colors.
8334	Middleby Quality Imperial Brand Apple Jelly. Absolutely Pure. Made by Jos. Middleby, Jr., Inc., Boston, Mass. Dealer, W. P. Stewart Co., Waterville.	No preservative, artificial color, foreign matter, or glucose found.
8335	Shawmut Brand Apple and Strawberry Compound. 1-10 of 1 per cent benzoate of soda. Artificially colored. Made by Jos. Middleby, Jr., Inc., Boston, Mass. Dealer, W. P. Stewart Co., Waterville.	Preserved with .06 per cent Sodium Benzoate. Glucose 72.5 per cent. Colored with coal tar dye, probably Ponceau 3R.
8391	Strawberry Preserves. Morse Brand. Strawberry and Apple Compound Preserves. 1-10 of 1 per cent benzoate of soda, Strawberry 10 per cent, Apple 16 per cent, Glucose 65 per cent, Gran. Sugar 9 per cent. Made by J. P. & P. Plummer Boston, Mass. Dealer, L. P. Senter, Woodfords.	No other fruits found. Preserved with .13 per cent Sodium Benzoate. Glucose 63.77 per cent. Artificially colored, probably with a mixture of allowed aniline colors.
8340	Special Brand Glucose Apple Preserves. Raspberry Artificially colored. Benzoate of soda .1 per cent. Made by Mansfield, Witham & Co., Lowell, Mass. Dealer, Spear & Webster, Lewiston.	No other fruits found. Preserved with .12 per cent Sodium Benzoate. Glucose 67.4 per cent. Colored with amaranth or possibly a mixture of this color with a small amount of another allowed color.
8358	Dainty Apple Jelly. 1-10 of 1 per cent Jelly Acid. 1-10 of 1 per cent Benzoate of Soda. Made by Mansfield, Witham & Co., Lowell, Mass. Dealer, Philip J. Ward, Portland.	No artificial color or glucose found. Preserved with .09 per cent Sodium Benzoate.
8349	Compound Glucose Apple Jelly. Contains ⅕ of 1 per cent tartaric acid. Made of Apple Juice (60 per cent) and Glucose (40 per cent). Guaranteed under the Food and Drugs Act, etc. Number 778. Made by Williams Bros. Co., Detroit, Mich. Dealer, Begin Bros., Lewiston.	No preservative or artificial color found. Glucose 66.6 per cent.
8351	Wilco Apple and Currant Jelly. Contains ⅕ of 1 per cent tartaric acid. Made of Apple and Current Juice and Sugar. Made by Williams Bros. Co., Detroit, Mich. Dealer, J. T. Dougherty, Portland.	No preservative, artificial color, foreign matter, agar agar, or glucose found.
8364	Beech-nut Quince Jelly. This jelly is made of quinces, lemons, and sugar only. Guaranteed under the Food and Drugs Act, etc. Number 3409 Made by Beech Nut Packing Co., Canajoharie, N. Y. Dealer, Foster's Market, Portland.	No preservative, artificial color, foreign matter, or glucose found.

Table showing results of examination of jams, jellies and preserves purchased in the summer of 1909. Samples arranged alphabetically by states and towns within the state where the goods were made—Continued.

Station No.	Brand, Maker and Dealer.	Results of Examination.*
8394†	Oneida Red Raspberries. Made by Oneida Community, Kenwood, N. Y. Dealer, Geo. C. Shaw Co., Portland.	No preservative or glucose found. Colored with coal tar dye, probably Ponceau 3R. Misbranded (†see note).
8359	Extra Quality Strawberries. Made by Curtice Bros. Co., Rochester, N. Y. Dealer, W. A. Johnson, Portland.	No preservative, glucose, or foreign matter found.
8327	Fresh Fruit Jam. Red Currant with 10 per cent apple, 1-10 of 1 per cent Benzoate of Soda. Made by Curtice Bros. Co., Rochester, N. Y. Dealer, Elmer L. Craig, Waterville.	No other fruit or artificial color found. Glucose less than 10 per cent. Preserved with .14 per cent Sodium Benzoate.
8341	Grape and Apple Jelly. Guaranteed under the Food and Drugs Act, etc. Number 3159. Made by Lutz & Schramm Co., Alleghany, Pa. Dealer, Palmer Market, Lewiston.	No preservative, foreign matter, artificial color, or glucose found.
8377	Pure Crab Apple Jelly. Made by American Preserve Co., Philadelphia, Pa. Dealer, F. H. Verrill, Portland.	No preservative, artificial color, glucose, or agar agar found.
8380	XX Brand Preserves, Red Raspberries. Carefully selected fresh fruit and granulated sugar. No preservative and no artificial coloring has been used in the manufacture of these goods. Guaranteed under the Food and Drugs Act, etc. Number 1017. Made by P. J. Ritter Conserve Co., Philadelphia, Pa. Dealer, W. L. Wilson & Co., Portland.	No preservative, foreign matter, glucose, or artificial color found.
8381	Strawberry Jam. Strawberries 45 per cent, apple juice 5 per cent, sugar 25 per cent, corn syrup 25 per cent. Contains no preservative and no artificial coloring matter. Guaranteed under the Food and Drugs Act, etc. Number 1017. Made by P. J. Ritter Conserve Co., Philadelphia, Pa. Dealer, W. L. Wilson & Co., Portland.	No preservative, artificial color, or foreign matter found. Glucose 39.59 per cent. Sucrose 6.9 per cent.
8344	Red Raspberries. Guaranteed under the Food and Drugs Act, etc. Number 557. H. J. Heinz Co., Pittsburg, Pa. Dealer, Atwood's Market, Lewiston.	No other fruit, preservative or artificial color found.
8395	Heinz Grape Jelly. Guaranteed under the Food and Drugs Act, etc. Number 557. Guaranteed absolutely pure. Contains no added artificial preservative, coloring matter or any substance injurious to health. Made by H. J. Heinz Co., Pittsburg, Pa. Dealer, W. L. Wilson & Co., Portland.	No preservative, artificial color, or glucose found.
8356	Red Raspberry Preserves. Guaranteed under the Food and Drugs Act, etc. Number 3159. Made by Lutz & Schramm Co., Pittsburg, Pa. Dealer, C. W. Horton, Portland.	No foreign matter or artificial color found.

†Foreign matter is reported upon the microscopic examination.

Table showing results of examination of jams, jellies and preserves purchased in the summer of 1909. Samples arranged alphabetically by states and towns within the state where the goods were made—Concluded.

Station No.	Brand, Maker and Dealer.	Results of Examination.*
8348	American Glucose Preserves. 7 Compounded from fruit 247, apple juice 200, gran. sugar 250, phos. acid .002, glucose 300, sodium benzoate .001. Artificially colored with aniline color. Made by American Pickling Co., Providence, R. I. Dealer, E. Janelle & Co., Lewiston.	No foreign matter found. Glucose 62.4 per cent. Preserved with .04 per cent sodium benzoate. Colored with amaranth.
8347	Pure Strawberry Preserves. Made by American Pickling Co., Providence, R. I. Dealer, J. E. Pelletier, Lewiston.	No foreign matter, or artificial color found.
8333	Raspberry Flavor American Brand Compound Apple Jelly. Sugar 15 per cent, raspberry juice $\frac{1}{3}$ of 1 per cent, apple juice 49 per cent, acid $\frac{1}{2}$ of 1 per cent, corn syrup 35 per cent, benzoate of soda 1-25 of 1 per cent. Artificially colored. Made by American Pickling Co., Providence, R. I. Dealer, Arthur Daviau, Waterville.	No foreign matter, artificial color, or agar agar found. Preserved with .02 per cent sodium benzoate. Glucose 40 per cent.
8378	Cherry Flavor Fort Henry Brand Jam. Harmless color, 1-10 of 1 per cent benzoate of soda. Fruit, apple juice, glucose, sugar. Made by McMechen Preserving Co., Wheeling, W. Va. Dealer, E. D. Dill, Portland.	No foreign matter found. Preserved with .14 per cent sodium benzoate. Contain Glucose, artificially colored.
8346	Fresh Fruit Jam, Gooseberry. Crosse & Blackwell, London, Eng. Dealer, Josiah Bowker, Lewiston.	No foreign matter or artificial color.

Cold Storage and Preserved Eggs.

