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TWENTY-EIGHTH ANNUAL REPORT

OF THE

Maine Agricultural Experiment Station

ORONO, MAINE

1912

STATE OF MAINE.

1913.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

Organization January to June, 1912.

THE STATION COUNCIL.

THE STATION STAFF.

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	GEM M. COOMBS,	*Stenographer*
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	WELLINGTON SINCLAIR,	*Superintendent*
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MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

Organization July to December, 1912.

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AND THE HEADS AND ASSOCIATES OF STATION DEPARTMENTS.

THE STATION STAFF.

ADMINISTRATION	CHARLES D. WOODS, Sc. D.,	*Director*
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	CHARLES S. INMAN,	*Assistant*

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.

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ANNOUNCEMENTS.

Establishment of the Station.

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

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

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

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

INVESTIGATIONS.

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

INSPECTIONS.

The inspection of food and drugs, the inspection of fertilizers, the inspection of concentrated commercial feeding stuffs, the inspection of agricultural seeds, the inspection of fungicides and insecticides and the testing of the graduated glassware used in creameries, are entrusted to the Station through its director, who is responsible for the execution of the public laws relating to these matters. The cost of the inspections is borne by fees and by a state appropriation, and the examination of chemical glassware by a charge for calibration.

OFFICES AND LABORATORIES.

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

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

HIGHMOOR FARM.

Highmoor Farm, purchased by the State for the use of the Station, is located in the town of Monmouth, 2½ miles from the Monmouth station and the same distance from the Leeds Junction station. It is on the Farmington branch of the Maine Central Railroad. A flag station, called Highmoor, is on the farm. Monmouth is the post, telegraph and telephone address for Highmoor Farm. Both Leeds Junction and Monmouth are freight and express addresses.

Visitors are always welcome. Granges, Farmers' Clubs and others desiring to visit Highmoor Farm are requested to arrange dates in advance.

THE AIM OF THE STATION.

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

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

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

Correspondence.

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

Agricultural Experiment Station,
Orono, Maine.

Publications.

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

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

BULLETINS ISSUED IN 1912.

No. 198. Orchard Spraying Experiments. 32 pages, 11 illustrations.
No. 199. Orchard Notes. 24 pages, 23 illustrations.
No. 200. Fungus Gnats of North America, Part IV. 90 pages, 244 illustrations.
No. 201. Spirit of Nitrous Ether. 12 pages, 1 illustration.

No. 202. Aphid Pests of Maine. Food Plants of the Aphids. Psyllid Notes. 96 pages, 179 illustrations.
No. 203. Elm Leaf Curl and Woolly Apple Aphis. 24 pages, 25 illustrations.
No. 204. Triplet Calves. 24 pages, 2 illustrations.
No. 205. Mode of Inheritance of Fecundity in the Domestic Fowl. 112 pages, 2 illustrations.
No. 206. Histology of Oviduct of Hen. 36 pages, 19 illustrations.
No. 207. Insect Notes for 1912. 36 pages, 16 illustrations.
No. 208. Finances, Meteorology, Index. 24 pages.

OFFICIAL INSPECTIONS ISSUED IN 1912.

No. 36. Seed Inspection. 12 pages.
No. 37. Carbonated Beverages, Ice Cream, Prosecutions. 12 pages.
No. 38. Feeding Stuffs Inspection. 48 pages.
No. 39. Miscellaneous Foods, Prosecutions. 16 pages.
No. 40. Drug Inspection. 12 pages.
No. 41. Miscellaneous Foods. 16 pages.
No. 42. Fertilizer Inspection. 40 pages.
No. 43. Clams, Oysters, Prosecutions. 8 pages.
No. 44. Creamery Sanitation, Creamery Inspection, Prosecutions. 16 pages.
No. 45. Carbonated Beverages and Ice Cream. 12 pages.

MISCELLANEOUS PUBLICATIONS ISSUED IN 1912.

No. 444. Notice of hearing. 1 page.
No. 445. List of Publications 1911. 1 page.
No. 446. Map of Highmoor Farm.
No. 447. Methods of Feeding Poultry. 4 pages.
No. 448. Egg Records. 1 page.
No. 449. List of Registered Feeding Stuffs. 8 pages.
No. 450. Requirements under the law regulating the sale of apples. 4 pages.
No. 451. Experiments at Highmoor Farm. 8 pages.
No. 452. Orchard Spraying Experiments notice. 1 page.
No. 453. Station Publications. 1 page.
No. 454. List of Publications. 1 page.
No. 455. Orchard Notes. 1 page.
No. 456. Orchard Spraying Experiments. 1 page.
No. 457. Orchard Notes. 1 page.
No. 458. Notice of hearing. 1 page.
No. 459. Elm Leaf Curl and Woolly Apple Aphis. 1 page.
No. 460. Requirements under feeding stuffs law. 8 pages.
No. 461. Available Bulletins. 4 pages.
No. 462. Station Publications. 1 page.
No. 463. Paints. 4 pages.

BIOLOGY PUBLICATIONS 1912.

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

No. 33. Studies on the Physiology of Reproduction in the Domestic Fowl. V. Data Regarding the Physiology of the Oviduct. By Raymond Pearl and Maynie R. Curtis. Jour. Exper. Zool. Vol. 12, No. 1, pp. 99-132.

No. 34. A Case of Hypospadias in a Ram. By Raymond Pearl. Amer. Veterinary Review, Vol. XL., pp. 794-796.

No. 35. Further Notes Regarding Selection Index Numbers. By Raymond Pearl. Amer. Nat. Vol. XLVI., pp. 302-307.

No. 36. Notes on the History of Barred Breeds of Poultry. By Raymond Pearl. Biological Bulletin, Vol. 22, pp. 297-308.

No. 37. The Mode of Inheritance of Fecundity in the Domestic Fowl. By Raymond Pearl. Jour. Exper. Zool., Vol. 13, pp. 153-268.

No. 38. The Interstitial Cells and the Supposed Internal Secretion of the Chicken Testis. By Alice M. Boring. Biol. Bull., Vol. XXIII., pp. 141-153.

No. 39. A Case of Triplet Calves, with some General Considerations Regarding Multiple Gestation in Normally Uniparous Animals. By Raymond Pearl. Me. Agr. Expt. Sta. Ann. Rpt. for 1912, pp. 259-282.

No. 40. The Histology of the Oviduct of the Domestic Hen. By Frank M. Surface. Me. Agr. Expt. Stat. Ann. Rpt. for 1912, pp. 295-430, 5 plates.

No. 41. Fat Deposition in the Testis of the Domestic Fowl. By Raymond Pearl and Alice M. Boring, Science, N. S., Vol. XXXVI., pp. 833-835.

Papers published but not in the numbered series.

a. Methods of Feeding Poultry, Me. Agr. Expt. Stat Circular No. 447, pp. 1-4.

b. The Inheritance of Fecundity. By Raymond Pearl. In "Problems in Problems in Tugenics. Papers Contributed to First International Eugenics Congress 1912," pp. 47-57. (Also reprinted in Popular Science Monthly, Vol. LXXXI., pp. 364-373).

c. Genetics and Eugenics. A Consideration of the Relation of Animal Experimentation to Human Inheritance and Infant Conservation. By Raymond Pearl. Eugenics Review, Vol. 3, pp. 335-339. (Also printed in American Assoc. for Study and Prevention of Infant Mortality. Proceedings of the Second Meeting, pp. 129-132).

d. The Secretory Activity of the Oviduct of the Domestic Fowl. By Raymond Pearl. Proc. Soc. Prom. Agr. Sci. 1911, pp. 29-34.

e. The Mendelian Inheritance of Fecundity in the Domestic Fowl. By Raymond Pearl. Amer. Nat. Vol. XLVI., pp. 697-711.

ENTOMOLOGICAL PAPERS FROM THE MAINE AGRICULTURAL EXPERIMENT STATION.

No. 51. Notes on Psyllidae: Livia. By Edith M. Patch. Psyche, Vol. 19, pp. 5-8.

No. 52. The Fungus Gnats of North America. Part IV. (Conclusion). By O. A. Johannsen. Bulletin No. 200. Me. Agr. Exp. St.

No. 53. Aphid Pests of Maine Part I. By Edith M. Patch. Bulletin No. 202. Me. Agr. Exp. Sta. pp. 159-178.

No. 54. Food Plant Catalogue of the Aphidae of the World. Part I. By Edith M. Patch. Bulletin No. 202. Me. Agr. Exp. Sta. pp. 179-214.

No. 55. Notes on Psyllidae. By Edith M. Patch. Bulletin No. 202. Me. Agr. Exp. Sta. pp. 215-234.

No. 56. Elm Leaf Curl and Woolly Aphid of the Apple. By Edith M. Patch. Science Vol. 36, pp. 30-31.

No. 57. A Tertiary Fungus Gnat. By O. A. Johannsen. The American Journal of Science. Vol. 34. p. 140.

No. 58. Elm Leaf Curl and Woolly Apple Aphid. By Edith M. Patch. Bulletin 203. Me. Agr. Exp. Sta.

No. 59. Woolly Aphid Migration from Elm to Mountain Ash. By Edith M. Patch. Journal Economic Ent., Vol. 5, p. 395.

Changes in Station Staff in 1912.

April 1, Mr. Walter W. Bonns, horticulturist to the Station, resigned to accept a position with the California Experiment Station.

April 1, Alfred K. Burke, assistant chemist, resigned to accept a position in commercial work.

July 1, Albert G. Durgin, assistant chemist to the Station, resigned to accept a position on the instruction force of the chemical department of the University of Maine.

September 1, Dr. O. A. Johannsen, entomologist to the Station, resigned to accept a professorship at Cornell University.

December 1, Mr. Albert Verrill, assistant chemist, resigned to accept a position in commercial work.

January 1, Miss Sybil Russell was appointed as computer in the biological department for the first half of the year. July 1, Miss Estella Morrison was appointed computer in her place.

April 1, Mr. George A. Yeaton was appointed orchardist. He served in that capacity until November 15, 1912.

June 1, Mr. Clarence W. Barber was appointed as assistant biologist.

July 1, Mr. Edward E. Sawyer and Miss Helen W. Averill were appointed as assistant chemists.

December 1, Mr. Elmer R. Tobey was transferred from the position of inspector to assistant chemist.

BULLETIN No. 198.

ORCHARD SPRAYING EXPERIMENTS.

W. W. Bonns.

Introduction.

In 1909 the Maine Agricultural Experiment Station came into possession of Highmoor Farm at Monmouth, Maine, the purchase of which had been authorized by the State legislature for experimental work in orcharding and other crops.

Such work was inaugurated in the spring of 1910. Several experiments aiming at the solution of orchard problems were begun at this time. It is the purpose of this bulletin to record only the work and results so far obtained in the plots devoted to spraying experiments with fungicides and insecticides.

It is not the purpose of the Station to plead for the establishment and furtherance of spraying as a common orchard practice in Maine. This must be emphasized by the State agents for agricultural education and extension. Spraying has long ago proved to be a profitable operation when intelligently and thoroughly conducted.* It remains for the experimenter in orchard work to concern himself, so far as spraying is concerned, solely with experiments that attack the problems arising from and proceeding with the extension of the practice.

Nevertheless the data resulting from a continued series of experiments along this line not only throw light upon the questions asked therein, but incidently furnish to the observant orchardist comparative figures whereby he may determine for himself whether the spraying of apple orchards is a profitable operation.

* For a concise account of an experiment dealing with this question see Farmers' Bulletin 479, U. S. D. A., pp. 8-10.

The results of the spraying experiments of the season of 1910 have already been published * and will be but briefly reviewed here.

EXPERIMENTS AT HIGHMOOR FARM 1910.

"The experiment aimed at determining the following points:

1. The comparative efficiency of the lime-sulphur sprays and bordeaux mixture as fungicides, especially for apple scab.

2. A comparison of these sprays in regard to possible injury to foliage and fruit on a variety especially susceptible to spray injury—the Ben Davis.

3. The effectiveness of arsenate of lead in combination with lime-sulphur solutions.

4. The relation of possible leaf and fruit injury to the combination of sulphur sprays with lead arsenate...............

An orchard of 140 Ben Davis trees from 20 to 25 years old, of fairly uniform size and condition, and promising a moderate yield per tree, was divided into 12 plots. Plot 1 contained 9 trees. The remainder consisted of 12 each, excepting Plot 9, which contained 11.**

The table on page 3 gives data of treatment:

In making the self-boiled lime-sulphur, hot water was used and an attempt made to secure a large amount of sulphur in solution by making it in a small 10-gallon cask, conserving the heat by a covering during the process, and allowing it to stand for about 45 minutes before using. The lime was high grade and quick acting. Sulphur flour was used. †

The lime of the boiled concentrated spray was slaked with a thin paste made of the sulphur in hot water, more water being added up to a total volume of 10 gallons. This volume was kept constant while the solution boiled for one hour. After cooling

* Bonns, W. W., "Orchard Spraying Experiments," Bul. 189, Me. Agr. Exp. Sta., pp. 33-80, Pl. XII. Inasmuch as the size of the edition proved somewhat inadequate it has been considered desirable to briefly review the account of the work and the results contained therein.

** Two trees in Plot 12 were accidently sprayed on one side in the second application and were omitted from the final count.

† It should be noted that the above method of making this mixture is in reality not the "self-boiled" preparation of Scott's recommendation, but an *intensified* modification, whereby more sulphur than Scott advises goes into solution. Concerning the self-boiled mixture see Appendix B of this bulletin, p. 32.

and straining it showed a density indicated in the table and was used at the same dilution as the commercial solutions.

Arsenate of lead was not added in any case until the time of application.

TABLE I.

Plot.	TREATMENT.	MANUFACTURED BY.	Average density degrees Beaumé.	Amount used in 50 gallons water.	AMOUNT LEAD ARSENATE IN 50 GALLONS WATER. First application.	Second and third applications.
1	Unsprayed					
2	Lime-sulphur	Niagara Sprayer Company	34	1½ gals	2 lbs	3 lbs.
3	Lime-sulphur	Bowker Insecticide Company	34	1½ gals	2 lbs	3 lbs.
4	Lime-sulphur	Sterling Chemical Company	31	1½ gals	2 lbs	3 lbs.
5	Lime-sulphur	Grasselli Chemical Company	33	1½ gals	2 lbs	3 lbs.
6	Lime-sulphur	Jas. A. Blanchard Company	32	1½ gals	2 lbs	3 lbs.
7	"Sulfocide"	B. G. Pratt Co.	40	⅓ gal*	2 lbs	3 lbs.
8	Intensified Self Boiled Lime-sulphur	Home made		10 lbs. lime, 10 lbs. sulphur	2 lbs	3 lbs.
9	Boiled lime-sulphur	Home made	31	2½ lbs. lime, 5 lbs. sulphur †	2 lbs	3 lbs.
10	Bordeaux mixture	Home made		4 lbs. copper sulphate, 4 lbs. lime	2 lbs	3 lbs.
11	Bordeaux mixture	Home made		3 lbs. copper sulphate, 3 lbs. lime	2 lbs	3 lbs.
12	Unsprayed					

* The third application of "Sulfocide" was 3-16 gallon to 50 gallons water.
† Boiled with a constant volume of 10 gallons water and used at same dilution as commercial concentrates.

TIME OF APPLICATION.

Owing to the nature of the experiment, a hand pump outfit was used. The applications, made with Mistry Jr. nozzles, were exceedingly careful and thorough, and occurred on the following dates:

1st. When fruit buds began to show pink, May 13 to 16.
2nd. After the petals fell, June 7 to 9.
3rd. July 15 to 18."*

* Bonns, W. W. loc. cit. pp. 53-55.

Weather conditions at the time of the first and last applications were favorable and remained so for some time thereafter. The second application was made during a period of extremely unsettled weather, with conditions most favorable for the production of spray injury, according to previous experiences with bordeaux. Showers were frequent and changes in temperature, humidity and sunshine intensity were great and sudden.

RESULTS.

In the course of the season, observations showed that injury to fruit and foliage occurred in varying degrees on all sprayed plots. On all the lime sulphur plots such injuries were negligible for practical purposes, compared with the markedly thrifty condition of the leaves and the fine appearance of the fruit.

An unusual form of injury at the calyx or "bloom" end of the fruit was also noted and was ascribed to the lead arsenate in combination with the lime-sulphur solution. This, with the one exception to be noted, was also small enough in amount to be an unimportant factor.

Only one of the proprietary sprays (advertised as a soluble sulphur and not a lime-sulphur solution), did very severe damage to leaves and fruit, and proved to be the one instance where injury was caused by each application.

No differences great enough to indicate superiority were found among the several commercial lime-sulphur preparations, nor between them and the boiled home made solution. The intensified self-boiled mixture proved less effective as a fungicide.

The concentrated lime-sulphur sprays in general showed superiority over bordeaux mixture in regard to the absence of fruit and foliage injury and effectiveness in fungus control. The sole exception in the latter respect was the home boiled solution, and the slight difference here can be accounted for on other grounds.

The conclusions drawn from this year's results were profoundly affected by some unknown factor, generally ascribed to the weather, which produced severe russeting and malformation of fruit on the unsprayed trees. Nevertheless, after taking this into account, the results tended to show the advantages of lime-sulphur sprays, commercial or home made, over bordeaux in a season which put all spray materials to a severe test.

The insecticidal value of lead arsenate was found to be undiminished when combined with lime-sulphur sprays.

The following table gives the results of inspecting all the fruit. Each plot was examined for the scab fungus, (*Venturia Pomi* (Fr.) Wint.), which was the only one seen on the trees in this experiment; for insect injury indicated by curculio stings or wormy fruit; for calyx injury and for fruit deformity caused either by natural agencies, spraying, or these factors combined.

TABLE 2.

Plot.	TREATMENT.	Density degrees Beaumé.	Number of apples.	Per cent. without scab.	Per cent. scabby.*	Per cent. deformed.	Per cent. Calyx injury.	Per cent. wormy.‡
1	Check, Unsprayed	....	3,102	58.34	41.65	1.96	......	13.79
2	Niagara Lime-sulphur	34	7,736	92.70	7.29	2.22	1.75	0.63
3	Bowker Lime-sulphur	34	5,040	93.33	6.66	3.57	1.07	1.54
4	Sterling Lime-sulphur	31	7,765	89.96	10.03	1.37	0.06	0.81
5	Grasselli Lime-sulphur	33	9,563	88.53	11.46	1.81	3.21	0.53
6	Blanchard Lime-sulphur	32	7,699	91.08	8.91	1.64	0.61	1.02
7	Pratt "Sulfocide"	40	3,660	94.42	5.57	44.39†		0.16
8	Intensified Self Boiled Lime-sulphur	......	3,181	84.59	15.40	2.13	1.03	1.03
9	Boiled Lime-sulphur	31	6,551	85.25	14.74	1.31	0.09	1.23
10	Bordeaux 4-4-50	......	7,185	83.29	16.70	6.77	......	1.51
11	Bordeaux 3-3-50	......	5,215	85.96	14.03	5.79	......	1.97
12	Check, Unsprayed	......	6,092	59.24	40.75	2.47	......	7.33

* On sprayed plots 50 per cent. of respective amounts so slightly scabbed as to have fair market value.
† Deformity and calyx injury sufficiently coincident to combine in one count.
‡ On sprayed plots practically all fruit under this heading (except Plots 1 and 12), was injured by the curculio and not by the codling moth. The latter was thoroughly controlled.

In planning the experiment for 1911, consideration was given not only to the problems arising from the preceding results at Highmoor, but also to the facts elicited and the questions arising from the recent work of other experiments in this field.

In the course of a number of spraying experiments conducted in several sections of the country, the use of arsenate of lead alone as a spray material gave results worthy of note.

It appeared from the work of Taylor * and Waite ** that

* Taylor, E. P. "Spraying Peaches for Brown Rot." Western Fruit Grower, Oct. 1909, pp. 20-21 and Feb. 1910, pp. 16-18.
** Waite, M. B., "Experiments on the Apple with Some New and Little-Known Fungicides." U. S. D. A., Bur. Plant Industry. Circular 58 (1910).

lead arsenate had some fungicidal properties, or at least was capable of inhibiting fungus attack. Taylor came to this conclusion from work done in Missouri peach orchards where the curculio (*Conotrachelus nenuphar,* Herbst) and the brown rot (*Sclerotinia fructigena* (Pers.) Schroet.) were very pernicious. In this instance the control of the rot is largely credited as indirectly due to the insecticidal action of the spray in warding off the insect whose fruit punctures form sources of infection by the fungus. In another instance, however, reference is made to the absence of peach scab following the use of lead arsenate, and this is ascribed to its probable fungicidal properties.

In Waite's experiments in Virginia with apples, however, the action of lead arsenate is specifically recognized as fungicidal. Discussing the results obtained on the lead arsenate plot, the author states: "This spray gave excellent results, not only in its absence of injurious effects on the foliage and fruit but in preventing fungous diseases...................... Furthermore, the spraying seemed to protect the fruits from the fly-speck, the smut fungus, and the fruit spots, just as in the case of the other mixtures." *

He concluded that "this insecticide seemed to possess considerable fungicidal value, though probably not enough to be depended upon for general use."

Wallace et al.** have also made extensive field and laboratory studies of the fungicidal value of spray mixtures, and included therein a test of the efficiency of lead arsenate diluted to spraying density, uncombined with other solutions. When so used it was found to reduce apple scab considerably and in mild cases to control it fairly well. Better percentages of control were obtained under field conditions than in the laboratory studies, and in both kinds of tests the addition of lead arsenate to lime-sulphur solutions increased the fungicidal value of the latter. Such increase is regarded by Wallace as due more to

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* Waite, M. B. loc. cit., p. 12.

** Wallace, E., Blodgett, F. M., and Hessler, L. R. "Studies of the Fungicidal Value of Lime-Sulfur Preparations," N. Y. (Cornell) Agr. Exp. Sta. Bul. 290 (1911).

(NOTE—The author does not indicate in his report the specific organisms thus controlled.. The lead arsenate in question was used at the dilution of 2 lbs. to 50 gallons.)

the changes resulting from the chemical combination of the two substances than to the simple addition of the arsenate.

In connection with the above experiment Wallace advances a theory accounting for the fungicidal action of the arsenate. He suggests that such action may be due largely to physical rather than chemical causes. Assuming that the leaf has been well sprayed and is thoroughly coated with a thin layer of insoluble arsenate, it would be possible for fungus spores to germinate in water on the leaf above this layer and still prevent the penetration of the germ tubes. This protective action might be reduced with the growth of the leaf, when the newer surfaces would be unprotected and the chances of infection greater.

On this hypothesis reliance must be placed on a spray material actually preventing spore germination, rather than on one merely presenting obstacles to germ tube penetration.

Other facts elicited by the work in question were the changes wrought in lime-sulphur used alone or with lead arsenate, in the presence of carbonic acid. This chemical compound is injected into the problem when the carbonic acid gas sprayer is used. It was found that under such conditions the soluble sulphur was precipitated before its application, but the resulting products were no less effective than the solutions applied by means other than the gas sprayer, after changes produced in them by exposure to the air had occurred. This appeared to be true irrespective of the use of the gas sprayer with lime-sulphur alone, or combined with lead arsenate. It was observed, however, that with the use of the gas sprayer in applying the two materials combined, arose the tendency to produce foliage injury, especially to the susceptible leaves of the peach.

For the past two years the work at Highmoor in spraying experiments has of necessity been confined to trees of fairly uniform condition, bearing a reasonable crop. These conditions have limited the work to the Ben Davis variety. Although other standard kinds are growing in the Highmoor orchards they were either scattered in a way poorly adapted to experimental work, or their poor condition rendered them unsuitable material. It was therefore considered very desirable that trials along lines similar to those being conducted in the Station orchard should also be made on other varieties in other orchards. Coöperative work under the supervision of the Station horticulturist was therefore begun in three orchards in the nearby town of Greene, owned by Messrs. H. Philbrook, J. Coburn and H. Keyser respectively. The writer wishes at this time to express his appreciation of the interest shown and the aid furnished by these gentlemen. A discussion of the work and results obtained in the Greene orchards will be made separate from the work at Highmoor.

It is a well recognized fact that in using the lime-sulphur preparations instead of bordeaux mixture in orchard spraying we are substituting for a spray that at the time of application is insoluble, one that is soluble and more or less caustic in nature, according to the strength of the solution. The basis, therefore, for the proper use of lime-sulphur sprays has been the determination of the strength of the stock solution, and its dilution for use according to its density. Simple instruments for this purpose and dilution tables graded for a scale of densities have been, and still are the only safe means of using lime-sulphur as a summer spray which, so far as known, will insure both fungicidal effectiveness and freedom from spray injury.

Nevertheless it is a matter of practical interest and importance to determine what may be the limits of dilution for a specific density, in regard to injury and to efficiency; in other words, can a solution of a known density be safely used at a reasonably greater strength than that indicated by its place in the dilution table, or can it be diluted beyond the amount indicated in the table, and still be an effective fungicide?

EXPERIMENTS AT HIGHMOOR FARM, 1911.

The experiment for this year, therefore, in addition to securing further comparative notes on the effectiveness of lime-sulphur and bordeaux mixture, aimed at the accumulation of data bearing on the points discussed above.

Both the lime-sulphur and the bordeaux preparations were home made. The latter was of 3-3-50 strength and the lime-sulphur was made according to the boiled stock solution formula.* A reliable commercial brand of lead arsenate was used throughout.

* Explanation of bordeaux 3-3-50 and directions for making and diluting concentrated lime-sulphur solutions are given in the Appendix.

The home made lime sulphur concentrate registered 27 degrees Beaumé density. This, according to Van Slyke et al.* should be used at a summer strength of 1 gallon to 29.5 gallons of water, or 1.69 gallons of concentrate for 50 gallons of spray. In the Highmoor experiment, therefore, 1 2-3 gallons was used upon the block to be sprayed with the recommended "standard" dilution. Two other blocks of equal size were sprayed with the same concentrate at dilutions of 2 gallons to 50 and 1 1-4 gallons to 50 respectively, or 20 percent stronger and 25 percent weaker, respectively, than the standard given according to the dilution table.**

The remaining portions of the experimental plot were divided into three parts. Two of these were treated simply with arsenate of lead, at 2 and 4 pounds to 50 gallons of water, respectively; the other was sprayed with the 3-3-50 bordeaux mixture plus 2 lbs. of lead arsenate. The lime-sulphur solutions also included 2 lbs. of arsenate to 50 gallons of spray.

All applications on all divisions of the plot were made with the Niagara carbonic acid gas sprayer.

The same block of Ben Davis trees used in 1910 served for the work under discussion. It was divided and treated as indicated in the following figure.

PLAN OF EXPERIMENT.

			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	A				B						C						D				E		F	

A. Arsenate of Lead, 4 lbs. to 50 gallons.

B. Lime-sulphur, 2 to 50 gallons, +2 lbs. lead arsenate.

C. Lime-sulphur, 1⅔ to 50 gallons, +2 lbs. lead arsenate.

D. Lime-sulphur, 1¼ to 50 gallons, +2 lbs. lead arsenate.

E. Lead Arsenate, 2 lbs. to 50 gallons.

F. Bordeaux mixture. 3-3-50 +2 lbs. lead arsenate.

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* Van Slyke, L. L., Bosworth, A. W., and Hedges, C. C. "Chemical Investigation of Best Conditions for Making the Lime-Sulphur Wash." N. Y. (Geneva) Agr. Exp. Sta. Bul. 329, p. 438, Tab. XI.

** The third application was made from a fresh stock solution registering 24 degrees Beaumé density, and was diluted on the above plan for the three blocks.

Time of Application.

The applications were made as aforesaid with the gas sprayer at 100 to 125 lbs. pressure. The machine was thoroughly washed out between use on each plot. Friend, Mistry Jr. and Scientific nozzles were used during the several sprayings, which occurred on the following dates:

1st. May 12 and 13. Flower buds half grown and showing pink at tips. Leaves fairly well developed.

2nd. May 30. After petals had fallen.

3rd. July 7 and 8.

Weather Conditions.

In regard to absence of rain or excessive humidity, the conditions for spraying were excellent. The season was one of exceptional drought. No rain fell from about April 1 until May 24. On May 29, one day preceding the second application, there was a precipitation of .2 inches. On July 6, again one day preceding the last application, .24 inches of rain fell.

The first rain following the first application occurred 11 days afterward; following the second, 2 days thereafter, and 7 days after the final spraying. The small amount of rain preceding the last application occurred during periods of high temperature.

The third application was made during two days of a week of exceptional heat; the relation of such extreme temperatures to spraying and its effect on fruit will be discussed later.

The following table gives the rainfall from the beginning of the record in April to the middle of the harvest.

Table 3.

Precipitation at Highmoor Farm. April 1-October 1, 1912.

Date.	Inches.	Date.	Inches.	Date.	Inches.
May 24	.7	July 17	.05	Aug. 28, 29	.65
May 29	.2	July 18	.26	Aug. 31	.17
June 1	.45	July 20	.18	Sept. 6	1.26
June 12	1.53	July 22	.05	Sept. 9	.14
June 13	.18	July 24	.62	Sept. 12	.02
June 14	.66	July 28	2.25	Sept. 22	.47
June 15	.07	July 31	.40	Sept. 25	.52
June 16	.88	Aug. 9	.04	Sept. 27	.22
June 26	.03	Aug. 11	.46	Sept. 29	.65
June 28	.03	Aug. 15	.36		
July 6	.24	Aug. 18, 19	.99	Total	15.14
July 15	.11	Aug. 26	.30		

The maximum and minimum shade temperatures of the weeks in which the spraying was done are here given in degrees Fahrenheit, the days of application being considered as the middle of the week. This will indicate the conditions immediately before and after the operations.

TABLE 4.

First Application, May 12, 13, 1912.
Maximum and Minimum Shade Temperatures May 10-16, Inclusive.

	May 10	11	12	13	14	15	16
Max.	75.5	74	89	76	69	65	73
Min.	46	46	51.5	55.5	41.5	41	51

TABLE 5.

Second Application, May 30, 1912.
Maximum and Minimum Shade Temperatures May 27-June 2, Inclusive.

	May 27	28	29	30	31	June 1	2
Max.	78.5	87	83	78	68	74	76
Min.	50.5	52	59	58	47.5	50	52

TABLE 6.

Third Application July 7, 8, 1912.
Maximum and Minimum Shade Temperatures July 4-10, Inclusive.

	July 4	5	6	7	8	9	10
Max.	103	93	99	86.5	81	94.5	99
Min.	79	70	66	63	55	59	69

It is also desirable here to note the temperatures for the following week of July 11-18 inclusive, given below, in the light of observations and deductions made from the experiment.

TABLE 7.

Maximum and Minimum Shade Temperatures, July 11-17, 1912, Inclusive.

	July 11	12	13	14	15	16	17
Max.	97	93	86	82	83	79	66
Min.	72	70	61.5	56	58	57	62

The humidity records, owing to inaccuracies in the self-recording hygrograph, are omitted. The precipitation and temperature tables given above, when considered in relation to the dates of spray application, will show that atmospheric humidity may be considered a negligible factor.

No dew formed in the night following the extremely hot days above recorded, so no consideration of lens action of intense light through drops of water need be included in a later discussion of fruit injury.

Results.

Effect on Foliage.

No injury whatever was noted on any of the trees in plots A to E, inclusive. The foliage, despite the unusually hot summer, coupled with insufficient rain, was most thrifty in all respects. Especially noticeable was the growth not only of the foliage as a mass, but of the size of the individual leaves. Evidently neither the strength of spray applied nor the existing conditions at time of application affected the foliage of these plots in any perceptible way.

In this connection it may be said that three or four trees in a row of about 20 Baldwins on the farm showed a moderate amount of leaf scorch. These trees were sprayed with the same solution and at the same strength as block C in the experiment,—i. e. in dilution table proportions. The injury was mostly marginal, scattered and in no way serious. The remainder of this variety in this row showed no evidence of having been affected. Considering that the Baldwin is regarded as less susceptible to foliage spray injury than the Ben Davis of the experimental plot, and that stronger applications did not affect the foliage of the latter variety in any way, the injury to the few Baldwins in question may be accounted for on the ground of individual susceptibility.

In plot F distinctly different results appeared. No spots that could be reasonably ascribed to bordeaux injury were in evidence up to the end of the second week in June. At that time the characteristic circular dead areas began to become noticeable * and increased very gradually throughout the sea-

* See Fig. 47, Me. Agr. Exp. Sta. Bul. 189.

son up to the middle of July. By August 11 the leaf injury on this plot, although by no means comparable with that of the preceding year, was still considerable in amount, and some yellowing and leaf fall had already occurred.

The occurrence and development of this leaf injury when viewed in relation to Table 3 clearly shows the well established connection between bordeaux injury and rainy weather.

Effect on Fruit.

On June 1, about two weeks after the second application, several of the small fruits on trees in plot B appeared distinctly russeted. None were found at that time in plots A, C, D, and E. In plot F very early stages of bordeaux injury flecks were beginning to show.

Following the rains of the first two weeks in June there appeared to be evidence of a slight increase in russeting in all plots. Here again none of this was sufficient in amount to be a serious matter from the commercial standpoint, even in a large orchard, as the data will show. A few rare instances occurred in all the plots where the apples were not only russeted, but the russeted surfaces were grotesquely distorted with irregular, corrugated and warty projections. So far as such malformations are concerned, it may be said that in no conceivable way can they be reasonably made to appear related to spray injury. Such malformation was entirely different in appearance from that accompanying the russeted fruit on the trees sprayed with lime-sulphur in the preceding year's work.

As might be expected, the injury to fruit of plot F increased with the rainfall of the two months preceding harvest. The injury this year, however, was characterized less by the well known bordeaux russeting than by an increased amount of the earlier stages of injury, so that at picking time the fruit appeared to be either well mottled with dull brown flecks a few millimeters in diameter, or speckled with minute dots. This gave to the fruit a general soiled, dull brown hue.

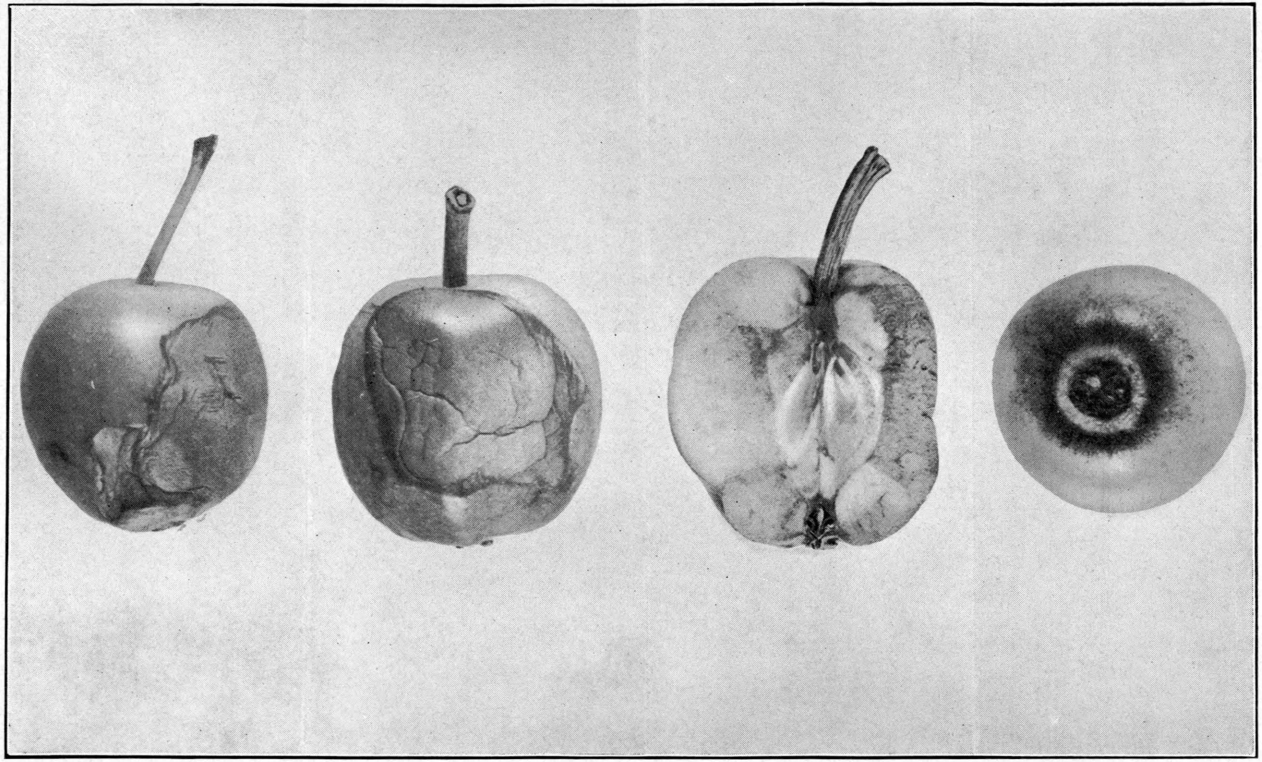
The coloring of the fruit from this plot, aside from the effect just noted, was far below that of the apples on any of the others. This is noteworthy in view of the fact that the seasonal conditions were such that apples everywhere in this State, regardless of treatment or lack thereof, were of especially fine color.

The fruit of the other experimental plots, benefited by the rains of later summer and the prolonged periods of sunshine, grew to unusual size for the variety and was of exceptionally high quality and color. The harvest occurred the third week in September.