The National Government has successfully maintained cases against eggs and people who have offered eggs for sale that were in an unfit condition for food, as well as stored eggs that have been sold for fresh eggs. The attention of dealers is called to the fact that only freshly lain eggs can be lawfully sold as eggs in Maine without being labeled to show exactly what they are. Cold storage eggs or eggs that have been preserved in any way when offered for sale must be labeled in accord with fact and every package delivered to the consumer containing stored eggs must be labeled to show exactly what they are. Eggs that have begun to decompose cannot be lawfully sold in Maine under any conditions whatever.

The Use of Chemicals in Food.

Section 5 of the Maine Food and Drug Law provides that "the director of the Maine Agricultural Experiment Station shall make uniform rules and regulations for carrying out the provisions of this act" and "also adopt or fix standards of purity, quality or strength when such standards are not specified or fixed by law." It further provides that "such rules, regulations and standards shall, where possible, conform to and be the same as the rules and regulations" adopted for the enforcement of the National Food and Drugs Act.

In accordance with these provisions of the law and the action of the United States Board of Food and Drug Inspection, the use of benzoate of soda in vegetable products, alum in limited amount in pickles and saccharine in carbonated beverages is at the present time allowed in Maine provided the presence and amount are clearly and plainly stated on every package of foods containing these chemicals. No other chemicals can under any conditions be lawfully used in foods offered for sale in Maine. *This concession should not be taken as evidence that the Food and Drug Official of this State endorses or wishes to encourage the use of chemicals in foods.*

There has, as nearly everyone is aware, been a very large amount of discussion recently regarding the advisability of permitting the use of benzoate of soda in food, a discussion largely brought on by the report of the so-called "Referee Board" of some of the foremost chemists in this country who were appointed by the Secretary of Agriculture to carry on investigations in regard to the effect of benzoate of soda upon human beings. Previous experiments under the direction of the Department of Agriculture had generally shown harmful results from the use of preservatives of all kinds. The experiments of the Referee Board would seem to point in the opposite direction. It should be noted, however, in this connection, that their experiments were continued for short periods of time only and that the subjects were mature, healthy individuals. What the results might have been had the experiments been continued for a period of several years, as is the case when one continually uses foods preserved with bezoate of soda, or had the subjects been invalids or infants, they do not pretend to say.

In view, therefore, of the necessarily incomplete nature of these experiments of the Referee Board; of the fact that the only arguments brought forward by the only champions of the use of preservatives in foods—the manufacturers who use benzoate of soda in their products and the manufacturers of benzoate of soda itself—are (1) not that it is *beneficial* but that it is *not harmful* and (2) that its use is necessary for the preservation of certain classes of food which could not be made to keep without it (a statement which is, however, contradicted in word and practice by many manufacturers who prepare the same foods without the use of artificial preservatives and say that cleanly and wholesome ingredients and sanitary manufacture are the only requisites for making their preparation without preservatives possible); and in view of the fact that the physicians of the country, almost without exception, express themselves unqualifiedly against the use of drugs of any sort in foods; it would seem that the desirability of the use of benzoate of soda as a preservative is at least doubtful.

But there is another question to be asked relative to the use of benzoate of soda in food which is fully as important as the question whether the drug itself is harmful; does the use of preservatives in food permit the use of inferior, waste or damaged materials in the preparation of foods in which they are used? And the answer to this question seems to be in the affirmative. Manufacturers, however, who desire to use benzoate of soda in their products claim that the preservative cannot possibly conceal inferiority because it is beyond its power to do more than keep the goods in their original condition; that is, it cannot improve what is once spoiled. This is true as far as it goes; but they do not add the perfectly obvious fact that the use of an artificial preservative will keep goods that are just on the point of spoiling from going beyond that condition to the point when they will be absolutely unfit for use, and the use of a preservative may make a food product salable when normally it would spoil before it could be gotten to market. That goods in such a condition are inferior there is no question.

A specific instance that has recently come under our direct notice is an illustration of the real purpose of the manufacturer in adding preservatives to food products. Last spring one of the inspectors from this Station purchased from a Maine dealer a bottle of catchup which, according to the label, contained 1-10 of 1 per cent of benzoate of soda. On analysis these goods were found to contain 2-10 of 1 per cent of benzoate of soda, or twice as much as was declared on the label. The Maine dealer established a written guaranty from the manufacturers and the matter was accordingly taken up with them. Their explanation of the presence of the excess of preservatives was, in brief, as follows:—the lot which we sampled was part of the catchup which they made in the fall and winter of 1907; 1907 was a poor tomato year and many of the tomatoes which they received were in "very poor condition;" consequently the tomato pulp, which is stored in barrels and preserved with benzoate soda until they are ready to make the catchup, was more likely to spoil than on years when the stock was better, and naturally more preservative had to be added to keep this half-decayed pulp than would be needed for healthy pulp. Accordingly, when they came to prepare the catchup and diluted the pulp with the ordinary amount of other ingredients, there was more than the usual 1-10 of 1 per cent of bezoate of soda in the finished product. Does this look as if the addition of artificial preservatives to food was done solely out of consideration to the public, in order that the goods might not spoil on the hands of the consumer if he did not use them immediately after they are opened?

Now the law, while it does not prohibit the use of bezoate of soda, does require that when used its presence and amount must be stated on the label of foods to which it has been added. Although mislabeling as to amount may occur, almost all goods are correctly labeled as regards the statement of the presence of benzoate of soda and it is for the consumer to decide whether he will use goods put up in such a manner that use of an artificial preservative is necessary. The only way for the consumer to protect himself is to read the labels, not only the large red capitals on the gold background but the fine print in the inconspicuous corners as well, and govern himself accordingly.

Whiskey.

Numerous sample packages of spirituous liquors seized by State officials have been sent to the Station for examination with the thought that the chief chemist of the Station, who holds a commission to act under the Bureau of Chemistry of the United States Department of Agriculture could make the analyses and if the goods were found adulterated they could be held and confiscated under the State law. Obviously this was not practicable, as a process could not be begun under United States law and finished under State law. Only in 4 instances were the samples so obtained that proceedings were possible under the National Food and Drug Law. These samples were analyzed and found to be rather weak imitation whiskeys. The cases were ready to report for prosecution at the time the whole question of the definition of whiskey was reopened by President Taft.

Rice.

Recently the inspector purchased rice at a number of different places in the State and for the most part the goods delivered to him were either pure uncoated rice or else they were correctly labeled to show that they were coated with glucose and talc, and carried printed directions for removing the foreign matters before cooking. In one instance adulterated rice was sold without being labeled to show that it was coated and in one instance coated rice was labeled and guaranteed to be uncoated. In the first instance the dealer was prosecuted and fined under the Maine Food and Drug Law. In the other case the Maine dealer was protected by a written guaranty and the matter was reported to the United States District Attorney and the goods were libelled under the provisions of the National Food and Drug Act. It is now possible for the consumer to know pretty accurately the quality of the rice offered for sale and for the most part uncoated rice can be had if he insists.

[368-12-09]

MAINE

AGRICULTURAL EXPERIMENT STATION

ORONO, MAINE.

CHAS. D. WOODS, Director.

Official Inspections.

17

Both the spirit and the letter of the Maine Inspection laws demand freedom from adulteration and truthful labeling.

SEED INSPECTION.

The Legislature of 1897 enacted a law regulating the sale of agricultural seeds. This law was satisfactory as far as it went, and resulted in an improvement in the character of the seed sold in the State. It did not provide for an inspection and as time passed the moral effect of the law to some extent and with some dealers grew less. To remedy this, the Legislature of 1905 passed an additional section to the law, calling for an inspection somewhat similar in requirements to that of the laws regulating the sale of commercial fertilizers, foods and feeding stuffs. The chief requirements of the law follow. The full text of the law will be sent on application.

Chief Requirements Of The Law.

Kind of Seeds Coming Under the Law. The law applies to every lot of seeds, containing one pound or more, of cereals, grasses, forage plants, vegetable and garden plants, but does not apply to sweet corn, trees, shrubs and ornamental plants.

The Guaranty. Every lot of seed sold, offered or exposed for sale must be accompanied by a written or printed guaranty of the percentage of purity. Dealers may base their guaranty upon tests conducted by themselves, their agents, or by the Director of the Maine Agricultural Experiment Station; provided, that such tests shall be made under such conditions as the said director may prescribe. The rules for testing the purity of seeds are given in Bulletin 36, a copy of which will be sent on application to the Station. Maine dealers will probably find it impossible to buy outside of the State, grass seed whose purity is guaranteed, hence Maine jobbers will have to fix the guaranty either by analysis made by themselves or by someone else. *The guaranty must be in accord with fact.* Maine retail dealers will have no difficulty in buying properly guaranteed seeds from Maine jobbers.

The Brand. A seed to be lawfully sold or offered for sale in Maine must carry "a written or printed guaranty of its purity and freedom from foreign matter." It is not enough that the package carries the figures but they must be accompanied by explanatory words naming the seed and what the figures mean. For example,—a bag of timothy seed labeled "99.5 per cent" is not lawfully branded; it should be labeled in some such a way as the following:—"Timothy, 99.5 per cent pure."

Analysis Of Unguaranteed Seeds.

The Station examines as promptly as possible all samples of seeds sent by Maine dealers to assist them to decide (1) whether they should or should not purchase the seed, and (2) what guaranty of purity should be placed upon the seeds. When the seed law first went into effect the Director of the Station decided to make free analysis of seed for dealers and did so for a number of years. The law requires that all analyses made by the Station under the law be published. This led to some dealers not submitting samples for examination because the published results of the analysis of a seed which they did not purchase because of its poor quality as disclosed by the analysis, were used against them by competitors. For this and other reasons it was decided not to make further free examination of unguaranteed seeds.

The Station, however, examines at cost samples of unguaranteed seeds, submitted to it by dealers, of which they wish to know the quality. The results of these analyses are not published and are considered as a private matter between the dealer and the Station. The charge for the examination of large seeds such as timothy, clover, etc., is 50c per sample. The charge for the examination of a fine seed like redtop is $1.00 for a reasonably clean sample. The report of the examination gives in addition to the percentages of purity, the character of the foreign matters and of the foreign seeds. There are no requirements as to the way in which the samples for paid analyses are drawn and it is optional with the dealer submitting the sample whether he does or does not give information as to the source of the sample.

The Maine Jobber And The Seed Trade.

At present it is impossible for the Maine dealer, wholesale or retail, to obtain guaranteed seeds from outside of the State. The retail dealer can purchase guaranteed seed from Maine wholesale houses, and the Station advises him so to do. The wholesale dealer must look to the outside. Two years ago the Director of the Station assumed a certain responsibility as to the statement of analysis given by two or three of the leading seed houses of the country. It however does not seem wise for him to continue this practice. Therefore any guaranties which a Maine dealer places upon seeds based upon out-of-state firms statements as to their purity is entirely at the risk of the Maine dealer. After consulting with some of the larger houses within the State the following suggestions were made to importing houses by the Director of the Station.

"I suggest that when a car of seed goes forward to you that you request your shipper to send you a type sample of the car stating the name of the shipper, the kind of seed and its special brand if any, the analysis which they place upon it if any, the lot number, and car number. When this sample is received by you send it to me. I will then have it examined This analysis will be made at your expense (usually 50 cents to $1.00) and the results will be reported to you. I will retain the sample here to check up with the samples to be sent to us from the car.

As soon as the car is received by you or by your customer, have a sample taken from not less than six packages and sent to us, also accompanied by the name of the shipper, the kind of seed and its special brand, the lot number and car number. This sample we will give prompt, free analysis and report the results to you. If there is a discrepancy between the analysis of the type sample submitted and the samples taken directly from the car, the guaranty, of course, would have to be changed before the goods could be sold, but it would give you a basis upon which to make a claim against the shipper as to quality.

My reason for writing the above is that it is my desire not only to enforce the provisions of the Maine seed law, but to protect, as far as possible, Maine wholesale handlers of seed against the irresponsibility which cleaners of seed profess."

Free Analysis of Seeds.

Samples of agricultural seeds on sale in Maine, taken in accordance with directions below, will be examined as promptly as possible and the results reported free of charge.

Directions for Sampling Seeds. The contents of packets should be emptied out, mixed thoroughly by stirring, and small quantities taken from different parts of the mixture to make the sample.

If seeds are in bulk or in large packages, take handfuls at random from the top, middle and bottom, and from these, after mixing, take the sample for testing.

Samples of seeds for free analysis must be taken in the presence of a disinterested and reputable witness, who shall certify that the sample was taken in his presence according to these directions. The sample must be enclosed in an envelope or other suitable package, securely fastened and sealed in the presence of the witness. The names of the sender and witness must be written on the outside of package, which shall be sent to the station prepaid. Samples shall weigh approximately as follows:

Grasses, clovers and all seeds of similar size, 2 ounces.

Cereals, vetches, beet "balls" and all larger seeds, 4 ounces.

Rye grasses, bromes, sorghums, and millets, 2 ounces.

All the smaller vegetable seeds, 1 ounce.

All the larger vegetable seeds except beet "balls," 2 ounces.

Sending Samples. Every sample of seeds sent to the Station for free analyses should be in a securely fastened package and must be accompanied by a statement certifying to the fairness of the sample, the name and address of the dealer, the name under which the seed is sold or offered for sale, the lot number and exact copy of any other marks on the package and the guaranteed percentage of purity. Blanks for the purpose of forwarding samples of seeds will be furnished on application to the Station.

The Written Guaranty The Retailers Safeguard.

Although the written guaranty clause of the Maine food and drug law applies only to the sale of food and drugs, discretion is given to the Director regarding prosecutions under other laws. No prosecutions will be made against any handler of agricultural seeds within the State *provided* he obtain at the time of purchase, a guaranty *personally signed in ink* that the goods are in conformity with the Maine law regulating the sale of agricultural seeds. The guaranty to be of value should identify and may be attached to the bill of sale, invoice, bill of lading, or other schedule, giving the names, marks upon the packages and quantities of the seeds sold.

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 frequently carries plantain seed. If this plantain 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—lanced leaved plantain 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 SEED DEALER AND SEED QUALITY.

Acting more or less in unison the seed handlers of the country have taken a position in the matter of their relation to the quality of the seeds which they handle that is not tolerated in the handling of any other commodity which touches agriculture or the general public. While they give reasons of more or less weight by which they attempt to justify their non-warranty position, the fact remains that their attitude is apparently more arrogant and intolerable than taken by any other legitimate business. Practically all seed houses print something like the following: "The ——— Company give no warranty, expressed or implied, as to description, quality, productiveness or any other matter of any seeds, bulbs or plants they send out. If the purchaser does not accept the goods on these terms they are at once to be returned." Singularly enough some Maine houses print a non-warranty clause like this even though they are handling seeds which they must under the State law guarantee. There is no reason, however, to suppose this means a defiance of law on their part. At least one Maine house that publishes this disclaimer gives a written guaranty of purity. It is to be hoped that the time will speedily come when a National law will be passed that will make this statement of non-warranty on the part of interstate seed handlers of no more force than the statement which is made by some Maine handlers in their catalogues.

Several states following the lead of Maine have enacted seed laws—many of them far more stringent and comprehensive than that of this State. The position of the seed distributor in issuing a disclaimer of responsibility for quality is irrational and will, sooner or later, be made non-effective by legislation.

Results of Inspection.

In the year 1909, the seed analyst of the Station acted as the inspector and during the months of April and May in which the seeds were chiefly on sale visited all parts of the State and examined many hundreds of lots of seed which were on sale. He has through his experience in analyzing seeds become so much of an expert that even with a small lens it is possible for him to estimate very closely as to whether the seed is or is not up to guaranty. Out of the many hundreds of lots of seeds which he found at the various stores in the State he found it necessary to take samples from only about 30 of which he had some doubts as to their corresponding to their guaranty. About half of these deviated more than could be passed over from their professed standard.

There were only five instances in which the violations seemed to call for action on the part of the executive officer of the law. In these cases hearings were appointed and affidavits taken in the cases which were accepted as satisfactory explanations of the wrong guaranty of the seeds.

Only one lot of seeds was exceedingly bad. That was an alsike clover found at the store of Mr. A. M. Brown, Augusta, which was offered under a guaranty of 95 per cent and carried only 69.3 per cent of alsike clover. It was claimed by Mr. Brown that this seed was purchased from a house within the State under a written guaranty. The house in question say that this particular seed they never had. The inspector failed to make a memorandum of the marks upon the package so that it was not possible to tell whether this lot of seed was or was not from the jobbing house in question. Because of this uncertainty neither the retailer nor the jobbing house were prosecuted. They both claimed through their affidavits to have acted in good faith.

A firm at Corinna purchased in 1908 grass seeds from a Boston firm which came to them marked "99 per cent pure." They did not obtain a written guaranty. These goods were not sampled by the Station in 1908 but were found in 1909 to be about 95 per cent pure instead of 99 per cent. The retailer made affidavit to statements that showed that he acted in good faith in this matter and the case was not prosecuted.