In examining the fruits of all these plots it was found impracticable, on account of the presence of a crop far beyond the anticipated yield, together with lack of storage facilities, to set aside and examine individually each fruit from the entire experiment. The three smaller plots were examined in full. Of the three large plots B, C and D, one-half the number of barrels from each was selected at random, and thoroughly examined for the points indicated in the following table. It will be seen that the number counted in these three plots is roughly 50 percent of the totals and is a reliable index of the general run in each plot.

Insect Injury. Under the column "stung" are included apples stung by the curculio and fruits affected by some factor which caused isolated wart-like developments, sometimes russeted and sometimes entirely smooth. The cause of this deformity is not known,—at least it has not yet been proved to be of insect origin. There also exists the possibility that some of the stings and "dimples" produced are the work of the tarnished plant bug (*Lygus pratensis*), or some insects similarly affecting the fruit; but as no definite data regarding the presence of these insects in the orchards is available, all such deformed fruits have been included in the column for wormy apples. In connection with this it may be stated that at Highmoor the curculio-injured apples constituted not more than half of the respective percents in the column. Thorough cultivation is proving highly effective in reducing the injury from these beetles.

Leaf and bud eating insects were not numerous after the first application in any of the orchards, being well controlled by the arsenate of lead. The browntail moth (*Euproctis chrysorrhea*), became much in evidence during the summer, but so far has done no damage in the orchard worthy of note. The tent-caterpillar (*Clisiocampa americana*) was very prevalent in the vicinity of Highmoor and did great damage to adjacent property, but none to the Station orchards.



Figs. 1 and 2 Sunscald on young Baldwins. Fig. 3 Section through 2, showing depth of injury. Fig. 4 Calyx injury on Ben Davis

Of the small number of fruits classed as "wormy" practically none from the experimental plots were affected by the codling moth (*Carpocapsa pomonella*). The fruit so recorded had the appearance of having been attacked from the outside by some insect, but the injury itself was not sufficiently characteristic to enable the Station entomologists to determine the cause, since no insect was caught at work. These "worm holes" were in the nature of feeding punctures,—small, round perforations of the skin about the size of a pin head. The injury was little more than skin deep; no great cavity had been eaten beneath the skin. There was no trace of insect life in such apples when examined, and little that is definite can be stated regarding the cause of this trouble. Thus far it is, as indicated in the table, of very slight importance.

In regard to codling moth in all the orchards at Highmoor it may be stated that of the large crop of 2450 barrels not enough fruit attacked by this insect was found to fill 2 barrels.

Fungus Control. It will also be noted that apple scab was found on but one of all the fruits examined. A conservative estimate places the amount of scabby fruit in the Highmoor crop of 1911 at less than 500 fruits out of the crop previously mentioned. The chief cause for the absence of fungi will be discussed later.

*Sunscald.** An unusual factor in the growing season of 1911 was the intense heat wave lasting from July 4 to 13 (see tables 6 and 7), coupled with clear skies and intense sunlight. As a result of these almost phenomenal conditions, fruit was sunburned or scalded on the trees. The surfaces affected, in the case of small green Baldwin apples at Highmoor, turned a light tan brown; the epidermis became wilted and wrinkled (Figs. 1 and 2), and the tissues below discolored and shriveled (Fig. 3).

On Ben Davis and Greening fruit less wilting or shrinking of skin and softening of tissues was observed in early stages. The first indication of injury was a yellowish brown wash sometimes tinged with red, of fairly well defined area, although the margin was not in every case definite (Fig. 7). Later in the season the color of such areas took on a darker, blackened hue with more definite outline, and as the expansion due to

* This term is not to be confused with a winter injury of the same name affecting trunk and limbs.

growth of the adjacent healthy tissue continued, it ultimately tore apart the dead areas and prominent splits or clefts appeared (Figs. 5 and 6).

The discussion of sunscald and spraying is considered later.

The table on page 17 gives the data according to the respective observations.

Discussion.

Calyx Injury. Only one instance of the calyx injury observed quite generally in last year's plots was found the past summer. This was seen in a few fruits of one or two Ben Davis trees belonging to another experiment, and which are and have been in sod for an unknown period. In this soil environment they have been naturally quite unthrifty, with poor and small amount of foliage. Their fruits in 1911 were remarkable for small size. Fully fifty percent were no larger than the larger crab varieties. (Fig. 4).

The fact that such injury was confined to these few unthrifty trees, whereas none whatever was to be seen during the season on several thousand trees of the same variety in vigorous condition; and the further fact that the trees showing such injury last year were in that year experiencing their first season of renovation, and were to a large degree bearing good fruit in 1910 more in spite of preceding neglect than as the result of any direct response to that year's treatment, raises the question whether or not such calyx injury was not indirectly due as much to the lack of vigor as indicated by the tissues of the fruit, as to the caustic action of the spray.

In a discussion of this calyx injury in an earlier publication * the writer attributed it largely to chemical reaction between the lead arsenate and lime-sulphur when combined. It has been found that such combination tends to release arsenic in soluble form, and this would in itself furnish the grounds for an explanation of such injury.

The fact, however, that the same spray materials were used this year, would present the same conditions, so far as formation of soluble arsenic is concerned. Furthermore, on the basis of Wallace's results, previously mentioned, we might expect a more serious injury when lime-sulphur and lead arsenate were

* Bul. 189, Me. Agr. Exp. Sta. (1911).

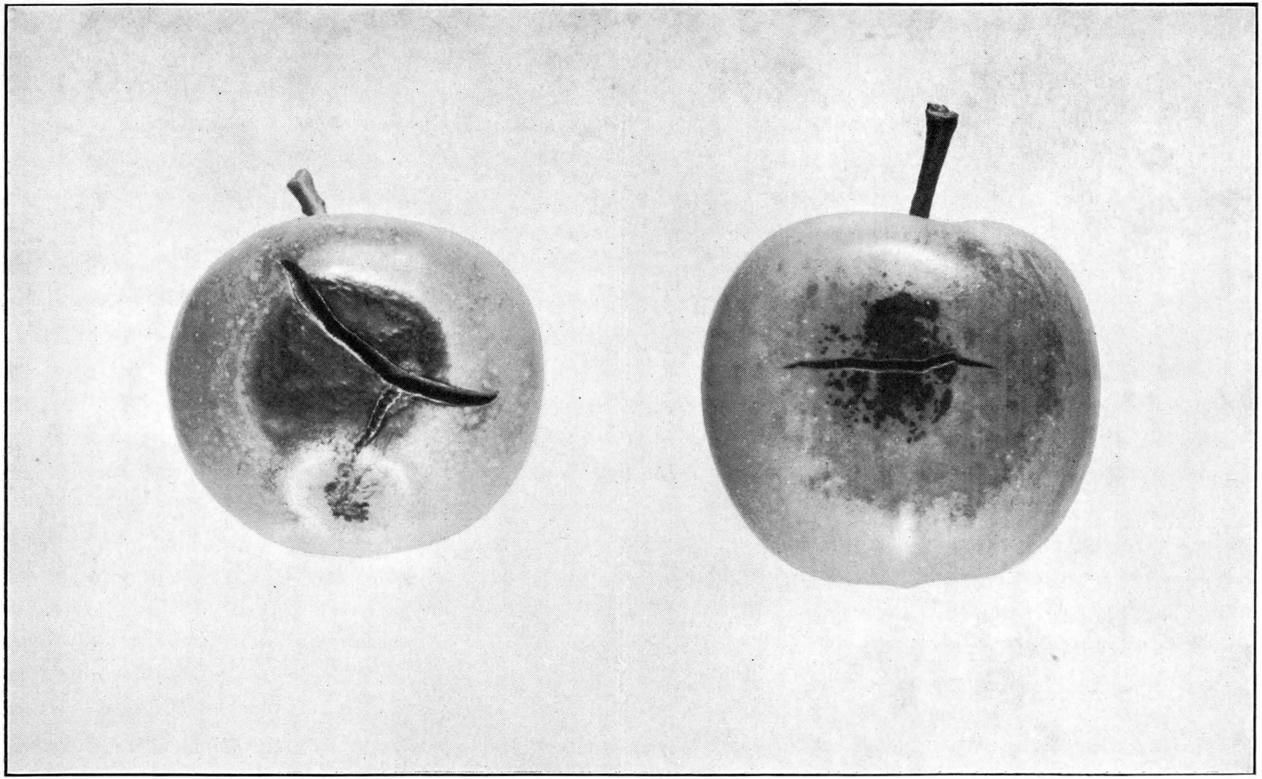


Fig. 5 Sunscald on Greening. Sprayed once, before buds opened.

Fig. 6 Sunscald on unsprayed Ben Davis.

TABLE 8.

Data of Spraying Experiments at Highmoor Farm, 1911.

Plot.	TREATMENT.	Number of trees.	Total Number of apples.	Number counted.	STUNG.*		SCALDED.		WORMY.*		RUSSETED.		SCABBY.	
					Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
A	Arsenate of Lead, 4 lbs., –50 gals. water	9	6,773	6,773	1,694	25.0	35	0.5	85	1.2	67	0.9	1	0.01
B	2 gals. Lime-sulphur, 2 lbs. Lead Arsenate,–50 gals. water	35	35,471	14,451	2,361	16.3	644	4.4	194	1.3	246	1.7	–	–
C	$1\frac{2}{3}$ gals. Lime-sulphur, 2 lbs. Lead Arsenate,–50 gals. water	36	29,744	14,137	1,562	11.0	435	3.0	193	1.3	264	1.8	–	–
D	$1\frac{1}{4}$ gals. Lime-sulphur, 2 lbs. Lead Arsenate,–50 gals. water	35	36,530	15,102	1,512	10.0	168	1.1	209	1.3	166	1.0	–	–
E	Arsenate of Lead, 2 lbs.–50 gals. water	12	10,323	10,323	1,828	17.7	100	0.9	217	2.1	186	1.8	–	–
F	Bordeaux Mixture, 3-3-50, +2 lbs. Lead Arsenate	12	6,833	6,833	679	9.9	38	0.5	166	2.4	4,835†	70.7	–	–
	Total	139	193,294	67,619	9,636	14.2	1,420	2.1	1,064	1.5	5,764	8.5‡	–	–

* The grouping of apples under these headings is explained on pp. 14 and 15 respectively.
† Fruit spotted, not much russeted. Early stages of bordeaux injury.
‡ It must be noted that the high *total* per cent. of russeted fruit is due to the inclusion of the great amount of bordeaux injury. Omitting fruit injured by bordeaux mixture the percentage of russeted apples is 1.3.

applied with the carbonic acid gas sprayer, as in the work of the past season.

On the contrary, no such effect was noted at Highmoor or in one of the coöperative experiments where a like sprayer and the same ingredients were used. In the present state of knowledge we may therefore admit the possible presence of soluble arsenic in the lime-sulphur-lead arsenate combination and still suggest as a plausible explanation of calyx or similar injuries the strength of such soluble arsenic in relation to the health of the tree, as indicated by its physiological resistance expressed in the apple tissues at time of spraying.

Effectiveness in Fungus Control. No conclusions can properly be made from this season's work, either in regard to the relative effectiveness of the several lime-sulphur sprays in various dilutions or the comparative efficiency of them and bordeaux mixture. The cause of this is the unusually hot, dry summer, preceded by a very warm dry spring. Under conditions such as these the spores of fungi parasitic to the apple could neither germinate to any degree nor make much growth after germination. This is shown by the presence of only one scabby apple in the entire experiment.

For the fruit grower such a season adverse to the dissemination and propagation of fungi is a great boon. To the worker in experiments with fungicides the contrary is true, for without the presence of parasites in considerable amount the experiment fails utterly in this respect.

Fungicidal Efficiency of Lead Arsenate. The explanation just given holds here for lack of data on this point. Work of this nature must be repeated until a sufficient number of seasons with conditions favorable for the accumulation of experimental data have passed. In this respect the work of 1911 well demonstrates the futility of making well defined deductions from the results of one or a few years' work.

Relation of Russeting to Lime-Sulphur. Nothing in the results of this year indicates any relation between the small amount of russeting found on the several plots and the nature of the spray applied. The table of results shows that the plot sprayed with lime-sulphur at dilution-table strength yielded practically the same percent of russeted apples as the plot sprayed with a strength 20 percent stronger than the table

Fig. 7 Sunscald on Ben Davis, showing relation of sunscald to exposure.

recommends. Again, arsenate of lead used at the rate of 2 lbs. to 50 gals. yielded double the percentage of russeted apples when compared with the plot sprayed with 4 lbs. to 50 gals.

A fair percent of the russeted apples in the several plots, with the exception of plot F, were affected to a degree no greater than is frequently found on unsprayed trees. We are here again confronted with the question of physical and natural causes vs. chemical ones in attempting a solution of this question of russeting. This point will again be referred to.

Lime-Sulphur Plus Lead Arsenate Applied with the Gas Sprayer. If any conclusions might legitimately be drawn from the results obtained this year it would appear that the effect of carbonic acid gas upon the spray was, when the latter was applied in fair weather, entirely negligible. Fortunately this is not a critical question, as it seems that the gas sprayer for several reasons is being increasingly supplanted by other power machines.

Sunscald. That the injury so designated was in reality a scald produced by sunlight, there is no room for doubt. In the first place, it was, with practically no exceptions, found only on fruit upon the south and southern sides of the trees, and in general only where such fruit because of its relation to adjacent foliage was directly exposed to the sun. (Fig 7). Secondly, the injury on such apples was always confined to the surfaces exposed to light at the hottest periods of the day.

As previously stated, no lens action of intense sunlight through drops of dew can here account for any such injury, owing as aforesaid to the absence of dew formation at this period and to the great areas of the injured surfaces.

Relation of Spraying to Heat. Did spraying during this season bear any relation to the primary nature of the injury? This question is readily disposed of. Fruit on trees that have never been sprayed exhibited the characteristic burned surfaces. Trees on Highmoor Farm that received only the first application showed no injury to fruit until after the hot weather, when typical sunscald was found.

Did spraying affect the extent or degree of injury? This seems to be a debatable point. In order to obtain the views of other observers, the writer sent a circular letter to Station botanists, horticulturists or pathologists of the several apple growing states that had been subjected to the heat wave of July.

Practically every reply confirmed the Maine experience in regard to the injury, its relation to the side of tree and fruit exposure, and all were unanimous in crediting the injury to sun and heat. Some also included drought as a factor.

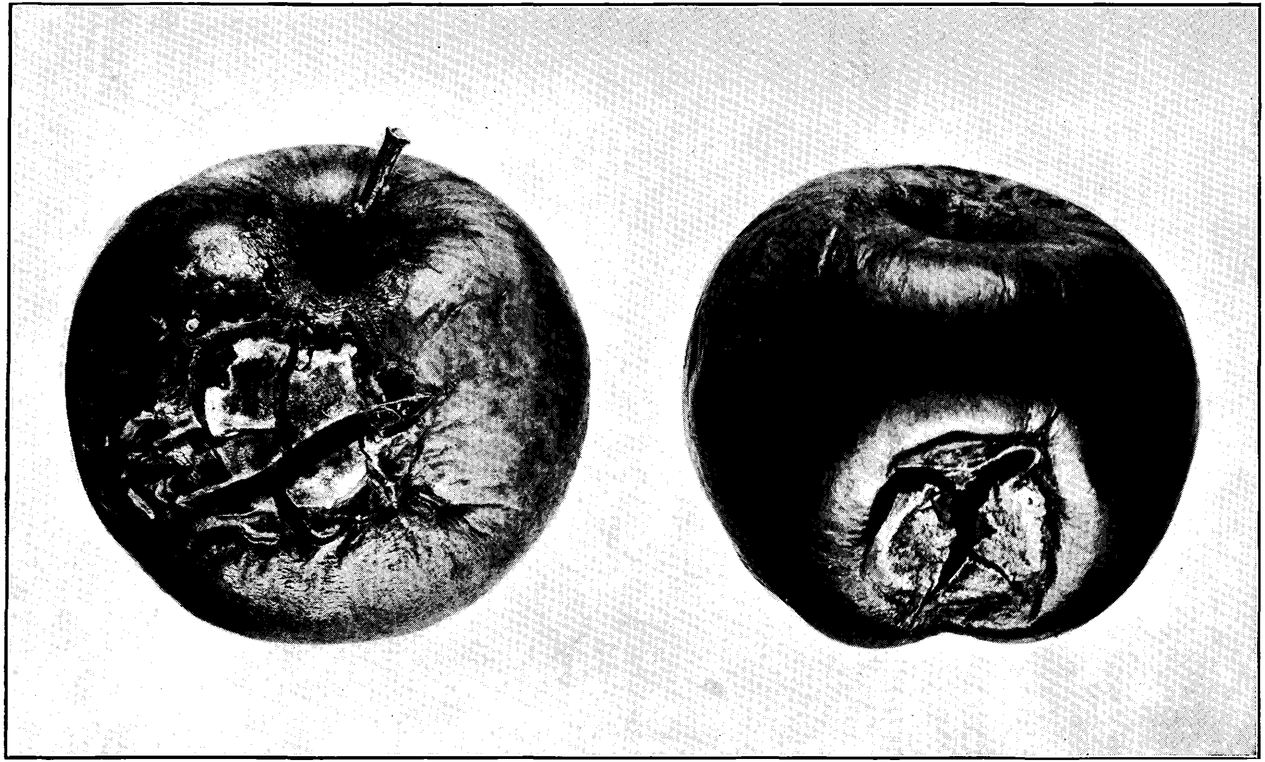
In regard, however, to the relation of spraying to sunscald of fruit, these observers are of divided opinion. Of 12 replies 8 state that spraying during the heated term increased the degree of damage. The others consider the injury due to sunburn pure and simple.

The writer inclines to the belief of the majority of his correspondents, to the extent that *spraying during the hot weather appeared to increase the severity where injured areas were present before this last spray was applied.* Whether or not the chemical nature of the spray has any influence in raising the degree of injury produced is still an open question. As the data for 1911 shows, the amount of scald varied directly with the strength of lime-sulphur spray used. On the other hand the injury on the lead arsenate plots, although considerably less in amount, was qualitatively equally serious, as Figs. 8 and 9 indicate. Unsprayed trees suffered no greater injury than shown in Figs. 5 and 6.

The distinguishing characteristics of spray injury as separate from sunscald, given by one of the aforementioned correspondents who attributes the injury of the past season entirely to sunscald, tends to confirm our opinion as just stated. His statement is as follows:

"The sunscald with us (fruit of apple), appeared as discolored sunken spots or maculations with a sharply defined margin. In the case of spray injury the tissues are never sunken, nor is the margin well defined, and the epidermis is scurfy, not smooth as in the case of sunscald. The epidermal tissues are brown and the discoloration more marked immediately beneath the epidermis in the case of sunscald, but in the case of spray injury they present no abnormal appearance."

An examination of Figs. 5 and 6 and Figs. 10 and 11 will lead one to conclude that if such distinctions hold, we have in the illustrations just referred to, sunscald as evidenced by the discolored, more or less sunken spots with rather well defined mar-



Figs. 8 and 9 Ben Davis, sprayed with arsenate of lead. Injury confined to sunscalded areas.

gins; in addition, the epidermis is scurfy, which, according to our correspondent, is a sure sign of spray injury. Furthermore, our observations in 1910 as well as in the past season showed that the tissues beneath the epidermis became discolored and depressed as well from spray injury alone as from the sunscald of the past summer.

In comparing the amount of scald on trees sprayed with lime-sulphur and bordeaux mixture, it is seen that the percent of injury in the latter plots is very small indeed. This is in accord with the consensus of observation of other men. In short, while lime-sulphur inflicted a very moderate percent of damage in connection with the sunscald, bordeaux seemed to effect far less; and the same holds true for lead arsenate when used alone. The *degree* of injury, however, was as severe on the two last named as on the lime-sulphur plots.

The most feasible explanation of the past season's fruit injury (except, of course, the well known bordeaux injury) is, in the writer's opinion, that which regards the spray as an injury producer only on those tissues already affected by sunscald. This may be accounted for, according to the results at Highmoor Farm and at Greene, by the fact that on trees subjected to the first application only, (Fig. 5) and on unsprayed trees observed elsewhere, (Fig. 6) the injury, while sufficient to throw the fruit out of market class, was nevertheless much less accentuated than the scalded spots on fruit sprayed during the extreme heat.

The chief point to be emphasized is, that *the excessive injury upon the sprayed fruit was distinctly confined to the previously or contemporaneously sunscalded areas.* Figs. 10 and 11 show two extremes of injury on sunscalded apples from the lime-sulphur plots, selected from a series of photographs showing gradations in order of severity. Figs. 8 and 9 illustrate similar injury on fruit sprayed with lead arsenate alone.

COOPERATIVE EXPERIMENTS AT GREENE.

The Philbrook Orchard.

This is a Baldwin orchard pastured to sheep. The trees are fairly high headed, and give evidence of being in tolerably good condition. Judicious pruning might well be carried out here, for some of the trees had too much growth in the center of their tops.

The material used was supplied by the Station and consisted of the lime-sulphur concentrate and arsenate of lead used in the first two sprayings at Highmoor. It was, therefore, used at the same dilution as in plot C (p. 9). This also holds true for the other experimental plots in Greene.

The first application on May 16 occurred before blossoming, although closer to that period than would generally be recommended. Two or three days earlier would have been more seasonable, had conditions permitted. No damage, however, resulted to the buds just ready to open. The second application was on May 31 and the third on June 16.

The spraying in this experiment could not be carried on under circumstances approaching ideal conditions. Power was obtained from the ordinary hand-pump barrel sprayer, and the short spray rods and hose did not permit easy access to the large trees or allow such effective work as was desired.

Results. No spray injury was noted in this orchard at any time during the season. The same conditions that made for healthy foliage and clean fruit at Highmoor obtained here. Some slight insect injury was noted, and this was more severe on the unsprayed than on the sprayed trees. On the former browntails were decidedly in evidence.

A very slight amount of scalded fruit was first noted on August 30. This orchard, as well as the next one to be considered, was markedly free from this injury. This is doubtless due to the fact that the tops were fairly dense and the fruit well protected from the sun.

The data for this orchard was taken under handicaps; no assistance was available to the writer, owing to the great scarcity of labor at this particular time. In view of this fact, and of the absence of scab and sunscald, coupled with the limited amount of time, indicative rather than exact data had to be taken. For this over 2000 apples from the sprayed plot and an almost equal number from the unsprayed trees were selected at random from different parts of the barrels. These were examined solely for insect injury.

The results as given in the combined tables for the coöperative work (p. 25) will show a ratio of sprayed to unsprayed fruit of 9 to 24 percent respectively. The percent of the sprayed fruit is higher than need be, even considering the pos-

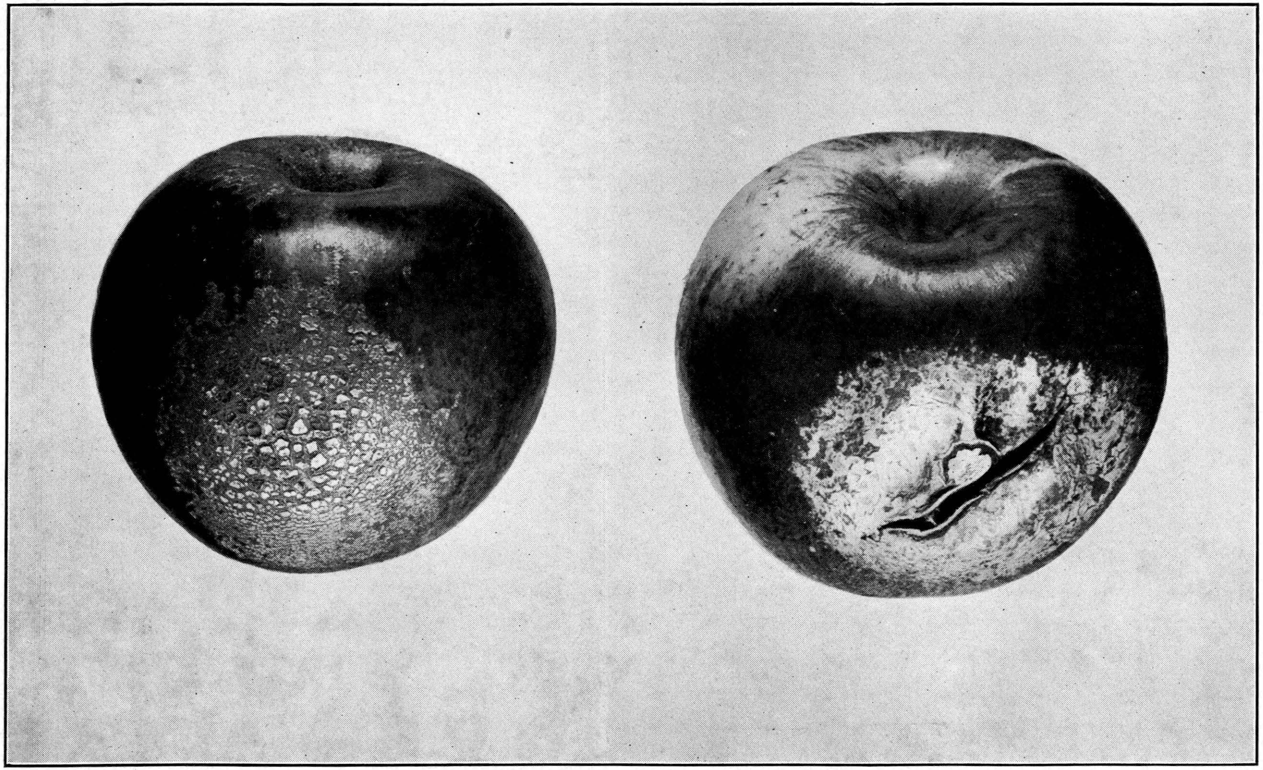


Fig. 10 Ben Davis ; sunscald, followed by lime-sulphur spray. Initial stage.

Fig. 11 Ben Davis. Similar injury of greater degree.

sible errors in methods of examination. It could doubtless have been reduced two-thirds with adequate equipment and more open growth of tree.

The Coburn Orchard.

Here were selected 12 scattered trees of four varieties,--4 McIntosh, 3 Baldwin, 3 Greening and 2 Ben Davis. With the exception of 2 McIntosh trees standing in the corner of an oat field, the trees were in sod.

The applications here also were made with a hand pump, but with longer leads of hose and longer spray rods than in the case aforementioned. The barrel was mounted on a stone boat, which allowed a closer approach to the trees, and the applications were in consequence somewhat more satisfactory than in the Philbrook plot.

The application before petal fall had to be omitted here, as the period of bloom was too near at hand to warrant risk of injury to the flowers. The first application, therefore, was after petal fall, on May 31. The second and last was on June 16.

Results. No spray injury to foliage or fruit was observed during several inspections throughout the season. A very moderate amount of sunscald was noted on Baldwin and Greening apples and considerably less on McIntosh and Ben Davis.

On August 30 the fruit in general was excellent in appearance; foliage likewise, except that there was increasing evidence of the blister mite (*Eriophyes* sp.). On one or two fruits of McIntosh, an exceptionally susceptible variety, scab was noted in small amount.

The Keyser Orchard.

Twenty-four vigorous bearing trees in two rows of 12 trees each were here selected, consisting of 19 Baldwins, 3 Greenings, and 2 Ben Davis. The aisle between these rows had been used as a garden and cultivated for 7 years; the bounding aisles had been cultivated every other year during the same period and seeded to clover. The year of the experiment the entire block was plowed about June 1 and cultivated up to July 6.

The first application occurred on May 31, as here also the early spraying before buds opened had to be omitted. Both this application, as well as the last on July 21 were made with the Niagara carbonic acid gas sprayer and were very thorough in every respect.

The weather during these and all other applications in the Greene orchards was favorable. As the town is only 6 miles from Highmoor, the conditions described for the latter locality will apply fairly well for the coöperative work.

Results. By July 21 considerable sunscald had been produced. This was common to all trees, irrespective of the nature of the spray. Aside from the 24 trees in question, the rest of Mr. Keyser's orchards had been treated with the insoluble lead arsenate alone. Unsprayed orchards in the vicinity showed injury of similar nature and of equal amount.

The foliage here, as in all other plots considered in this bulletin, was most excellent. Scab was practically absent and the same was true of chewing insects.

No ill effect of the spray itself was found either on fruit or leaves. The adhesive power of the mixture was here, and in all the experiments under discussion, excellent.

The table on page 25 indicates the results. The same statement regarding the curculio-injured and the "wormy" fruits in the table of the Highmoor results (pp. 14 and 15) holds true here, except that the wormy apples in the Philbrook plot consisted almost entirely of injury done by the codling moth and other chewing insects. In the case of both Mr. Coburn's and Mr. Keyser's plots the conditions allowed for a full count of all the fruit on the trees.

Discussion. The results of the three plots at Greene may be briefly considered as a whole. As at Highmoor, we have this year learned nothing regarding the efficiency of lime-sulphur as a fungicide, since the development of fungi was practically prevented by weather conditions.

The use of a gas sprayer in making the applications produced no injury that could in any way be ascribed to it.

Where sunscald occurred, the injury was increased by later applications, irrespective of their chemical nature.

No foliage injury occurred from the use of lime-sulphur and lead arsenate combined.

Russeting in all these plots was so utterly insignificant in amount as well as degree that whether the few cases were due to natural agents or to spraying is totally immaterial, so far as the production of high grade fruit is concerned.

TABLE 9.

Data of Coöperative Experiments, 1911.

Orchard.	Number and Variety of Trees.	Number of apples.	Stung. Number.	Stung. Per cent.	Scalded. Number.	Scalded. Per cent.	Wormy. Number.	Wormy. Per cent.	Russeted. Number.	Russeted. Per cent.	Scabby. Number.	Scabby. Per cent.
Keyser........	2 Ben Davis.................	1,988	778	39.1	10	0.5	35	1.7	5	0.2	–	–
	3 Greening...................	4,311	1,679	38.4	84	1.9	87	2.0	112	2.5	6	0.1
	19 Baldwin...................	41,664	5,261	12.6	1,042	2.5	1,198	2.8	189	0.4	–	–
Total........	24	47,963	7,718	16.0	1,136	2.3	1,320	2.7	306	0.6	6	0.01
Coburn........	2 Ben Davis.................	3,064	1,368	44.6	7	0.2	78	2.5	4	0.1	–	–
	3 Baldwin...................	9,030	994	11.0	82	0.9	492	5.4	25	0.2	–	–
	3 Greening...................	7,389	693	9.3	196	2.6	293	3.9	7	0.09	12	0.1
	4 McIntosh...................	4,411	600	13.6	12	0.2	176	3.9	6	0.1	112	2.5
Total........	12	23,894	3,655	15.2	297	1.2	1,039	4.3	42	0.1	124	0.5
Philbrook......	12 Baldwin.................	2,065*	Sprayed.........................				497	24.0				
	3 Baldwin...................	2,698*	Unsprayed.......................				245	9.0				

* Number of apples counted. For explanation of data from this orchard see page 22.

As in Table 8, the number of fruits indicated in the "Stung" column includes all apples with wart-like deformities, the cause of which is not known.

The apparently numerically large number of "wormy" Baldwins in Mr. Keyser's plot is not so great as it appears,—being but 2 percent. Here also, as at Highmoor, very few "wormy" apples were caused by the codling moth. The same statements made regarding such fruit in the discussion of the Highmoor results (pp. 14 and 15) hold for this case.

The scab on Mr. Coburn's McIntosh apples undoubtedly developed in storage during the damp weather intervening between harvesting and sorting. But few infections of the fungus were observed on the trees and the above is the only reasonable explanation of its increase.

Conclusions.

Regarding the several experiments as a whole, it is evident that the observations group themselves into two general divisions; one associated with a certain unusual, or perhaps we may say abnormal factor, distinctly associated with one seasonal period. To this factor, i. e., excessive heat, may be ascribed certain definite effects.

The other observations are associated with climatic conditions, the effects of which can only be considered to advantage on the normal or average results of many years. One year will vary from another in its total precipitation or in the relative times of the rainy periods, and upon such conditions the great prevalence or comparative absence of parasitic fungi may rest. Another year may be unfavorable to fungous epidemics and at the same time bring an invasion of insect pests. Again, these two groups of orchard enemies may combine forces, or on the other hand, the seasonal conditions may coincide with the presence of inhibitive factors to result in the absence of both fungus and insect injury to any practical degree.

This last named condition seems to have existed during the past season. Hence there is no data of any great value for estimating the fungicidal or insecticidal value of the sprays.

In the case of fruit russeting, none of the percentages from any plots are high and all are so nearly alike that no deductions are warranted. The relation of lime-sulphur injury to strength of solution is not indicated in any way. Again, if the same percent of injury can be secured from both the lime-sulphur-lead arsenate combination (plot E), and the insoluble arsenate used alone (plot E); and if a double dose of arsenate (i. e., 4 lbs. to 50 gals.) used alone produces injury half as great as the 2 to 50 formula, it is difficult to point out any results that may well be attributed to chemical action.

Furthermore, the gas sprayer cannot well be held accountable for the results on the lime-sulphur plots at Highmoor, since these are contradicted by the results in the Keyser orchard at Greene, where the nature of the application was identical.

The following facts must also be kept in mind. The russeting in 1911 was in large measure no more severe than the "natural" russeting found on unsprayed trees. The weather conditions, according to past experiences, were adverse to the production of russeting; nevertheless, in a season almost ideal for the development of fine fruit, the bordeaux mixture was still able to effect a very high percent of injury (Table 8). The cause of the latter is well known to be indirectly due to meteorological factors acting upon the insoluble spray. Why may not such factors, if they are able to effect bordeaux injury in a comparatively favorable season, produce some damage to fruit otherwise treated? It would at least seem probable that if the sprays themselves (not including bordeaux) were primarily responsible, that some indication would have shown itself in the form of leaf injury on the plot treated with lime-sulphur solution 20 percent in excess of the recommended strength.

In general, then, we are led to the same conclusions published in last year's bulletin on this point,*—namely that spray injury may be, and very likely is, due as much to a physical factor, i. e., the application of a mist or spray to growing plant tissues under extreme, or some now undetermined, but unfavorable, meteorological conditions, as to any chemical action of the material used. Certain it is that spraying should be avoided if possible during such extreme heat as was experienced in Maine in July 1911.

Fruit growers must not be discouraged by the above statement into abandoning spraying operations. Granting the great-

* Me. Agr. Exp. Sta. Bul. 189, p. 69.

est amount of injury obtained under the conditions of 1911, it is seen that from the commercial standpoint the injury is altogether negligible in comparison with the advantages of annual crops of clean, worm-free fruit. Spray applications must, of course, be made at fairly definite, and in some instances at very definite, periods of the season. At times of unsettled weather or during very hot periods the orchardist must exercise his judgment with a view to applying his spray at an opportune time both in regard to making it effective and at the same time to avoid all possible ill effects that might be induced by unfavorable weather.

It is unlikely that a heat wave of such severity as that of last summer will be known in Maine for many years,—perhaps decades. Hence this question of sunscald in relation to spray injury will prove to be more a matter of scientific interest than a practical obstacle to the fruit grower. It is probable that with the highest of summer temperatures common to this State experiments with the spray pump can be made which will throw some light upon the relation of physical to chemical factors in this problem.

APPENDIX.

A.—Expressing Ingredients in Spray Formulas.

In discussing spraying experiments it is customary for authors to indicate the proportions of the materials used in a definite order. In general, the formulas for bordeaux mixture are given in the following order: Copper sulphate in pounds, lime in pounds, and the volume to which the ingredients are to be diluted with water, in gallons. Sometimes the amount of lead arsenate is inserted between the figure representing lime and that indicating final volume.

For example: 3-3-50 bordeaux mixture means that 3 pounds copper sulphate and 3 pounds of stone lime are used to make a spray solution of 50 gallons. 3-3-2-50 means that 2 pounds of lead arsenate have been added to the bordeaux of the strength indicated, *after* said mixture has been made and is ready to be applied.

A similar rule applies to the formulas for making the home boiled concentrated stock solution of lime-sulphur. In this case, however, authors differ in the order of stating the ingredient amounts. Some give sulphur in pounds, lime in pounds, and dilution volume in that order. Others reverse the order of lime and sulphur weights. In practically all cases the order of ingredients in the formula is stated by the author.

Lead arsenate may be inserted in the lime-sulphur formulas as indicated in the example for bordeaux mixture.

In diluting the stock solution of lime-sulphur, either for a dormant spray or for summer use, the number of gallons precedes the total volume of mixtures ready for use. Thus, $1\frac{3}{4}$-50 indicates $1\frac{3}{4}$ gallons of concentrate diluted with water to a volume of 50 gallons.

B. Directions for Making Concentrated Lime-Sulphur Solutions.

The directions given in former publications of this Station for the preparation of the stock solution have been superseded by the more recent chemical investigations referred to in this bulletin. The formula recommended is as follows:

Stone lime	40 lbs.
Sulphur	80 lbs.
Water sufficient to make..................	50 gals.

Larger or smaller amounts can be made by multiplying or dividing respectively these quantities.

The lime must be of high grade, not less than 90 percent pure; no lime should be used that contains more than 5 percent of magnesium oxide. The sulphur should also be high-grade, either in the form of flowers of sulphur or sulphur flour. Do *not* use ground brimstone.

Place lime in the cooker. Make a thin paste of the sulphur with hot water and note the amount of water so used. Slake the lime with this paste, taking care neither to drown nor burn the lime in the process. Add water sufficient to make a total of 50 gallons. Bring to the boiling point, and boil vigorously for 1 hour, stirring frequently.

Before boiling begins the volume of liquid should be determined by a measuring stick. As the mixture boils, some of the water will evaporate. It is, therefore, necessary to determine the loss at short intervals by means of the stick and to add water up to the original volume. If this is attended to frequently the water can be added without stopping the boiling of the liquid to any extent.

At the end of the hour the solution should be allowed to settle and should then be dipped out and strained through a fine sieve into a barrel or other container. Its density should not be determined while hot.

The surface of the liquid should be protected from the air by a layer of heavy mineral oil. By putting a spigot in the lower end of one of the staves the liquid can be drawn off from time to time, its surface will remain protected and no oil will go into the diluted spray. Stock solutions made and protected in this way can be put up in considerable amount in the months preceding the spraying season.

The most convenient vessel in which to make the concentrate is some form of iron stock feed cooker. Such vessels are made in various capacities. The size of cooker to be used should have a volume somewhat greater than the amount of concentrate to be made at one boiling; that is, a 50 gallon vessel will probably not hold 50 gallons of spray mixture, owing to the lime and sulphur present in addition to the volume of water. A cooker of about 35 or 60 gallons capacity should be large enough to make a stock of 25 or 50 gallons respectively.

This process is simple and requires but little experience. After one or two batches have been made, it will be found that if directions have been followed, the density of the several batches will not vary beyond a degree Beaumé, and frequently less. There should be the very slightest amount of sediment in the cooker after the liquid has been removed.

For very extensive spray operations in large orchards the concentrate can be made in larger amounts than 50 gallons at a time. This is not recommended, however, for the average Maine fruit grower.

Directions for making the self-boiled lime-sulphur mixture are not given. This preparation has in practically all cases been found to have much less fungicidal value and to be far less adhesive than the boiled solution. Directions for making it may be found on pp. 385-386 of Bulletin 185 of this Station.

C.—Dilution of Lime-Sulphur Concentrated Solutions.

Although fairly well understood, it is advisable to emphasize the fact that concentrated lime-sulphur sprays, commercial or home made, cannot be used with success by guess-work dilutions. The density of the concentrate must be determined by a hydrometer and the dilutions made according to the reading of the instrument and the dilution table.

Since the publication of the dilution tables in the bulletins of this Station in recent years, additional work has been done elsewhere relating to the chemistry of the lime-sulphur compounds and the most economical and effective dilutions to use.

The table * on p. 32 is recommended. The figures in parentheses are the number of gallons for the respective densities, determined to the hundredth part of a gallon. *The numbers in heavier type are the practical amounts to use.*

In practice, then, the first step is to determine the density with the hydrometer. Knowing the density, the table shows the amount necessary per 50 gallons of spray. Next, find the weight of a gallon of concentrate; then figure out the weight of the respective fraction shown in the table. The height of this latter amount of liquid can then be marked on a measuring stick. This, of course, need be done only once for each stock of concentrate.

For example, with a stock solution reading 31° Beaumé, having made a measuring stick showing the height in the measure of 2-5 of a gallon, it is only necessary for summer spraying to pour 1 2-5 gallons of the concentrate into a mixing barrel or barrel pump of 50 gallons capacity, fill with water and stir. Greater amounts are of course made in proportion.

Do not add arsenate of lead in any case until ready to apply the spray. It should be thoroughly stirred into the solution. 2 or 3 pounds to 50 gallons is considered sufficient. It should be thoroughly mixed with a few gallons of the water that go to make the total volume of spray so that it may be in a finely divided state and pass readily through the sieve.

* Based on Table XI, Bul. 329, N. Y. (Geneva) Agr. Exp. Sta.

TABLE 10.

Stock Solutions.

Hydrometer reading. Density of solutions in degrees Beaumé.	Gallons of solution in 50 gallons of spray. (To be used when trees are not in leaf; for aphid eggs and scale insects.)		Gallons of solution in 50 gallons of spray. (Summer spray; for scab and other fungi.)	
36	**5.6**	(5.55)	**1.1**	(1.11)
35	**5.7**	(5.71)	**1.2**	(1.15)
34	**6.1**	(6.06)	**1.2**	(1.20)
33	**6.3**	(6.25)	**1.3**	(1.25)
32	**6.7**	(6.66)	**1.3**	(1.32)
31	**6.9**	(6.89)	**1.4**	(1.37)
30	**7.4**	(7.40)	**1.5**	(1.46)
29	**7.7**	(7.69)	**1.5**	(1.52)
28	**8.3**	(8.33)	**1.7**	(1.61)
27	**8.7**	(8.69)	**1.8**	(1.79)
26	**9.5**	(9.52)	**1.8**	(1.80)
25	**10.0**	(10.00)	**1.9**	(1.92)
24	**11.1**	(11.11)	**2.1**	(2.06)
23	**11.8**	(11.76)	**2.2**	(2.19)
22	**13.3**	(13.33)	**2.4**	(2.35)
21	**14.3**	(14.28)	**2.5**	(2.53)
20	**15.4**	(15.38)	**2.7**	(2.73)
19	**16.7**	(16.66)	**2.9**	(2.94)
18	**18.2**	(18.18)	**3.1**	(3.12)
17	**20.0**	(20.00)	**3.3**	(3.33)
16	**22.2**	(22.22)	**3.6**	(3.57)
15	**25.0**	(25.00)	**3.9**	(3.92)

BULLETIN No. 199.

ORCHARD NOTES.

W. W. BONNS.

INTRODUCTION.

From 1891 to 1907 the results of the experimental work in pomology obtained by the late Dr. W. M. Munson were for the most part published by the Station from time to time under the title "Orchard Notes."

From 1907 to 1909 the Station carried on no investigations upon orchard problems. The present accumulation of data on orchard management, together with notes of pomological interest, is the first publication under the old title since the re-establishment of work in orcharding in 1909. The change in personnel that becomes effective April 1, 1912, makes it advisable to publish at this time the observations of the past two years on orcharding.*

Previous to 1909 the experimental work in pomology was carried on under considerable handicap. On account of soil and climatic conditions, the location of the Station at Orono is not favorable for experimental studies with the varieties of fruit grown in the apple sections of the State. Hence such work was of necessity much restricted and dependent upon the generosity of individuals sufficiently interested in the pomological development of the State to place part of their orchards at the disposal of the Station.

*The accounts of the spraying experiments in 1910 and 1911 have been published separately (Bulletins 189 and 198 of this Station) and no discussion thereof will herein be given.

Under such conditions valuable and interesting data was obtained. At the same time it was clearly recognized that the prime requisite for the accumulation of data on orchard management and for the proper attack of scientific orchard problems, upon the solution of which depend the fundamental practices of pomology, was the use of land for orchards for a continuous, indefinite period. Such work could only be successfully prosecuted by this Station in the Maine apple region in orchards under State ownership.

The legislative appropriation and subsequent purchase of Highmoor Farm, Monmouth, in 1909 met the necessary conditions in regard to ownership. The condition of the trees, however, at the time the Station assumed control in the summer of that year was such that only a small part of the orchards was suitable for any real work of investigation. It was therefore imperative that the orchards as a whole be brought into vigorous condition before they could be regarded as proper media for experimental work. The need for restoration as a prerequisite for experimentation is obvious from a consideration of the orchard conditions in the fall of 1909.

Condition of Highmoor Orchards, 1909.

The orchards at Highmoor Farm, consisting originally of 5000 trees, were set out about 25 years previous to the above date. No records are available giving data upon the exact year of planting, the number of each variety set, the replacing of the original trees or the subsequent treatment of the orchards. The trees received indifferent, if any, treatment at times, according to the ideas of the several owners who preceded the Station. Some plots were evidently fertilized occasionally with barnyard manure, but there is no evidence that any system of intelligent orchard management had been followed and no attempt had been made to handle the trees by up to date horticultural practices up to the time the Station came into possession. On the contrary, persistent neglect seems to have been the case for many years.

The number of trees in the orchards proper in the fall of 1909 was a little over 3100, set 25 by 25 feet apart. With the exception of a small block of about two score trees near the farm buildings, which will not be considered, and a scattering

Fig. 12. Average Tree in Baldwin Orchard, Oct. 1909.

Fig. 13. Young Tree in Baldwin Orchard, July 25, 1911. Seasonal Growth extends above point indicated by hand.

of odd varieties along the roads and in pasture fields, these trees were grouped in five large blocks; one consisted chiefly of Baldwin trees, another of Baldwin and Ben Davis with the admixture of a few Russet, Greening, Mann and Tolman Sweet. The remaining three divisions were practically solid blocks of Ben Davis. According to their composition these orchards are known as the Baldwin, Mixed and Ben Davis Number 1, 2, and 3 respectively.

All of the orchards were at the time of purchase covered with a thick sod of witch grass.

The Baldwin orchard was in the very poorest condition of all. The trees averaged about 10 feet in height and 4 inches in diameter. The heads were high and scant, had very little and poor foliage, bore practically no fruit and appeared to be very badly starved. (Fig. 12) In addition to injury by borers, mice and fungi, the trees had several times in the past been severely damaged by fires in the orchard grass.

The Mixed orchard ranked nearly with the Baldwin in its unsatisfactory condition. The trees were somewhat lower, with an average diameter a little greater than the Baldwin plot. The foliage was also somewhat more abundant, but the trees as a whole indicated great lack of vigor and many were beyond profitable renovation.

Ben Davis No. 1 comprised the greatest number of trees in any one plot, and although in quite unsatisfactory state when the farm was purchased, was in a general condition that promised response to good handling. The trees were mostly well formed, quite uniform, about 15 feet high and 6 inches in diameter, excepting those of more recent planting. The foliage in 1909 was moderate, but not normal in amount or color and suffered a severe attack of fungus leaf spot.

Ben Davis No. 2 was in by far the thriftiest state of all the orchards. The trees were well headed, averaged about 20 feet in height and about 7 inches in diameter. The foliage in 1909 was fair in amount, although not normal in appearance. This orchard had in the past received more attention in the way of plowing and manuring than the others, and at one time had been used as a sheep pasture. These facts account in a large measure for its superior condition. This was the plot reserved for experimental work.

Ben Davis No. 3 gave little promise. This orchard was younger than any of the others, as the trees replaced those originally set which were destroyed by mice, fires in the orchard grass and by lack of drainage, as this was one of the few blocks where water had a tendency to stand. Nearly all the trees were small, lacked vigor, and in many cases were not well rooted. Little was to be expected from this block.

The age and size of the trees varied in nearly all blocks, according as new trees supplanted those destroyed by various agencies. This fact, together with the years of neglect and lack of plant food, made it difficult to more than guess at the age of the trees on the basis of size.

With the exception of Ben Davis No. 2, already noted, the general condition of the trees was extremely bad. The vast majority had never known a pruning knife; fully 75 percent on a general average, had been and were being injured to varying degrees by apple tree borers and girdled by field mice. The damage inflicted by the latter and by insects such as the codling moth, leaf curler, case bearers, tent caterpillars and curculio was very great, and fungus parasites such as leaf spots and scab reduced the vitality of the foliage and damaged the fruit. In addition, the bark of a great number of trees was badly encrusted with growths of lichen.

Aside from the injuries due to living organisms, nearly all the trees showed marked symptoms of lack of plant food. The foliage was notably scant and deficient in healthy green color. Some trees of about two inches in diameter and not over five feet high bore small unmarketable apples,—an indication that injury to the food supply channels had shortened life and abnormally hastened maturity. The continued existence of a thick grass sod had checked the tendency to deep root growth and had reduced the moisture of the soil. The trees were in consequence shallow rooted and not equipped to withstand a season of drought to best advantage.

Only one plot, Ben Davis No. 2, bore fruit to any extent in 1909, although the trees bloomed more or less abundantly in nearly all parts of the orchards. The harvest yielded but 200 barrels, of which only 90 could be packed for market.

In general, then, it may be said that the orchards at the time they came under Station control were in notably bad condition.

Some trees were damaged beyond hope of repair. Others were in doubtful shape, indicating but a chance of response to good treatment. The rest, so far as surface indications warranted, were capable of being brought into thrifty profitable condition by proper methods of orchard renovation.

Table 11 indicates the condition in the several plots.

TABLE 11.

Survey of Orchards, September 1909.

PLOT.	Acres.*	Number of trees.	TO BE REMOVED.		TOTAL NUMBER IN POOR CONDITION.	
			Number.	Per cent.	Number.	Per cent.
Baldwin	6.4	447	149	33.3	276	61.7
Mixed	7.4	514	105	20.4	304	59.1
Ben Davis, No. 1	17.8	1,233	152	12.3	230	18.6
Ben Davis, No. 2	7.6	529	37	7.9	71	13.4
Ben Davis, No. 3	6.0	418	156	37.3	244	58.3
Total	45.2	3,141	599	19.0	1,125	35.8

* Acreage estimated on basis of trees existing and not on actual area covered by orchard.

The survey on which the above table is based was made in the fall of the year. Little could be done in the months that preceded in the way of renovation work, as the farm did not come into Station control until midsummer. Nevertheless an attempt was made to check the ravages of insects and fungi by spraying with bordeaux mixture and lead arsenate. About the last of June the trees received a moderate application of chemical fertilizer containing the three necessary elements, nitrogen, phosphorus and potash, at the rate of 300 lbs. per acre. Apparently the witch grass received all the benefit from this, judging by its thrifty condition in September of that year. The trees had to all appearances profited nothing.

In the fall of this year (1909) the orchards received their first pruning. The immense amount of intertwined growth that formed the tops of the trees made necessary a plan of pruning somewhat different than is uusually conducted annually in an orchard in thrifty condition. Had all the wood been removed that season that was necessary for the proper shaping and thinning out of each tree, the result would have been a stimulus to wood growth that would doubtless have delayed the production of fruit for several years. It was, therefore, decided to extend over a period of at least three seasons pruning that might properly have been done at that time, thus gradually shaping the trees to the desired form and at the same time allowing greater opportunity for the formation of fruit buds by avoiding undue vegetative stimulus.

Renovation Work 1910-11.

It was not until the spring of 1910 that general renovation work was started. This included thorough cultivation from early spring until the end of July, the application at plowing time of lime at the rate of 1000 lbs. per acre, followed shortly thereafter by 1500 lbs. per acre of high grade complete chemical fertilizer of 3.3-10-7 formula.* Applications of insecticides and fungicides in the form of lead arsenate and bordeaux mixture were made at the proper times. At the close of cultivation cover crops of vetch or rye were sown, except in one orchard where weeds were allowed to form the winter cover. Twice during this season each tree was carefully examined for borers.

Notable improvement was shown as the result of the first year's work. The large Ben Davis No. 1 showed marked response to treatment and gave promise of good fruit production the next season. Ben Davis No. 2 was as a whole in good condition and superior to all other blocks. Ben Davis No. 3 showed a scattering of thrifty trees; the remainder were removed, as their size, condition and lack of response to treatment rendered them useless for any future experimental work.

For the same reasons it was necessary to remove the orchard of mixed varieties almost in its entirety. So shallow rooted were the trees in this block that practically all were pulled up with their roots with one pair of horses. In many cases the roots ran for 15 to 20 feet from the trunk within 8 inches of the soil surface.

The Baldwin orchard had been reserved in the spring of 1910 for a purely practical renovation experiment, and in the fall of that year this block was squared up into definite shape

* A fertilizer containing 3.3 percent of nitrogen, 10 percent of available phosphoric acid and 7 percent of potash.

for that purpose. On account of its extremely poor condition in 1909 this block showed less marked improvement at the end of one year's treatment than did the others.

The season of 1911 repeated the general operations of 1910 in the several non-experimental blocks, with one or two exceptions; no lime was applied and the amount of fertilizer used per acre was 1000 lbs. of 4-8-7 composition. Lime-sulphur was used as the fungicidal spray in all the orchards in place of bordeaux mixture. Lead arsenate was added as usual to the former to control leaf and fruit destroying insects.

The close of the growing season and the subsequent harvest of the past fall gave results that not only were satisfactory to the Station but should be of interest to fruit growers in the state who are confronted with the problem of orchard renovation.

The Baldwin orchard, apparently in hopeless condition two years previous, has made remarkable progress. (Fig. 13). The trees are fast becoming firmly rooted; the wood growth averaged about 12 inches, the foliage was especially noteworthy for its dark healthy color, great mass and size of leaves and the persistence with which it adhered. Although killed by frost, the foliage in this orchard was still on the trees, not in isolated patches, but as a mass, up to the first of December.

No great amount of fruit was borne here; this was to be expected in view of its former condition. Nevertheless, the larger trees averaged in a number of cases 2 or 3 barrels of large, well colored fruit per tree.

Ben Davis No. 1 has in two seasons been transformed from an unprofitable unthrifty block into a vigorous, bearing orchard, and is now in condition to be used for experimental purposes. The foliage, wood growth, yield and character of fruit left nothing to be desired.

Ben Davis No. 2 (omitting certain experimental plots to be considered later) increased in general thrift, and more than doubled its fruit production over the preceding year. Similar improvement occurred in Ben Davis No. 3 and the trees not in orchard blocks.

The necessary removal in 1910 of the greater part of the block of mixed varieties, the shaping up of the Baldwin orchard and the weeding out of the hopeless trees in Ben Davis No. 3

reduced the total orchard area given in Table 11 to 33 acres,—making, with the addition of the scattering trees, a total of about 2300 in the fall of 1911.

A comparison of the yields (Tables 12 and 13) from 1909 to 1911 inclusive emphasizes the progress more concretely.

TABLE 12.

Annual Yields, 1909-1911.

Year	Number of trees (approximate).	Total yield in barrels.	Marketable.
1909	3,100	200	90
1910	2,300	350	275
1911	2,300	2,450	2,336*

* Consisting of 2,006 barrels of Fancy and No. 1 grades and 330 barrels No. 2 grade.

TABLE 13.

Annual Yields by Orchards.

1910.		1911	
Baldwin }		Baldwin...	154
Ben Davis, No. 1 }	146	Ben Davis, No. 1	1,600
Ben Davis, No. 3 }		Ben Davis, No. 3 }	231
Scattering }		Scattering }	
Ben Davis, No. 2.	204	Ben Davis, No. 2.	465
Total	350	Total	2,450

The foregoing account of the conditions existing at Highmoor three years ago and of the results since obtained has been made with recognition of the fact that the work so far described has had in itself nothing of experimental nature. Such work was simply a matter of necessity, being incidental to the establishment of the necessary conditions requisite for experimental plots.

On the other hand, while the function of the Station lies in general outside the sphere of purely demonstration work, these results, secondary as they are from the experimental point of view, have value in indicating the possibilities of this kind of work in the neglected orchards throughout the state. What has been done in the Station orchards can be accomplished elsewhere with equal success by the use of a proportionate amount of intelligently applied effort and judicious expenditure.

The latest available census statistics (1900) on apple production show that of the nine states (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey and Pennsylvania) comprising the North Atlantic Division of the United States, Maine ranks third in the total number of apple trees and seventh in the yield of fruit. In the average number of trees per farm Maine ranks first (104.7), while on the score of yield in bushels per farm this State comes last with a record of 35.6 bushels. While it may be reasonably expected that the census figures of 1910 may show an increase of yield per tree for this State, it must be recognized that the two fundamental problems of the Maine orchardist needing immediate attack are economic. They are (1) increase in the production per unit, and (2) improvement in quality of product.

These are problems in orchard management, involving the factors of soil manipulation, fertilizers and insect and fungus control. As previously stated, the experiments dealing with control of parasites have recently been published by this Station, and the present discussion is confined to the experimental results obtained to date along the other lines.

Of the several million apple trees in this state not over 5 percent, as a conservative estimate, are subject to any regular system of cultivation. Perhaps 25 percent are standing in land pastured to animals,—generally sheep or hogs. The remainder stand in grass, with occasional or no applications of either organic or inorganic fertilizers.

Since these are without doubt the chief conditions relating to the low unit production in this State, they were utilized as the basis for the experimental work begun in 1910.

Experimental Work, 1910-1911.

As stated above, the experimental work up to the present has of necessity been confined to the one block of trees whose average condition and comparative uniformity, together with the prospect of moderate fruit yield, warranted its use for such purposes. Ben Davis orchard No. 2 was divided in the spring of 1910 as follows:

Spraying experiments with fungicides and insecticides	2.00	acres,	(140 trees).
Sheep pasturage experiment	1.10	"	(76 ").
Hog pasturage experiment	1.10	"	(76 ").
Sod plot. (Check)	0.71	"	(49 ").*
Organic fertilizer experiment	1.18	"	(82 ").
Inorganic fertilizer experiment	1.04	"	(72 ").
Total	7.13	acres,	(495 trees).**

The arrangement of the plots is indicated in the following diagram.

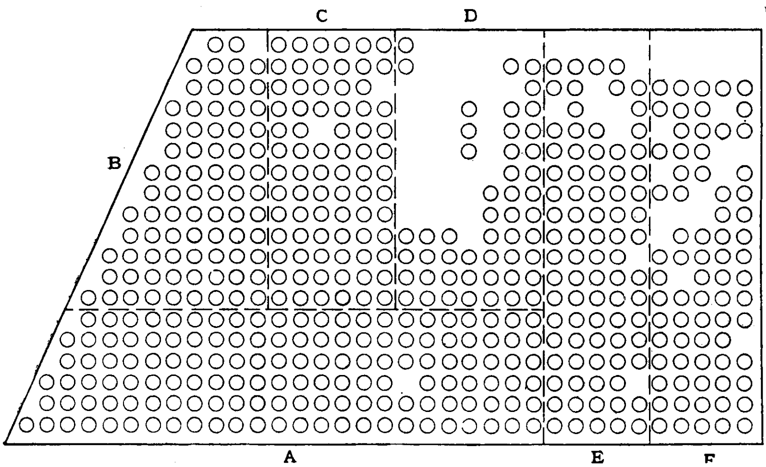


Fig. 14.

Diagram of Experiments, Ben Davis Orchard No. 2, 1910-1911. Diagram.

A.—Spraying experiments. B.—Sheep pasturage experiments. C.—Hog pasturage experiments. D.—Sod plot (check). E.—Organic fertilizer experiment. F.—Inorganic fertilizer experiment.

* The number of trees in this plot was later reduced to 37 by omitting 12 trees adjoining the organic fertilizer plot.

**Tree acreage here given is less than that given in Table 11, p. 37, owing to removal of 34 trees.

Fig. 15. Trees in Plot B, Oct. 3, 1910.

Fig. 16. Trees in Plot D, Oct. 3, 1910.

Fig. 17. Trees in Plot A, Oct. 3, 1910.

Treatment 1910. All six plots were pruned according to the need of each tree and all except A were thoroughly sprayed three times during the season with bordeaux mixture and lead arsenate. Plot A was treated with lime-sulphur and bordeaux according to the experiments described in the publications referred to.

Plots A and F received an application of chemical fertilizer of 3.3-10-7 formula at the rate of 1500 lbs. per acre. Plot E received 6 cords of barnyard manure. No fertilizer was applied to Plots B, C and D during this season. B and C were fenced and 5 sheep and 5 brood sows were turned into the respective plots about the first of May. Sod was broken in A, E and F about the last week in April, and cultivation was continued throughout the season up to August 1. Then winter vetch was sown in these three plots as a cover crop. The animals in the two plots were removed at the close of harvest.

Treatment 1911. Treatment was identical with that of the preceding year, except that all plots, with the omission of E, received 1000 lbs. of chemical fertilizer of 4-8-7 composition. Lime-sulphur and lead arsenate were the spray materials used.

General Notes. Comparative and specific data are given in tables to follow. In general the results so far obtained seem to indicate most strikingly that the chief factor accountable for low production per tree is the lack of cultivation.

It must be remembered that in 1909 the condition of all the trees in this entire experimental orchard, even making due allowance for the few cases of difference in size and age, was not uniform. However, the trees showed no greater differences in vigor or lack thereof than would be observed in any block of trees planted presumably at one time, and having experienced the same treatment or neglect for an indefinite period; and this, of course, holds true for their condition in the spring of 1910.

By the close of the season, however, the difference in amount and color of foliage between the cultivated and the uncultivated divisions was significant. The yield of fruit, although comparatively small for the entire orchard, showed notable plot differences, wherever the size of trees allowed a fair basis of comparison.

The foliage in Plots B, C and D withstood the dry summer of 1910 poorly. Disregarding the early leaf yellowing, for which bordeaux spray injury may have been accountable, the leaves were light in color and small. Lack of vigor and vastly insufficient growth were everywhere evident in the sheep, hog and sod plots. Defoliation began early and before harvest the appearance of the trees was that indicated in Figs. 15 and 16.

In Plots A, E and F the reverse of the above conditions obtained. Foliage was dark green, abundant (Fig. 17) and adhered until frost killed it. No noteworthy differences in this respect were seen between the three plots under cultivation nor between the two pastured to animals. Plot D was in poorer condition, however, than either B or C. The fruit yield, as will be seen later, showed equally strikingly differences.

In 1911, as already noted, it was decided to topdress the uncultivated plots to see if the plant food so applied would show any effect. No decided improvement resulted. The foliage in plots B, C and D was again far inferior in amount, color and size of leaves to that of A, E or F. A few isolated instances occurred in plot C where a tree was prominent among its neighbors for increased vigor. Such were trees around which the hogs had done enough rooting to destroy the sod entirely, and in a way had performed the work of cultivation. It is worthy of note that practically all of the trees in all the non-cultivated divisions that showed any noticeable improvement were on the boundary row of their respective plots,—i. e. one-fourth of their root systems, theoretically, had felt the stimulus of cultivation.

Much of the inhibition to growth of trees in sod is of course accounted for by lack of needed water. The grass roots absorb the greater part of the available surface soil moisture before the latter has time to reach the lower soil. This moisture is lost through the processes of growth, and the soil water from the greater depths is drawn up by physical forces and likewise dissipated through the grass growth.

To a small extent this competition for water between grass and tree roots was reduced in the uncultivated plots in these experiments. The sheep kept the grass well cropped, and the hogs, although they rooted very unevenly, did in a measure check the growth of grass. On the sod plot an attempt was made to conserve soil moisture and check the sod growth by cutting the grass at intervals and leaving it to form a mulch. In none of these divisions, however, was there any observable benefit.

RESULTS.

Notes on the several points presented in the following tables have been made for each tree during the past two seasons. The data is of necessity governed by a personal factor, as must be the case when classifications are made, as they had to be in this work, by general observations. For example, a "showy" bloom in the eyes of one man would appear to be only "full" to another. Nevertheless the data are fairly comparable, since results for both seasons are from the notes of one observer.

Plot A is used as the cultivated plot in these tables as a basis for comparison with B, C and D because of the more uniform size of the trees and the relation of the plots in the orchard (see Fig. 14). The rows in B, C and D are simply the extensions of the respective rows in A.

TABLE 14.

Size of Trees.

	1910.				1911.			
Plot.	Total number.	Per cent. large.	Per cent. medium.	Per cent. small.	Total number.	Per cent. large.	Per cent. medium.	Per cent. small.
A.....	140	38.5	52.1	9.2	139	38.8	51.7	9.3
B.....	76	51.3	42.1	6.5	74	52.7	41.8	5.4
C.....	76	36.8	55.2	7.8	76	36.8	55.2	7.8
D.....	37	48.6	18.9	32.4	37	48.6	18.9	32.4

One tree, it will be noted, was removed at the close of 1910. The great percentage of the trees in all plots are medium or large and of commercial bearing age. In plot D the percent of small trees exceeds that of medium ones.

TABLE 15.

Degree of Bloom.

	1910.					1911.				
Plot.	Per cent. showy.	Per cent. full.	Per cent. medium.	Per cent. scant.	Per cent. none.	Per cent. showy.	Per cent. full.	Per cent. medium.	Per cent. scant.	Per cent. none.
A........	-	92.1	2.8	4.2	0.7	1.4	25.1	30.9	35.9	6.4
B........	-	92.1	6.5	1.3	-	-	1.3	10.8	68.8	18.9
C........	-	90.7	2.6	5.2	1.3	-	5.2	15.7	71.0	7.8
D........	-	54.0	13.5	21.6	10.8	-	-	5.4	62.1	32.4

It will be noted here that the bloom was excellent in 1910, much better, indeed, than in 1911. The flower buds of the former year had of course been formed before the Station acquired the orchards. It is not given for comparison with the bloom of 1911; the noteworthy comparison is that between the above table and those following, showing the percent of fruit actually set, and the yields of the plots.

TABLE 16.

Fruit Set.

	1910.				1911.			
Plot.	Per cent. abundant.	Per cent. medium.	Per cent. poor.	Per cent. none.	Per cent. abundant.	Per cent. medium.	Per cent. poor.	Per cent. none.
A.....	22.1	47.1	27.8	2.8	23.0	53.9	17.2	5.7
B.....	43.4	31.5	22.3	2.6	-	6.7	54.0	39.1
C.....	13.1	31.5	50.0	5.2	-	18.4	71.0	10.5
D.....	16.2	32.4	35.1	16.2	-	10.8	59.4	29.7

Table 17.

Yield in Barrels and Relative Gain or Loss.

	1910.			1911.			
Plot.	Number of trees.	Number of barrels.	Per cent. of total.	Number of trees.	Number of barrels.	Per cent. of total.	Per cent. gain or loss in 1911.
A...	140	121.25	73.37	139	254.50	81.66	Gain, 109.89
B...	76	25.00	15.12	74	13.40	4.30	Loss, 46.40
C...	76	9.00	5.44	76	32.18	10.32	Gain, 257.55
D...	37	10.00	6.05	37	11.54*	3.70	Gain, 15.40
Total.........		165.25		Total...	311.62		

* Of this yield 7.54 barrels were picked from 11 trees bordering on Plot E, and therefore partially subjected to influence of cultivation.

Table 18.

Yield per Tree.

1910.		1911.	
Plot.	Barrels.	Barrels.	Gain or loss.
A................	0.86	1.83	Gain, 0.97 barrels.
B................	0.32	0.18	Loss, 0.14 "
C................	0.11	0.42	Gain, 0.31 "
D................	0.27	0.31	Gain, 0.04 "

Table 19.

Yield per Tree, Discarding all Non-Bearing Trees.

1910.		1911.	
Plot.	Barrels.	Barrels.	Gain or loss.
A................	0.89	1.94	Gain, 1.05 barrels.
B................	0.33	0.29	Loss, 0.04 "
C................	0.12	0.50	Gain, 0.38 "
D................	0.32	0.44	Gain, 0.12 "

A comparison of Tables 15 and 16 indicates a very good bloom in 1910 for all trees except the sod plot. Of this bloom, considering the relatively small percent of fruits that are formed in proportion to the number of blossoms on any tree, it may be said that the fruit set (Table 16) for that year was fairly good in the first three plots. In fact plot B promised at fruit setting time to equal, if not exceed, A in proportionate yield. Table 17, however, shows the contrary to be true. Of all four plots, the one that received cultivation and available plant food early in the season was the only one in which the trees could not only set fruit, but could to a reasonable degree carry, develop and mature it. In the uncultivated plots the dropping of the fruits at an early date after setting accounts largely for the discrepancy between set and yield. The food reserve was not sufficient to carry the fruit through the season. The trees under cultivation were sufficiently stimulated to action to perform the necessary functions for fruit development.

The bloom of 1911 was far below that of the preceding year in abundance (Table 15). Likewise the fruit set was greatly reduced in all plots, except the cultivated one, where it was slightly better. Bearing in mind, however, that plot A yielded in 1910 almost three-fourths of the entire crop from this orchard, it might reasonably have been expected that B, C and D would increase their proportional yields and that A's yield might prove proportionally smaller than in 1910. Nevertheless, Table 17 shows a total yield almost double that of the preceding year, for four-fifths of which A is again responsible. Of the three uncultivated plots, D made a fair percentage gain in yield over the preceding year and B suffered loss, but C was the only uncultivated plot to show a high percentage increase in its contribution to the total yield of 1911, compared with the proportion it formed of the 1910 crop. The percentage gain, moreover, must be considered in relation to the size of the crops in the two years.

Table 18 shows the relative yield per tree with respective gain or loss in barrels. This is based on the total number of trees per plot. Table 19 shows similar data, omitting in every case the trees that failed to bear fruit; i. e., the data in this table show the comparative yield per bearing tree. Both of these tables show that the normal yield of fruit, even from the cultivated plot, is much below the normal for trees of the size and age under consideration. The significance of the results lies in the differences so far obtained, and the fact that but one year of cultivation has in the main, been responsible therefor. Whether the fertilizer applied in the uncultivated plots in 1911 will affect the fruit yield of the coming season remains to be determined. Certainly no obvious results were obtained in the way of wood growth or improved foliage, except in the isolated instances in plot C, already noted.

The past season, although characterized by great drought during the greater part of the growing period, resulted nevertheless in the production of large, well colored fruit. In this respect, relation of size to culture is indicated by Fig. 18 which shows the *average* size of apples from A, and Fig. 19, showing a similar average for D. The fruits of B and C were on the average equal in size to the largest specimen shown in Fig. 19. Contrary to general rule, the cultivated plots produced fruit of higher color and finer finish than that from the other divisions.

The observations and results of the last two years, therefore, point most decidedly to the conclusion that orchards in Maine with conditions similar or worse than those existing at Highmoor in 1909 cannot be successfully rejuvenated by any system that does not involve the factor of cultivation. This is exposition of no new doctrine. but the numerical data given above may serve to emphasize the fact that increased apple production in the immediate future depends on the rejuvenation of the existing trees of bearing age, and that no single factor of the several involved in orchard management is so potent in bringing about the desired results as proper tillage.

Results from Fertilizer Plots.

In view of the short existence of this experiment nothing can be said regarding the effect of the two forms of fertilizer in question. The trees of both plots average closely in point of vigor. The foliage of plot E was perhaps slightly darker and the annual growth somewhat greater the past season than in Plot F.

The fruit yields from plots E and F have been meager compared with plot A. The results are also somewhat difficult to compare justly, owing to the considerable differences in the size of trees in the two plots.

TABLE 20.

Size of Trees.

Plot.	1910. Number of trees.	Per cent. large.	Per cent. medium.	Per cent. small.	1911. Number of trees.	Per cent. large.	Per cent. medium.	Per cent. small.
E.....	82	42.6	43.9	13.4	82	42.6	43.9	13.4
F.....	72	8.3	61.6	30.5	70	8.5	42.8	28.5

Plot E contains on the percentage basis more than 5 times as many large trees as F, almost one-fourth less of medium size, and less than half as many classed as small.

TABLE 21.

Degree of Bloom.

Plot.	1910. Per cent. showy.	Per cent. full.	Per cent. medium.	Per cent. scant.	Per cent. none.	1911. Per cent. showy.	Per cent. full.	Per cent. medium.	Per cent. scant.	Per cent. none.
E........	–	79.2	9.7	8.5	2.4	–	8.5	35.3	52.4	3.6
F........	–	62.5	16.6	12.5	8.3	–	20.0	20.0	55.7	4.2

TABLE 22.

Fruit Set.

Plot.	1910. Per cent. abundant.	Per cent. medium.	Per cent. poor.	Per cent. none.	1911. Per cent. abundant.	Per cent. medium.	Per cent. poor.	Per cent. none.
E.....	14.6	40.2	37.8	7.3	7.3	26.8	62.1	3.6
F.....	15.2	20.8	40.2	23.6	8.5	41.4	45.7	4.2

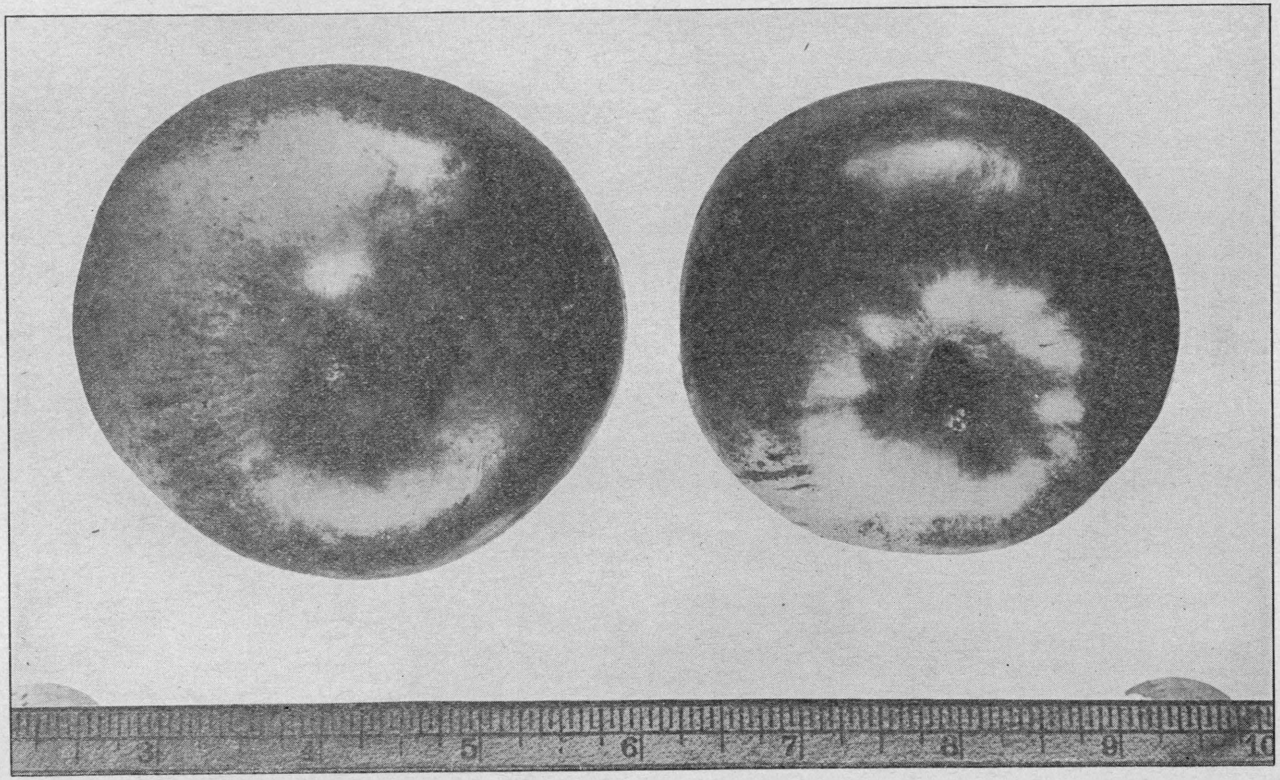


Fig. 18. Average Size of Ben Davis Fruit. Plot A, 1911.