In the case of several lots of alsike clover the wrong guaranty was placed upon the seeds owing to a clerical error in the percentage of purity which was placed upon the invoice of the Chicago firm who shipped the goods into the State.

The State has great reason to congratulate itself upon the wonderful improvement that there has been not only in the agreement of samples with the guaranty over the past but what is still more important, upon the marked improvement in the quality of seeds which are on sale. While there are still dealers, particularly in the small country towns, that demand of the jobber low priced and consequently low grade seed, by far the major portion of the dealers, retail as well as wholesale, are realizing the importance of handling high grade seeds. The dealers are the more to be commended in that this has not come about largely through the demand of the farmers themselves, for there are still far too many farmers who are looking to saving a cent or two a pound in the seed which they purchase. The dealers desire as a class not only to keep well within the law but prefer to sell high grade goods when they can persuade their customers to pay the price. In this connection it is interesting and instructive to note that while over 250 samples of seeds were sent to the Station in 1909 by dealers not a single sample was received from a practical farmer. Is the farmer requesting that the dealer show him the results of the Station analysis before he will purchase or is he indifferent to the kind of seed he buys?

Description of the Tables.

The table on pages 174 and 175 contain a list of the 79 kinds of weed seeds obtained from seeds which were examined in the year 1909. They are arranged alphabetically in accordance with the English name. As the common name differs in different parts of the country, the scientific name following the classification given in the last edition of Gray's Manual of Botany is given for the purpose of identification.

The table on pages 176 to 177 summarizes the results of the examinations of samples of seeds examined by the Station in 1909.

The table on pages 179 and 180 contain the analyses of samples of seeds collected by the inspector in 1909. The inspector only drew samples from lots of which he was doubtful as to their corresponding to their guaranty.

A list of weed seeds found in seeds examined in 1909.

Nomenclature, Gray's Manual, 17th Edition, 1908.

Common name.	Scientific name.
American wild mint.	Mentha canadensis (L.) Brig.
Barnyard grass.	Echinochloa crusgalli (L.) Beauv.
Black medick.	Medicago lupulina, L.
Bladder ketmia.	Hibiscus trionum, L.
Blue vervain.	Verbena hastata, L.
Bracted p'antain.	Plantago aristata, Michx.
Bull thistle.	Cirsium lanceolatum, (L.) Hill.
Canada thistle.	Cirsium arvense (L.) Scop.
Canadian blue grass.	Poa compressa, L.
Catnip.	Nepeta cataria, L.
Charlock.	Brassica arvensis (L.) Ktze.
Chicory.	Cichorium intybus, L.
Clover dodder.	Cuscuta epithymum, Murr.
Common chickweed.	Stellaria media (L.) Cyrill.
Corn mayweed.	Matricaria inodora, L.
Corn spurry.	Spergula arvensis, L.
Crabgrass.	Digitaria sanguinalis (L.) Scop.
Crane's bill.	Geranium maculatum, L.
Dandelion.	Taraxacum officinale, Weber.
Dock.	Rumex, sp.
Ergot.	*Claviceps purpurea (Fr.) Tul.
Evening primrose.	Oenothera biennis, L.
False flax.	Camelina microcarpa, Andrz.
Field dodder.	Cuscuta arvensis, Beyrich.
Field peppergrass.	Lepidium campestre (L.) R. Br.
Field poppy.	Papaver rhoeas, L.
Field scorpion grass.	Myosotis arvensis (L.) Hill.
Fireweed.	Epilobium angustifolium, L.
Five finger.	Potentilla monspeliensis, L.

A list of weed seeds found in seeds examined in 1909—Concluded.

Common name	Scientific name.
Fowl meadow grass.	Glyceria nervata (Willd) Trifal.
German millett.	Setari italica–var.
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.
Mayweed.	Anthemis cotula, L.
Meadow fescue.	Festuca elatior, L.
Mint.	Mentha, sp.
Moth mullen.	Verbascum blattaria, L.
Mouse-ear chickweed.	Cerastium vulgatum, L.
Mustard.	Brassica nigra (L.)Koch.
Night flowering catchfly.	Silene noctiflora, L.
Nightshade.	Solanum nigrum, L.
Ox-eye daisy.	Chrysanthemum leucanthemum, L.
Pennsylvania persicaria.	Polygonum pennsylvanicum, L.
Peppergrass.	Lepidium virginicum, L.
Pimpernel.	Anagallis arvensis, L.
Pigweed.	Amaranthus retroflexus, L.
Plantain.	Plantago major, L.
Purslane.	Portulaca oleracea, L.
Ragweed.	Ambrosia artemisiifolia, L.
Rats-tail fescue grass.	Festuca myuros, L.
Ribgrass.	Plantago lanceolata, L.
Rugel's plantain.	Plantago rugelii, Done.
Sedge.	Carex, unidentified.
Sheep sorrel.	Rumex acetosella, L.
Shepherd's purse.	Capsella bursa-pastoris (L.) Medic.
Slender crabgrass.	Digitaria filiformis (L.) Koeler.
Slender melilot.	Melilotus officinalis, (L.) Lam.
Slender paspalum.	Paspalum setaceum, Michx.
Smart weed.	Polygonum hydropiper, L.
Spiny sida.	Sida spinosa, L.
Spurge.	Euphorbia preslii, Guss.
Suckling clover.	Trifolium dubium, Sibth.
Tumbleweed.	Amaranthus graecizans, L.
Unknown Sp.	Unidentified.
Vrginia three seeded mercury.	Acalypha virginica, L.
White vervian.	Vervena urticaefolia, L.
Wild buckwheat.	Polygonum convolvulus, L.
Wild carrot.	Daucus carota, L.
Witch grass.	Panicum capillare, L.
Wormseed mustard.	Erysimum cheiranthoides, L.
Yarrow.	Achillea millefolium, L.
Yellow daisy.	Rudbeckia hirta, L.
Yellow foxtail.	Setaria glauca (L.) Beauv.
Yellow rocket.	Barbarea vulgaris, R. Br.
Yellow wood sorrel.	Oxalis corniculata, L.

*Sclerotia of the fungus.

Table showing results of examination of samples of seed in 1909.

Names of Weeds.	Kinds of Seed and number of samples.									
	Red clover.	Alsike clover.	Mammoth clover.	White clover.	Timothy.	Redtop.	Alfalfa.	Kentucky blue grass.	Hungarian.	Millett.
Number of samples examined.......	55	49	12	3	57	19	1	2	7	5
American wild mint..............	—	2	—	—	4	3	—	—	—	—
Barnyard grass..................	2	—	—	—	—	—	—	—	3	—
Black medick....................	1	40	—	2	—	—	—	—	—	—
Bladder ketmia..................	—	—	—	—	—	—	—	—	1	—
Blue vervain....................	4	—	2	—	6	3	—	—	2	—
Bracted plantain................	5	—	—	—	—	—	—	—	—	—
Bull thistle....................	2	—	—	—	—	—	—	—	—	—
Canada thistle..................	—	4	—	—	—	—	—	—	—	—
Canadian blue grass.............	—	4	—	1	20	5	—	1	—	—
Catnip..........................	1	1	—	—	2	—	—	—	—	—
Charlock........................	3	1	—	—	—	—	—	—	2	—
Chicory.........................	2	3	—	—	—	—	—	—	—	—
Clover dodder...................	—	4	—	—	—	—	—	—	—	—
Common chickweed................	—	4	—	1	—	—	—	—	—	—
Corn mayweed....................	—	2	—	—	—	—	—	—	—	—
Corn spurry.....................	1	3	—	1	—	—	—	—	—	—
Crabgrass.......................	6	—	—	—	—	—	—	—	2	2
Crane's bill....................	3	—	—	—	—	—	—	—	—	—
Dandelion.......................	—	—	—	—	—	—	—	1	—	—
Dock Sp.........................	31	32	9	—	7	—	—	—	—	—
Ergot...........................	—	2	—	—	23	19	—	—	—	—
Evening primrose................	2	2	—	—	31	3	—	—	—	—
False flax......................	—	1	—	—	—	—	—	—	—	—
Field dodder....................	4	—	—	—	—	—	—	—	—	—
Field peppergrass...............	2	—	—	—	—	—	—	—	—	—
Field poppy.....................	—	1	—	—	—	—	—	—	—	—

Table showing results of examination of samples of seed in 1909—Continued.