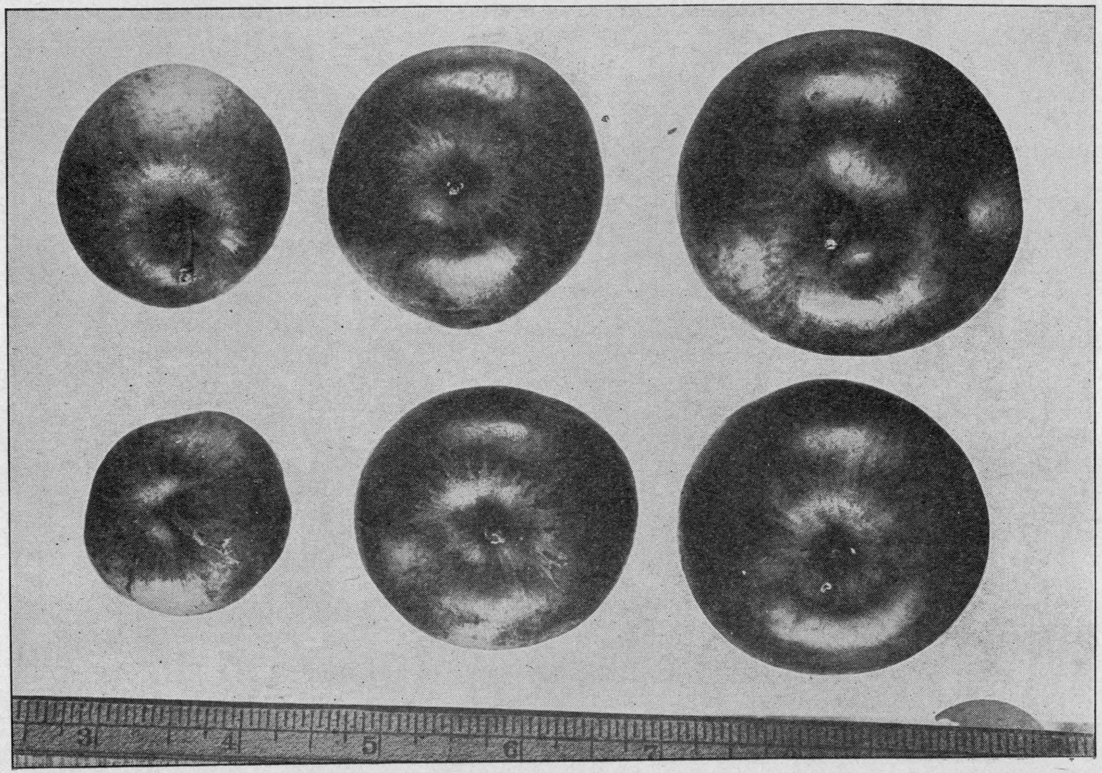


Fig. 19. Average Size of Ben Davis Fruit. Plot D, 1911.

Table 22 shows that here, as in the other plots already considered, the bloom was excellent in 1910. Fairly good percents of abundant and full sets were partially offset by the trees of medium or no set. Nevertheless the 1910 yield, indicated in the next table, is far below the amount reasonably anticipated from the respective set of fruit.

On the other hand, the 1911 data of tables 21, 22, 23 and 24 show a degree of bloom greatly reduced from that of the preceding year, a strikingly greater proportional set of fruit and an equally notable increase in the crop.

It is well to here reiterate the point that however small the actual crop of fruit from these plots may be, it is the increased yield per tree and the percent of increase indicated in the following tables that are full of meaning. The fact that these results have been obtained within the second season of the experiment gives the data an added significance.

TABLE 23.

Yield in Barrels, and Relative Gain.

1910.		1911.	
Plot.	Number of barrels.	Number of barrels.	Per cent. gain in 1911.
E.............	30	92.9	209.66
F.............	9	59.7	563.33

TABLE 24.

Yield per Tree.

1910.			1911.			
Plot	Number of trees.	Number of barrels.	Number of trees.	Number of barrels.	Gain in barrels.	Per cent. gain in 1911.
E.....	82	0.36	82	1.13	0.77	113.88
F......	72	0.12	70	0.82	0.70	583.33

POMOLOGICAL NOTES.

A Successful Method for Emasculating Blossom Buds.

Experiments in the artificial fecundation of pome fruits has in all known instances been characterized by a surprisingly small percent of successes in proportion to the number of blossoms pollinated. Allowing for poor technique in pollination or improper preservation of pollen, the success of such work has seemed to the writer to depend to a large degree upon the manipulation of the blossom bud in castration. In the breeding work inaugurated last spring this question was considered as one of the important points to be determined in developing a successful technique.

The methods generally recommended by horticultural experimenters is to entirely remove the petals before castration, either by grasping them at the apex of the bud and pulling them off, or by cutting them away. In this manner greater freedom is obtained in removing the stamens.

Such procedure would appear to be undesirable and not conducive to successful results. The method most likely to insure a fair degree of success would be, theoretically, one which combines the necessary emasculation with the minimum disturbance to the organism. Removal of floral parts may be followed by results analagous to surgical shock in animals. In addition, the removal of petals and stamens is doubtless followed by drying out processes at the points of severance.

The emasculation at this Station was therefore made without removal of either petals or filaments. The buds were carefully opened by prying apart and laying back the enfolded petals. The anthers were then removed with the minimum portion of filament by means of a small thin bladed scalpel with straight cutting edge tapering to an acute V.

In this way buds measuring 7 mm. axially were castrated, and developed into full bloom in bags without suffering apparent disturbance from the emasculation process. Buds of more advanced stages were operated upon with greater rapidity and ease, with similar results. The fruits obtained in the crossing work of the past season, although comparatively few in number, all resulted from buds emasculated by the above method. No fruits were set on blossoms whose petals were removed before castration.

It is hoped that a repetition of the method, coupled with the scheme of pollen preservation suggested by Simon * will result in a larger percent of successful crosses than has heretofore been made.

Teratology.

The season of 1911 was most favorable to the production of apples of great size; hence it may be properly assumed that the climatic factors affecting rapidity of growth may have had some relation to the comparatively large number of abnormal fruits reported in various apple growing sections of the country.

Figs. 20 and 21 show a double Baldwin apple found at Highmoor during the past season. The two distinct calices (Fig. 20) would indicate a duplication of floral parts in the blossom. Fig. 21 illustrates the attachment to a common stem, and the normally developed seeds within the carpels of the two independent cores. The only tissues common to both individuals of this fruit pair are those of the stem, flesh and skin.

Less common than double fruits is the abnormal development shown in Figs. 22 and 23. Apples exhibiting this unusual growth were found in surprisingly large numbers in orchards in Greene during the summer of 1911. They were about equally frequent on Baldwin and Greening; the illustrations are from one of the latter variety.

Examinations of this outgrowth showed a striking resemblance to a calyx lobe. It was pubescent, of grayish brown color, triangular in form, the base developing from the skin, and the apex recurved. In most cases it was nearer the basin than the cavity, and the base of this so-called lobe was connected with the calyx cluster by a slight lineal depression or a light line of color in the skin. In the majority of such apples examined there appeared to be but four normally developed calyx lobes in the basin of the fruit (Fig. 23),—a fact which inclines one to the belief that such growth is an abnormally located calyx lobe. The actual cause of this phenomenon rests on a morphological examination and the determination of the point of growth in the apple.

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*Simon, J., Gartenwelt, 15 (1911), No. 7, "A New Method of Preserving Flower Pollen in a Viable Condition," Abst., E. S. R. 24: 6, p. 543.

Winter Injury.

Following the winter of 1910-1911 a considerable amount of winter injury to the trunks of trees was noted in a number of localities in the several orchard divisions. This injury took the form of a severe loosening and splitting of the bark of the trunk; in the less serious cases longitudinal splits occurred, extending through the living tissues to the wood. The bark immediately about these splits either stood free from the wood or else was very loosely attached thereto.

These less severe cases healed to some degree during the past season, to the extent that loosely adhering bark became more firmly attached. In the great majority of cases the injury had been severe enough to cause complete sloughing of the injured tissues with the advent of warm weather, leaving the wood exposed.

All gradations of the latter type of damage were found, from cases where a small area the size of a hand had been affected to a few extreme instances where the tree had been practically girdled for several feet from the ground.

Treatment has been the same as that for removal of a diseased area,—namely, cutting away of all dead tissues, disinfecting the exposed surfaces and protecting them with a coat of paint. In this way, the greater part of the trees affected will doubtless heal over; those most severely damaged, however, give little hope of recovery.

The cause of this kind of injury is not known with any certainty, and the question calls for extended study. The common assumption that the growth of the season preceding the winter in which the injury occurred had not sufficiently ripened before the advent of cold weather, does not apply here. The trees incurring the greatest damage made, on the whole, less wood growth than the vast majority that came through the winter unharmed. Neither can sunscald be held directly responsible for the trouble, in view of the fact that the injury occurred as frequently upon the northern as upon the southern sides of the trees.

In the absence of specific experiments bearing on this question, two factors would seem to have a relation to this type of winter injury. They are insufficient soil drainage and a sudden

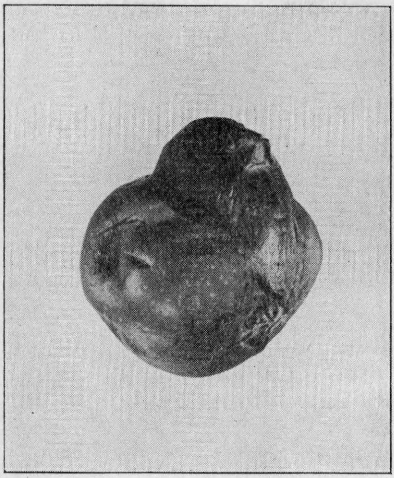

Fig. 20. Double of "Twin" Apple.

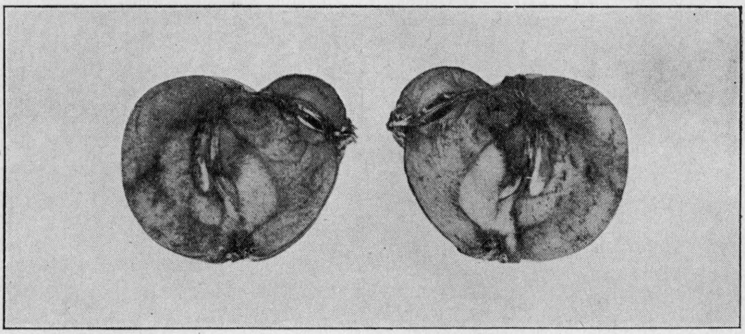

Fig. 21. Section Through Double Apple.

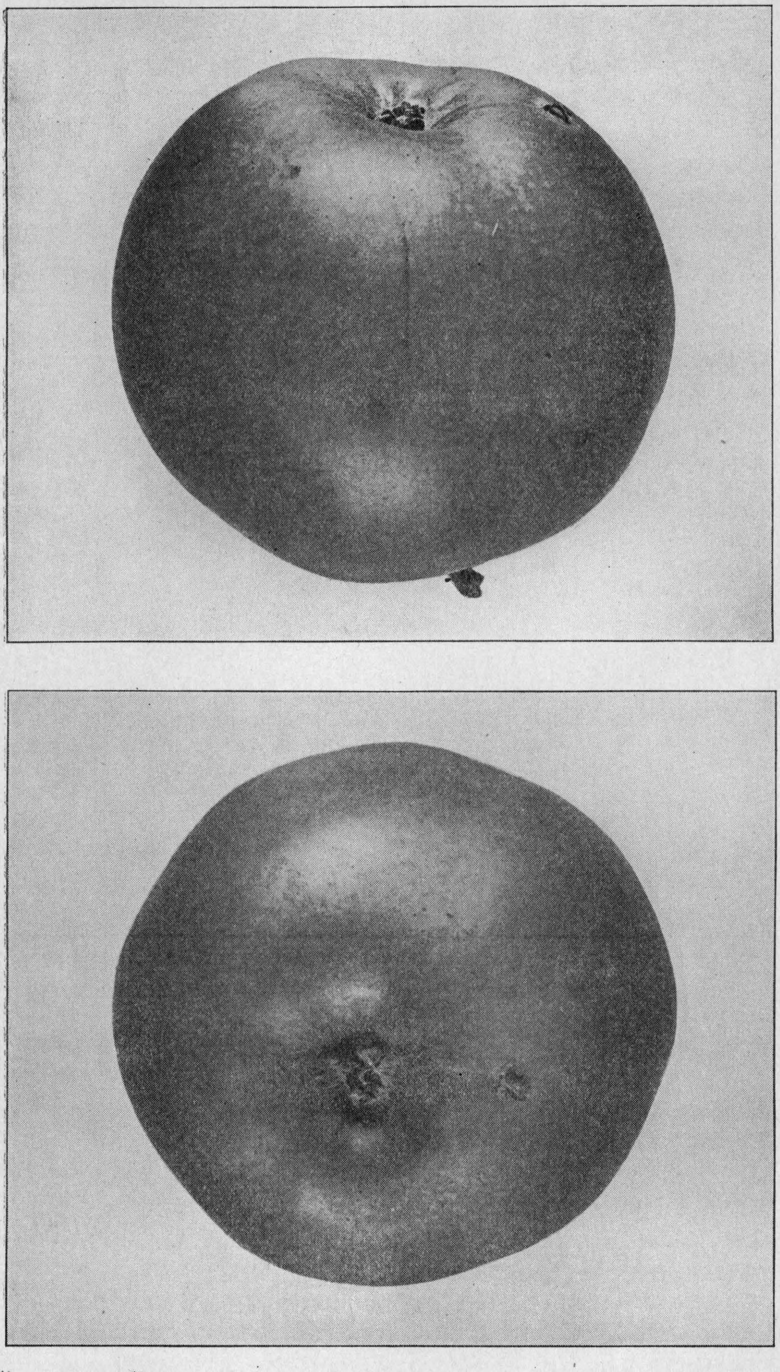

Fig. 22 and Fig. 23. Greening, Showing Skin Resembling Calyx Lobe.

temperature drop below the freezing point, following a period of warm weather.

A significant fact is that the trees most severely affected were confined to a small group standing in a slight depression that serves as a drain for the slightly higher ground surrounding. The cases of lesser injury also indicate the probable relation of topography and consequent drainage to the injury. Land which collects a greater amount of soil moisture than neighboring areas will, if said moisture is not excessive and other conditions are equal, tend to produce in trees growing therein a greater response to temperatures inducing plant activity.

The records for the winter of 1910-1911 show that from January to the end of March several periods of temperatures high for those months were followed by sudden and rather great drops below the freezing point. The hypothesis is that the warm periods referred to induced considerable activity in some trees, so that when the temperature fell suddenly close to 30 degrees Fahr. cleavage of bark from wood occurred by the freezing of the water-containing tissues of the former. The trees responding most actively were those in locations of highest soil moisture content. Those in dryer soil responded slowly enough to suffer no damage.

Announcement.

There are three lines of apple studies that from the beginning have stood out as the important ones to be undertaken at Highmoor Farm. These are orchard management, investigations upon apple enemies, and investigations in apple propagation and growth. Orchard management covers such questions as cultivation, fertilization, pruning, cover crops, thinning of fruit and protection from insects and fungi. These more practical questions call for the work of an experienced orchardist and one familiar with the grosser field experiments. The apple diseases require the expert scientist skilled in plant pathology. To be of real permanent value these call for more than superficial investigation. Their study demands the expert botanist to discover, classify, and learn the life habits of the low forms of plant life that cause the injuries. He must have knowledge and ability to study the differences between fungi that are accidentally present because of the damaged and diseased tissue and those that are the cause of the injury. He must have that intimate knowledge with plant physiology that makes it possible for him readily and surely to distinguish between normal and abnormal growth, between healthy and pathological tissues. The work in propagation and growth demands the trained biologist. On the one hand the skill and knowledge requisite to the breeder of plants and on the other that of the biometrician who is trained to measure growth accurately. Orchard management demands the skilled operative, the other questions demand the highly trained scientific specialists.

During the past three years the work in orchard management has been under the control of the horticulturist and the studies upon apple enemies have been made in cooperation with the plant pathologist and those in breeding with the biologist. With the resignation of Mr. Bonns as horticulturist all of the apple work will be planned by a committee consisting of the director, the biologist and the plant pathologist. The details of the work will be carried out by and under the personal supervision of Mr. Yeaton who has been appointed orchardist.

CHAS. D. WOODS,
Director.

BULLETIN No. 200.

THE MYCETOPHILIDAE OF NORTH AMERICA.

PART IV (CONCLUSION)*.

O. A. JOHANNSEN.

The species of the genera belonging to Series I as well as the first 6 genera of Series II of the subfamily *Mycetophilinae* were described in Part III. In this paper the species of the remaining genera are characterized, as well as those of the subfamily *Sciarinae*. The members of the former so far as known injure mushrooms only; the latter constitute the most important group so far as the agriculturist is concerned.

Though occasionally reported as injuring mushrooms the members of the *Sciarinae* are not as a rule regarded as serious pests of the fleshy fungi, differing in this respect from the species of the other subfamilies. After partial decay of fungous growths, however, larvæ of *Sciara* are found in abundance, and it is this fact, which in some cases at least, has led observers and growers to attribute the destruction to these gnats when in all probability the injury was caused by species of *Mycetophila*, *Exechia* or *Phorids*.

On the other hand there is no lack of evidence of the harmful character of some species of *Sciarinae* to seed corn, to potatoes, to wheat, and to the roots of other plants. Professor Forbes in his 7th report refers to the injury which the larvæ do to seed corn, and in his 15th (pp. 95-98) notes the destruction of cucumber plants by these pests. In an earlier report he mentions the occurrence of larvæ infesting the roots of grass.

* Papers from the Maine Agricultural Experiment Station, Entomology No. 52. Parts I, II and III were published in Bulletins 172, 180 and 196 respectively.

Florists look upon these little gnats with a suspicion which is more than justified, as the fact that the larvæ feed upon the tender roots of potted plants is well established. *Sciara tritici* is identified with an injury to the roots and stems of wheat, and it is probable that the damage caused by it or by some other member of this genus is far more widespread than is generally known owing to the insidiousness of its attack.

In Bulletin 27, n. s. (U. S. Dept. Agr. Div. of Entomology) Mr. Chittenden cites several instances of damage occasioned by *S. inconstans* to peas growing in flower pots, and to lettuce, cucumbers, and carnations. The injury caued by *S. mali* is according to Fitch's own account, secondary in its nature, the larvæ feeding on apples already affected by the Codling moth. It may be moreover only an accidental occurrence, as there is no record in entomological literature, as far as I know, of a similar attack. Benj. Walsh's Grape Midge (First Ann. Rept. Ill. 21, 1867) belongs in the same category, it being a guest of more injurious species.

Walsh and others have long ago suggested the possibility that the larvæ of some species of *Sciara* are associated in some way with a sort of potato scab. The fact that the larvæ of these gnats are so abundant in barnyard manure and that scab is most prevalent on potatoes from fields which have been well fertilized has suggested the possibility of this relationship. Most significant in this connection is the account given by Dr. A. D. Hopkins of *Pnyxia (Epidapus) scabiei*. Concerning this species he says: "I have observed the larvæ of a *Sciara* and an *Epidapus* feeding on the living, healthy tissue of potato tubers, and have obtained conclusive evidence that they are capable of causing, and actually do cause, conditions which in one stage would be recognized as potato-scab and in a more advanced stage would be recognized as a form of potato-rot."

From the context of Mr. Hopkin's article it is not necessarily inferred that he associates that form of potato scab caused by *Oospora scabiei* with the injury (or infection) produced by the insect.

My own observations of the larvæ of *Sciara* confirm the statements made by some of the earlier writers. I have found larvæ in potatoes feeding on the sound tissue, on the roots of various grasses and in tulip bulbs. In some preliminary experiments I failed to induce larvæ to attack a tuber with unbroken skin, but more extensive trials may give different results. The cut surfaces of seed potatoes are readily attacked and the seed at times seriously damaged especially where the soil has been fertilized by barnyard manure.

Other data along these lines are on hand and more experiments are contemplated, the results of which are to be published at a later date. Besides the acknowledgments already made in Part I, I wish to add that through the kindness of Mr. Fredr. Knab I have had the privilege of again examining the types in the U. S. National Museum. To Dr. E. P. Felt I desire to express by obligations for the loan of type material of Felt's and Lintner's species.

THE MYCETOPHILINAE (Concluded.)

24. Genus *Phronia Winnertz.*

Verh. Zool.-bot. Ges. Wien. XIII. 857, 1863.

Lateral ocelli contiguous to the eye margin, the middle one small, placed in a groove near the base of the frontal triangle; antennæ in the male frequently, in the female, usually cylindrical. Legs slender, tibial setæ delicate, fore tarsi of female sometimes incrassate. Costa produced, sometimes but very slightly, beyond tip of Rs; subcosta short, rarely half as long as the basal cell R, usually ending free, media forks distad of the base of Rs, rarely directly under it, cubitus forks distad of the fork of the media, its branches usually widely divergent; anal vein incomplete.

The forking of the media distad of the base Rs and the slightly produced costa will distinguish this genus from *Exechia.*

Table of Species.

a. Costa produced about 1-3 of distance from Rs to M_1; Mass. 1. *producta* n. sp.

aa. Costa produced less than 1-5 of distance from Rs to M_1.

b. Fore tarsal joints 2-4 not distinctly swollen beneath.

c. Hind coxæ, and usually middle coxæ also, fuscous, hypopygium black (Fig. 25). 2. *insulsa* n. sp.

cc. All coxæ yellowish.

d. Western or middle western species.

e. Males; hypopygium with globose terminal appendages.
f. Brown species (Fig. 26). 3. *venusta* n. sp.
ff. Thorax yellow with brown vittæ. 7. *incerta.*
ee. Females.
f. Third antennal joints nearly three times as long as broad; abdomen uniformly fuscous. 3. *venusta,* var. a.
ff. Third antennal joint less than twice as long as broad, or otherwise distinct.
g. Pleura fuscous, S. D. 3. *venusta.*
gg. Pleura largely yellow; hind margin of abdominal tergites, yellow; Wyo. and B. C. 7. *incerta?*
dd. Eastern species; males.
e. Terminal lobes of hypopygium longer than basal segment. 4. *difficilis* n. sp.
ee. Terminal lobes of hypopygium shorter than basal segment.
f. Hind femora tipped with brown; base of abdomen largely yellow; hypopygium with short broad forceps (Fig. 28). 5 *similis* n. sp.
ff. Hind femora without conspicuous brown apices; hypopygium with more elongate forceps (Fig. 29). 6. *rustica* var. a.
bb. Fore tarsal joints, 2-4, distinctly swollen beneath and broader than the metatarsus, apex of the latter enlarged; females.
c. Western species; base of abdomen fuscous; Stanford Univ., Cal. *Phronia* sp.
cc. Eastern species.
d. Hind coxæ yellow. 4, 5. *difficilis, similis.*
dd. Hind coxæ fuscous. 2. *insulsa* n. sp.

1. *Phronia producta* n. sp.

Male. Length 2 mm. Head with antennæ fuscous, the face, palpi and scape reddish yellow; intermediate antennal joints about 1.5 times as long as wide. Thorax reddish yellow with three subconfluent brown stripes; hairs pale, setæ black; 4 scutellar setæ. Abdomen yellow anteriorly with dorsal stripe and posterior segments blackish; hypopygium (Fig. 24) dark. Coxæ and legs yellow, tips of hind femora and of tibiæ blackish; tibial spurs and tarsi brown; fore metatarsus about 7-8 as long as tibia. Wings (Fig. 152) hyaline, tinged with yellow; halteres yellow. Brookline, Mass. (C.W.J.). Aug.

2. *Phronia insulsa* n. sp.

Male. Length 2 mm. Head and antennæ fuscous, palpi and scape yellow. Thorax brown, the humeri and pleura yellowish brown; hairs yellow; setæ brown to black, those of the scutellum 4 in number. Abdomen brown, apical segments, and hypopygium (Fig. 25) blackish. Legs and fore coxæ yellow, the middle and hind coxæ, tips of middle and hind femora and of tibiæ, dark brown; tibial spurs and tarsi brown. Wing (Fig. 153) hyaline, with a brownish tinge; halteres yellow.

Female. Similar to the male in coloring. Fore metatarsus and tibia subequal; fore tarsal joints, 2-4 swollen beneath, tip of the 1st enlarged. R. I. and Ithaca, N. Y. March and Aug.

Var. a. Female. Similar to the foregoing but only the 4th and tip of the third joint of fore tarsus distinctly swollen. Ithaca, N. Y.

3. *Phronia venusta* n. sp.

Male and female. Length 2.5 mm. Head and antennæ brown; palpi and scape dusky yellow; intermediate antennal joints about twice as long as wide. Thorax brown, including hairs and setæ; scutellum with 6 or more marginal setæ. Abdomen brown, hairs pale; hypopygium (Fig. 26) yellow with blackish claspers. Coxæ and legs yellow, tips of middle and hind femora and tibiæ slightly brownish, tibial spurs and tarsi brown; fore metatarsus about 1-16 shorter than the tibia. Wings (Fig. 154) yellowish hyaline; halteres yellow. Male, Vollmer, Ida! (J.M.A.) Sept.; female, Brookings, S. D.

Var. a. Female. Similar to foregoing but thorax more yellowish with 3 subconfluent brown stripes. Antennæ more elongate, third joint nearly 3 times as long as wide. Moscow Ida. (J.M.A.).

4. *Phronia difficilis* n. sp.

Male. Length 2.5 mm. Head brownish; face, palpi and 3 to 4 basal joints of antennæ yellow, remainder of antennæ brown; intermediate segments about 1.5 times as long as wide. Thorax yellow, the center of the mesonotum, scutellum and metanotum from pale to dark brown; hairs yellow, setæ brown; 4 marginal setæ on scutellum. Abdomen yellow, the dorsum of each sclerite with a brown triangle the base upon the posterior margin, the fifth and sixth segments wholly blackish, hypopygium (Fig. 27) yellow, its hairs darker especially at the apex. Coxæ and legs yellow, the tips of the hind femora and of hind tibiæ, and all the tibial spurs and tarsi, brown; fore metatarsus and tibia subequal in length. Wings (Fig. 155) yellowish hyaline; halteres yellow. Ithaca, N. Y. 2 specimens.

Female. Similar to the male in coloring but the abdomen is largely brown, the anterior margin of each sclerite and the anterior portion of the venter yellow. The tip of the metatarsus and joints 2-4 of the fore tarsi swollen beneath. Ithaca, N. Y

5. *Phronia similis* n. sp.

Male. Length 2.5 mm. Coloring as in the preceding species (*P. difficilis*) excepting that the pleura are brown, light brown in one specimen, darker in another, and that the dark triangles of the abdomen are larger. Hypopygium (Fig. 28) black, the appendages shorter than the basal sclerite. Wing, Fig. 156. Ithaca, N. Y. Sept. 2 specimens. The hypopygium resembles that of *P. Taczanowskyi* Dzd.

It is barely possible that the females described under P. *difficilis* belong here.

6. *Phronia rustica* Winnertz.

Verh. Zool.-bot. Ges. Wien. XIII. 875. 1863.

Male and female. Length 3-3.3 mm. Head brown, 3 or 4 basal joints of antennæ, and palpi yellow; antennæ of male about 1.5 times, of female about as long as head and thorax united. Thorax brown, with ashy reflection, in teneral specimens the pleura are yellow; setæ brownish. Abdomen brown with appressed pale hairs; hypopygium large, yellow, sometimes darker apically. Coxæ and legs yellow, tarsi brown; fore metatarsus at least as long as the tibia. Wing brownish hyaline; halteres yellow. "Greenland."

Var. a. Differs in structure of the hypopygium (Fig. 29) Ithaca, N. Y. Aug.

7. *Phronia incerta* Adams.

Wash. Carnegie Inst. 67. 37. 1907. (Mycetophila).

Male. Length 4 mm. Head dark brown, mouth parts and basal joints of antennæ yellow. Thorax obscure yellow; mesonotum with 2 V-shaped figures, one set within the other, resulting in fusion of the two lateral stripes posteriorly and with the median one between them being divided anteriorly. Scutellum and metanotum brown, former with an apical pair of bristles, mesonotum with short yellow pile laterally and black bristles. Abdomen obscure yellow, base of each segment dark brown dorsally, on the posterior segment the color comes to encircle the segment; the short pile is black. Legs light yellow, tarsi becoming tinged with brown; beside the long apical bristles the middle and hind tibiæ have each a row of shorter bristles; anterior tarsi twice as long as their tibiæ, middle tarsi 1.5 times as long and hind tarsi as long as their respective tibiæ. Wings hyaline; Rs and anterior branch of media divergent, furcation of media beyond base of Rs. Halteres light yellow. "Mayfield Cave, Ind."

An examination of the type specimen, which was sent to me by Dr. Adams, proves it to be a true *Phronia.* The costa is but slightly produced beyond the tip of Rs. The hypopygium which is pale yellow, resembles that of *P. venusta* in the form of the terminal lobes but differs in having upon the inner side of each lobe near the tip a patch of short stout setæ projecting dorsad.

Female. A specimen from Selkirk Mts. B. C. and one from Wyoming may belong here. They differ in not having the lateral stripes of the mesonotum fused posteriorly.

25. Genus *Telmaphilus* Becker.

Mitt. Zool. Mus. Berl. IV. 67. 1908.

With the characters of *Phronia,* differing only in having an elongate attenuated subcosta which ends free beyond the middle of the basal cell R and in having one or two dusky clouds upon the wing. Besides the two species assigned to this genus by Mr. Becker it is probable that the European species *Phronia forcipula* (var. *humeralis*) *basalis* and *nitidiventris* also belong here.

Table of species.

a. Apical wing cloud wide, arising proximad of apex of R_1; Rs strongly bowed. Cal. 1. *tenebrosa.*

aa. Apical wing cloud narrow, arising at apex of R_1; Rs not strongly bowed (Fig. 158). N. H., N. Y. 2. *nebulosa* n. sp.

1. *Telmaphilus tenebrosa* Coquillett.

Proc. Ent. Soc. Wash. VI. 170. 1904 (*Phronia*).

Female. Length 2.5 mm. Black, the halteres and legs yellow, the last 2 pairs of coxæ, the hind edge of the front ones, a streak on under side of each femur near the base, the apices of the hind femora, and the tarsi except their bases, brown. Third joint of antennæ nearly twice as long as wide, the following joints becoming successively shorter to the fourteenth which is as wide as long; first joint slightly longer than wide, the second as wide as long. Body grayish pruinose, the hairs and bristles yellowish. Wings hyaline, the apex from a short distance before the apex of R_1 to tip of Cu_2 and a cloud below the latter, dark gray; Sc attenuated toward its apex, becoming obsolete slightly beyond middle of basal cell R, Rs strongly bowed toward R_1; media forks at 1-3 of distance from the crossvein to the forking of the cubitus. "San Mateo Co., Cal."

2. *Telmaphilus nebulosa* n. sp.

Male and female. Length 2.5. Similar to the foregoing but differing as follows: Underside of each femur without dark streak; apical wing cloud begins at the apex of R_1; Rs not strongly bowed toward R_1 (Fig. 158); fore metatarsus and tibia subequal; hypopygium (Fig. 30) black. Hampton, N. H. (S. A. Shaw), April; Ithaca, N. Y.! April.

26. Genus *Exechia* Winnertz.

Verh. Zool.-bot. Ges. Wien. XIII. 879. 1863.

Lateral ocelli closely contiguous to the eye margin; middle ocellus, when present, placed in a groove on the front (Fig. 67 in Part I). Legs long and slender, fore metatarsus subequal or slightly longer than the tibia, rarely much shorter; tibial setæ delicate (Fig. 62, Part I); posterior basal seta of hind coxæ present. Subcostal vein very short, incomplete or ending in R_1; costal vein does not extend beyond the tip of the radial sector; media fork proximad of the basal section of the radial sector, or rarely directly under it; cubitus forks distad of the fork of the media; its branches widely divergent.

The larvæ, which are frequently found in fungi, do not have transverse rows of ambulacral setulæ.

Owing to the great similarity of the members of this genus, and the frequent though slight variation of the wing venation and coloration in individuals of the same species as demonstrated in breeding experiments, I am only able to give a table to the males based largely upon the form of the hypopygia. For brevity the first segment of R_1 measured from the humeral crossvein is designated as a, the second segment, b.

Table of species.

Males.

a. Curvature of Rs conspicuous, the ratio of the maximum normal of the chord to the chord itself 4.5% or more, and the ratio of a to b, .65 or less.

b. Fore metatarsus 1.15 or more longer than the tibia.

c. Curvature of Rs moderate (4.5%), fork of cubitus noticeably distad of base of Rs (Fig. 159); hypopygium with two of the 3 pairs of appendages each tipped with a black spine. 1. *perspicua* n. sp.

cc. Curvature of Rs 7.5% or over; fork of cubitus but slightly distad of base of Rs.

d. Hind margins of abdominal segments yellow; hypopygium (Fig. 32). 2. *umbratica.*

dd. Yellow marking of abdominal segments, when present, confined to the anterior margin; hypopygium (Fig. 33). 3. *nugax* n. sp.

bb. Fore metatarsus shorter than the tibia; hypopygium (Fig. 34). 4. *nexa* n. sp.

aa. Curvature of Rs not conspicuous, ratio of maximum normal of the chord to the chord 4% or less, and the ratio of a to b, .70 or more.

b. *Hind* margins of abdominal segments yellow and the two larger pairs of appendages of hypopygium broad, lobular.

c. Fore metatarsus over 1.25 tibia in length; curvature of Rs moderate (Fig. 163); hypopygium (Fig. 35). 5. *abrupta* n. sp.

cc. Fore metatarsus less than 1.12 tibia in length, curvature of Rs slight (Fig. 164); hypopygium (Fig. 36). 6. *canalicula* n. sp.

bb. Abdomen unicolored, black or yellow or hind margins of abdominal segments dark, or hypopygium of different structure.

c. Yellow species, darker markings on thorax and abdomen pale brown.

d. Each branch of longer forceps with curved branch on inner side (Fig. 39). 9. *satiata* n. sp.

dd. Ventral sclerite of hypopygium, large, quadrangular (Fig. 38a). 8. *quadrata* n. sp.

cc. Thoracic and abdominal markings dark brown.

d. Fore metatarsus about 1-8 longer than the tibia; each limb of the longer forceps either with distinct branch near apex or wide lobe at base.

e. Thorax and abdomen with considerable yellow.

f. Smaller species, 3 mm in length; each limb of longer forceps with curved branch on inner side; (Fig 39). 9. *satiata* n. sp.

ff. Larger species, over 4 mm in length.

g. Limbs of both forceps forked (Fig. 41). 10. *nugatoria* n. sp.

gg. Longer forceps not forked at apex.

h. Hypopygium as shown in figure. (Fig. 42).
11. *nativa* n. sp.

hh. Hypopygium as shown in figure. (Fig. 43).
12. *interrupta.*

ee. Thorax, and abdomen largely, dark.

f. Apex of limbs of one pair of forceps palmate with setæ, the other pair lobular (Fig. 44).
13. *palmata* n. sp.

ff. Longer forceps with attenuated apices (Fig. 45).
14. *fungorum.*

dd. Fore metatarsus not more than 1.1 longer and sometimes shorter than tibia; hypopygium various.

e. Lateral sclerite of hypopygium with bent or curved setæ, appendages short (Fig. 37). 7. *cincinnata* n. sp.

ee. Without bent setæ.

f. Limbs of one pair of forceps at least, over 1-3 as broad as long.

g. Both pairs of forceps with oval limbs; (Fig. 46); fore metatarsus about .9 as long as the tibia; cubitus forks very slightly distad of the base of Rs. 15. *assidua* n. sp.

gg. One of the forceps with tapering apices; cubitus forks noticeably distad of the base of Rs.

h. Thorax yellow with brown dorsum; one pair of forceps oval but apex tapering (Fig. 47).
16. *auxiliaria* n. sp.

hh. Thorax dark; broader forceps with spatulate limbs each with 2 stout mesad projecting setæ (Fig. 48). 17. *bellula* n. sp.

ff. Both forceps rather slender, at least apically.

g. Postero-ventral angles of hypopygial sclerite with 1 to 3 strong setæ, or a blunt process.

h. A single blunt spine or process on each posterior ventral angle.

i. A single long blunt spine on each postero-ventral angle (Fig. 49s); thorax and abdomen with yellow markings. 18. *bella* n. sp.

ii. Postero-ventral angle produced into a slender blunt process; thorax and abdomen dark.
27. *analis.*

hh. One or more setæ on the angles.

i. Postero-lateral margins of hypopygial segment ciliate (Fig. 50); pleura in part yellow.
19. *captiva* n. sp.

ii. Margin not distinctly ciliate; pleura brown.

j. Postero-ventral angle each with a single seta; the broader forceps without tuft of setæ on the preapical angle; (Fig. 51b).
20. *absoluta* n. sp.

jj. Postero-ventral angles each with several setæ; the broader forceps with blunt apex and a tuft of setæ on the preapical angle (Fig. 52). 21. *capillata* n. sp.

gg. Postero-ventral angles of hypopygial sclerite without several conspicuously strong setæ or spines.

h. One pair of the hypopygial appendages curved on apical third and conspicuously longer than the others. (Fig. 53); dark brown species. 22. *obediens* n. sp.

hh. Two pairs of appendages subequal in length.

i. Appendages unusually slender; one pair blunt, each limb of the other pair with a long subbasal branch (Fig. 54b); thorax brown; abdomen with yellow. 23. *attrita* n. sp.

ii. Appendages otherwise.

j. The more slender forceps with several apical setæ (Fig. 55); pleura in part yellow. 24. *repanda* n. sp.

jj. Slender forceps without apical setæ.

k. Abdomen with yellow markings at base of venter; hypopygium (Fig. 56). 25. *absurda* n. sp.

kk. Abdomen brown; hypopygium (Fig. 57). 26. *casta* n. sp.

E. *analis* Coq. belongs to Mycothera.

General description of Species of Exechia.

The species described below, unless specifically stated to the contrary, possess the following characters in common:

Head and antennæ fuscous, the scape and base of the first flagellar joint and the palpi yellow. Dorsum of the thorax fuscous apparently consisting of 3 confluent stripes, leaving the humeri yellow; scutellum and metanotum fuscous; hairs pale, setæ blackish; scutellum with 2 black setæ. Dorsum of abdomen fuscous, hypopygium yellow. Coxæ and legs yellow, the tibiæ dusky yellow, spurs and tarsi infuscated. Subcosta short, ends free; venation as figured. Halteres yellow.

Although the ovipositor of the female offers good specific characters, descriptions are only given of those females which are definitely associated with males.

1. *Exechia perspicua* n. sp.

Male. Length 3.25 mm. Pleura brown. Abdomen brown, the posterior segments darker brown; appendages of the hypopygium (Fig. 31) slender; terminal ventral sternites, paired, rectangular. Fore metatarsus over 1.15 the tibia in length. Wing dusky hyaline (Fig. 159). Sage Creek, Wyo., (W.M.W.) Sept.; Orono, Me.! Oct.

2. *Exechia umbratica* Aldrich.

Annual Rept. Dept. Geol. Ind. XXI. 186. 1896. (Mycetophila).

Female. Length 5.2 mm; wing 4.5 mm. . . . . Thorax clay yellow, somewhat pruinose with white, dorsum somewhat infuscated and provided with numerous stout black hairs along the sides; scutellum and metanotum also brownish. Abdomen brown, compressed, the distal part of each segment with a lighter ring, which is broader underneath. . . .. . In the front leg the entire tarsus is about 4 times the length of the tibia, in the middle leg 2.5 and in the hind leg 1.5 times. Wing tinged with yellow along the costa and to a less degree all over the apical half. "Shilo Cave, Ind. July."

Male and female. Like the female as described above, but dorsum with 3 subconfluent brownish stripes. Foremetatarsus nearly 1.5 the tibia in length. The longer appendages of the hypopygium broad, with a preapical angle (Fig. 32). Wing (Fig. 160). Ithaca, N. Y.

3. *Exechia nugax* n. sp.

Male. Length 5 mm. Pleura light brown, mesonotum a little darker, thoracic setæ dark brown, humeri yellow. Abdomen brown, on each side of segments 2 and 3 each with narrow yellow triangle whose base rests upon the posterior margin of the segment; hypopygium yellow (Fig. 33). Wings hyaline, tinged with brown in the costal cell and in the forks of media and cubitus (Fig. 161). Fore metatarsus about 1.25 longer than the tibia. Rouville Co. Que.! Oct., Ithaca, N. Y. April.

4. *Exechia nexa*. n. sp.

Male. Length 5 mm. Thorax reddish brown; abdomen brown, darker brown posteriorly, hind margins of segments 2-5 faintly dusky yellow; hypopygium yellow (Fig. 34). Foremetatarsus and tibia subequal in length. Wings hyaline, tinged with brown (Fig. 162). Ithaca, N. Y.

5. *Exechia abrupta* n. sp.

Male. Length 4 mm. Thoracic setæ black; abdomen yellow, each segment with large, brown, dorsal triangle widest part on the anterior margin, on all segments, except 1 and 2, the anterior angles meeting on the venter, apex not reaching the posterior margin except on 5, 6 wholly brown; hypopygium yellow

(Fig. 35). Fore metatarsus about 1.3 tibia in length. Wings hyaline, tinged with yellow (Fig. 163). Ithaca, N. Y.

6. *Exechia canalicula* n. sp.

Male. Length 5 mm. Mesonotum with 3 wide brown stripes, humeri and space between the stripes yellow; scutellum, metanotum and pleura paler brown; setæ black. Abdomen as in *E. abrupta;* hypopygium (Fig. 36) black. Fore metatarsus about 1.06 the tibia in length. Wings hyaline, yellow tinged (Fig. 164). N. C.! N. J., July.

Female. The brown of the abdomen a little more extended, sixth segment also with yellow margin. N. C.

7. *Exechia cincinnata* n. sp.

Male. Length 3-4 mm. Thorax brown, humeri yellow, setæ blackish. Abdomen dark brown, each side of segments 2, 3 and 4 each with a yellow triangle one side of which rests on the anterior margin of the segment, the other meeting the side of the opposite triangle along the venter; hypopygium (Fig. 37) yellow, with strong, curved, brown hairs, hence the specific name. Fore metatarsus very little longer than the tibia. Wing hyaline, tinged with yellow (Fig. 165).

Female. Sides of segment 5 also yellow. Orono, Maine! Oct.; Burlington, Vt., (C.W.J.) June; Mass., (C.W.J.), April, June, Sept., Dec., Ithaca, N. Y.

The Orono specimens reared from *Boletus granulatus.*

8 *Exechia quadrata* n. sp.

Male and female. Length 4.5 mm. Head, thorax and abdomen yellow, the apical half of the antennæ, center of the mesonotum, metanotum, and the posterior abdominal segment, usually more dusky yellow, hypopygium with a large quadrangular ventral plate (Fig. 38a). Fore metatarsus about 1.10 longer than the tibia. Wings hyaline tinged with yellow (Fig. 166). Cape May, N. J. (Viereck) Sept.; Price Co., Wis., (W.M.W.) Aug.; Ithaca, N. Y.! Aug. Hemlock Falls, N. J., (Weidt), Aug.

9. *Exechia satiata* n. sp.

Male. Length 2.5 mm. Dorsum of thorax usually pale brown, pleura dusky yellow. Abdomen yellow, hind margins of the first 4 segments narrowly brown and the whole of 5 and 6 dark brown or black; hypopygium yellow (Figs. 39, 40) Fore metatarsus about 1.10 longer than the tibia. Wings hyaline, tinged with yellow (Fig. 167).

Female. Hind margins of all abdominal segments widely brown, produced forward on the median line. Ithaca, N. Y., July, reared from a shelving mushroom.

10. *Exechia nugatoria* n. sp.

Male. Length 4.5 mm. Pleura dusky yellow to light brown. Abdomen dark brown, venter of first 3 segments yellow, extending up on the sides of the third segment; hypopygium yellow (Fig. 41). Fore metatarsus about 1.15 longer than the tibia. Wings hyaline, tinged with yellow (Fig. 168). Kingston, R. I. (J.B.). Nov., Price Co., Wis. (W.M.W.) Aug., Ithaca, N. Y.! July, Aug.

11. *Exechia nativa* n. sp.

Male. Length 4.5 mm. Pleura brown, the abdomen as in *E. nugatoria,* but the anterior margin of the 4 segments on each side with oval yellow spot; hypopygium yellow (Fig. 42). Fore metatarsus about 1.15 longer than the tibia. Wings hyaline, tinged with yellow (Fig. 169). Orono, Me.! Oct.; Ithaca, N. Y., Nov. Reared from *Collybia* sp.?

Female. A specimen from Montpelier, Vt., (C.W.J.) June, which I believe belongs here, is similar to the male but each segment of the abdomen is widely margined with brown on sides and dorsum, produced forward on the median line.

12. *Exechia interrupta* Zetterstedt.

Dept. Scand. XI. 4240. 1852.

Male. Length 3.5-4 mm. Similar to *E. nugatoria* but the fourth segment is also largely yellow on the venter and sides. Hypopygium as figured (Fig. 43).

Female. First and sixth abdominal segments dark brown, the intermediate segments with dark triangles, smallest on the fourth and fifth, caudal segments yellow. "Europe and Greenland."

13. *Exechia palmata* n. sp.

Male. Length 3.5 mm. Thorax and abdomen dark brown; hypopygium yellowish (Fig. 44). Fore metatarsus about 1.10 longer than the tibia. Wings hyaline, tinged with brown (Fig. 170).

Female. Anterior half of the sides of the intermediate abdominal segments yellow. Torrey's Lake, Jackson Lake and Hunter's Creek! Wyo. (W.M.W.) Sept., Selkirk Mts., B. C. (J.C.B.) July; Mt. Rainier, Wash (J.M.A.) Aug.

14. *Exechia fungorum* Degeer.

Ins. VI. 142. 14 p. 22, fig. 1-13 (Tipule).

Male. Length 4 to 4.7 mm. Coloring as with *E. palmata,* a yellow humeral spot present, hypopygium dusky yellow (Fig. 45). Fore metatarsus about 1.15 longer than the tibia. Wings hyaline, tinged with brown.

Female. Similar to *E. palmata* in coloring, but yellow coloring less extended. "Europe and Greenland."

15. *Exechia assidua* n. sp.

Male. Length 3.5 mm. Thorax brown, dorsum dark brown, humeri yellow, hairs yellow, setæ black. Abdomen brown, anterior part of the venter a little paler, posterior segments almost black, hypopygium dusky yellow (Fig. 46). Fore metatarsus about .87 of the tibia. Wings hyaline, tinged with brown (Fig. 171).

Female. A defective specimen from the same place, which may belong here, differs only in having fore metatarsus and tibia subequal, and in having the fork of the cubitus slightly more distad. Mt. Constitution, Orcas, Id. Wash. (J.M.A.), July.

16. *Exechia auxiliaria* n. sp.

Male. Length 2.5 mm. Dorsum of thorax brown; abdomen brown, the anterior part of the venter and the sides of segment 3, yellow; hypopygium (Fig. 47). Fore metatarsus about 1.05 longer than the tibia. Wings hyaline, tinged with yellow (Fig. 172). Price Co., Wis. (W.M.W.), Aug., Ithaca, N. Y.!

17. *Exechia bellula* n. sp.

Male. Length 2.5 mm. Similar to *E. auxiliaria* but with brown pleura and with brown parts darker brown, posterior end of abdomen nearly black and different hypopygium (Fig. 48). Fore metatarsus and tibia subequal. Wings (Fig. 173) hyaline, tinged with brown.

Female. Similar but the lower anterior part of the sides of the intermediate abdominal segments more or less yellow. Orono, Me. Nov.

18. *Exechia bella* n. sp.

Male. Length 2.5 mm. Thorax brown, humeri yellow, abdomen brown, the anterior part of the venter, yellow, this color extending well up the sides on segments 3 and 4, thus resembling *E. interrupta;* hypopygium yellow (Fig. 49). Fore metatarsus about 1.06 longer than the tibia. Wings hyaline tinged with yellow (Fig. 174). Price Co. Wis., (W.M.W.), Aug.; Ithaca, N. Y.!

19. *Exechia captiva* n. sp.

Male. Length 2.5 mm. Similar to *E. bella* in coloring but differs in having more yellow upon the pleura and none on the sides of abdominal segment 4; hypopygium also differs (Fig. 50). Fore metatarsus and tibia about 1.04 longer than the tibia. Wings hyaline, tinged with yellow (Fig. 175). Cape May, N. J.! (Viereck) Sept.; Burlington, Vt., (C.W.J.) June; Boston, Mass. (C.W.J.), Sept.; N H. (Weed).

20. *Exechia absoluta* n. sp.

Male. Length 3.5 mm. Thorax brown, sides lighter brown, humeri yellow. Abdomen dark brown, the venter of the first 3 segments narrowly, an indistinct spot on each side of segment 2 and a larger, more distinct one on sides of 3, yellow; hypopygium yellow (Fig. 51). Fore metatarsus and tibia subequal. Wings hyaline, tinged with brown (Fig. 176). Rouville Co., Que.; Orono, Me.! Oct. Reared from *Boletus granulatus.*

Female. Like the male but with broad dark brown or blackish margins on each segment produced along the median line, thus leaving the venter and triangular spots on the sides, yellow Ithaca, N. Y.; Brookings, S. D. (J.M.A.); New Haven, Ct., (Viereck), Riverton, N. J. (C.W.J.).

21. *Exechia capillata* n. sp.

Male. Length 3.5 mm. Thorax and abdomen dark brown, humeri and small spot on venter of segments 2 and 3 faintly yellow; hypopygium yellow (Fig. 52). Fore metatarsus and tibia subequal in length. Wings hyaline, tinged with brown (Fig. 177).

Female. Like the male but venter yellow, this color extending up on the sides along anterior margin of each segment.

Kingston, R. I. (J.B.), May; Dinwiddie Creek and Torrey's Lake, Wyo. (W.M.W) Sept.; Stanford Univ., Cal. (J.M.A.) Feb.; Ithaca, N. Y.! May, Sept. Bred from *Collybia dryophila.*

22. *Exechia obediens* n. sp.

Male. Length 3.5 mm. Thorax and abdomen brown; hypopygium dusky yellow (Fig. 53). Fore metatarsus about 1.04 longer than the tibia. Wing hyaline, tinged with brown (Fig. 178). Stanford Univ.! (J.M.A.) Feb.; Berkeley, Cal., (W.M.W.) March.

23. *Exechia attrita* n. sp.

Male. Length 3.5 mm. Thorax and abdomen brown, lateral margins of the mesonotum paler, posterior end of abdomen darker brown, humeri and venter and sides of segment 2 and 3, yellow; hypopygium dusky yellow (Fig. 54). Fore metatarsus and tibia subequal in length. Wings hyaline, tinged with brown (Fig. 179).

Female. Like the male but venter yellow, this color extending up on the sides along anterior margin of each segment. Wis., (W.M.W.) Aug.; R. I. (J.B.), Nov.; Ithaca, N. Y. Aug.; Orono, Me., Nov.; Forest Hill, N. J.; (Weidt), Apr., Nov.

24. *Exechia repanda* n. sp.

Male. Length 3 mm. The mesonotum, scutellum and metanotum brown, the humeri, pleura and lateral margins of the mesonotum yellow. Abdomen dark brown; the venter of segments 1, 2 and 3, the posterior part of the sides of 2, the greater part of the sides of 3, and hypopygium (Fig. 55) yellow. Fore metatarsus but little if any longer than the tibia. Wings hyaline, tinged with brown (Fig. 180). Ithaca, N. Y.! Aug.

Female. Like the male but with abdomen like that of the female of *E. attrita.* Boston, Mass., (C.W.J.). Sept.

25. *Exechia absurda* n. sp.

Male. Length 3 mm. Thorax brown, pleura a little paler brown, humeri yellow. Abdomen dark brown, the venter of segment 2, venter and sides of 3, and hypopygium yellow (Fig. 56). Fore metatarsus about 1.1 longer than the tibia. Wing hyaline, tinged with brown (Fig. 181). Ithaca, N. Y.! and Orono, Me. Nov.

26. *Exechia casta* n. sp.

Male. Length 3.5 mm. Thorax and abdomen brown, the latter darker brown, humeri yellow; hypopygium yellow (Fig. 57). Fore metatarsus about .95 as long as the tibia. Wings hyaline tinged with brown (Fig. 182).

Female. Like the male but the anterior margin of each segment on the venter and sides sometimes faintly tinged with yellow. Black Rock Creek, Dubois,! Dinwiddie Creek, Hunter's Creek, Wyoming (W.M.W), Sept.

27. *Exechia analis* Adams.

Wash. Carnegie Inst. Pub. 67. 37. 1907. (*Mycetophila.*).

Male. Length 4 mm. Head brownish black, mouth parts and basal joints of antennæ yellow, remaining joints of antennæ light brown. Thorax brownish black, lateral margins of mesonotum and pleura brownish-yellow, mesonotum with short yellow pile and black bristly hairs, the latter distributed along the sides; scutellum with an apical pair of strong bristles. Abdomen brownish-black, apex yellow, with short yellow pile. Coxæ yellow, femora light yellow, tibia and tarsi becoming darker distally; the front tibiæ without bristles except the apical ones, the second are provided with a row of indistinct setulæ and the hind tibiæ have rather strong bristles; front tarsi a little over twice as long as front tibiæ; middle tarsi above twice as long as middle tibiæ, hind tarsi 1.5 times as long as their tibiæ. Wings nearly hyaline, Rs and anterior branch of media divergent distally, furcation of media in front of base of Rs, furcation of cubitus considerably posterior to it. Halteres light yellow. "Mayfield Cave, Ind."

The type specimen, which was sent to me by Dr. Adams for examination, has an hypopygium resembling that of *E. attrita*, the longer process very similar to that shown in fig. 54, but the postero-ventral angles of the hypopygial sclerite are produced almost as far as the tips of the articulated processes in the form of slender, blunt almost spine-like lobes, in *E. analis.*

27. Genus *Dynatosoma* Winnertz.

Verh. Zool.-bot. Ges. Wien. XIII, 947, 1863.

Front broad, anterior margin not produced into a triangle, vertex high; ocelli usually 2 in number, large; the middle one, when present, very minute; Thorax pubescent, margins setose. scutellum semicircular with setose margin. Legs stout, hind femora each usually with 3 ranges of stout setæ on extensor surface. Costa not extended beyond tip of Rs; subcosta nearly half as long as the basal cell R and ends in R_1; branches of the cubitus widely divergent; first anal long but incomplete, strong.

Table of Species.

a. Cubitus forks distad of the basal section of the radial sector; wing with distinct spots; 3 ranges of setæ on each hind tibia.
  b. Thorax largely and abdomen, fuscous; hypopygium (Fig. 58). 1. *nigrina* n. sp.
  bb. Thorax largely and basal portion at least of abdomen, yellow, hypopygium (Fig. 59). 2. *fulvida.*
aa. Cubitus forks proximad of the base of radial sector; wing unspotted; 2 ranges of setæ on each hind tibia.
  b. Thorax black. 3. *thoracica.*
  bb. Thorax fulvous. 4. *placida* n. sp.

1. *Dynatosoma nigrina* n. sp.

Male. Length 5 mm. Head fuscous, antennæ subfuscous basal 3 or 4 joints and palpi yellowish. Thorax fuscous, the narrow posterior angles of the mesonotum and the humeri, widely, reddish yellow; hairs and setæ yellow. Abdomen blackish, the hind margins of the segments narrowly and indistinctly, yellow; hairs, appressed, yellow; hypopygium (Pl. 7, fig. 19, Genera Insectorum, Fasc. 93) and (Fig. 58). Coxæ yellow, middle and hind ones each with an oval black spot near the apex on the outer side; femora and tibiæ, yellow, the bases of all and the apices of middle and hind femora, black, tip of hind tibia black; tarsi brownish. Wing grayish hyaline, marked with a large brown central spot, a preapical fascia and a faint grayish apical margin (Fig. 183). Halteres yellow. Mass.

2. *Dynatosoma fulvida* Coquillett.

Canad. Ent. XXVII. 201. 1895.

Male. Length 4.5 mm. to 7 mm. Head dusky yellowish with darker transverse fascia, or wholly brown, antennæ subfuscous, 4 or 5 basal joints and palpi yellowish. Thorax reddish yellow, hairs yellow, setæ reddish yellow to brown. Abdomen reddish yellow, the 3 posterior segments largely subshining blackish with yellow margins; hypopygium (Fig. 59). Coxæ and legs yellow, the tarsi and the tips of the hind femora brownish. Wings grayish hyaline, marked with a large brown central spot, a preapical fascia and a fainter grayish apical margin (Fig. 184). Halteres yellow. Capens, Me. (C.W.J.), July; Friday Harbor, Washington (J.M.A.), May; Ithaca, N. Y.

Female. Similar to the male, but the abdomen with less dark coloring, in 2 specimens wholly reddish yellow. Selkirk Mts. (J.C.B.); Friday Harbor, Washington (J.M.A.), May; Ithaca, N. Y., June.

3. *Dynatosoma thoracica* Coquillett.

Proc. U. S. Nat. Mus. XXIII. 598. 1901.

Male and female. Length 4 to 5 mm. Head black, upper part of face, base of antennæ and the mouth parts yellow, thorax and scutellum black, subopaque; abdomen dark brown, the first 4 segments partly or wholly reddish yellow; legs yellow, tarsi brownish, anterior tibiæ each bearing about 4 downwardly directed spines at apex of outer side, the anterior spine the longest, nearly half as long as the tibial spur; many of the lateral bristles of middle and hind tibia much longer than greatest diameter of the tibiæ, those on inner side of the middle tibiæ shorter than greatest diameter of the latter; wings grayish hyaline, tinged with yellowish along the costa, cubitus forking about opposite the crossvein. Halteres yellow. "Ill., N. H." An examination of the type shows that there are 2 ranges of setæ on each hind tibia.

4. *Dynatosoma placida* n. sp.

Male. Length 5.5 mm. Head fulvous, frontal groove dusky, ocelli 2, face and palpi pale yellow, antennæ fuscous, 4 or 5 basal joints yellowish, setæ on the upper eye margin, brown. Thorax fulvous, mesonotum with 3 indistinct pale brown vittæ, setæ pale brown; pleura, scutellum, and metanotum yellow:

scutellar setæ brown. Abdomen fulvous, shining, each segment with a brown triangular "saddle," broadest posteriorly, indistinctly divided along the median line; hypopygium shining fulvous, prominent, superior claspers slender, curved, each with curved black spine at the tip and a long stout subapical seta. Coxæ and legs yellow, tarsi darker, hind tibiæ each with 2 ranges of setæ. Wings yellow hyaline, veins fulvous (Fig. 215). Kearney, Ont., (M. C. Van Duzee), July.

28. Genus *Opistholoba* Mik.

Wien. Ent. Zeit. X. 87, 1891.

Ocelli three, laterals contiguous to the eye margin, middle one very minute; hypopygium very large and conspicuous, much broader than the abdominal segments, husk-like (Fig. 60). Ventral posterior margin of the sixth abdominal segment in the female provided with a row of long setæ which project beyond the tip of the abdomen. In other respects like *Mycetophila.*

Opistholoba ocellata Johannsen.

Genera Insectorum, Fasc. 93, 126. 1909.

Male. Length 3 mm. Head shining black, antennæ fuscous, 4 or 5 basal joints and the palpi yellow. Thorax and abdomen deep brown or black; large quadrangular spot on each humerus, a minute spot on each posterior angle of the mesonotum, and the large hypopygium, yellow. Hypopygium when seen from the side, subtriangular, folded under the abdomen, nearly reaching the middle of the fourth abdominal segment (Fig. 60. See also pl. 7, fig. 18, Genera Insectorum, Fasc. 93).

Coxæ and legs yellow, the tarsi slightly darker, tips of hind femora blackish; middle tibiæ each with one short and two long setæ on the flexor surface. Wings grayish hyaline, with a central spot and a short preapical fascia, cubitus forks slightly proximad of the fork of the media (Fig. 185). Halteres yellow. Ithaca, N. Y. May. Aug.

29. Genus *Epicypta* Winnertz.

Verh. Zool-bot. Ges. Wien. XIII. 909, 1863.

Head round, flattened in front, the anterior margin of the thorax produced over it; front broad, its anterior margin produced into a triangle which descends to the base of the antennæ; ocelli small, laterals contiguous to the eye margin, the middle one minute, placed in a groove at the base of the frontal triangle. Legs strong, with tibial setæ which on the hind legs are noticeably longer than the diameter of the tibia at the widest part. Costa more or less produced beyond the tip of Rs; fork of the cubitus under or proximad of the fork of the media, the angle at the base very acute, the branches slightly diverging, anal strong but incomplete.

Table of Species.

a. Wings unspotted, hyaline.
  b. Cubitus forks proximad of the prominal end of the crossvein by the length of this vein.
    c. Humeri dusky yellow; costa produced. 1. *pulicaria.*
    cc. Humeri black; middle ocellus absent; costa produced but little if at all. *Mycetophila anomala* n. sp.
  bb. Cubitus forks under the crossvein. *Mycetophila vitrea.*
aa. Wing marked with brown.
  b. Mesonotum shining, unicolored, blackish; a single spot on the wing. 2. *punctum.*
  bb. Mesonotum yellowish with 3 dark subconfluent stripes, or sometimes confluent, leaving only the humeri and anterior margin yellow; wing with central spot and broad preapical spot which may be rather faint, rarely wanting. 3. *trinotata.*

1. *Epicypta pulicaria* Loew.

Berlin. Ent. Zeitschr. XIII, 151, 1869.

Female. Length 2.5 mm. Black, moderately shining, clothed with short appressed dusky pile. Head black, palpi yellow, antennæ fuscous, the scape and the immediate base of the flagellum reddish. Coxæ and legs pale yellow, the tibial spurs and the fore tarsi fuscous, the other tarsi subfuscous; middle tibiæ each with 2 setæ on flexor surface. Wings yellowish gray hyaline, the costal cell and part of cell R_1 yellowish. Halteres yellow. "Pa."

After examining the type at Cambridge, I may add that the humeri are dusky yellow, R_1 and Rs curved parallel to the costa, the cell between quite narrow, cubitus forks the length of the crossvein proximad of the proximal end of the latter.

2. *Epicypta punctum* Stannius.

Observ, de Myc. 16. 1831 (*Mycetophila*).

Male and female. Length 3 mm. Head black, subshining. antennæ brown, scape, at least the second joint, and the palpi reddish yellow, hairs yellowish. Thorax and abdomen brownish black with appressed yellow hairs, hypopygium dusky yellowish; longer hairs at the bases of the wings and the 4 scutellar setæ, black. Coxæ and legs reddish yellow, tips of hind femora, the spurs and the tarsi brown; middle tibiæ each with 1 shorter and 2 longer setæ on the flexor surface; fore metatarsus very slightly shorter than the tibia, subequal in the female; the entire tarsus about 2.4 the tibia in length; soles of the 2-4 fore tarsal joints slightly swollen in the female. Wing hyaline, tinged with brownish yellow, with a brownish central spot; costa noticeably produced beyond the tip of Rs; the base of Rs, the forks of media and cubitus nearly equidistant from the base of the wing, or the last very slightly proximad; second anal long, though incomplete, somewhat curved up at the end. Halteres yellow. "Europe and N. J." Auburndale, Mass. (C.W.J.) Aug.

3. *Epicypta trinotata* Staeger.

Kröyer: Tidsskr. 242. 1840 (*Mycetophila*).

Male and female. Length 3 mm. Head and antennæ brown, scape and palpi yellow, hairs yellow. Mesonotum reddish yellow with 3 subconfluent brown stripes, or in the male, brown, with only yellow humeri, pleura and metanotum brown, scutellum brown in the male, yellow with brown lateral spots in the female, setæ black, hairs appressed, yellow. Abdomen dark brown with appressed yellow hair, hypopygium yellowish (Fig. 61). Coxæ and legs yellow, hind margins and tips of hind femora, the spurs and the tarsi brown; fore metatarsus and tibia subequal in length, the entire tarsus about 2.2 longer than the tibia, middle tibiæ each with a short and 2 long setæ on flexor surface. Wings yellowish hyaline, with a brown central spot, an elongate pale brownish preapical cloud, a pale brown spot behind the fork of the cubitus, and a yellow costal cell (Fig. 186). Excepting the central spot the markings are sometimes quite faint. Halteres yellow. Mass., (W.M.W.); N.

Adams, Mass., (C.W.J.). June; Ithaca, N. Y., June-Aug.: Kingsmere, Canada, (Dr. Hewitt). The Canadian specimens were reared from *Enteridium spendens*.

30. Genus *Mycothera* Winnertz.

Verh. Zool.-bot. Ges. Wien XIII. 913, 1863.

Front broad, its anterior margin produced into a triangle the apex of which reaches to the base of the antennæ; ocelli small, the laterals contiguous to the eye margin, the minute middle one placed in a groove at the base of the frontal triangle. Anal segments and forceps small. Tibial setæ strong, the middle tibia frequently with one or more on the flexor surface, fore metatarsus shorter than the tibia. Costa not produced beyond the tip of Rs, cubitus forks proximad, at, or distad of the base of Rs, the branches convergent or parallel toward their apices The 3 ocelli distinguish this genus from *Mycetophila,* the converging or parallel branches of the cubitus separate it from *Epicypta*. The larvæ live in decaying wood and fungi.

Table of Species.

a. Cubitus forks as far distad of the crossvein as the length of the cell Cu_1.

b. Thorax black; wings hyaline, with a brown fascia which fills apex of cell R_1 and crosses Rs. 1. *analis*.

bb. Thorax brownish or yellowish; hypopygium (Fig. 62). 2. *paula*.

aa. Cubitus forks proximad, under, or but slightly distad of the fork of the media.

b. Cubitus forks distinctly proximad of the proximal end of the crossvein; middle tibia with 2 or 3 setæ on the flexor surface; apical wing cloud diffuse; abdomen reddish, indistinctly fasciate. 3. *paradoxa* n. sp.

bb. Cubitus forks only slightly proximad, at, or distad of the proximal end of the crossvein.

c. Preapical wing cloud diffuse, its margin ill defined or wanting; or if more distinct, then middle tibia each with 1 setæ on flexor surface.

d. Middle tibiæ each with two or three setæ on flexor surface; females. 4. *Mycothera* sp.

dd. Middle tibiæ each with 0 or 1 seta on flexor surface.

e. Thorax reddish or reddish brown with sub fucous dorsum; abdomen reddish brown indistinctly fasciate.

f. No apical wing cloud; hypopygium (Fig. 64). 5. *mitis* n. sp.

ff. With diffuse apical wing cloud; hypopygium (Fig. 65). 6. *recta* n. sp.
ee. Dark brown or blackish species; hypopygium (Fig. 66).
f. Wing with hyaline spot under Rs (Fig. 191). 7. *fenestrata.*
ff. Wing not marked thus. 7a. var. *praenubila* n. var.
cc. Preapical wing cloud sharply defined with an anterior spur which fills out the apex of cell R_1; middle tibiæ each with 2 or 3 setæ on flexor surface. 8. *impellans* n. sp.

1. *Mycothera analis* Coquillett.

Proc. U. S. Nat. Mus. XXIII. 598, 1901. (*Exechia*).

Male. Length 2 mm. Head black, the face, mouth parts and base of antennæ yellow; thorax black slightly polished, a small triangular yellow spot below the humeri; abdomen dark brown, the third and fourth segments, except hind margin of the latter, yellow; legs yellow, the broad apices of hind femora dark brown, tarsi brownish yellow; wings hyaline, a brown facia fills the apex of cell R_1 and crosses cell Rs. "Delaware Water Gap, N. J."

2. *Mycothera paula* Loew.

Berlin. Ent. Zeitschr. XIII. 151, 1869.

trifasciata Coq. Invert. Pacifica I. 18. 1904. (*Mycetophila*).

Male and female. Length 2.2-2.5 mm. Head fuscous, antennæ brown, the 3 or 4 basal joints and the palpi yellow. Mesonotum reddish brown, opaque, the front and lateral margins and front angles yellow; hairs yellow, setæ brown; scutellum yellow, pleura and metanotum brown. Abdomen black, genitalia (Fig. 62) yellow. Legs yellow, tips of hind femora, of middle and hind tibiæ, and the larger part of the tarsi, brown; middle tibiæ each with 2 setæ on flexor surface. Wing grayish hyaline with 3 brown fasciæ (Fig. 187). Halteres yellow.

I have seen the types of *paula* and *trifasciata*, and they do not appear to differ. "Middle States," "Stanford Univ., Cal.;" Carbondale Landing, Columbia River, B. C., (J.C.B.); Ithaca, N. Y., Aug., Oct.; Brookside, N. J. (Weidt).

3. *Mycothera paradoxa* n. sp.

Female. Length 3 mm. Head and antennæ dark brown, the scape and palpi yellow. Thorax reddish yellow, dorsum with faint indication of 3 dark stripes, the scutellum, center of metanotum and the lower margin of the pleura, brown; hairs yellow; setæ blackish. Abdomen reddish yellow, each segment with a broad, indistinct, subfucous transverse fascia; ovipositor yellow (Fig. 63). Coxæ and legs yellow, tarsi brown; middle tibiæ each with 2 or 3 setæ on the flexor surface. Wings grayish hyaline, with a central spot and a diffuse preapical cloud: cubitus forks distinctly proximad of the proximal end of the crossvein (Fig. 188). Halteres yellow. Ithaca, N. Y.

4. *Mycothera* sp.

Female. Length 3 mm. Thorax and abdomen brown, humeri yellow. Cubitus forks about under the fork of the media. In other respects like *M. paradoxa*. Black Rock Creek, Wyo., Price Co., Wis., (W.M.W.); Ithaca, N. Y., Aug. In one N. Y. specimen the thorax is yellow with 3 distinct brown stripes, and the apical wing cloud faint, in another the apical wing cloud is entirely wanting.

5. *Mycothera mitis* n. sp.

Male. Length 3 mm. Head and antennæ brown, scape and palpi yellow. Thorax reddish brown, the center of the mesonotum, scutellum and metanotum fuscous, humeri yellowish, setæ black. Abdomen dark reddish brown, hind margin of each tergite indistinctly yellow, venter and hypopygium yellow (Fig. 64). Coxæ and legs yellow, tarsi brown; middle tibiæ each with a single seta on flexor surface. Wing hyaline, central spot pale brown, no preapical cloud (Fig. 189). Halteres yellow. Wisconsin, July.

6. *Mycothera recta* n. sp.

Male. Length 3 mm. Head and thorax brown, scape and palpi yellow. Thorax reddish brown, the center of the mesonotum, the scutellum and metanotum brownish, humeri yellow, setæ black. Abdomen dark reddish brown, darker posteriorly, hind margins of segments and venter indistinctly yellowish, hypopygium dusky yellow (Fig. 65). Coxæ and legs yellow, tarsi and tips of hind femora brown; middle tibiæ each with a single seta on flexor surface. Wing hyaline, central spot and diffuse preapical cloud pale brown (Fig. 190). Halteres yellow. Ithaca, N. Y. (Aug.).

Female. A female from the same locality with dark brown thorax, yellow humeri, brown abdomen with yellow venter and yellow margins on the tergites, may belong here.

7. *Mycothera fenestrata* Coquillett.

Inv. Pacifica, I. 19. 1905 (Mycetophila).

Male. Length 3 mm. Head, antennæ, thorax and abdomen dark brown, scape, palpi, humeri and hypopygium (Fig. 66) dusky yellow. Coxæ and legs yellow, the tarsi, tips of coxæ, of middle and hind tibiæ and of hind femora brownish, middle tibiæ each with one seta on the flexor surface. Wings hyaline with a brown spot over the crosvein, apical third of wing smoky less distinct posteriorly, a clear spot behind Rs below tip of R_1 (Fig. 191). Halteres yellow. Buffalo, N. Y.; Moscow, Id. (J.M.A.); "Stanford Univ., Cal."

7a. *Mycothera fenestrata*, var. *praenubila* n. var.

Male. Only the anterior part of the preapical wing cloud is distinct, the wing marks appearing as in *M. recta*.

Female. Thorax more reddish brown, with dark vittæ feebly indicated. Friday Harbor, Wash. (J.M.A.); Price Co., Wis. (W.M.W.); Alabama; Ithaca, N. Y., Forest Hill, N. J. (Weidt), April.

8. *Mycothera impellans* n. sp.

Male. Length 2.5-3 mm. Head and antennæ dark brown, the scape and palpi yellow. Thorax brownish; the mesonotum, scutellum and metanotum fuscous, setæ brown. Abdomen brownish, each tergite darker posteriorly, but the extreme margin and the venter pale; hypopygium yellow (Fig. 67). Coxæ and legs yellow, tarsi and tips of hind femora, brown; middle tibia with 2 or 3 setæ on flexor surface. Wings hyaline, a brown central spot, and a brown sharply defined preapical spot, a spur of which is produced into the tip of cell R_1; apical margin of wing very faintly smoky (Fig. 192). Halteres yellow.