Names of Weeds.	Kinds of Seed and number of samples.									
	Red clover.	Alsike clover.	Mammoth clover.	White clover.	Timothy.	Redtop.	Alfalfa.	Kentucky blue grass.	Hungarian.	Millett.
Field scorpion grass	—	1	—	—	—	—	—	—	—	—
Fireweed	—	2	—	—	—	—	—	—	—	—
Five finger	—	16	—	2	37	11	—	—	1	—
Fowl meadow grass	—	—	—	—	1	—	—	—	—	—
German millett	1	—	—	—	—	—	—	—	—	—
Goosefoot	7	20	—	—	19	—	—	—	6	3
Green foxtail	40	18	8	—	6	—	—	—	7	4
Heal-all	3	5	1	1	3	—	—	—	—	—
Hedge mustard	—	16	—	1	2	—	—	—	—	—
Knot grass	3	1	1	—	—	—	—	—	1	—
Lady's thumb	14	—	3	—	1	—	—	—	3	3
Mayweed	1	15	—	1	11	—	—	—	—	—
Meadow fescue	—	2	—	—	—	—	—	—	—	—
Mint Sp	1	1	—	1	8	6	—	—	—	—
Moth mullein	—	1	—	—	5	5	—	—	—	—
Mouse-ear chickweed	—	24	—	2	5	10	—	—	—	—
Mustard	1	—	—	—	1	—	—	—	—	—
Night-flowering catchfly	7	41	1	3	1	—	—	—	—	—
Night shade	2	—	—	—	—	—	—	—	1	—
Ox-eye daisy	—	3	—	—	—	—	—	—	—	—
Pennsylvania persicaria	—	—	—	—	—	—	—	—	1	3
Peppergrass	—	21	—	2	12	3	—	—	—	—
Pimpernel	2	2	—	—	—	—	—	—	—	—
Pigweed	6	6	—	—	—	—	—	—	1	—
Plantain	—	10	—	3	1	11	—	—	—	—
Purslane	—	1	—	—	—	—	—	—	—	—
Ragweed	1	—	—	—	—	—	—	—	1	3
Rats-tail fescue grass	—	—	—	—	—	3	—	—	—	—

Table showing results of examination of samples of seed in 1909—Concluded.

Names of Weeds.	Kinds of Seed and number of samples.									
	Red clover.	Alsike. clover.	Mammoth clover.	White clover.	Timothy.	Redtop.	Alfalfa.	Kentucky blue grass.	Hungarian.	Millett.
Ribgrass	28	14	1	2	4	1	1	1	—	—
Rugel's plantain	34	14	2	—	48	4	—	—	1	—
Sedge Sp	—	13	—	—	37	15	—	2	—	—
Sheep sorrel	20	37	5	3	12	4	—	—	—	—
Shepherd's purse	—	15	—	2	1	1	—	—	—	—
Slender crabgrass	7	5	—	—	—	—	—	—	1	1
Slender melilot	1	—	—	—	—	—	—	—	—	—
Slender paspalum	1	—	—	—	—	—	—	—	—	—
Smart weed	1	—	—	—	—	—	—	—	—	—
Spiny sida	2	—	—	—	—	—	—	—	—	—
Spurge	7	—	—	—	—	—	—	—	2	—
Suckling clover	—	4	—	1	—	—	—	—	—	—
Tumbleweed	3	1	—	—	—	—	—	—	—	—
Unknown Sp	1	1	—	—	—	—	—	—	1	—
Virginia three seeded mercury	—	—	—	—	—	—	—	—	1	—
White vervian	1	—	1	—	5	1	—	—	—	—
Wild buckwheat	—	—	—	—	1	—	—	—	—	—
Wild carrot	5	2	1	—	—	—	—	—	—	—
Witch grass	11	12	—	—	7	5	—	—	2	2
Wormseed mustard	—	5	—	—	4	—	—	—	—	—
Yarrow	—	1	—	—	2	20	—	—	—	—
Yellow daisy	—	2	—	—	18	5	—	—	—	—
Yellow foxtail	7	—	—	—	—	—	—	—	5	4
Yellow rocket	—	8	—	—	10	—	—	—	—	—
Yellow wood sorrel	—	4	—	—	3	—	—	—	—	—

Table showing the kind of seed, name and location of dealer, and the results of the analyses of official samples collected in 1909.

Station number.	Kind of seed, name and town of dealer. Special Marks.	Purity.		Impurities.		
		Guaranteed.	Found.	Inert matter.	Harmless—foreign.	Noxious—Foreign.
	ALSIKE CLOVER.	%	%	%	%	%
6317	Cyrus Abbott, Gorham.	96.0	91.4	0.7	4.7	3.2
6399	A. M. Brown, Augusta.	95.0	69.3	5.8	9.0	15.9
6342	Curtis & Roberts, Kennebunk.	96.0	88.5	1.3	9.2	0.1
6417	O. P. Gerry, Brownville.					
	Kaiser brand Alsike.	92.0	87.0	2.8	8.1	2.1
6406	J. E. Gray, Corinna.	99.0	88.6	1.8	8.9	0.7
6392	J. B. Ham Co., Lewiston.					
	Climax Superfine brand.	97.7	81.5	3.3	9.2	6.0
6415	J. Martin & Son, Van Buren.					
	Globe Alsike.	99.0	97.9	0.5	1.0	0.6
6330	Saco Grain & Milling Co., Saco.	96.0	91.6	0.7	5.8	1.9
6327	J. Q. Sawyer, Saco.	96.0	91.7	0.8	5.5	2.0
6414	F. W. Snow, Bridgewater.	99.0	97.5	0.4	2.0	0.1
6320	John S. Watson, Gorham.	96.0	91.8	0.7	5.8	1.7
6418	Weatherbee & Walton Co., Milo.					
	Kaiser brand Alsike.	92.0	86.5	2.9	8.5	2.1
	RED CLOVER.					
6316	Cyrus Abbott, Gorham.					
	Ace Red Clover.	99.0	98.7	0.7	0.4	0.2
6331	Bell & Torrey, Kennebunkport.					
	K. &. W. N. Y. Clover.	99.0	99.0	0.5	0.4	0.1
6404	J. E. Gray, Corinna.					
	N. Y. Clover.	99.0	98.3	0.6	0.0	1.1
6337	Littlefield & Webber, Kennebunk.	99.0	98.9	0.6	0.4	0.1
6416	C. L. Pettengill & Son, Island Falls.					
	Queen brand Red Clover.	95.0	95.0	1.6	1.8	1.6

Table showing the kind of seed, name and location of dealer, and the results of the analyses of official samples collected in 1909—Concluded.

Station number.	Kind of seed, name and town of dealer. Special Marks.	Purity.		Impurities.		
		Guaranteed.	Found.	Inert matter.	Harmless—Foreign.	Noxious—Foriegn.
6397	H. M. Springer, Augusta.	%	%	%	%	%
	Wib Clover.	95.0	94.2	1.1	1.5	3.2
	HUNGARIAN.					
6329	Saco Grain & Milling Co., Saco.	99.0	98.3	0.6	0.0	1.1
	MILLETT.					
6393	Gray, Hildreth Co., Gardiner.					
	Japanese Millett.	96.0	84.1	0.3	0.0	15.6
6400	Merrill Bros., Augusta.					
	Japanese Millett, J. M. 81844.	96.0	94.7	0.6	0.5	4.2
	REDTOP.					
6318	Cyrus Abbott, Gorham.					
	Fancy Red Top.	91.0	90.1	7.5	1.3	1.1
6405	J. E. Gray, Corinna.	99.0	94.2	2.4	2.9	0.5
6338	Littlefield & Webber, Kennebunk.	97.0	95.5	3.2	0.3	1.0
6351	F. E. Rankin, Wells.	91.0	88.5	9.8	0.9	0.8
6319	John S. Watson, Gorham.					
	Fancy Red Top.	89.0	88.4	8.8	0.3	2.5
	TIMOTHY.					
6332	Bell & Torrey, Kennebunkport.	98.0	97.2	1.2	1.0	0.6
6333	Henry B. Dennett, Kennebunkport.	98.0	97.3	1.1	1.1	0.5
6390	Jones & Co., Winthrop.	98.0	97.3	0.7	1.7	0.3
6386	Geo. A. Kennison, Waterville.					
	(DL) Square Deal Timothy.	98.7	98.4	0.5	0.6	0.5
6324	John Lawrence, Westbrook.	99.0	98.9	0.8	0.2	0.1
6321	Gleason-Marshall Co., Westbrook.	98.0	98.3	0.5	0.8	0.4

*Samples were drawn only from lots of which the inspector was doubtful of their being up to the guaranty on the package.