Female similar, but abdomen more uniformly brown. Mt. Ranier, Longmire's Spring, Wash., (J.M.A.) July, Aug.;

North Mt., Pa., North Adams, Mass., (C.W.J.) June; Lavallette, N. J., (Vierick) May; Ithaca, N. Y.! August.

Var. a. Female. Length 3.7 mm. Thorax dark brown, humeri and lateral margins of the mesonotum reddish yellow; abdomen blackish. Mt. Constitution, Orcas, Id. Wash. (J.M.A.) July.

31. Genus *Mycetophila* Meigen.

Illiger's Mag. II. 263, 1803; Klass, I, 90, 1804.

Fungivora Meigen, Nouv. Class. 16. 1800, (without type).

Head placed low on the thorax so that in profile it makes a continuous curve with the thorax, ocelli 2, placed close to the eye margin. Legs stout, tibial setæ stout, those of the hind legs longer than the greatest diameter of the tibia. Costa not produced; subcosta short, incomplete; cubitus forks nearly under the fork of the media, its branches nearly parallel apically; anal vein incomplete. The larvæ, which are commonly found in decaying wood and in fungi, possess transverse rows of microscopic ambulacral setulæ upon the margins of the segments of the venter.

The following table should be considered only as a guide; and if a specimen be found which cannot be placed, it must not be assumed undescribed without making a careful study of the hypopygium, the most reliable single character. Color and wing markings, and possibly even the number of the setæ of the middle tibia are subject to occasional variation.

Table of Species.

a. Three ranges of setæ on the extensor surface of the hind tibia, and with 2 or more setæ on flexor surface of middle tibia.

b. Wing without a distinct cloud, though the petiole of the media itself may be darkened.

c. Thorax subopaque, humeri and posterior lateral angles yellow; female. 1. *exstincta.*

cc. Thorax shining black; hypopygium (Fig. 69). 2. *jucunda* n. sp.

bb. Wing with distinct spots or cloud.

c. Wing with a single spot which covers the crossvein.

d. With 2 setæ on flexor surface of middle tibia; hypopygium (Fig. 70). 3. *perita* n. sp.

dd. With 3 setæ on flexor surface of middle tibiæ; hypopygium (Fig. 68). 1. *exstincta.*

cc. Wing with preapical cloud or fascia in addition to the central spot.
d. Scutellum black, humeri yellow; females.
e. Preapical wing cloud does not reach vein M_1. 4 M. sp.
ee. Preapical wing cloud crosses M_2. 5. M. sp.
dd. Robust species with scutellum largely yellow.
e. Cubital cell broad, branches of Cu slightly divergent. 6. *procera.*
ee. Cubital cell moderate (Fig. 196), branches of Cu subparallel apically.
f. Wing with about 4 spots; one on each of M and Cu; hypopygium (Fig. 71). 7. *fastosa* n. sp.
ff. No distinct spots on media and cubitus; female. 8. M. sp.
aa. Two ranges of setæ on extensor surface of each hind tibia.
b. With no setæ on flexor surface of middle tibiæ.
c. Wing immaculate; last joint of palpus spatulate; hypopygium (Fig. 72). 9. *punctata.*
cc. With wing spots.
d. With but a central wing spot.
e. Thorax dark brown, with not more than 4 fine setæ near apex of hind tibia on inner lateral side; hypopygium (Fig. 73). 10. *falcata* n. sp.
ee. Reddish brown or yellow thorax; 5 or more fine setæ on inner lateral side of hind tibia apically.
f. Thorax yellow; apically half of inner lateral side of hind tibia ciliate; hypopygium (Fig. 74). 11. *mutica.*
ff. Thorax reddish brown, brown dorsum and pleura; hypopygium (Fig. 75). 11a *mutica* var. a.
dd. With 2 wing spots; branches of the cubitus slightly divergent; hypopygium (Fig. 76). 12. *lenis* n. sp.
bb. With one or more setæ on flexor surface of middle tibia.
c. With but one seta on flexor surface of middle tibia.
d. Wing without distinct spot. 17. *dolosa.*
dd. Wing with one or more spots.
e. Wing with discal spot and a preapical cloud which does not pass the media. 13. *monochaeta.*
ee. The apex of the wing more or less clouded, or other spots present.
f. Apex of wing brown, an oval hyaline spot below Rs. *Mycothera fenestrata.*
ff. Apex not distinctly clouded, a spot on cell M_2 distinctly separated from the preapical spot. 15. *quatuornotata.*
cc. With 2 or more setæ on flexor surface of middle tibia.
d. Wing without distinct spots.
e. With a distinct thickening of the apical half of the basal section of the media; fore metatarsus longer than its tibia. St. Vincent Isl. 16. *nodulosa.*

ee. Wing not so marked.
f. Mesonotum opaque dark brown. St. Vincent Isl. 17. *dolosa.*
ff. Mesonotum polished black, branches of cubitus diverging.
g. Cubitus forks under the crossvein. 18. *vittrea.*
gg. Cubitus forks proximad of the proximal end of the crossvein. 19. *anomala* n. sp.
dd. Wing with one or more spots.
e. Wing with only one spot which covers the crossvein.
f. Fore metatarsus longer than its tibia; mesonotum yellowish red. St. Vincent Isl. 20. *insipiens.*
ff. Fore metatarsus not longer or shorter than the tibia.
g. Thorax and abdomen blackish; length 2.3 mm; hypopygium (Fig. 78). 21. *bipunctata.*
gg. Thorax shining brown, lateral margins and a spot on center of scutellum yellow; length 3.7 mm. 22. *inculta.*
ee. Wing with 2 or more spots or clouds.
f. Abdomen yellowish, intermediate segments each with a large blackish spot on each side leaving a median yellow stripe; sometimes largely black with only a narrow median vitta; thorax with 3 subconfluent stripes, scutellum yellow.
g. Superior forceps of hypopygium rather broad and short, with a blunt black spine (Fig. 80). 23. *scalaris.*
gg. Superior forceps somewhat elongate (Fig. 82). 23a. *scalaris* var. a.
ff. Abdomen not marked thus.
g. Tibial spurs whitish abruptly tipped with black; thorax reddish yellow, moderately shining with 3 dark stripes; besides the central spot a series of 3 spots on the wing forming an irregular preapical fascia. 34. *sigmoides.*
gg. Tibial spurs not distinctly black tipped.
h. Middle tibiæ each with 3 or 4 setæ on flexor surface.
i. Fore tarsi slightly swollen below, joints 2, 3 and 4 wider than 1.
j. Ochraceous, shining, thorax with subconfluent dusky stripes; abdominal segments with wide yellow posterior margins. 24. *pinguis.*
jj. Dusky species, humeri yellow.
k. Incisures of abdomen yellow; hypopygium (Fig. 81). 25. *foecunda* n. sp.
kk. Abdomen wholly dark; hypopygium (Fig. 91). 26. *imitator* n. sp.

ii. Fore tarsi robust, but not swollen below.

j. Preapical wing cloud arises at the costal margin proximad of the tip of R_1.

k. Preapical wing cloud reaches apex of Rs.

l. Length 5 mm; hypopygium (Fig. 83). 27. *perlonga* n. sp.

ll. Length 3 mm. 26. *imitator* n. sp.

kk. Preapical wing cloud does not reach apex of Rs; length 2.5 mm. 28. *polita*.

jj. Preapical wing cloud does not cover tip of vein R_1.

k. Hind margin of abdominal segments broadly and distinctly yellow. 29. *fallax*.

kk. Hind margins of segments not broadly and distinctly yellow.

l. The superior forceps with about 6 blunt black spines and one longer curved one on each limb (Fig. 84). 30. *pectita* n. sp.

ll. The limbs of the forceps with fewer spines.

m. Preapical wing cloud produced to unite with a gray cloud on posterior margin; superior forceps with 3 or 4 blunt spines and a longer curved one (Fig. 85). 31. *lassata* n. sp.

mm. Preapical wing cloud abbreviated; superior forceps with one short blunt spine on each limb. 32. *lenta* n. sp.

hh. Middle tibiæ each with 1 or 2 setæ on flexor surface, rarely with an additional smaller one above.

i. Fork of the cubitus noticeably retracted proximad of the base of the crossvein; thorax reddish, slightly darker dorsally, margins of abdominal segments broadly yellow; length 4 mm. 33. *propinqua?*

ii. Fork of cubitus not retracted when thorax is reddish.

j. Species 4.5 mm long; preapical fascia extends to Cu_1, apical wing cloud present; coxæ and femora each with brownish spot; inner lateral side of hind tibiæ each ciliate to near the middle; hypopygium (Fig. 87). 35. *fatua* n. sp.

jj. Smaller species.

k. Cubitus forks slightly proximad of the proximal end of the crossvein; thorax and abdomen dull brown; hypopygium (Fig. 88). 36. *edura* n. sp.

kk. Cubitus forms under or distad of the fork of the media.

l. Preapical wing cloud diffuse, longitudinal in position, covers apices of veins R_1 and Rs; hypopygium (Fig. 89). 37. *exusta.* n. sp.

ll. Preapical wing cloud transverse in position, at least at proximal end.

m. Preapical wing cloud reaches M_2.

n. Thorax reddish with brown vittæ; preapical wing cloud reaches hind margin; hypopygium (Fig. 90). 38. *jugata* n. sp.

nn. Thorax dark brown.

o. Wing cloud reaches hind margin; scutellum dark brown; hypopygium (Fig. 91). 26. *imitator* n. sp.

oo. Wing cloud passes vein M_2.

p. Scutellum with yellow center and apex; hypopygium (Fig. 92). 39. *extenta* n. sp.

pp. Scutellum black. 40. M. sp.

mm. Preapical wing cloud does not reach vein M_2.

n. Middle and hind coxæ brown outwardly; proximal end of preapical cloud covers R_1, apex of wing with paler cloud; hypopygium (Fig. 93). 41. *edentula* n. sp.

nn. Middle and hind coxæ yellow; preapical wing cloud smaller; apex of wing not clouded; posterior angles of thorax yellow.

o. Scutellum yellow, sides darker. 42. *trichonota.*

oo. Scutellum black.

p. Fore tarsi swollen; preapical wing cloud oblique; hypopygium (Fig. 94). 42a. *trichonota* var. a.

pp. Fore tarsi not swollen; wing cloud broader; hypopygium (Fig. 95). 43. *socia* n. sp.

AUXILIARY TABLE TO SPECIES OF MYCETOPHILA sens. lat.

The species included in this table I cannot recognize. Some of them do not appear to belong to the genus Mycetophila as now restricted.

a. Wing with one or more spots.
  b. With a single spot which covers the crossvein.
    c. Head blackish, disk of thorax with 3 confluent blackish vittæ. 44. *discoidea.*
    cc. Head and thorax clay yellow. 45. *ichneumonea.*
  bb. With 2 wing spots.
    c. Head and thorax black; length 5 mm. 46. *bifasciata*
    cc. Head and thorax yellowish to brown.
      d. Length 2.5 mm; abdomen reddish brown. 47. *parva.*
      dd. Length 3 mm or over; abdomen reddish brown, segments with yellow margins.
        e. Preapical wing cloud broader but little longer than the central spot; halteres yellow; length 4 mm. 33. *propinqua.*
        ee. Preapical wing cloud much larger than the other.
          f. Halteres white; head brown; length 3.5 mm. 48. *laeta.*
          ff. Halteres and head tawny; length 3 mm. 49. *contigua.*
aa. Wing unspotted.
  b. Head black, thorax tawny with 3 broad black stripes, abdomen wanting. 50. *plebeia.*
  bb. Otherwise.
    c. Body brown, thorax with tawny stripe "forked in front on its hinder part," scutellum and breast yellow, abdominal segments yellow at base. 51. *obscura.*
    cc. Abdominal segments yellow at apex.
      d. Head brown, thorax ferruginous, reddish brown on disk. 52. *despecta*
      dd. Head and mesonotum dusky, (Allodia?).
        e. Halteres whitish, knob dusky before the tip. 53. *nubila.*
        ee. Halteres yellowish white. 54. *sericea.*

I. *Mycetophila exstincta* Loew.

Berlin Ent. Zeitschr. XIII. 152. 1869.

Female. Length 2.5 mm. Head fuscous, opaque, the face and mouth parts yellowish. Scape yellow, flagellum blackish, its base sometimes yellow. Thorax fuscous, subopaque, humeri and posterior angle, luteous. Scutellum wholly fuscous black. The first 5 abdominal segments fuscous, the venter and apex of the abdomen yellow. Coxæ and legs pale yellow, the tip of the hind femora fuscous, tarsi subfuscous, middle tibiæ with 3 setæ on flexor surface, tarsi slender, the hind metatarsus subequal in length to the remaining joints; wing veins luteous with very indistinct spot on the petiole of the media. There are 3 ranges of setæ on the extensor surface of the hind tibia in the type specimen at Cambridge. "Middle States;" N. Adams, Mass. (C.W.J.) June.

Male. Length 2.5 mm. Thorax brown, subshining, anterior lateral margins yellow; hairs yellowish, setæ brown. Abdomen brown, venter yellowish; hypopygium with short, broad appendages (Fig. 68). Coxæ and legs yellow, hind femora tipped with brown; fore metatarsus about .8 as long as the tibia; middle tibiæ each with 3 setæ on flexor surface, hind tibiæ each with 3 ranges of setæ on extensor surface; hind metatarsus about 7-8 as long as the remaining joints. Wing yellowish hyaline, with rather indistinct central spot (Fig. 193). Halteres yellow, Auburndale, Mass., (C.W.J.) Aug.

2. *Mycctophila jucunda* n. sp.

Male. Length 2.5 mm. Head shining black, scape, palpi and base of first flagellar joint yellow, flagellum fuscous. Thorax shining black, small post humeral depression yellow, hairs dusky yellow to brown, setæ brown. Abdomen black; hypopygium small, globular (Fig. 69). Coxæ and legs yellow, hind femora tipped with black, fore metatarsus about .85 as long as its tibia; middle tibia with 3 setæ on flexor surface; hind tibiæ each with 3 ranges of setæ on extensor surface, hind metatarsus about .8 as long as the remaining 4 joints. Wing yellowish hyaline, unmarked (Fig. 194). Halteres yellow. Ithaca, N. Y., August.

3. *Mycetophila perita* n. sp.

Male. Length 3.0 mm. Head black; scape, basal joint of flagellum and palpi yellow; flagellum fuscous. Thorax shining brownish black, the humeri widely and the posterior lateral angles narrowly yellow, hairs and setæ brown; 4 scutellar setæ. Abdomen brown, venter and the posterior margins of the intermediate segments on the sides, yellow; hypopygium with one pair of appendages elongate (Fig. 70). Coxæ and legs yellow; fore metatarsus about 1-16 shorter than the tibia, middle tibiæ each with 2 setæ on flexor surface, hind tibiæ each with 3 ranges on extensor surface. Wing yellowish hyaline, with central spot (Fig. 195). Milwaukee, Wis., (W.M.W.), June; Wild Cat Canyon, Costa Co., Cal. (J.C.B.) Nov.; Ithaca, N. Y.! July.

4. *Mycetophila* sp.

Female. Length 3 mm. Resembles the foregoing, but the yellow abdominal fasciæ are wider, distinct also on the dorsum. The hind femora are broadly tipped with black, the fore metatarsus is about 3-4 the length of the tibia, middle tibiæ each with 3 longer and one shorter setæ on flexor surface; fore tarsal joints 2, 3, and 4 are much broader than 1. Wing with 2 distinct spots, the preapical spot fills apex of cell R_1 but does not reach vein M_1. Eastport, Maine, July.

5. *Mycetophila* sp.

Female. Length 2.5. Resembles No. 4 but the thorax is subopaque, abdomen is largely brown; the fore tarsi are not swollen, middle tibiæ each with 3 setæ on flexor surface, preapical wing spot is more slender and crosses M_2, and the fork of the cubitus is narrower. Price Co., Wis. (W.M.W.) August.

6. *Mycetophila procera* Loew.

Male. Length 5 mm. Head dusky reddish yellow; antennæ blackish, scape and base of flagellum luteous. Thorax luteous, with 3 dorsal stripes, the angles of the scutellum, pleural spots and the metanotum blackish; pile yellow, longer hairs and the setæ black. Abdomen blackish, the posterior margin of each segment narrowly, and the lateral margins widely yellow. Coxæ and legs yellow, slender, tips of hind femora black, flexor surface of each middle tibia with 4 or 5 setæ, tarsi long and slender, the metatarsus and the following joints of hind foot subequal. Besides the central spot there is a series of fuscous spots from the tip of cell R_1 across the wing, and the apical third of the posterior margin is gray; veins strong, the branches of the cubitus widely separated and slightly divergent. "New York."

There are three ranges of setæ on the extensor surface of the hind tibiæ in the type specimen.

7. *Mycetophila fastosa.* n. sp.

Male. Length 4 mm. Head blackish, dusky yellow on the sides; scape, palpi, and base of flagellum yellowish, flagellum blackish. Thorax subshining blackish, the wide humeral and posterior lateral angles, a spot in front of the scutellum, the scutellum, except the sides, yellow; hairs pale, setæ black, abdomen brownish black, anteriorly more brownish, anterior part of venter pale brown; hypopygium (Fig. 71). Coxæ and legs yellow, the trochanters, a large spot on flexor surface near the base of all femora, tips of middle and hind femora and of middle and hind tibiæ, blackish, tarsi brown; fore metatarsus about 1-16 shorter than the tibia, middle tibiæ each with 2 setæ on flexor surface; hind tibiæ each with 3 ranges of setæ. Wing yellowish hyaline with central spot and several spots forming a broken preapical fascia (Fig. 196). Halteres yellow. Ithaca, N. Y.!

Female. Segments of abdomen narrowly margined with yellow, with an indication of a median longitudinal stripe on segment 2. Riverton, N. J., Delaware W. Gap, N. J. (C.W.J.).

8. *Mycetophila* sp.

Female. Length 3.5-4 mm. Similar to the foregoing but the preapical wing fascia is unbroken and does not reach M_1. In an Ithaca, N. Y. specimen, the thorax is wholly shining black, the hind margins of the intermediate abdominal segments narrowly yellow and the fore tarsi slightly swollen.

A specimen from Mt. Constitution, Washington, with wing marking as above is similar to *M. fastosa* but the disk of the thorax is brown. Another specimen from the same locality is similar to this but the narrow hind margins of the intermediate abdominal segments, the anterior part of the venter and narrow median dorsal stripes on segments 2 and 3 are yellow.

9. *Mycetophila punctata* Meigen.

Syst. Beschr I, 264. 1818.

Male and female. Length 4 to 6 mm. Ochraceous; the apical half of the antennæ, the center of the mesonotum, the "saddles" of each abdominal tergite, and the tarsi usually dusky yellow or in occasional, usually southern specimens, brownish; sometimes wholly yellow. Apical joint of palpus oval (Fig. 55, Plate I, Part I). Fore metatarsus and tibia subequal; no setæ on flexor surface of middle tibiæ, hind tibiæ each with 2 ranges on extensor surface; both middle and hind tibiæ each ciliate with a range of finer setæ on inner lateral surface, which are uniform in size on hind tibiæ and extend to above the middle; hind coxæ with a tuft of fine slightly curved setæ near the tip on the hinder wide; hypopygium (Fig. 72. See also Pl. 7, fig. 17, Genera Insectorum, Fasc. 93). Wing yellow tinged, without spots (Fig. 56, Plate I, Part I and Fig. 245, Part III). Bred from several species of fleshy fungi. Our commonest species. Alab., Id., Mass., Maine, N. C., N. J.. N. Y., R. I., Tenn., Tex., Wis., Wyo.

10. *Mycetophila falcata* n. sp.

Male and female. Length 2.5 mm. Head, thorax and abdomen dark brown; scape, palpi, and hairs yellow, setæ black: superior forceps of the hypopygium elongate, curved (Fig. 73) Coxæ and legs yellow, tarsi brownish; fore metatarsus about 1-16 shorter than the tibia; middle tibiæ without setæ on flexor surface; hind tibiæ each with 2 ranges on extensor surface; hind metatarsus nearly .8 as long as all of remaining joints. Wings yellowish hyaline, with a central spot (Fig. 197). Halteres yellow. Ithaca, N. Y.!

A male specimen from Mt. Constitution, Id., differs in having humeri and scutellum yellowish; a female from the same locality differs from the female from N. Y. only in being slightly paler brown.

11. *Mycetophila mutica* Loew.

Berlin. Ent. Zeitschr. XIII. 152. 1869.

Female. Length 2.7 mm. Head reddish yellow, front subcinereous, face, mouth parts, scape and base of flagellum yellow; flagellum brownish. Thorax opaque reddish yellow, scutellum similarly colored. Abdomen fuscous, the sides of the last 4 segments widely yellowish. Coxæ and legs pale yellow, tarsi slender, subfuscous, the fore tarsus twice as long as the tibia, the hind metatarsus a little longer than the remaining joints taken together; middle tibiæ without setæ on flexor surface. Wing with a central spot. "Middle States." Hind tibiæ each with 2 ranges of setæ on extensor surface; inner lateral side ciliate to the middle.

Male. Differs in having abdomen wholly brown; hypopygium (Fig. 74). N. C., (W.B.); N. Y.; Selkirk Mts., B. C., (J.C.B.); Wash. (J.M.A.); Wis., and Wyo. (W.M.W.).

Var. a. Differs in having disk of mesonotum brownish, a slight difference in the form of the inferior forceps (Fig. 75).

and in having fewer cilia on inner lateral side of hind tibia. Wash. (J.M.A.).

12. *Mycetophila lenis* n. sp.

Male. Length 4 mm. Head brown, yellowish at the sides; scape, base of flagellum and palpi yellow, flagellum brown. Thorax yellow, a spot, 3 subconfluent vittæ on dorsum, center of the metanotum, and the pleura in part, brown; hairs pale, setæ dark. Abdomen brown, the anterior margin of each segment very narrowly, the posterior margin more widely and the venter, yellow; hypopygium (Fig. 76). Coxæ and legs yellow, tips of middle and hind femora narrowly dark brown, tarsi brownish; fore metatarsus about 7-8 as long as the tibia; middle tibiæ without setæ on the flexor surface; hind tibiæ each with 2 ranges of setæ on extensor surface; hind metatarsus about .9 as long as the remaining joints taken together. Wing yellowish gray hyaline, with 2 large dark brown spots; branches of cubitus distinctly divergent (Fig. 198). Halteres yellow. Eastport, Maine, (C.W.J.), July.

13. *Mycetophila monochaeta* Loew.

Berl. Ent. Zeitschr. XIII. 158. 1869.

Male and female. Length 2.7-3 mm. Head fuscous black, opaque, mouth parts subfuscous, scape chiefly yellow, flagellum fuscous black, the base yellowish. Thorax and abdomen fuscous black, mesonotum opaque, sides pollinose, humeri sometimes yellowish; genitalia pale. Coxæ and legs pale yellow; middle tibiæ each with one seta on flexor surface; hind metatarsus subequal in length to the remaining joints taken together. Wing cinereous with a central spot and a short preapical fascia. "D. C."

14. *Mycetophila fenestrata* Coquillett.

An examination of the type in the National Museum shows that this species is a member of the genus *Mycothera*. See page 83 for the description.

15. *Mycetophila quatuornotata* Loew.

Berlin. Ent. Zeitschr. XIII. 157. 1869.

Female. Length 4.2 mm. Head dusky yellow, front largely fuscous; antennæ fuscous black, scape and base of flagellum yellow. Mesonotum yellowish with 3 broad black vittæ dilated anteriorly; hairs yellowish, setæ black; pleura and metanotum fuscous black; scutellum yellow, lateral angles blackish. Abdomen fuscous black, moderately shining, the last segment except the base, the posterior margins of the remaining segments, a median stripe on segment 2 and the bases of 3 and 4 yellow; lamellæ of the ovipositor ochraceous. Coxæ and legs pale yellow, tips of posterior femora black, flexor surface of each middle tibia with a single setæ; hind metatarsus shorter than joints 2, 3 and 4 taken together. Central wing spot large; preapical spot fills out the apex of cell R_1 from tip of vein R_1 and reaches Cu_1 interrupted over cell M_1; a more or less distinct gray cloud behind the cubitus opposite the central spot. "Maryland;" Hemlock Falls, N. J. June.

16. *Mycetophila nodulosa* Williston.

Trans. Ent. Soc. London. 264. 1896.

Male. Length 2.5 mm. Antennæ brownish-yellow, the basal joints yellow; longer than the head and thorax together. Front and face light ochraceous yellow; palpi brown. Mesonotum light ochraceous yellow, lightly white pruinose on the sides, and with blackish and yellow hair; pleura brownish-yellow. Abdomen reddish-brown; pubescence chiefly black. Legs yellow, the coxæ and femora light yellow, the broad hind femora at the tip brown. Front tibiæ about 1-3 of the length of the tarsi and shorter than the metatarsi; middle tibiæ with spines on the inner side; hind tibiæ with 2 rows of spines on the outer side. Wings lightly tinged, the outer part of the first section of the media, the crossvein and the base of the second section of Rs thickened, forming a straight spindle-shaped mass. "St. Vincent Isl."

17. *Mycetophila dolosa* Williston.

Trans. Ent. Soc. London. 264. 1896.

Male. Length 2.5-3 mm. Antennæ brown, somewhat compressed, the basal joints yellowish. Front and face brown, mesonotum dark brown, opaque, with a thin yellowish sheen in some reflections. Abdomen dark brown or black, the venter yellow. Pleura yellowish-brown. Coxæ and legs light yellow, the tarsi appearing blackish from the hair; front tibiæ less than half of the length of the tarsi and a little longer than the metatarsi; hind tibiæ with 2 rows of spines on the outer side: middle tibiæ with spines on the inner side; hind metatarsi nearly as long as the following joints together. Wings tinged with brownish. "St. Vincent Isl."

Mr. William R. Thompson who kindly examined the co-type (?) specimens in the St. Vincent collection at Cornell University writes "......The specimen bearing the label has one seta on the flexor surface of the middle tibia .... The second specimen placed beside the first has the tarsus of the first leg practically equal to (only very slightly longer than) the tibia of that leg; it has 2 setæ on the flexor side of the middle tibia"

18. *Mycetophila vitrea* Coquillett.

Length 2.5 mm. Black, the face, mouth parts, bases of antennæ, halteres and legs, yellow, apices of tarsi brown. Body polished, the hairs yellowish, bristles black. Middle tibiæ each bearing a very long and a short bristle on the inner side. Wing hyaline, tinged with yellowish and gray along the costa, cubitus forks opposite the crossvein. "N. J., B. C."

This species and *M. anomala* resemble *Epicypta* in general appearance and in venation.

19. *Mycetophila anomala* n. sp.

Male and female. Length 3 mm. Head, thorax and abdomen brownish black, shining, venter sometimes narrowly yellowish. Scape, palpi, coxæ, legs, halteres and hypopygium (Fig. 77) yellow; flagellum, tips of hind femora and tarsi brownish; tibiæ each with 2 setæ on flexor surface. Wings grayish yellow hyaline; fork of cubitus proximad of the base of the crossvein (Fig. 199). Halteres yellow. Price Co., Wis. (W.M.W.) August.

20. *Mycetophila incipiens* Williston.

Trans. Ent. Soc. London. 264. 1896.

Female. Length 2.5 mm. Antennæ about as long as the thorax, yellow; brownish toward the end; front and face yellow. Mesonotum yellowish-red. Abdomen reddish-yellow; each segment broadly brown on its posterior part. Legs, including the coxæ light yellow; front tibiæ about 1-3 of the length of the tarsi and shorter than the metatarsi; middle tibiæ with 2 large and one small bristle on the inner side; middle and hind tibiæ with spines on the outer side; hind metatarsi distinctly shorter than the remaining joints of the tarsi together. Wings tinged with yellowish; a small brownish cloud on the basal section of the radial sector. "St. Vincent Isl."

21. *Mycetophila bipunctata* Loew.

Berlin. Ent. Zeitschr. XIII. 152. 1869.

Female. Length 2.4 mm. Head fuscous, opaque, face and mouth parts pale yellowish; scape and sometimes base of flagellum, yellow; flagellum blackish. Thorax fuscous black, humeri luteous; scutellum and abdomen fuscous black, the extreme tip of the latter and the venter, yellow. Coxæ and legs pale yellow, tips of hind femora fuscous, tarsi subfuscous; middle tibiæ each with 2 setæ on flexor surface; hind metatarsus about equal in length to the remaining 4 joints taken together. Wing with a small central spot. "Wis." There are 2 ranges of setæ on the extensor surface of the hind tibiæ in the type specimen.

Male and female. The female as above, the male like the female but the middle tibia usually bears a small setæ above the larger ones on the flexor surface and the humeri and venter are usually not much paler than the other parts; hypopygium (Fig. 78).

Orono, Maine, Nov.; Ithaca, N. Y., June-Aug.; N. J., Wis., Wyo., (W.M.W.), Sept.

22. *Mycetophila inculta* Loew.

Berlin. Ent. Zeitschr. XIII. 153, 1869.

Female. Length 3.7 mm. Head brown, face and mouth parts luteous, antennæ brownish, scape and the very base of the flagellum luteous. Mesonotum brown, shining, hairs appressed, yellowish; setæ black; pleura fuscous; scutellum dark brown with a median luteous spot. Abdomen fuscous or blackish, each segment except the first yellow margined, dilated into triangles on the sides; anal lobes brownish at the base, ochraceous apically. Coxæ and legs yellowish, tips of hind femora blackish, tarsi subfuscous, hind metatarsus about equal in length to the 3 following joints taken together; middle tibiæ each with 2 setæ on flexor surface. Wing with a central spot, apex of wing posteriorly more grayish. "Middle States."

Male and female. The female as above though the humeri are more yellowish. The male differs in having less yellow on the abdomen and the middle tibiæ each with 3 setæ on the flexor surface. Hypopygium (Fig. 79). Chicago, Ill., (W.M.W.), May; Ithaca, N. Y., May-Aug.; R. I. (J.B.); Wis., (W.M.W.).

23. *Mycetophila scalaris* Loew.

Berl. Ent. Zeitschr. XIII. 154. 1869.

Male and female. Length 3 mm. Head luteous, antennæ subfuscous, scape and the base of the flagellum yellowish. Mesonotum yellowish, moderately shining, with 3 dark, sometimes confluent stripes; hairs yellow, setæ black; scutellum yellow, lateral angles black; anterior part of pleura yellow, posterior part and the metanotum fuscous. First abdominal segment yellow, margin dusky, sometimes with median yellow line, segments 2, 3 and 4 each with a large blackish spot on each side which rarely may meet on the dorsum; segments 5 and 6 with yellow hind margin, apex of abdomen and venter yellowish. Coxæ and legs yellow, hind femora with black tips, tarsi subfuscous, middle tibia with 3 setæ on flexor surface; hind metatarsus about as long as the remaining joints taken together. Wing with a central spot and a preapical fascia which fills the apex of cell R_1 and extending obliquely proximad into cell R_5, below this the veins of the media are indistinctly surrounded by a grayish cloud. "Middle States." The robust hind tibiæ each have 2 ranges of setæ on the extensor surface; hypopygium (Fig. 80). The hypopygium of Var. a. differs in being more elongate (Fig. 82). Reared from *Boletus* and *Polyporus* Ithaca, N. Y., June-Oct.; Lawrence, Kas., (E.S.T.) July; Brookside, N. J., Selkirk Mts., B. C. (J.C.B.); Vt., (C.W.J.) Woods Hole, Mass.; Wis., (W.M.W.).

24. *Mycetophila pinguis* Loew.

Berlin. Ent. Zeitschr. XIII. 153. 1869.

Female. Length 4 mm. Front brownish, antennæ subfuscous, scape and the very base of the flagellum yellowish.

Thorax ochraceous, shining, mesonotum with 3 confluent stripes, hairs yellow, blackish on the dark stripes, setæ black; pleura in part fuscous. First abdominal segment wholly fuscous black, the remaining segments fuscous black each margined anteriorly and posteriorly with yellow, venter yellowish tinged. Coxæ and legs yellowish, hind femora with black tips; middle tibiæ each with 3 setæ on flexor surface, fore tarsi moderately thickened, hind metatarsus about as long as the 3 following joints taken together. Wing with central spot and a preapical fascia which fills the apex of cell of R_1 and extends into cell Rs beyond this are 2 small very indistinct clouds, one on each branch of the media. "English River;" "Maine;" Wis. (W.M.W.) July.

25. *Mycetophila foecunda* n. sp.

Male and female. Length 3 mm. Head, thorax and abdomen shining fuscous black, the scape, palpi, humeri and lateral posterior margins of mesonotum narrowly, small spot on apex of scutellum and very narrow hind margin of intermediate abdominal segment, yellow; hypopygium long, with acute forceps (Fig. 81). Coxæ and legs yellow, bases of hind coxæ, a spot under middle and hind femora, the tips of the middle femora, the apical 1-4 of each hind femur, dark brown, tarsi brownish; fore metatarsus less than 7-8 of tibia; middle tibiæ each with 3 or 4 setæ on flexor surface, hind metatarsus nearly .8 as long as the 4 remaining joints taken together, fore tarsi of female swollen below. Wing hyaline, with a central spot, a faint cloud behind the fork of the cubitus, and a preapical fascia which fills the apex of cell R_1 and extends to Cu_1 though broken and very faint beyond M_1 (Fig. 200). Halteres yellow. In some specimens the coxæ and under side of the femora are not marked and the preapical wing cloud obsolete beyond M_1. Juliaette, Id., (J.M.A.); Orono, Me., Ithaca, N. Y.! (Nov.). Reared from *Polyporus* sp.

26. *Mycetophila imitator* n. sp.

Male and female. Length 3 mm. Similar to *M. foecunda* but differs in being subopaque, in lacking the abdominal fasciæ and in the structure of the hypopygium. Head, thorax, and abdomen black, subopaque, palpi, scape and small humeral spot yellowish; hypopygium short (Fig. 91). Coxæ and legs yellow, tips of hind femora and of hind tibiæ blackish, spot on under side of hind femora near base, and tarsi brownish; fore metatarsus nearly .75 as long as its tibia; middle tibiæ each with 3, rarely 2, setæ on flexor surface, hind tibiæ each with 2 ranges of setæ on extensor surface; hind metatarsus nearly .8 as long as the remaining joints taken together. Wings grayish hyaline with central spot and preapical fascia which reaches hind margin, narrowest on cell M_1 (Fig. 201). Halteres yellow. Ithaca, N. Y.! and Orono, Me. Nov.

27. *Mycetophila perlonga* n. sp.

Male. Length 5.5 mm. Head dusky reddish yellow, front and antennæ dark brown, scape and palpi yellow. Thorax dusky reddish yellow, mesonotum with 2 wide dark brown stripes; pleura and metanotum dark brown. Abdomen dark brown, paler at the incisures; hypopygium (Fig. 83). Coxæ and legs yellow, tips of hind femora black; fore metatarsus about 7-8 as long as the tibia; middle tibiæ each with 3 or 4 setæ on flexor surface; hind tibia each with 2 ranges of setæ on the extensor surface. Wing yellowish gray hyaline, costal cell more yellow, central spot and large preapical fascia dark brown, posterior apical margin tinged with brown (Fig. 202). Halteres yellow. N. Y. August.

28. *Mycetophila polita* Loew.

Berlin. Ent. Zeitschr. XIII. 158. 1869.

Male. Length 2.5 mm. Head black, face and mouth parts luteous; antennæ fuscous black, scape and base of flagellum yellowish. Thorax shining black, humeri and the tips of the posterior lateral angles of the mesonotum luteous. Abdomen shining black, segments 5 and 6 each with yellow basal fasciæ, hypopygium luteous, minute. Coxæ and legs pale yellow, extensor surface and tip of each hind femur black; middle tibiæ each with 3 setæ on flexor surface. Wing with small central spot and a preapical fascia which arises on the costa before the tip of R_1 and reaches M_1; directly opposite this the veins M_1 and M_2 are gray clouded. "N. Y." There are 2 ranges of setæ on the extensor surface of each hind tibia in the type specimen.

A female specimen from Ithaca, N. Y., does not differ. The humeri are widely yellow.

29. *Mycetophila fallax*. Loew.

Berl. Ent. Zeitschr. XIII. 156. 1869.

Male. Length 3 mm. Fuscous black, subopaque, humeri, scutellum except the angles and the hind margin of each abdominal segment pale; thoracic hairs pale, setæ black. Middle tibiæ each with 3 setæ on the flexor surface. Wing with a central spot, and a preapical arcuate fascia which extends from the tip of cell R_1 to vein M_1, the spots being larger and darker than in *M. trichonota,* and R_1 ends nearer the apex of the wing. "Middle States." The hind tibiæ each have 2 ranges of setæ on the extensor surface in the type specimen.

Var. a. Female. Length 3.7 mm. Thorax dark brown, humeral spot large; middle tibiæ each with 4 setæ; preapical wing fascia followed by a pale brown spot on each of M_1 and M_2, thus making an interrupted fascia extending beyond M_2. This specimen may represent a distinct species. Stanford Univ., Cal., March.

30. *Mycetophila pectita* n. sp.