[370-12-09.]

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director.

Official Inspections.

18

Both the spirit and the letter of the Maine Inspection laws demand freedom from adulteration and truthful labeling.

RESULTS OF ANALYSES OF DRUGS.

During September and October samples were purchased of a few of the more common and easily prepared druggist preparations. In all of the violations hearings were appointed and the cases investigated.

Ammonia water. It will be noted that in quite a large number of instances stronger ammonia water, although not of full strength, was given when ammonia water was called for.

Lime water is very easily prepared but if it is not kept tightly stoppered the carbon dioxide in the atmosphere unites with the calcium hydroxide and reduces its strength.

The *solution of ferric chloride* and *tincture of ferric chloride* were found nearly standard strength.

Spirit of camphor proved to be a stumbling block to several druggists. Its being too strong was probably due to the evaporation of the alcohol occasioned by loosely fitting ground glass stoppers.

Spirit of gaultheria and spirit of peppermint were purchased to see if the druggists were making a distinction between the spirit used for medicinal purposes and the extract used for food. The over-strength may have been due to the evaporation of alcohol rather than to faulty preparation.

Spirit of nitrous ether. The table gives results of analyses of samples which have been examined by the Station since May, 1909. These samples for the most part were sent in by druggists who desired to find out if they were making their preparations rightly.

Tincture of Iodine. Apparently the druggists have profited somewhat by the experience with tincture of iodine as only two lots were found to be below standard strength.

Liquefied phenol was purchased as it had been reported that a certain pharmacist was using crude carbolic acid. It was found, however, that these goods were made from carbolic acid of good quality and were practically in conformity with the standard.

Ammonia Water.

NAME AND TOWN OF DEALER.	Station number.	Date.	AMMONIA GAS. Found.	Standard.	* Per cent. U. S. P. standard.
		1909	%	%	
Bumpus & Getchell, Auburn	8467	Sept.	23.70	10.0	237
D. T. Dougherty, Bath	8539	Oct.	8.16	10.0	82
	8554	Oct.	9.01	10.0	90
Leonard & Mitchell, Bath	8458	Sept.	27.30	10.0	273
R. H. Moody, Belfast	8448	Sept.	10.60	10.0	106
Page's Pharmacy, Brownville	8567	Oct.	27.30	10.0	273
Cochran Drug Store, Houlton	8608	Oct.	11.73	10.0	117
O. F. French & Son, Houlton	8517	Oct.	13.12	10.0	131
Perks Brothers, Houlton	8520	Oct.	27.03	10.0	270
Island Falls Drug Store, Island Falls	8521	Oct.	25.82	10.0	258
R. W. Clark, Lewiston	8469	Sept.	25.10	10.0	251
W. S. Owen, Milo	8569	Oct.	11.50	10.0	115
John D. Keefe, Portland	8579	Oct.	8.96	10.0	90
Smith & Broe, Portland	8573	Oct.	8.80	10.0	88
W. H. Kittredge, Rockland	8457	Sept.	23.20	10.0	232
C. H. Pendleton, Rockland	8535	Oct.	20.74	10.0	207
Geo. W. Dorr, Waterville	8490	Sept.	8.59	10.0	86
Willard R. Jones, Waterville	8545	Oct.	7.52	10.0	75
	8564	Oct.	9.41	10.0	94

* In this column 100 means in accord with U. S. P.; goods from 90 to 110 are within reasonable limit; and goods above 110 or below 90 are too far from standard to be "passed".

Lime Water.

Name and Town of Dealer.	Station number.	Date.	Calcium Hydroxide.		
			Found.	Standard.	* Per cent. U. S. P. standard.
		1909	%	%	
O. W. Jones, Auburn	8468	Sept.	0.131	0.14	94
D. T. Dougherty, Bath	8460	Sept.	0.082	0.14	81
	8530	Oct.	0.133	0.14	95
			0 126	0.14	90
	8661	Nov.	0.140	0.14	100
	8662	Nov.	0.127	0.14	91
Wm. O. Poor & Son, Belfast	8449	Sept.	0.135	0.14	96
R. H. Hurd, North Berwick	8595	Oct.	0.147	0.14	105
Page's Pharmacy, Brownville	8566	Oct.	0.140	0.14	100
Cochran Drug Store, Houlton	8519	Oct.	0.085	0.14	61
H. J. Hatheway, Houlton	8518	Oct.	0.127	0.14	91
Edward C. Miller, Kennebunkport.	8596	Oct.	0.104	0.14	74
	8624	Nov.	0.136	0.14	97
Babcock & Sharp, Lewiston	8471	Sept.	0.067	0.14	48
	8529	Oct.	0.114	0.14	81
	8664	Nov.	0.137	0.14	98
	8665	Nov.	0.130	0.14	93
Wm. J. Heebner, Millinocket	8506	Sept.	0.132	0.14	94
	8549	Oct.	0.123	0.14	88
			0.110	0.14	79
			0.133	0.14	95
			0.122	0.14	87
	8651	Nov.	0.121	0.14	86
			0.141	0.14	101
W. S. Owen, Milo	8568	Oct.	0.131	0.14	94
Patten Drug Store, Patten	8522	Oct.	0.129	0.14	92
John D. Keefe, Portland	8581	Oct.	0.137	0.14	98
Smith & Broe, Portland	8575	Oct.	0.144	0.14	103
C. H. Pendleton, Rockland	8456	Sept.	0.112	0.14	80
	8537	Oct.	0.138	0.14	99
E. J. Bradbury, Saco	8594	Oct.	0.134	0 14	96
Harry R. Dennett, Saco	8593	Oct.	0.126	0.14	90
C. H. Sawyer, Saco	8592	Oct.	0.113	0.14	81
Dr. H. A. Weymouth, Saco	8591	Oct.	0.135	0.14	96
Harry H. Dunbar, Waterville	8551	Oct.	0.472†	0.14	337
Willard R. Jones, Waterville	8492	Sept.	0.115	0.14	82
	8533	Oct.	0.127	0.14	91
			0.148	0.14	106
	8656	Nov.	0.133	0.14	95

* In this column 100 means in accord with U. S. P.; goods from 90 to 110 are within reasonable limit; and goods above 110 or below 90 are too far from standard to be "passed".

† See note page 189.

Ferric Chloride.

Name and Town of Dealer.	Station number.	Date.	Iron.		
			Found.	Standard.	* Per cent. U. S. P. standard.
Solution Ferric Chloride.		1909	%	%	
City Drug Store, Edmund Wilson, Belfast	8447	Sept....	12.00	10.0	120
A. Hallet & Co., Bath	8459	Sept....	10.18	10.0	102
Wakefield Bros., Lewiston	8470	Sept....	10.45	10.0	104
Wm. C. Hawker & Co., Waterville	8491	Sept....	11.05	10.0	110
Tincture of Ferric Chloride.		1909	%	%	
Edward C. Miller, Kennebunkport	8618	Nov....	4.98	4.587	109
C. H. Sawyer, Saco	8615	Oct.....	5.05	4.587	111

* In this column 100 means in accord with U. S. P.; goods from 90 to 110 are within reasonable limit; and goods above 110 or below 90 are too far from standard to be "passed".

Spirit of Camphor.

Name and Address of Dealer.	Station number.	Date.	Camphor.		
			Found.	Standard.	* Per cent. U. S. P. standard.
		1909	%	%	
D. T. Dougherty, Bath	8599	Oct.....	10.0	10.0	100
Cochran Drug Store, Houlton	8605	Oct.....	10.0	10.0	100
Edward C. Miller, Kennebunkport	8622	Nov....	25.0	10.0	250
Babcock & Sharp, Lewiston	8558	Oct.....	16.0	10.0	160
John D. Keefe, Portland	8580	Oct.....	22.0	10.0	220
Smith & Broe, Portland	8571	Oct.....	12.0	10.0	120
C. H. Sawyer, Saco	8613	Oct.....	9.5	10.0	95
Harry H. Dunbar, Waterville	8610	Oct.....	20.0	10.0	200
Willard R. Jones, Waterville	8563	Oct.....	8.5	10.0	85
	8659	Nov.....	10.0	10.0	100

* In this column 100 means in accord with U. S. P.; goods from 90 to 110 are within reasonable limit; and goods above 110 or below 90 are too far from standard to be "passed".

Spirit of Gaultheria.

Name and Address of Dealer.	Station number.	Date.	Oil of Gaultheria.		
			Found.	Standard.	* Per cent. U. S. P. standard.
		1909	%	%	
D. T. Dougherty, Bath	8598	Oct.	3.8	5.0	76
	8660	Nov.	5.0	5.0	100
Cochran Drug Store, Houlton	8602	Oct.	6.2	5.0	124
Babcock & Sharp, Lewiston	8557	Oct.	4.8	5.0	96
John D. Keefe, Portland	8578	Oct.	5.4	5.0	108
Smith & Broe, Portland	8574	Oct.	4.4	5.0	88
Harry H. Dunbar, Waterville	8611	Oct.	5.3	5.0	106
Willard R. Jones, Waterville	8562	Oct.	3.6	5.0	72
	8658	Nov.	7.6	5.0	152

* In this column 100 means in accord with U. S. P.; goods from 90 to 110 are within reasonable limit; and goods above 110 or below 90 are too far from standard to be "passed".

Spirit of Peppermint.

Name and Address of Dealer.	Station number.	Date.	Oil of Peppermint.		
			Found.	Standard.	* Per cent. U. S. P. standard.
		1909	%	%	
D. T. Dougherty, Bath	8600	Oct.	10.8	10.0	108
Cochran Drug Store, Houlton	8606	Oct.	12.9	10.0	129
Edward C. Miller, Kennebunkport.	8619	Nov.	9.0	10.0	90
Babcock & Sharp, Lewiston	8559	Oct.	10.0	10.0	100
John D. Keefe, Portland	8577	Oct.	10.0	10.0	100
Smith & Broe, Portland	8576	Oct.	10.0	10.0	100
C. H. Sawyer, Saco	8614	Oct.	12.4	10.0	124
Harry H. Dunbar, Waterville	8612	Oct.	11.0	10.0	110
Willard R. Jones, Waterville	8561	Oct.	10.4	10.0	104

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Spirit of Nitrous Ether.

(Sweet Spirit of Nitre.)

Name and Address of Dealer.	Station number.	Date.	Ethyl Nitrite. Found.	Ethyl Nitrite. Standard.	Ethyl Nitrite. * Per cent. U. S. P. standard.
		1909	%	%	
Sweet's Drug Store, Bangor	8272	May	3.98	4.00	100
D. T. Dougherty, Bath	8538	Oct.	4.04	4.00	101
E. A. Chase, Brownville	8261	May	1.91	4.00	48
F. H. Wilson, Brunswick	8236	May	3.98	4.00	100
White's Drug Store, Caribou	8249	May	4.18	4.00	104
Danforth Drug Store	8362	June	4.02	4.00	100
Ft. Fairfield Drug Store, Ft. Fairfield	8240	May	2.94	4.00	74
Scates & Co., Fort Fairfield	8241	May	3.33	4.00	83
The Cochran Drug Store, Houlton	8255	May	2.70	4.00	68
	8316	June	3.92	4.00	98
	8607	Oct.	4.11	4.00	103
Perk's Drug Store, Houlton	8254	May	3.54	4.00	89
Island Falls Drug Store, Island Falls	8259	May	0.80	4.00	20
Babcock & Sharp, Lewiston	8542	Oct.	3.40	4.00	85
Martel's Pharmacy, Lewiston	8235	May	1.24	4.00	31
			3.98	4.00	100
	8275	May	3.45	4.00	86
			4.03	4.00	101
South End Pharmacy, Lewiston	8238	May	4.04	4.00	101
W. S. Owen, Milo	8262	May	2.73	4.00	68
	8287	May	3.63	4.00	91
	8293	June	4.06	4.00	101
	8318	June	4.28	4.00	107
Patten Drug Store, Patten	8260	May	1.48	4.00	37
	8285	May	3.57	4.00	89
	8288	June	4.33	4.00	108
John D. Keefe, Portland	8584	Oct.	3.64	4.00	91
John W. Perkins Co., Portland	8271	May	3.21	4.00	80
Smith & Broe, Portland	8572	Oct.	4.00	4.00	100
Henry's Pharmacy, Presque Isle	8244	May	3.92	4.00	98
Kerr & Larrabee, Presque Isle	8243	May	4.42	4.00	111
C. H. Pendleton, Rockland	8534	Oct.	3.43	4.00	86
	8666	Nov.	3.84	4.00	96
Van Buren Drug Co., Van Buren	8253	May	1.56	4.00	39
	8353	June	2.74	4.00	69
Harry H. Dunbar, Waterville	8552	Oct.	3.78	4.00	95
Willard R. Jones, Waterville	8544	Oct.	3.77	4.00	94
	8657	Nov.	4.20	4.00	105

* In this column 100 means in accord with U. S. P.; goods from 90 to 110 are within reasonable limit; and goods above 110 or below 90 are too far from standard to be "passed".

Tincture of Iodine.

Name and Address of Dealer.	Station number.	Date.	Iodine. Grams per Liter. Found.	Standard.	* Per cent. U. S. P. standard.
		1909	%	%	
D. T. Dougherty, Bath	8540	Oct.	76.9	68.6	112
	8553	Oct.	72.6	68.6	106
Cochran Drug store, Houlton	8603	Oct.	58.4	68.6	85
Edward C. Miller, Kennebunkport	8620	Nov.	67.0	68.6	97
Babcock & Sharp, Lewiston	8541	Oct.	65.5	68.6	95
W. S. Owen, Milo	8317	June.	65.0	68.6	95
John D. Keefe, Portland	8582	Oct.	69.9	68.6	102
Smith & Broe, Portland	8570	Oct.	68.4	68.6	99
C. H. Pendleton, Rockland	8536	Oct.	57.5	68.6	84
	8667	Nov.	68.6	68.6	100
C. H. Sawyer, Saco	8617	Oct.	72.5	68.6	106
Harry H. Dunbar, Waterville	8550	Oct.	73.5	68.6	107
Willard R. Jones, Waterville	8543	Oct.	67.7	68.6	98

* In this column 100 means in accord with U. S. P.; goods from 90 to 110 are within reasonable limit; and goods above 110 or below 90 are too far from standard to be "passed".

Liquified Phenol.

(Liquified Carbolic Acid.)

Name and Address of Dealer.	Station number.	Date.	Phenol. Found.	Standard.	* Per cent. U. S. P. standard.
		1909	%	%	
East Side Pharmacy, Bangor	8525	Oct.	90.21	86.4	105
Essex Pharmacy, Bangor	8524	Oct.	91.32	86.4	106
Frawley's Pharmacy, Bangor	8527	Oct.	89.48	86.4	103
Caldwell Sweet Co., Bangor	8526	Oct.	85.59	86.4	98
Cochran Drug Store, Houlton	8604	Oct.	89.15	86.4	104
Babcock & Sharp, Lewiston	8556	Oct.	89.00	86.4	103

* In this column 100 means in accord with U. S. P.; goods from 90 to 110 are within reasonable limit; and goods above 110 or below 90 are too far from standard to be "passed".

Preparations as Found in 10 Drug Stores.