Male. Length 3.5 mm. Head and antennæ brown, scape, base of flagellum and palpi yellow. Thorax subopaque dusky yellow, the 3 subconfluent stripes of mesonotum, sides of scutellum, posterior parts of pleura and the metanotum brown, hairs pale, setæ dark. Abdomen dark brown, hypopygium (Fig. 84). Coxæ and legs yellow, tips of hind femora and tarsi brown; fore metatarsus about .85 as long as the tibia. middle tibiæ each with 3 setæ on flexor surface, hind tibiæ each with 2 ranges on extensor surface. Wing yellowish hyaline, with central spot, and oblique preapical fascia distinct to the middle of cell Rs beyond which it is very faint apparently reaching M_2 (Fig. 203). Halteres yellow. Selkirk Mts., B. C.! (J.C.B.) and Friday Harbor, Wash. (J.M.A.).

31. *Mycetophila lassata* n. sp.

Male. Length 3.5 mm. Similar to *M. pectita* in coloring and structure, but differs in having the preapical wing cloud produced covering the posterior apical margin of the wing (Fig. 204); and in the form of the hypopygium (Fig. 85). Felton, Cal. (J.C.B.) May.

32. *Mycetophila lenta* n. sp.

Male. Length 3.5 mm. Similar to *M. pectita* but differs in having the mesonotum subshining, and in the form of the hypopygium (Fig. 86). The thorax of the Maine specimen is blackish with the humeri broadly yellow and with spots on posterior angles of mesonotum, a spot in front of the scutellum and the center of the scutellum, yellow; wing as figured (Fig. 205). Price Co., Wis. (W.M.W.) Aug.; Orono, Maine! Oct., (Bred from Mushrooms); N. C.

33. *Mycetophila propinqua* Walker.

List of Diptera, Brit. Mus. I. 96. 1848.

Length 4 mm. Head tawny, very thickly clothed with yellow hairs; palpi tawny; eyes black; feelers tawny, brown towards the tips; chest reddish tawny, with a short brown stripe on each side; hind chest pale tawny; its three reddish lobes covered with a white bloom; abdomen reddish brown, clothed with yellow hairs; hind borders of the segments tawny; legs yellow; tips of the thighs tawny; shanks darker than the thighs; feet brown, tawny toward the base; wings pale tawny especially towards the fore border, and adorned with two brown bands, of which the one nearest the wing tip is continued along the fore border of the wing to the tip, and is a little broader, but hardly longer or more irregular than the other; veins tawny; poisers yellow. "Nova Scotia."

A female specimen from N. Y. which appears to be this species has 2 setæ on flexor surface of each middle tibia and 2 ranges on extensor surface of each hind tibia.

34. *Mycetophila sigmoides* Loew.

Berlin. Ent. Zeitschr. XIII. 156. 1869.

Male. Length 4 mm. Head yellowish, front darker, antennæ fuscous black, the scape and the very base of the flagellum yellowish. Thorax yellowish moderately shining, mesonotum with 3 fuscous vittæ; hairs yellowish, setæ black; scutellum yellow, lateral angles fuscous, setæ black; pleura with fuscous, metanotum wholly fuscous. Abdomen yellowish, the segments with fuscous markings, hypopygium small, yellow. Coxæ and legs pale yellow; all femora with an oblong dark spot below, near the base, apex of each hind femur black; middle tibiæ each with 2 or 3 setæ on flexor surface; tibial spurs whitish distinctly tipped with black; tarsi dusky; hind metatarsus about as long as the 3 following joints taken together. Wing with central spot with a preapical fascia formed of 3 fuscous spots arranged like the letter S, the first and largest extends from the apex of cell R_1 to vein M_1. "Middle States."

There are 2 ranges of setæ on the extensor surface of the hind tibiæ in the type specimen.

35. *Mycetophila fatua* n. sp.

Male. Length 4.5 mm. Head and antennæ brown, the scape, palpi and very base of flagellum yellow. Thorax dull yellowish, mesonotum with 3 subconfluent dull dark brown vittæ, pleura, metanotum and sides of scutellum brown, setæ black Abdomen dark brown, the intermediate segments with yellow hind margins; hypopygium (Fig. 87). Coxæ and legs yellowish, the central portion of the coxæ, flexor surface of the femora near the base, tips of hind femora and of tibiæ and the apical part of the tarsi, brown, fore metatarsus about 7-8 as long as the tibia; middle tibiæ each with 2 setæ on flexor surface; hind tibiæ each with 2 ranges on extensor surface; hind metatarsus 7-8 as long as the 4 remaining joints. Wings grayish hyaline, costal cell yellowish; with central spot, a large brown preapical more or less interrupted fascia, a faint cloud at apex of the wing and another behind the fork of the cubitus (Fig. 206). Halteres yellow. Moscow, Idaho (J.M.A.).

Female. Similar, but thorax a little paler brown, and the preapical wing fascia more broadly interrupted in cell M_1. Vollmer, Idaho.

36. *Mycetophila edura* n. sp.

Male. Length 2.5 mm. Head and antennæ grayish brown, the palpi, scape and base of flagellum yellow. Thorax and abdomen dark brown, subopaque, the humeri and the narrow posterior angles of the mesonotum yellow, hairs yellow, setæ black; hypopygium (Fig. 88). Coxæ and legs yellow, the extensor surface of the hind femora and the tarsi brownish; fore metatarsus about .8 of tibia in length, middle tibiæ each with 2 setæ on flexor surface, hind tibiæ each with 2 ranges of setæ on extensor surface, hind metatarsus about 1-16 shorter than the 4 remaining joints. Wings grayish hyaline with central spot and a preapical spot which reaches from apex of Rs to proximad of tip of R_1, transversely not quite reaching M_1 (Fig. 207). Halteres yellow. Ithaca, N. Y.!

Female. A single specimen from Price Co., Wis. (W.M.W.) differs in having the dorsum of the thorax and base of the abdomen paler brown.

37. *Mycetophila exusta* n. sp.

Male. Length 3 mm. Head and antennæ brown, palpi, scape and base of flagellum yellow. Thorax brown, humeri yellow. Abdomen dark brown, hypopygium (Fig. 89). Coxæ and legs yellow, tarsi darker, fore metatarsus about .8 as long as the tibia; middle tibiæ each with 2 setæ on flexor surface, hind tibiæ each with 2 ranges of setæ on extensor surface. Wings grayish hyaline with central spot and an elongate brown diffuse preapical spot longitudinal in posterior extending from tip of Rs to proximad of tip of R_1; apical third of wing grayish with an oval hyaline spot below Rs (Fig. 208). Halteres yellow. Mass., June; Id., (J.M.A.) Sept., Cal.! (J.C.B.) May, Nov.

This species is very similar to *Mycothera fenestrata* in wing markings.

38. *Mycetophila jugata* n. sp.

Male. Length 3 mm. Head and antennæ grayish brown, palpi, scape and base of first flagellar joint reddish yellow. Thorax reddish yellow, the 3 wide vittæ of mesonotum, the pleura, and metanotum dark reddish brown, hairs yellow, setæ black. Abdomen dark brown, hairs yellow, appressed, hypopygium (Fig. 90). Coxæ and legs yellow, tips of hind femora blackish, tarsi dusky; fore metatarsus about .8 as long as the tibia; middle tibiæ each with 2 setæ on flexor surface, hind tibiæ each with 2 ranges of setæ on extensor surface; hind metatarsus subequal in length to the 4 following joints taken together. Wings grayish hyaline with a large brown central spot, a large paler cloud opposite this behind the cubitus, a preapical fascia which extends from the costa to the hind margin of the wing where it is paler, constricted in the middle (Fig. 209). Halteres yellow. Felton, Calif. (J.C.B.).

39. *Mycetophila extenta* n. sp.

Male and female. Length 3.5 mm. Head, antennæ, thorax, and abdomen subshining fuscous, the scape, base of flagellum, palpi, humeri, center of scutellum and the hind angles of the mesonotum narrowly dusky yellowish; hairs pale, thoracic setæ black; hypopygium (Fig. 92). Coxæ and legs yellow, tips of hind femora black, tarsi dusky; fore metatarsus about 7-8 as long as the tibia; middle tibiæ each with 2 setæ on flexor surface; hind tibiæ each with 2 ranges of setæ on extensor surface; hind metatarsus nearly .8 as long as the 4 following joints taken together. Wing grayish hyaline, with central spot and a preapical arcuate fascia which extends from the tip of Rs to M_2, narrowest in cell M_1 (Fig. 210). Halteres yellow. Ithaca, N. Y. April.

40. *Mycetophila* n. sp.

Female. Length 3.5 mm. Similar to the foregoing, but thorax more shining, the paler parts lighter yellow, no yellow spot on the scutellum, venter yellowish, and fore tarsi more distinctly swollen. N. Y., August.

41. *Mycetophila edentula* n. sp.

Male. Length 2.7 mm. Head, antennæ, thorax and abdomen fuscous, the scape, base of flagellum, palpi, small spot on humerus, dusky yellow; hypopygium (Fig. 93). Hairs pale, setæ black. Legs and fore coxæ yellow, middle and hind coxæ fuscous outwardly, fore metatarsus less than .8 as long as the tibia; middle tibiæ each with 2 setæ on flexor surface; hind tibiæ each with 2 ranges of setæ on extensor surface, hind metatarsus about 1-16 shorter than the following 4 joints taken together. Wing grayish hyaline, with central spot, a preapical fascia which fills apex of cell R_1 arising proximad of tip of vein R_1 and extends transversely slightly beyond vein M_1; apex of wing margined with gray (Fig. 211). Halteres yellow. Selkirk Mts., Rogers pass, B. C.! (J.C.B.) July.

Female. Fore coxæ brown, otherwise as above. Hampton, N. H., (S. A. Shaw), Oct.

42. *Mycetophila trichonota* Loew.

Berlin. Ent. Zeitschr. XIII. 155. 1869.

Male. Length 2.8 mm. Head fuscous, opaque, face, mouth parts, scape and base of flagellum yellowish, antennæ fuscous black. Thorax fuscous black, subopaque, humeri, posterior angles, spot in front of scutellum, and the scutellum except the sides, luteous; hairs yellow, setæ black. Abdomen fuscous black, the lateral and posterior margins of each segment except the first yellowish; the small hypopygium yellow. Coxæ and legs pale yellow, tips of hind femora black; middle tibiæ each with 2 setæ on flexor surface, hind metatarsus about equal to the following 4 joints taken together; tarsi more or less dusky. Wing with rather large central spot and a preapical fascia which extends from the tip of the cell R_1 obliquely proximad into cell Rs but not reaching vein M_1; below this fascia the veins M_1 and M_2 are clouded with gray. "D. C." There are 2 ranges of setæ on the extensor surface of each hind tibiæ in the type specimen.

Var. a. Male. Thorax subshining dark brown, scutellum wholly brown, fore tarsi slightly swollen, otherwise as above; hypopygium (Fig. 94). Ithaca, N. Y., July, August.

43. *Mycetophila socia* n. sp.

Male and female. Length 3 mm. Thorax and abdomen subshining brownish black, humeri, posterior angles of mesonotum and narrow hind margins of the segments of the abdomen yellow; hypopygium (Fig. 95). Fore metatarsus about 7-8 as long as the tibia; fore tarsi not swollen. Wing with brown central spot and an oval grayish preapical spot (Fig. 212). Otherwise as in *M. trichonota*. Ithaca, N. Y., August.

44. *Mycetophila discoidea* Say.

Journal Ac. Sc. Phil. VI. 153, 1829.

Thorax pale with a blackish disk, wings with a fuscous spot. Head blackish, antennæ whitish, at tip blackish; thorax pale honey-yellow, disk blackish owing to 3 vittæ of that color being confluent into one, wings hyaline, with a fuscous spot on the connecting nervures; tergum blackish, somewhat sericeous; poisers whitish; feet whitish, with blackish tarsi; abdomen whitish at base. Length more than 1-10 inch. Belongs to Meigen's first division of the genus. Indiana.

45. *Mycetophila ichneumonea* Say.

Journal Ac. Sc. Phil. III. 16. 1823.

Female. Length 3 mm. Clay yellow, abdomen brown dorsally. Belongs to Meigen's first division. Antennæ paler, head more dusky clay yellow. Mesonotum more dusky, pleura paler clay yellow. Segments

2 to 4 of abdomen, brown above. Wing yellowish, crossveins broadly margined with brown. Legs pale clay yellow, tarsi brownish. "Pa."

46. *Mycetophila bifasciata* Walker.

List. of Dipt. I. 96. 1848.

Head and chest black, clothed with short tawny down; eyes and feelers black, the latter ferruginous at the base; scutcheon ferruginous; abdomen brownish black; hind borders of the segments tawny; feet, thighs at the base and at the tips, and tips of the hind hips, brown; wings somewhat gray, clouded with brown below the fore border about the middle and near the tip, which is also indistinctly clouded with gray; veins brown; poisers tawny. Length of the body 5mm. St. Martin's Falls, Albany River, Hudson's Bay.

47. *Mycetophila parva* Walker.

List. of Dipt. I. 97. 1848.

Head brown; eyes black, palpi tawny; feelers brown; yellow at the base; chest reddish brown, varied with tawny on each side; breast yellow; abdomen reddish brown; hips and thighs yellow, tips of the latter brown; shanks dull tawny; feet brown; wings slightly gray, with two brown spots beneath the fore border; the one nearest the tip of the wing is larger and more irregular than the other; veins brown, poisers yellow. Length of the body 2.5 mm. St. Martin's Falls, Albany River, Hudson's Bay.

48. *Mycetophila lacta* Walker.

List. of Dipt. I. 97. 1848.

Body thickly clothed with yellow hairs; head brown; eyes black; palpi tawny; feelers dull tawny yellow at the base; chest bright tawny: its hind part pale reddish brown and varied with yellow; abdomen reddish brown, with five yellow bands along the sutures of the segments; hips and thighs pale yellow; tips of hind thighs brown; shanks pale tawny; feet brown, wings slightly tawny, especially towards the fore border, and adorned with two brown bands of which the one nearest to the wing tip is much larger and more irregular than the others. Veins tawny; poisers white. Length of body 3.5 mm. Nova Scotia.

49. *Mycetophila contigua* Walker.

List. of Dipt. I. 96. 1848.

Body clothed with short yellow hairs; head tawny; eyes black, palpi tawny; feelers brown, tawny at base; chest reddish brown, yellow on each side in front. Abdomen reddish brown; hind border of each segment pale yellow; legs pale yellow; tips of hind thighs brown; feet and tips of shanks dull tawny; wings pale tawny adorned with two brown bands, of which the one nearest to the wing tip is much longer and more irregular than the other; veins dark tawny; poisers bright tawny. Length of the body 3 mm. Nova Scotia.

50. *Mycetophila plebeia* Walker.

List of Dipt. I. 100. 1848.

Head black; palpi tawny; feelers black, yellow at the base; chest tawny with three broad black stripes which occupy nearly all the back and are united behind; the middle one is much in advance of the other two; abdomen wanting; hips and thighs pale yellow; shanks dull pale tawny; feet brown; wings slightly gray; veins brown; poisers yellow. Length of body 3.5 mm. St. Martin's Falls, Albany River, Hudson's Bay.

51. *Mycetophila obscura* Walker.

List of Dipt. I. 101. 1848.

Body brown; head yellow beneath; eyes black; palpi yellow; feelers brown, yellow at the base; chest with a tawny stripe forked in front on its hinder part; scutcheon and breast yellow; abdominal segments yellow at the base; legs yellow; hips very pale yellow; feet dull yellow; wings colourless; veins brown; poisers yellow. Length of the body 3 mm. St. Martin's Falls, Albany River, Hudson's Bay.

52. *Mycetophila despecta* Walker.

List of Dipt. I. 101. 1848.

Head and palpi brown; eyes black; feelers brown, yellow at the base; chest ferruginous, reddish brown on the disk; abdomen brown; ventral segments and hind borders of dorsal segments ferruginous; legs yellow; feet brown; wings colourless; veins tawny; poisers yellow. Length of body 3 mm. St. Martin's Falls, Albany River, Hudson's Bay.

53. *Mycetophila nubila* Say.

Journal Ac. Sc. Phil. VI. 153. 1829.

Dusky; wings immaculate; feet whitish. Inhabits Indiana. Body dusky, brownish; antennæ first and second joints yellowish; wings hyaline; immaculate; poisers whitish, capitulum dusky before the tip; abdomen slender, gradually enlarging to the tip; tergum with the tips of the segments pale; anal segments pale; feet whitish, dusky towards the tips; spines 1-3 the length of the first tarsal joint. Length 3-20 inch. Belongs to Meigens 5th Division.

54. *Mycetophila sericea* Say.

Long's Exped. App. 365. 1824.

Male and female. Length over 4 mm. Scape yellow, flagellum brown; palpi yellow. Head blackish with yellowish sheen. Pleura yellowish, mesonotum fuscous with whitish silky sheen. Abdomen deep brown, posterior margins of the segments yellow broadened at the sides in the form of triangular spots. Wing slightly yellowish with brown veins. Course of veins as in Plate 9, Fig. 18, in Meigen's Syst. Beschr. I. Halteres and legs pale yellowish with brown tarsi and spurs. "N. W. Terr." Perhaps *Allodia*.

32. Genus *Sceptonia* Winnertz.

Verh. Zool.-bot. Ges. Wien. XIII. 1863.

Front broad, the anterior margin produced into a triangle the apex of which reaches the base of the antennæ; lateral ocelli contiguous to the eye margin, middle one minute, in a groove at the base of the triangle. Anterior margin of thorax produced over the head so that in profile making a continuous curve with the head. Legs strong, hind tibial setæ longer than the greatest diameter of the tibia. The branches of the radius curved parallel to the costa, the cells between very narrow, the costa therefore apparently produced beyond the tip of Rs; subcosta short; cubitus simple; anal long but incomplete. The larvæ are found in decaying wood and in fungi.

Sceptonia nigra Meigen.

Syst. Beschr. I. 270. 1818. (*Mycetophila*).

Male and female. Length 2.2-2.5 mm. Head, thorax and abdomen shining black. Antennæ brown, scape sometimes yellowish; palpi yellow. Hairs pale shimmering, setæ dark. Hypopygium yellowish (Fig. 96). Coxæ and legs yellowish, the bases of the hind coxæ, the apical third of the hind femora, black; spurs and tarsi brown; fore metatarsus a fourth shorter, the entire tarsus about 2.3 longer than the tibia; middle tibiæ each with a single minute seta on flexor surface. Wings hyaline tinged with yellowish brown, with dusky yellow veins. (Fig. 213). Halteres yellowish. In an occasional specimen the base of the venter is obscurely yellowish. Selkirk Mts., Dowie Creek and Rogers Pass, B. C. (J.C.B.) July; Wis., (W.M.W.); Brookline, Mass. (C.W.J.) June; Ithaca, N. Y., Aug.; Orono, Me., Nov.

33. Genus *Zygomyia* Winnertz.

Verh. Zool.-bot. Ges. Wien. XIII. 901. 1863.

Front broad, the anterior margin produced into a triangle which descends to the root of the antennæ; lateral ocelli contiguous to the eye margin, the middle one minute, placed in a groove at the base of the frontal triangle. Legs strong, tibiæ with strong setæ, those of the hind tibiæ longer than the greatest diameter of the tibia. Costa not produced, subcosta short, ending free; cubitus simple, anal vein incomplete. The larvæ live in decaying wood and in fungi.

Table of species.

a. Wing spotless. 1. *ignobilis.*
aa. Wings marked with brown central spot and preapical cloud.
b. Preapical fascia of wing distinctly crosses the media; length 2.5 mm. 2. *ornata.*
bb. Preapical cloud diffuse, its long axis parallel to the long axis of the wing; length 4 mm. 3. *varia.*

1. *Zygomyia ignobilis* Loew.

Berl. Ent. Zeitschr. XIII. 150. 1869.

Male and female. Length 2.5 mm. Fuscous, subopaque, pile pale, appressed, setæ black. Head black, antennæ brown, scape dusky yellow. Hypopygium yellowish (Fig. 97). Coxæ and legs yellow, hind margins and tips of hind femora brown to blackish; spurs and tarsi brown; middle tibiæ each with one small and one large seta on the flexor surface. Wings grayish hyaline (Fig. 214). Halteres yellow. "Middle States;" Ithaca, N. Y.

2. *Zygomyia ornata* Loew.

Berl. Ent. Zeitschr. XIII. 150. 1869.

Male and female. Length 2.2-2.5 mm. Head blackish, antennæ fuscous, scape, base of flagellum and palpi yellow; hairs pale. Thorax and abdomen fuscous, opaque, pile pale, setæ black; hypopygium yellowish (Fig. 98). Coxæ and legs yellow, tips of middle and hind femora and hind tibiæ, more or less dark brown, tarsi largely brown. Wing cinereous hyaline, yellowish toward the costa, a brown central spot, a preapical fascia, and a small less distinct spot behind the cubitus (Fig. 216). Halteres yellow. Wis.; Chicago, Ill., (W.M.W.) June, Aug.; Ithaca, N. Y., Aug.

3. *Zygomyia varia* Staeger.

Kröjer: Tidskr. 266. 1840. (*Mycetophila*).

Male and female. Length 3 mm. Head and antennæ brown, scape and palpi usually yellow. Thorax and abdomen brownish black subopaque; humeri reddish yellow; hypopygium dusky yellow; hairs brown with a yellowish tinge, appressed. Coxæ and legs reddish or rusty yellow, the tarsi and spurs, the tips of the hind femora, the extensor surface of the last and a spot on the under side of the fore femur, brown; fore metatarsus about .88 as long, entire tarsus about 2.5 longer than the tibia. Wing more or less dusky yellow hyaline, with central spot and an elongate preapical cloud filling the apex of the cell R_1 and spreading out below it. Halteres yellow. "Europe." A female specimen 4 mm. long from Capens, Me. (C.W.J.), July.

THE SCIARINÆ.

(Exclusive of Arctic and Tropic species).

In the literature on economic entomology there are numerous references to members of this subfamily, though in but few instances were the species known.

Of the described North American species of *Sciara,* 16 are known to occur only in the Arctic region, 11 are from Mexico, the West Indies and Central America, and 32 are from the United States and Canada. Of the last only 15 are described in a recognizable manner. In view of our very imperfect knowledge of these gnats, an apology will be scarcely necessary for presenting this paper to economic entomologists. Though over 25 new species are described, it is very probable that they represent but a tithe of those which may eventually be found in the United States. It is quite possible that some of the species described here as new may be the same as some of those named by Say, Walker, or Fitch, but to attempt to link them is quite useless as only a comparison with the type specimens of these authors would lead to definite results. As far as I am aware, of these types, Walker's only are in existence.

The brief descriptions published by these authors are here reproduced for the sake of completeness. Some one else, possessing greater perspicacity than I, may have better fortune in identifying them with the species they are supposed to designate.

In my previous papers on the *Mycetophilidae* I have included the few arctic and tropic species described from North America but in the present treatment of the *Sciarinae* I deem it expedient to omit them, for none has been found in the material I have had the privilege of examining.

In studying these flies it was found that balsam mounts were far superior to pinned specimens. It is desirable to remove one wing and mount it under a separate cover glass, to insure its lying perfectly flat. The hypopygium, unless it is turned sidewise, should also be cut off and separately mounted. A few color notes, describing palpi, halteres, thorax, and abdomen are necessary, but they may be quite brief, the description not necessarily occupying more space than is found upon a micro scope slide label. In the descriptions which follow it must be borne in mind that the body length given refers to dried specimens, balsam mounts and alcoholic specimens being about a third longer. The same caution must be observed in interpreting antennal lengths relative to that of the body; in drying, the antennæ do not shrink proportionally to that of the body, or more particularly of the abdomen. In comparing dimensions, wing measurements, etc., of any specimen with the figures given it will be imperative to use a micrometer scale and not depend solely upon the eye to estimate proportions.

Characters of the subfamily. Distinguished from the *Mycetophilinae* by the shorter coxæ and by the wing venation the R-M crossvein being in the same right line with the second section of the radial sector, and the cubitus forking near the base of the wing.

In a recent paper (Archiv f. Naturgeschichte, 1911) Professor Enderlein proposes a new arrangement of the genera based upon what appear to be good grounds. He separates the *Mycetophilidæ* from the *Sciaridæ* upon the form of the eye. In the former the eye is oval, sometimes more or less emarginate, but not contiguous over the base of the antennæ. In the *Sciaridæ* the eye posesses a slender process which passes over the base of the antenna meeting or nearly meeting the process from the opposite eye, thus forming a yoke or bridge over the base of the scape. He divides the *Sciaridæ* into 2 subfamilies, the *Lycoriinæ* (*Sciarinæ*) and the *Lestremiinæ*, the latter heretofore having been considered a group under the *Cecidomyiidæ*. If this classification were adopted, of the following 10 genera, *Probolæus*, *Manota* and *Pnyxia* would find a place with the *Mycetophilinæ*, *Zygoneura* with *Lestremiinæ*, and the remaining genera with the *Sciarinæ*.

Table of North American Genera.

a. Proboscis longer than the thorax.

b. Wing venation defective, several veins detached at base. (See page 258 Part III) *Probolaeus.*

bb. Wing venation complete, no detached veins. 1. *Eugnoriste.*
aa. Proboscis not greatly prolonged.
b. Wing venation defective, several veins detached at base. 2. *Manota.*
bb. Wings when present with complete venation, no detached veins.
c. Female wingless, in the male the media springs from the radius at an angle, the crossvein being obsolete (Fig. 264). 3. *Pnyxia* n. g.
cc. Both sexes with wings; crossvein present.
d. Wings very distinctly hairy; claws not denticulate. 4. *Trichosia.*
dd. Wings with microscopic setulæ but not hairy.
e. Antennal joints of the male pedicillate and with whorls of hair; forks of media arcuate. 5. *Zygoneura.*
ee. Antennal joints bare or with short hairs.
f. Forks of media arcuate, and claws toothed. 6. *Metangela.*
ff. Forks of media not arcuate, or if so, claws not toothed.
g. Claws toothed. 7. *Phorodonta.*
gg. Claws not toothed.
h. Face strongly produced. 8. *Rhynchosciara.*
hh. Face not produced. 9. *Sciara.*

1. Genus *Eugnoriste* Coquillett.

Proc. Wash. Ent. Soc. III, 321, 1896.

Head, small, antennæ filiform, pubescent, 16-jointed; proboscis rigid, filiform, directed downward and backward, longer than the head, palpi 4-jointed, the first joint very short; 3 ocelli; eyes deeply emarginate. Wings bare, venation like *Sciara* (Fig. 253). Entire insect Sciara-like in appearance except for the elongate proboscis. Structure of eyes as in *Sciara.*

Table of Species.

a. Proboscis longer than the head and thorax. 1. *occidentalis.*
aa. Proboscis slightly longer than the head, slender, horny. 2. *brevirostris.*

1. *Eugnoriste occidentalis* Coquillett.

Proc. Wash. Ent. Soc. III, 321, 1896.

Male and Female. Length 2.5 to 3 mm. Head and thorax black, subshining, antennæ, proboscis, palpi and halteres blackish brown, abdomen dark brown; coxæ and legs yellowish to brownish, tarsi darker; hypopygium (Fig. 138). Wings hyaline, veins brown (Fig. 253). "Las Cruces, N. M." Moscow, Id., Manlius and Ithaca, N. Y.

2. *Eugnoriste brevirostris* Coquillett.

Proc. Wash. Ent. Soc. VI. 169, 1904.

Female. Length 3.5 mm. Black, the stems of the halteres yellow. Head narrow and elongate, about 3 times as long as wide, proboscis slightly longer than the head, slender, horny, over 6 times as long as wide. Wings grayish, apex of R_1 a short distance before the forking of the media. "Halfway House, Pike's Peak, Col." Sept.

2. Genus *Manota* Williston.

Dipt. of St. Vincent, W. I., 260, 1896.

Head flattened, placed rather high as regards the thorax; antennæ situated high up, 16-jointed. Three ocelli, in a gently curved line, laterals remote from the eye margin; palpi 3 jointed, elongate. Dorsum of thorax moderately convex, abdomen slender, flattened cylindrical. Coxæ elongate. Wings longer than the abdomen; Sc vestigial; R_1 ends before the middle of the wing; Rs not furcate; only apical parts of M_1 and M_2 present, bases and petiole of M wanting; costa far produced. *M. defecta* from the St. Vincent Isl. W. I. the only species.

In Enderlein's classification would be placed with the *Mycetophilinae*.

3 Genus *Pnyxia* n. gen.

Eye widely separate, ommatidia prominent, few in number; ocelli 3, in a triangle on the vertex; proboscis small, obscure; antennæ 16-jointed. Legs like *Sciara,* claws simple. Sexes dimorphic. Female wingless and without halteres, 40 ommatidia in each eye; palpus consist apparently of but one cup shaped joint. Male with halteres and wings, the latter of 2 sizes, the majority of the individuals possessing very short wings which do not reach the 4th abdominal segment (Fig. 262); the remaining individuals with longer wings which extend beyond the tip of the abdomen (Fig. 264); petiole of the media arises at the angle of the basal section of Rs, the cross-vein hence obliterated; palpus with truncated tip, 2 or 3 jointed; ommatidia 50 to 75 in each eye. Hypopygium of the simple *Sciarid* type. Type species *Pnyxia scabiei* Hopkins.

This genus also would be placed with the *Mycetophilinae* in the classification of Enderlein.

Pnyxia scabiei Hopkins.

Proc. Ent. Soc. Wash. III, 152. 1895 (Epidapus).

Male. Length 1 to 1.5 mm. Antennæ 3-4 the length of the body with short hairs. Thorax and abdomen dusky; legs pale spurs short. Wings hyaline; venation similar in both the short and long winged forms (Figs. 262, 264). Hypopygium pubescent, claspers simple (Fig. 136). Halteres long, knob dark, pedicel pale at base.

Female. Length 1 to 2 mm. Color lighter than the male. Head dark, antennæ about as long as the head and thorax. Ovipositor like that of Sciara, terminal joint oval.

Dr. Hopkins reared this species in West Virginia from scabby and diseased potato tubers. He also observed the larvæ feeding on the healthy living tissue of the potato and states that they cause conditions which in one stage would be recognized as potato scab and in a more advanced stage be recognized as a form of potato rot.

Specimens of this species were submitted to me for examination by Professor H. A. Surface who stated that the larvæ were found in Pennsylvania injuring peony bulbs. I have also seen specimens from Rhinebeck, N. Y., and from Columbia, Mo., which were collected by Prof. C. R. Crosby in rubbish while sifting for spiders.

4. Genus *Trichosia* Winnertz.

Monogr. Sciarinen. 173, 1867.

In structural characters similar to the genus *Sciara,* but differs in having the wing surface distinctly hairy instead of microscopic setulose.

Trichosia hebes Loew.

Berlin. Ent. Zeitschr. XIII. 161. 1869.

Female. Length 2.9 mm., wing 2.6 mm. Black including head; face, palpi, and antennæ fuscous black, the base of the last paler. Mesonotum moderately shining, humeri yellowish.

Abdomen blackish, including lamellæ of ovipositor. Legs dusky yellowish, posterior tibiæ darker, tarsi fuscous black. Wings blackish, semihyaline, veins blackish; R_1 ends about opposite the base of cell M_1. Halteres black with yellow pedicel. "N. Y." Ithaca, N. Y. Also a single defective specimen which may belong here from Douglass Co., Kas. (E. S. Tucker).

5. Genus *Zygoneura* Meigen.

System. Beschr. VI. 304. 1830.

In structural characters similar to *Sciara* but differs in having both forks of the media strongly arcuate so that the cell between is wider near the base than farther distad, widening again on the wing margin, in this respect resembling *Metangela* from which it differs in having simple tarsal claws and in the male with pedicellate antennal joints having whorls of hair.

Zygoneura flavicoxa n. sp.

Male. Length 1 mm. Head and thorax blackish brown, shining, abdomen brown, hypopygium darker brown; clasper (Fig. 99). Palpi yellow, antennæ brown, the petiole of each joint nearly as long as the distal part, total length of antenna about 1-3 greater than the body, the hairs brown. Coxæ and legs pale yellow, tarsi darker, hind tarsus less than 3-4, the metatarsus 3-8 as long as the tibia. Wing yellowish hyaline, veins yellowish brown; costa ends about 3-4 of the distance from Rs to M_1 (Fig. 254). Ithaca, N. Y.

6. Genus *Metangela* Rübsaamen.

Berlin. Ent. Zeitschr. XXXIX. 19. 1894.

In structural characters, including those of the wings and antennæ, similar to the genus *Sciara* but differs in having both forks of the media strongly arcuate so that the cell between is wider near the base than at a point near the tip widening again on the wing margin. Tarsal claws toothed.

Metangela toxoneura Osten Sacken.

Proc. Ent. Soc. Phil. 165. 1862. (*Sciara*).

This species was later referred by Osten Sacken to *Zygoneura* in spite of its Sciara-like antennæ. Rübsaamen suggests that it belongs to *Metangela* though the original description of the species does not mention the claws. I neglected to examine the type at Cambridge, Mass.

Male and female. Length 3 to 4 mm. Black, including antennæ, mouth and palpi; thorax shining, legs and fore coxæ yellowish; wings of the male subhyaline, of the female tinged with black. "D. C." Larvæ in cow dung.

7. Genus *Phorodonta* Coquillett.

Proc. U. S. Nat. Museum. XXXVII. 589. 1910.

Odontonyx, Rübs. Berlin. Ent. Zeitschr. XXXIX. 19. 1894.

Wings, proboscis, and antennæ as in *Sciara;* claws elongate and distinctly toothed.

Phorodonta niger Wiedemann.

Diptera exot. I. 44. 1821 (Sciara).

Male. Length 4.7 mm. Black; the antennæ alone in certain lights more grayish. "Ga., N. M., Mexico." *O. helveolus* Rübs. is a Porto Rican species.

8. Genus *Rhynchosciara* Rübsaamen.

Berlin. Ent. Zeitschr. XXXIX. 19. 1894.

Face produced snoutlike; proboscis with broad lamellæ; eyes, antennæ, and venation as in *Sciara.* Legs strong, claws simple, empodium and pulvillæ present. This genus occurs in Mexico.

9. Genus *Sciara* Meigen.

Illiger's Mag. II. 263, 1803.

Lycoria Meigen, Nouv. Class. 1800 (without type).

Head small; proboscis short; palpi 4-jointed, the first very short and not always distinctly differentiated from the second; antennæ 2+14-jointed; three ocelli, the laterals remote from the eye margin. Thorax moderately arched. Legs slender, tarsal claws not toothed. Wings microscopically setulose, not hairy (Figs. 218-252). Halteres present.