Dealer.	Kind of Goods.	Station number.	* Per cent. U. S. P. standard.
Babcock & Sharp, Lewiston........	Lime water..............	8471	48
	Tincture of iodine........	8541	95
	Sweet spirit of nitre.......	8542	85
	Sweet oil, three samples...	8555	100
	Liquified carbolic acid....	8556	103
	Spirit of gaultheria.......	8557	96
	Spirit of camphor.........	8558	160
	Spirit of peppermint......	8559	100
	Lime water..............	8664	98
The Cochran Drug Store, Houlton..	Sweet Spirit of nitre......	8255	68
	Sweet spirit of nitre.......	8316	98
	Lime water..............	8519	61
	Spirit of gaultheria.......	8602	124
	Tincture of iodine........	8603	85
	Liquified carbolic acid.....	8604	103
	Spirit of camphor.........	8605	100
	Spirit of peppermint......	8606	129
	Sweet spirit of nitre.......	8607	103
	Ammonia water..........	8608	117
	Sweet oil...............	8609	100
Harry H. Dunbar, The Dorr Drug Store, Waterville...............	Ammonia water..........	8490	86
	Tincture of iodine........	8550	107
	Lime water..............	8551	Note.
	Sweet spirit of nitre.......	8552	95
	Spirit of camphor.........	8610	200
	Spirit of gaultheria.......	8611	106
	Spirit of peppermint......	8612	110
D. J. Dougherty, Bath...........	Lime water..............	8460	81
	Tincture of iodine........	8540	112
	Tincture of iodine........	8553	106
	Ammonia water..........	8554	90
	Sweet oil...............	8597	100
	Spirit of gaultheria.......	8598	76
	Spirit of camphor.........	8599	100
	Spirit of peppermint......	8600	108
	Spirit of gaultheria.......	8660	100
	Lime water..............	8661	100
	Lime water..............	8662	91
Willard R. Jones, Waterville.......	Lime water..............	8492	82
	Tincture of iodine........	8543	99
	Sweet spirit of nitre.......	8544	94
	Ammonia water..........	8545	75
	Sweet oil...............	8560	Note.
	Spirit of peppermint......	8561	104
	Spirit of gaultheria.......	8562	72
	Spirit of camphor.........	8563	85
	Ammonia water..........	8564	94
	Lime water..............	8565	95
	Sweet spirit of nitre.......	8657	105
	Spirit of gaultheria.......	8658	152
	Spirit of camphor.........	8659	100
John D. Keefe, Portland..........	Spirit of peppermint.....	8577	100
	Spirit of gaultheria.......	8578	108
	Ammonia water..........	8579	90
	Spirit of camphor.........	8580	220
	Lime water..............	8581	98
	Tincture of iodine........	8582	102
	Alcohol................	8583	98
	Sweet spirit of nitre.......	8584	91
Edward C. Miller, Kennebunkport..	Lime water..............	8506	74
	Tincture of iron..........	8618	109
	Spirit of peppermint......	8619	90
	Tincture of iodine........	8620	98
	Spirit of camphor.........	8622	250

Preparations as Found in 10 Drug Stores—Concluded.

Dealer.	Kind of Goods.	Station number.	* Per cent. U. S. P. standard.
C. H. Pendleton, Rockland	Lime water	8456	80
	Sweet spirit of nitre	8534	86
	Ammonia water	8535	207
	Tincture of iodine	8536	84
	Lime water	8537	99
	Sweet spirit of nitre	8666	96
	Tincture of iodine	8667	100
C. H. Sawyer, Saco	Lime water	8592	81
	Spirit of camphor	8613	95
	Spirit of peppermint	8614	124
	Tincture of iron	8615	111
	Tincture of iodine	8617	106
Smith & Broe, Portland	Tincture of iodine	8570	98
	Spirit of camphor	8571	120
	Sweet spirit of nitre	8572	91
	Ammonia water	8573	88
	Spirit of gaultheria	8574	88
	Lime water	8575	103
	Spirit of peppermint	8576	100

* In this column 100 means in accord with U. S. P.; goods from 90 to 110 are considered to be within reasonable limit; and goods above 110 or below 90 are too far from standard to be "passed".

NOTE.—Lime water, 8551, carried some alkali that could not be identified in the small sample that made it appear more than three times as strong as it is possible for lime water to be. Sweet oil, 8560, while being an olive oil, was not of good quality and had a sharp, disagreeable taste suggestive of formaldehyde. The nature of this was not discovered.

THE DRUGGIST AND THE LAW.

The law regulating the sale of foods has been effective in Maine since the spring of 1905. The law regulating the sale of drugs will have been in effect two years on the first of January, 1910. Naturally with the longer time more has been accomplished in the regulation of the sale of foods than in the sale of drugs.

It has been something of a disappointment to the executive officer of the law to find that the drug trade in Maine needs supervision. When it is remembered that men have to be specially educated and pass special examinations conducted by a State Board constituted for that purpose before they are permitted to compound drugs, it would naturally be thought that this business would be uniformly well conducted.

In the late spring of 1908, tincture of iodine, a preparation which is very readily and accurately made and which has good keeping qualities, was purchased at a large number of drug stores and found to be in about half the cases of unlawful strength. Only in one instance, however, was fraud detected. The goods were as liable to run too high as they were to run too low and indicated carelessness in preparation and in storage.

An investigation of the sweet spirit of nitre showed, that much of the sweet spirit of nitre on sale in Maine was far below standard strength. This is a more difficult preparation to make and keep and after the poor showing made in the case of tincture of iodine it was perhaps to be expected that this medicine might not be found to be up to standard. It is to be noted, however, that samples of sweet spirit of nitre were not obtained until three months after explicit directions for its preparation and storage had been sent to the drug trade of the State.

Occasionally during the present year samples of various drugs have been purchased at different places in the State and far too many of them have been found to be not of standard strength—sometimes too high, sometimes too low. In the case of 10 druggists there were reasons to make somewhaat extended inquiries into their methods of doing business and quite a large number of samples of different preparations was taken from their stocks and analyzed. (See pages 188 and 189). These preparations were such as could be easily and accurately prepared.

These investigations into the drug trade in Maine do not show intentional criminality but they do point out that there is a large amount of carelessness. That it is not lack of ability in manipulation is evidenced by their preparing, after their attention is definitely called to it, goods of standard strength. One is again forced to the conclusion, which seemed to be the only explanation relative to the first investigation made with tincture of iodine, that the druggists as a whole are not as careful in making their preparations as they should be and do not exercise the care that is essential in their business. Investigations of some of the methods used in preparing drugs to be used as medicines has indicated that nothing like the care is exercised in the dispensatory that is required in a chemical laboratory. Inaccurate, flaring measuring glasses are in quite common use. The druggists scales are, at least in some instances, inaccurate. Although the U. S. P. directions are all given in the metric system of weights and measures, many druggists do not use them. The translation from the metric system to apothecaries weights and measures is a fruitful source of mistake. Even in some of the better establishments the registered pharmacist makes up the preparations without referring to the Pharmacopœia and merely trusting to memory. It is needless to say that such a method would never be tolerated in a well regulated chemical laboratory.

Druggists are urged to give careful attention to all these essential details. Use only carefully graduated narrow measuring apparatus. Be sure that the scales are right and that the set of weights has not become inaccurate from rust or other reasons. Use only metric weights and measures. Never make even the simplest preparations without having the authority directly before your eyes. Be sure that all alcoholic preparations are kept in well stoppered bottles. Ground stoppers which are especially fitted to the individual bottle can usually be depended upon, but selected cork stoppers are far safer for most volatile preparations.

The executive officer has endeavored to act with a large amount of patience and charity concerning the shortcomings of the drug trade, but it would seem after the law has been in effect for two years as though a druggist ought to be held srictly responsible for the reasonable accuracy of preparation of materials which involve comparatively little technical knowledge and chiefly an ability to weigh, to measure and to mix. It is not his intention to in any way threaten the trade but the druggist must remember that the executive officer is responsible to the public for his actions in the matter and that he has no moral right to continue to pass over unnecessary and entirely unjustifiable violations of the law. The plea that the druggist does not intend to defraud his customer is not an adequate one, nor is the appeal that the goods are too strong and hence an indication that the druggist had no pecuniary motive, an adequate plea. It hardly seems unduly severe to hold a druggist as responsible for the strength of his preparations as the maker of a chemical fertilizer is held. There are departures from strength in the case of medicines reported in this number of Official Inspections that cannot be paralleled in any fertilizer report made by this Station in 20 years. The detection of such departures from a professed standard in the case of a fertilizer would certainly result in loud complaints on the part of the agricultural community and the criminal prosecution of the offender.

In the case of a drug it is just as serious for it to be above strength as to be below strength. There are three ways, depending upon the individual, in which the law may be violated. The law may be violated because of a hope of obtaining pecuniary advantage; in this case it is from fraud. The law may be violated because through trusting to memory, poor weighing or measuring, or other slack methods, the goods were not properly prepared; this is carelessness. Or the law may be violated because the pharmacist is making his preparations from antiquated and displaced formulas; this is ignorance.

The physician depends upon the pharmacist to compound the medicine and his reputation as well as the health and possibly the life of the patient are involved in the goods that go out from the drug store. In the practice of medicine the quality of the drug and the dose are all important. It matters little whether the departure of the goods from the standard and the resulting wrong dosage be due to fraud, to carelessness, or to ignorance. The result upon the reputation of the physician and upon his patient is the same in either case.

All correspondence relative to the laws regulating the sale of food and drugs, feeding stuffs, fertilizers, seeds and creamery glassware, should be addressed to

Director CHAS. D. WOODS,
Orono, Maine.