*Table of Species.**

a. Large southern species, 6 mm. or more in length; males undescribed.
  b. R_1 ends distad of the base of the fork of M; wing blackish (Fig. 218). 1. *picea.*

* This table is based in part on male characters, only a few well-defined species represented by females alone are included. By wing length is meant the distance from the humeral crossvein to the tip of the wing, measured parallel to the longitudinal axis.

bb. R_1 ends about opposite the base of the fork of M. 2. *cingulata.*
aa. Medium or small species.
b. Costa, radius, media except sometimes the petiole, and cubitus of the wings distinctly though sparsely setose.
c. R_1 ends noticeably proximad of the fork of M; small species.
d. Petiole of the cubitus 1-8 as long as the basal section of M (Fig. 219); clasper (Fig. 100); N. Y. 3 *vicina* n. sp.
dd. Petiole of the cubitus over half as long as the basal section of M (Fig. 220); clasper (Fig. 101); Cal. 4. *dives* n. sp.
cc. R_1 ends about opposite or distad of the base of the fork of M; species 2.5 mm. or more in length.
d. Petiole of the cubitus over 1-2 as long as the basal section of M.
e. R_1 ends about opposite the forking of M (Fig. 221). 5. *futilis* n. sp.
ee. R_1 ends distad of the forking of M (Fig. 266). 6. *abdita* n. sp.
dd. Petiole of the cubitus less than 1-4 as long as the basal section of M.
e. Humeri, pleura in part and hypopygium (Fig. 103) more or less yellow; knob of halteres dark. 7. *ochrolabis*
ee. Thorax and abdomen, black.
f. Halteres and coxæ yellow; claspers (Fig. 139). 8. *habilis* n. sp.
ff. Halteres and coxæ black; claspers (Fig. 104). 9. *sciophila*
bb. Media and cubitus without setæ.
c. R_1 ends distad, or opposite (not more than 1-10 of wing length proximad) of the base of the fork of M, *and* base of Rs at or proximad of a point midway between the humeral crossvein and the tip of R_1.
d. Thorax yellowish to rufous, coxæ and femora dull yellow, claspers large, triangular (Fig. 111), hind tarsus 1-8 shorter than tibia. 10. *fulvicauda.*
dd. Thorax dusky, claspers of different structure.
e. Rs ends proximad of the tip of M_2; halteres dark.
f. Flagellar joints scarcely longer than broad; clasper with 2 median lobes (Fig. 109). 11. *tridentata.*
ff. Intermediate flagellar joints over twice as long as broad; clasper without median lobes (Fig. 105). 12. *munda* n. sp.
ee. Rs and M_2 end about equidistant from the base of the wing.
f. R_1 ends distad of the forking of M; halteres dark.
g. Mesal process of clasper robust (Fig. 106 m); wing (Fig. 225). 13. *dux* n. sp.
gg. Mesal process of claspers slender (Fig. 107 m); wing (Fig. 226). 14. *imitans* n. sp.
ff. R_1 ends about opposite the forking of M.

g. Apical tooth of clasper placed near the mesal margin of the apex (Fig. 115); species under 2.5 mm, halteres dusky yellow. 40. *varians,* var. c.

gg. Apical tooth of clasper placed at apex (Fig. 108) or tooth wanting (Fig. 123).

h. Halteres blackish; hind coxæ and legs brownish; claspers without apical tooth (Fig. 123); wing (Fig. 232). 23. *jucunda* n. sp.

hh. Halteres and coxæ yellowish; clasper with distinct apical tooth (Fig. 108).

i. Petiole of cubitus about .6 as long as the basal section of M (Fig. 227). 15. *prolifica.*

ii. Petiole of cubitus over .8 as long as the basal section of M.

j. Wing veins heavily shaded (Fig. 228). *prolifica,* var. a.

jj. Wing veins not shaded. *prolifica,* var b.

cc. R_1 ends at least 1-16 of the wing length proximad of the forking of M; the base of Rs is distad of the mid point between the humeral crossvein and the tip of R_1.

d. Fulvous mesonotum, abdomen more dusky; or reddish species.

e. Dusky red species, female 4 mm. long, halteres white, male not described. 16. *silvestrii.*

ee. Fulvous mesontum, abdomen more dusky; length 2 mm., or less.

f. Clasper without strong spines at apex (Fig. 110); tip of Rs far remote from apex of wing (Fig. 229). 17. *mellea* n. sp

ff. Clasper with one or more apical spines.

g. M_1 less than .8 as long as the petiole of the media. 18. *tritici.*

gg. M_1 over .9 as long as the petiole of the media (Fig. 265). 48. *ocellaris.*

dd. Black or fuscous species.

e. Clasper with a mesal articulated process (Fig. 112); Rs ends far remote from apex of wing (Fig. 230). 19. *hastata* n. sp.

ee. Clasper without mesal articulated process.

f. Hypopygium near its base with a patch or tuft of setæ on the median ventral line (Figs. 117a, 123a 124); petiole of the cubitus under .6 as long as the basal section of M.

g. Clasper with a terminal tooth.

h. With about 10 setæ in the basal median ventral patch of the hypopygium (Fig. 117a). 20. *pauciseta.*

hh. With over 25 setæ in this patch (Fig. 124).

i. Abdomen variable dark ochreous, palpi yellowish, anterior veins dark ochreous. 21. *multiseta.*

ii. Abdomen variable dark brown; palpi brown, anterior veins nearly black. 22. *agraria.*

gg. Clasper without terminal tooth (Fig. 123); the hypopygium with the setæ of the ventral median patch arranged in a transverse line (Fig. 123a); halteres black. 23. *jucunda* n. sp.

ff. Hypopygium without a tuft of setæ on the median ventral line near the base.

g. Clasper with about 5 large subequal teeth or spines (Figs. 113, 119).

h. Tip of Rs about .10 of wing length proximad of tip of M_2 and ending proximad of .85 of wing length (Fig. 239); palpi and halteres dark; mesonotum shining black. 24. S. sp.

hh. Tip of Rs less remote from apex of wing; costa produced fully 3-4 of distance from tip of Rs to M_1; coxæ and halteres yellow. 25. *mutua* n. sp.

gg. Clasper of different structure.

h. Petiole of cubitus short, less than half as long as basal section of M.

i. Wing veins strongly marked; Rs ends distad of M_2; costa produced about 1-2 of distance from Rs to M_1; thorax shining.

j. Halteres and coxæ bright yellow. 35. *nigricans* n. sp.

jj. Halteres fuscous, (Figs. 217, 260). 36. *actuosa* n. sp.

ii. Costa produced over 1-2 distance from Rs to M_1, if not, then Rs ends proximad of tip of M_2.

j. Clasper with several apical teeth or spines.

k. Clasper short, curved, with several apical teeth (Fig. 114); R_1 ends at about 1-3 length of wing; Rs and M_2 end about equi-distant from base of wing (Fig. 234); halteres yellow. 26. *nacta* n. sp.

kk. Clasper with apical setæ or spines (Fig. 133, 261).

l. R_1 ends near middle of wing; costa produced over half way to M_1. 46. *coprophila.*

ll. R_1 ends noticeably proximad of the middle of the wing; costa produced scant half way from Rs to M_1 (Fig. 267). 32. *cucumeris* n. sp.

jj. Clasper without any, or with only a single prominent apical or subapical tooth besides the setæ; or if 2 or 3 smaller spines are present then tip of Rs is proximad of the tip of M_2.

k. R_1 ends only slightly proximad of the forking of M (Fig. 255); knob of halteres and coxæ brownish; clasper (Fig. 115).
40. *varians,* var c.

kk. R_1 ends far proximad of the forking of M.

l. Clasper subglobular.

m. Clasper subglobular, with the tooth subapical in position (Fig. 116); wing broad. 27. *S. sp.*

mm. Without subapical tooth.
28. *lugens* n. sp.

ll. Clasper more slender, wing narrow.

m. Halteres yellow; Rs ends far proximad of the tip of M_2 (Fig. 241).
30. *fatigans* n. sp.
(See S. sp. p. 144).

mm. Halteres fuscous; Rs and M_2 end about equidistant from base of wing (Fig. 250). 44. *acuta* n. sp.

hh. Petiole of the cubitus at least half as long as the basal section of M.

i. Rs ends proximad of .85 of the length of the wing.

j. Clasper with 2 strong apical spines (Fig. 118); wing veins strongly defined (Fig. 238); thorax shining black. 29. *parilis* n. sp.

jj. Clasper and wing of different structure.

k. Costa produced less than 2-3 of distance from Rs to M_1.

l. Wing narrow (Fig. 240); hypopygium (Fig. 120). 31. *sativae* n. sp.

ll. Wing wider (Fig. 267); costa less produced; hypopygium (Fig. 261).
32. *cucumeris* n. sp

kk. Costa produced over 2-3 from Rs to M_1.

l. Clasper with 2 apical teeth (Fig. 121); petiole of cubitus about 3-4 as long as basal section of M; hind tarsus shorter than the tibia. 33. *S. sp.*

ll. Clasper with a median process (Fig. 122); petiole of the cubitus about half as long as the basal section of M (Fig. 242); hind tarsus and tibia subequal.
34. *neglecta* n. sp.

ii. Rs ends distad of .85 of wing length.

j. Clasper with one prominent terminal or subterminal spine or tooth, or if several teeth are present, one is conspicuously larger than the others.

k. Costa produced about 1-2 way from Rs to M_1.

l. Halteres bright yellow; claspers (Fig. 125); wing (Fig. 243). 35. *nigricans* n. sp.

ll. Halteres fuscous; wing (Fig. 217). 36. *actuosa* n. sp.

kk. Costa produced over 1-2 way from Rs to M_1.

l. Costa produced over 3-4 way from Rs to M_1. (Fig. 244); halteres yellow, claspers (Fig. 126). 37. *S. sp.*

ll. Costa produced less than .7 from Rs to M_1.

m. R_1 ends over 1-5 of wing length proximad of the forking of the media (Fig. 245); halteres dark; clasper (Fig. 127). 38. *dolens* n. sp.

mm. R_1 ends less than .15 of wing length proximad of forking of M.

n. Apex of clasper with a number of spines of which one is somewhat larger than the others (Fig. 132).

o. Halteres yellow; clasper (Fig. 132). 39. *diluta* n. sp.

oo. Halteres dark; clasper (Fig. 140). *diluta* var. a.

nn. Spine of apex of clasper distinctly differentiated from the apical setæ (Fig. 115); halteres yellow.

o. Costa produced less than 5-8 of distance from Rs to M_1.

p. Hind tibia a little shorter than the tarsus; wing (Fig. 246). 40. *varians* n. sp.

pp. Hind tibia and tarsus subequal in length. *varians* var a.

oo. Costa produced over 2-3 of distance from Rs to M_1. *varians*, var b.

jj. Clasper with 2 or more prominent apical teeth, spines, or with strong setæ.

k. Clasper with 2 or 3 apical or subapical spines; halteres black or brown.
 l. Black species 3 mm. in length, with blackish legs, clasper subglobose (Fig. 128). 41. *scita* n. sp.
 ll. Smaller species with yellow legs, clasper more slender.
  m. Spines of clasper short (Fig. 129); pleura reddish. 42. *fumida* n. sp.
  mm. Spines of clasper long (Fig. 130); pleura fuscous. 43. *trivialis* n. sp.
kk. Clasper with 5 or more apical and subapical setæ or spines.
 l. Apex of clasper with 6 or 8 setæ of which one is somewhat set apart from the others (Fig. 137); halteres yellow; hind coxæ dark; wing (Fig. 252). 45. *impatiens* n. sp.
 ll. Setæ of apex of clasper subequal in size.
  m. Antennæ of male less than 3-4 length of body in dried specimens; coxæ yellowish. 46. *coprophila.*
  mm. Antennæ of male over 3-4 of length of body in dried specimens; coxæ brownish, hind pair darker. 47. *caldaria.*

Females may usually be traced by means of the key but to do so it will be necessary to follow out several branches of the dichotomic divisions. The females of the species *pauciseta, multiseta, agraria, coprophila, caldaria,* and *varians* all bear a close resemblance to each other; and are therefore separated with difficulty.

Say's, Walker's and Fitch's species are not included in the table. The descriptions of all are reproduced on page 138 and following.

1. *Sciara picea* Rübsaamen.

Berlin. Ent. Zeitschr. XXXIX, 32. 1894.

Female. Length 11 mm., wing 9 mm., antennæ 4 mm. Head and thorax black, the latter slightly pruinose. Abdomen fuscous with broad orange colored lateral spots, posterior margins of the tergites narrowly yellow; all the parts fuscous. Costal cell of the wing broad, wing brown, costal, subcostal and cell R_1 darkest; subcosta ends free opposite base of Rs; R_1 ends somewhat distad of the base of the fork of M; costa produced half way from Rs to M_1; petiole of the cubitus very short. "Ga."

Twelve specimens, from N. C., Ga., and Fla., are as described above with the following variations. R_1 in most of the specimens ends a little more distad and the costa is somewhat more produced (Fig. 218); the thorax is subshining, though also somewhat pruinose; the abdomen varies from wholly reddish, excepting the fuscous terminal joints, to a uniform fuscous, most of the specimens having the sides of the abdominal segments more or less dusky red. Length 8 to 9 mm. (dried specimens), wing 8 mm. Only the costa and radius of the wing with setæ. Ovipositor as figured (Fig. 143).

2. *Sciara cingulata* Rübsaamen.

Berlin. Ent. Zeitschr. XXXIX. 31. 1894.

Female. Length 7.25 mm.; wing 5.5 mm., antennæ 3 mm. Mesonotum black polished; humeri and collar yellow; pleura yellowish brown, abdomen fuscous black, with orange colored lateral spots; segments with yellow posterior margins. Palpi, antennæ, knobs of halteres, and tarsi brown; pedicel of halteres, coxæ, femora, and tibiæ yellow, trochanter black below. The basal flagellar joints, twice, the more terminal joints thrice as long as broad. R_1 of the wing ends about opposite the base of the fork of the media; costa produced 2-3 of distance from Rs to M_1; petiole of the cubitus shorter than the width of the costal cell (less than 1-2 as long as the basal section of M according to the author's figure). Legs slender, setæ of the tarsi strong; claws small. Terminal lobe of ovipositor oval, 1-2 as long as the preceding joint. "Georgia."

3. *Sciara vicina* n. sp.

Male. Length 2.2 mm. Head shining black, face dull, palpi and antennæ fuscous, the last about as long as the body. Thorax including scutellum and metanotum shining black, pleura dull. Abdomen subshining black, sparsely black haired; hypopygium black, clasper (Fig. 100). Coxæ yellow, legs yellow, tarsi more brownish, trochanters black below; hind tarsus an eighth shorter than the tibia. Wing (Fig. 219) hyaline, anterior veins darker, longitudinal veins except subcosta and petiole of media sparsely setose. Halteres dark, petiole paler toward base. Ithaca, N. Y., June.

4. *Sciara dives* n. sp.

Male and female. Length 2 mm. Head, thorax and abdomen subopaque fuscous black; palpi and antennæ fuscous (apical joints lacking). Abdomen sparsely black haired; hypopygium dark, clasper (Fig. 101). Coxæ and legs yellowish brown, tarsi darker, hind tibia and tarsus subequal in length. Wing hyaline (Fig. 220), anterior veins brownish, longitudinal veins except subcosta and petiole of media sparsely setose. Halteres dark, petiole slightly paler towards base. Stanford Univ., Cal. (J.M.A.) Jan.

5. *Sciara futilis* n. sp.

Male and female. Length 2.5-3.5 mm. Head subshining blackish, face and palpi reddish, 2 basal joints of antennæ yellowish; flagellum dusky. Thorax subshining brownish black, humeri, scutellum, and pleura reddish brown. Abdomen dark brown venter a little paler; hypopygium yellow, clasper (Fig. 102). Coxæ and legs yellow, tarsi darker, trochanters black below; hind tarsus nearly 1-4 shorter than the tibia. Wings hyaline (Fig. 221), anterior veins darker, longitudinal veins except subcosta and petiole of media sparsely setose. Halteres dusky yellow. Wis. (W.M.W.).

6. *Sciara abdita* n. sp.

Male. Length 2.5 mm. Head, thorax and abdomen blackish, mesonotum subshining, humeri paler; palpi, antennæ and halteres fuscous; coxæ and legs yellowish; tarsi darker; hypopygium black, claspers subglobose with several apical spines which are not sharply differentiated from the apical setæ (Fig. 258); antennæ about 0.6 as long as the body. Wings hyaline, anterior veins brownish, all longitudinal veins except the subcosta, setose (Fig. 266). Kearney, Ont. (M. C. VanDuzee).

7. *Sciara ochrolabis* Loew.

Berliner. Ent. Zeitschr. XIII. 160, 1869.

Male. Length 2.5-3 mm. Head black, face more reddish, palpi fuscous, scape of antennæ yellow, flagellum fuscous, nearly as long as the body. Mesonotum with 3 shining brownish black subconfluent stripes which in immature specimens may be reddish, scutellum the color of the mesonotum; metanotum and pleura ranging from reddish yellow to reddish brown. Abdomen reddish brown, or more rarely subfuscous, apical segments fuscous; hypopygium very large, yellow, margin of clasper black (Fig. 103). Coxæ and legs pale yellow, trochanter tipped with black, tarsi dusky. Wings subhyaline (Fig. 222), anterior veins dark; longitudinal veins except subcosta and petiole of the media, sparsely setose. Halteres black, petiole yellow. "N. Y.;" Ithaca, N. Y., Wis.

Female. Colored like the male; though the abdomen is usually somewhat darker; ovipositor dark (Fig. 145); antennæ not elongate. Same localities.

8. *Sciara habilis* n. sp.

Male and female. Length 3 to 4.5 mm. Black, thorax and abdomen subshining, with yellow hairs; antennæ and palpi fuscous, antennæ about half the length of the body in the male. Hypopygium dark, claspers (Fig. 139). Coxæ and legs bright yellow; hind tibia and tarsi subequal, trochanters black below. Wings hyaline, all veins setose except subcosta, yellow (Fig. 256). Halteres yellow. Ithaca, N. Y.!, June; Black Mts., N. C., (W.B.), June; Kearney, Ont.

9. *Sciara sciophila* Loew.

Berliner Ent. Zeitschr. XIII. 160, 1869.

Male and female. Length 3.2-3.9 mm. Black including the palpi and knob of the halteres; thorax shining, humeri dusky yellow, coxæ and legs pale yellow, trochanters and tarsi fuscous black, wings, semi-hyaline, "D. C."

Some males captured at Falls Church, Va. (Banks, Col.) agree with Loew's extended description and with the type at Cambridge excepting that the antennæ are wholly black including the second joint of the scape, the humeri are black, and the coxæ and legs are dusky yellow. The longitudinal veins, excepting the subcosta, are sparsely setose (Fig. 223). The hypopygium is large, subglobose, and black; clasper (Fig. 104).

10. *Sciara fulvicauda* Felt.

Rept. State Ent. N. Y. XII. 227, 1897.

Male. Length 4 mm. Face ochreous; vertex dark ochreous; scape of antennæ yellow, flagellum dark ochreous with rather dense whitish pubescence barely as long as head and thorax;

palpi fuscous; dorsum of thorax yellowish to rufous, the scutellum of the metathorax with variable dark stripes, in some specimens hardly discernible; pleura yellow; wings hyaline, anterior veins fuscous; knob of halteres fuscous with yellow tip, pedicel yellowish, tip of trochanter black; coxa and femur dull yellow; tibia darker; tarsi fuscous apically, abdomen fuscous except the yellow terminal segment bearing the large ochreous claspers which are tipped with fuscous (Fig. 111). Costa and radius with setæ, R_1 ends about opposite the fork of the media, the base of Rs proximad of the mid point between the humeral crossvein and the tip of R_1, Rs ends slightly proximad of the tip of M_2; petiole of the cubitus less than half as long as the basal section of the media; cubitus produced over 3-4 of distance from tip of Rs to tip of M_1. Reared from decaying blackberry roots. "Atlantic Co., N. J."

11. *Sciara tridentata* Rübsaamen.

Grönländische Mycetophiliden, etc. 107. 1898.
validicornis Lundbeck. Dipt. Groenl. 1. 243. 1898.

Male. Length 3 mm., wing 3.5 mm., antenna 1.5 mm. Shining black, lateral stripe of abdomen scarcely paler; halteres and palpi fuscous. Flagellar joints scarcely longer than wide, except the last which is 1.5 as long as wide. R_1 ends about opposite the base of the fork of M, base of Rs arises a little distad of the mid point between humeral crossvein and the tip of R_1; costa produced about half way from the tip of Rs to M_1; petiole of cubitus somewhat shorter than basal section of the media. Clasper as figured (Fig. 109). "Greenland; Lowe Inlet, B. C."

12. *Sciara munda* n. sp.

Male. Length 3 mm. Black, antennæ wholly, palpi, halteres and apical part of abdomen fuscous black, thorax subshining; base of abdomen brown; coxæ and legs pale brown, tarsi darker; hind tibia and tarsi subequal. Hypopygium black, clasper (Fig. 105). Wings subhyaline, veins strong (Fig. 224). Friday Harbor, Washington (J.M.A.).

13. *Sciara dux* n. sp.

Male. Length 2.5 mm. Black, thorax shining, second joint of scape, petiole of halteres, coxæ and legs yellow, tarsi dusky;

hind tibia and tarsi subequal. Hypopygium black, subglobose, clasper (Fig. 106). Wings grayish hyaline, anterior veins dark (Fig. 225). Wis.! (W.M.W.).

Female. Length 4 mm. Colored like the male but the anterior cells of the wing more smoky. Ithaca, N. Y. June.

14. *Sciara imitans* n. sp.

Male. Length 2.8 mm. Black, thorax shining, fore coxæ yellowish, hind coxæ and legs brownish, tarsi darker; hind tibia and tarsi subequal, antennæ about half the length of body. Hypopygium black, robust, subglobose, clasper (Fig. 107). Wings grayish hyaline, anterior veins dark (Fig. 226). Resembles *S. dux* but differs chiefly in the form of the mesal process of the claspers. Friday Harbor, Wash. (J.M.A.) May.

15. *Sciara prolifica* Felt.

Rept. State Ent. N. Y. XII. 226. 1897.

Male. Length 2.8 mm. Black, subopaque, the scape and the dorsal surface of the prominent hypopygium dusky yellow; clasper (Fig. 108); antennæ about 1-2 the length of the body; the narrow hind margins of the abdominal tergites sometimes distinctly cinereous; halteres, coxæ and legs yellow, the hind coxæ and tarsi more dusky; trochanters black. Wings grayish hyaline, the veins fuscous (Fig. 227). Id., Wash., (J. M. A.). Ithaca, N. Y.

The type specimens (balsam mounts) are 4.4 mm. long. According to Dr. Felt's description the knob of the halteres are fuscous and coxæ and legs are darker, otherwise there are no differences.

Female. Like the male but slightly larger. "Mass."

Var. a. Male. As above with the wings more heavily shaded (Fig. 228) and petiole of the cubitus over .8 as long as the basal section of M. Ithaca, N. Y.

Var. b. Male and female. Cubitus like in Var. a, otherwise as in the typical variety. S. D., Cal., (J.M.A.); R. I. (J.B.); Selkirk Mts., B. C. (J.C.B.).

16. *Sciara silvestrii* Kieffer.

Bol. Lab. Zool. Scuola d'Agr. Portici IV. 327, 1910.

Female. Length 4 mm. Dusky red, antennæ brown, legs pale brown, halteres white. Wings like those of *S. Zealandica* but the tip of R_1 ends at the middle of the wing which is much nearer the tip of Rs than to the base of wing, tip of Rs more proximad than the tip of M_2, the costa ends 4 to 5 times nearer the tip of M_1 than to Rs. Tarsi with short setæ below. Lamellæ of the ovipositor 2 to 3 times as long as broad, "N. Y." The *S. zealandica* here referred to has a venation strongly resembling the wing of *S. coprophila* (Fig. 236), but differs in having R_1 ending more proximad than in *S. coprophila,* and in the cubitus forking distad of the base of the petiole of the media. The latter condition is rare and if true also for *S. silvestrii* would make it readily recognizable.

17. *Sciara mellea* n. sp.

Male. Length 2 mm. Honey yellow; the vertex, the abdomen and tarsi pale brown, the flagellum of antenna fuscous, eyes black; hypopygium pale, clasper (Fig. 110). Wing hyaline, anterior veins dusky (Fig. 229). Salineville, Ohio.

18. *Sciara tritici* Coquillett.

Insect Life. VII. 408. 1895.

Male. Length 1.8 mm. Antennæ two-thirds as long as the body, black, the first 2 joints fulvous; head black, the face fulvous; palpi brown. Thorax dorsally fulvous, the pleura brownish, marked on the lowest third with a whitish vitta, also with a whitish spot below the humerus. Abdomen reddish-brown, clasper with several short claw-like processes on the apical third of the inner side and at the tip (resembling Fig. 120). Legs testaceous. Wings grayish hyaline, venation resembling that of *Sciara neglecta* shown in Fig. 242, but in *S. tritici* M_1 is .78 as long as the petiole of the media and the cell R_1 narrower toward the apex. Halteres yellow, the knob brownish.

Female. Length 2.5 mm. Same as the male except that the antennæ are only half as long as the body. The last joint of the ovipositor is slightly longer than wide.

This species is injurious to wheat, its larvæ feeding on the roots and mining in the stems.

19. *Sciara hastata* n. sp.

Male and female. Length 1.5 mm. Shining black, scape and flagellum of antennæ and palpi fuscous; hypopygium dark, clasper (Fig. 112). Coxæ and legs dusky yellow, tarsi darker, hind tibia and tarsus subequal, trochanter black. Wings (Fig. 230), hyaline, veins fuscous. Halteres brownish. Tompkins Co., N. Y. June, July.

20. *Sciara pauciseta* Felt.

Rept. State Ent. N. Y. XII. 224, 1897.

Male. Length 2 mm. Black, thorax subshining; antennæ and palpi fuscous; hypopygium dark, clasper (Fig. 117). Antennæ nearly as long as the body. Coxæ and legs yellowish, trochanters black below, tarsi fuscous, hind tibia and tarsi subequal. Wings hyaline, anterior veins fuscous (Fig. 231). Halteres fuscous with yellowish petiole.

Female. Like the male in coloring; antennæ about half the length of the body. Ovipositor (Fig. 141). Both sexes from Grand Forks, B. C. (Dr. Hewitt); Ithaca, N. Y., July-Oct.; Claremont, Cal. (Prof. Baker). The Ithaca specimens were reared from gooseberries, the Canadian specimens from decaying choke cherries, those from California, from orange or lemon twigs.

Co-type specimens (balsam mount) kindly loaned by Dr. Felt measures 2.75 mm. "N. J." Reared from decaying potatoes.

21. *Sciara multiseta* Felt.

Rept. State Ent. N. Y. XII, 223. 1897.

Male. Length 2.5 mm. Closely resembles the foregoing in structural characters but differs in having a larger number of setæ (over 25) in the patch stiuated on the middle of the dorsal surface of the hypopygium near its base (Fig. 124). In color it differs in being lighter, the abdomen variable dark ochreous, palpi yellowish and anterior wing veins dark ochreous.

Female. Similar in color; length 3 mm. Reared from mushrooms by Dr. J. B. Smith, "N. J."

22. *Sciara agraria* Felt.

Rept. State Ent. N. Y. XII. 225, 1897.

Male. Length 2.5 mm. In all structural characters like *S. multiseta,* setæ in dorsal patch of the hypopygium over 25 in number. In coloring like *S. pauciseta.*

Female. Similar but slightly larger. "Numerous in mushroom cellar, Albany, N. Y."

23. *Sciara jucunda* n. sp.

Male. Length 2.5 mm. Black, including antennæ, palpi, and halteres; mesonotum subopaque. Antenna about 1-2 as long as the body. Hypopygium black, near its base with a small median dorsal lobe margined with setæ (Fig. 123a); clasper without apical tooth (Fig. 123). Coxæ, dusky yellow, hind pair brown, legs dusky yellow to brownish, tarsi darker; hind tarsus but little longer than the tibia. Wings grayish hyaline; veins brown, strongly marked (Fig. 232). Halteres fuscous, pedicel paler fuscous, Kingston, R. I.! (J.B.); Ithaca, N. Y., June-Aug., Niagara Falls, N. Y.

Female. Length 3 mm. Colored like the male, but anterior cells of the wing more smoky. Wisconsin and Ithaca, N. Y.

24. *Sciara* sp.

Male. Length 1.2 mm. Black, thorax shining, hypopygium dark, clasper (Fig. 119). Antennæ broken, basal joint and palpi black. Coxæ fuscous, legs brownish, tarsi darker; hind tarsus shorter than the tibia. Wings hyaline (Fig. 239). Halteres fuscous. Kingston, R. I. (J.B.).

25. *Sciara mutua* n. sp.

Male. Length 2 mm. Head and antennæ fuscous, scape and 2 basal joints of flagellum yellow; antenna about 3-4 the length of the body. Thorax and abdomen reddish brown, subshining, mesonotum, scutellum and metanotum subfuscous. Hypopygium yellowish to dusky, clasper (Fig. 113). Coxæ and legs yellow, tarsi darker, trochanters black below, hind tarsus 1-16 shorter than the tibia. Wings hyaline, veins subfuscous (Fig. 233). Halteres yellow. Ithaca, N. Y.!, June; N. Evans, N. Y.

26. *Sciara nacta* n. sp.

Male and female. Length 1 mm. Fuscous, including antennæ and palpi; thorax subshining, hypopygium dusky, clasper (Fig. 114). Coxæ and legs dusky yellow, trochanters black below, tip of metatarsus and remaining tarsal joints fuscous; hind tibia .05 longer than the tarsus. Wings hyaline, veins fuscous (Fig. 234). Halteres subfuscous. Ithaca, N. Y.

27. *Sciara* sp.

Male. Length 2.5 mm. Fuscous, including antennæ and palpi; thorax subshining; hypopygium dark, clasper (Fig. 116). Coxæ and legs yellowish, tarsi darker. Wings hyaline, veins dusky (Fig. 235). Halteres dusky yellow. Orono, Maine; June.

28. *Sciara lugens* n. sp.

Male and female. Length 2.5 mm; antennæ of male 2.2 mm; of female 1.3 mm. Black; thorax highly polished, abdomen subshining; antennæ, palpi, halteres, and hypopygium fuscous, resembling that of *S. jucunda* but lacking the median ventral transverse row of setæ; claspers subglobose resembling Fig. 123; coxæ, and legs brown, tarsi darker; hind metatarsus 1-8 shorter than the tibia. Wing hyaline (Fig. 257). Reared from larvæ found in decaying wood. Orono, Maine.

29. *Sciara parilis* n. sp.

Male. Length 2 mm. Shining black, palpi, halteres, and antennæ fuscous, the last about 3-4 as long as the body, the intermediate joints of the flagellum robust, less than twice as long as broad. Coxæ and legs pale brownish, fore coxæ rather paler; hind tibia 1-16 longer than the tarsus. Wings grayish hyaline, anterior veins fuscous (Fig. 238). Hypopygium dark, clasper (Fig. 118). Lawrence!, and Douglas Co., Kas. June-August.

Female. Similar to the male in coloring; antennæ shorter. Ithaca, N. Y. and Kansas.

30. *Sciara fatigans* n. sp.

Male and female. Length 1 mm. Fuscous, thorax subshining, hypopygium dark, clasper (Fig. 135); antenna of the male long, more than .8 length of the body, fuscous; palpi yellow. Coxæ and legs yellow, tarsi darker. Wings hyaline, anterior veins brownish (Fig. 241). Halteres dusky yellow. Ithaca, N. Y.

31. *Sciara sativae* n. sp.

Male. Length 1 mm. Fuscous, hypopygium dark, clasper (Fig. 120); antenna long, more than .8 length of the body, fuscous; palpi, coxæ, legs and halteres yellow, tarsi darker. Wings hyaline, petiole of media and M_2 subequal in length (Fig. 240). Bred from wheat plant infested by Hessian flies. Wilson, Kas. (T. J. Headlee). The larvæ are supposed to prey upon the puparia of the Hessian fly.

32. *Sciara cucumeris* n. sp.

Male. Length 0.8 mm. Black, mesonotum shining, abdomen sometimes fuscous; palpi, halteres and antennæ fuscous, the last about 0.6 as long as the body; coxæ and legs yellowish, the tarsi darker, hind tibia and tarsi subequal. Hypopygium dark, claspers resembling those of *S. sativae* but with 3 subequal apical spines (Fig. 261). Wings hyaline with dusky veins (Fig. 267). This species was bred from cucumbers, by Mr. E. W. Gabourie, at Savanna, Ill. Feb. 29.

33. *Sciara* sp.

Male. Length 1.2 mm. Head and antennæ fuscous, palpi pale brown; antennæ nearly 3-4 as long as body; thorax reddish, dorsum slightly darker with two oval fuscous marks, one over the base of each wing; abdomen fuscous, hypopygium dark, clasper (Fig. 121). Coxæ and legs yellow, tarsi darker, hind tibia about .10 longer than the tarsus. Wings hyaline, veins infuscated. Costa produced .8 of distance from tip of Rs to M_1. Venation closely resembling Fig. 242 but with slightly longer petiole of the cubitus. Halteres infuscated, pedicel yellow at base. Ithaca, N. Y., August.

A specimen from Wisconsin differs in having the costa less produced.

34. *Sciara neglecta* n. sp.

Male and female. Length 1 to 1.5 mm. Fuscous, including palpi, antennæ, halteres and tarsi. Antennæ of the male nearly 3-4 length of the body. Coxæ and legs except tarsi, yellow;

hind tibia and tarsus subequal. Hypopygium dark, clasper (Fig. 122). Wings hyaline (Fig. 242). Stanford Univ.!, Feb., and Pacific Grove, Cal., (J.M.A.) May.

35. *Sciara nigricans* n. sp.

Male and female. Length 2 mm. Shining black, mesonotum highly polished, hypopygium dark, clasper (Fig. 125). Antennæ fuscous, about 3-4 as long as the body in the male, palpi subfuscous. Coxæ and legs pale yellow, tarsi fuscous. Wings grayish hyaline, vein dark, well marked (Fig. 243). Halteres pale yellow. Kingston, R. I.! (J.B.); Kas. (Tucker); Ithaca, N. Y. (May-Aug.)

36. *Sciara actuosa* n. sp.

Male and female. Length 1.5 mm. Black, shining, mesonotum highly polished, its longitudinal rows of pale setulæ conspicuous; hypopygium dark, clasper suboval with strong terminal spine (Fig. 260), antennæ fuscous with grayish pile, about 0.6 as long as the body in the male, but only about twice the longest diameter of the eye in length in the female. Palpi and halteres fuscous; coxæ and legs yellowish brown, tarsi darker, hind tarsi about 1-5 shorter than the tibia. Wings hyaline, anterior veins dark brown (Fig. 217). Niagara Falls (M. C. Van Duzee), Oct.; Ithaca, and Freeville, N. Y., (July).

37. *Sciara* sp.

Male. Length 2.2 mm. Head brown, palpi yellow, (antennæ broken off). Thorax dusky yellowish, the mesonotum fuscous, subopaque. Abdomen dusky yellow, posterior margins of the segments more brownish; hypopygium yellowish, clasper (Fig. 126). Coxæ and legs pale yellow, trochanters black below, tarsi broken. Wings hyaline, anterior veins dusky yellow (Fig. 244). Halteres yellow. Ithaca, N. Y.

38. *Sciara dolens* n. sp.

Male. Length 1.2 mm. Black, mesonotum subshining; scape and palpi fuscous, flagellum broken; hypopygium dark, clasper (Fig. 127). Coxæ and legs yellow, trochanters black below, hind tarsus 1-10 longer than the tibia, tarsi infuscated. Wings grayish hyaline, veins dark (Fig. 245). Halteres fuscous with yellow pedicel. Tompkins Co., N. Y., June.

39. *Sciara diluta* n. sp.

Male. Length 1.5 mm. Fuscous, including palpi and antennæ; mesonotum subopaque, antennæ nearly 3-4 length of the body; hypopygium dark, clasper (Fig. 132). Coxæ and legs pale brown, tarsi darker, hind tarsus slightly longer than the tibia. Wings grayish hyaline, veins darker (Fig. 251). Halteres yellowish.

Female. Colored as the male; larger, halteres infuscated. Both sexes from Ithaca, N. Y., July.

Var. a. Male. Similar but more blackish, halteres dark, and teeth of the claspers stronger (Fig. 140). Freeville, N. Y.

40. *Sciara varians* n. sp.

Male and female. Length 2 mm. Fuscous black, including antennæ and palpi; hairs of antennæ, thorax and abdomen light gray; thorax subshining; hypopygium dark, clasper (Fig. 115). Antennæ about 2-3 as long as the body. Coxæ and legs dusky yellow, hind pair more brownish, tarsi fuscous, hind tarsus .10 longer than the tibia. Wings grayish hyaline, anterior veins dark (Fig. 246). Halteres dusky yellowish. Lawrence, Kas.

Var. a. Male. Similar to the above but smaller, R_1 ends more proximad; and tibia and tarsus subequal in length. Halteres yellow. Ithaca, N. Y.

Var. b. Male and female. Similar to typical variety but the costa ends nearer M_1 and veins are heavier. Ithaca, N. Y.

Var. c. Male and female. Similar to the typical variety but R_1 ends nearly opposite the base of the fork of M (Fig. 255). Moscow, Id.

41. *Sciara scita* n. sp.

Male. Length 3 mm. Fuscous black, including palpi, antennæ, halteres and legs; mesonotum subshining; hairs and spines brown, antennæ about 2-3 as long as the body; claspers of hypopygium as figured (Fig. 128); hind tibia slightly longer than the tarsus. Wing brownish hyaline, veins black (Fig. 247). Newport, Oregon! (J.M.A.).

Female. Antennæ shorter, petiole of the cubitus a little shorter, and cell M_1 relatively narrower. Wash.

42. *Sciara fumida* n. sp.

Male and female. Length 2.2 mm. Head and antennæ fuscous, the latter elongate, (apical joints broken), palpi fuscous.

Thorax reddish, mesonotum, scutellum and metanotum fuscous, subopaque; humeri yellow. Abdomen and hypopygium fuscous, clasper (Fig. 129). Coxæ and legs yellowish, tarsi brown, hind tibia 1-8 longer than the tarsus. Wings hyaline, anterior veins brown (Fig. 248). Halteres brownish, pedicel yellowish. Ithaca, N. Y., August.

43. *Sciara trivialis* n. sp.

Male. Length 1.5 mm. Fuscous, including antennæ, palpi and halteres. Antennæ about 3-4 length of the body. Mesonotum subshining; hypopygium dark, clasper (Fig. 130). Coxæ and legs yellow, tarsi darker, hind tarsus .8 as long as the tibia. Wings grayish hyaline, veins dark (Fig. 249). Ithaca, N. Y.; Bronx Park, N. Y.!, (W.B.).

44. *Sciara acuta* n. sp.

Male and female. Length 1.75 mm. Black, head and mesonotum highly polished, the latter with the lines of paler hairs quite distinct, antennæ, palpi and halteres fuscous, pedicel of the last yellowish at base; antennæ over 3-4 length of the body in the male; hypopygium dark, clasper (Fig. 131). Coxæ and legs pale brown to brown, hind coxæ and tarsi darker, hind tibia and tarsi subequal. Wings hyaline, anterior veins brown (Fig. 250). Friday Harbor, Wash.!, and Moscow, Id. (J.M.A.), May; Lawrence, Kas.

45. *Sciara impatiens* n. sp.

Male. Length 1.25 mm. Fuscous, including antennæ which are less than 1-2 as long as the body, intermediate segments being but little longer than broad; palpi yellow. Thorax subopaque; hypopygium dark, clasper (Fig. 137). Coxæ and legs yellow, tarsi darker, hind tarsus slightly shorter than the tibia. Wings grayish hyaline, veins dark, strong (Fig. 252). Halteres fuscous. Bred from larvæ found in earth adhering to the roots of *Impatiens*. Ithaca, N. Y.

46. *Sciara coprophila* Lintner.

Rept. State Ent. X. 394. 1895.

Male. Length 2.5 mm., slightly shorter in dried specimens. Head and thorax black, subshining, abdomen dark brown to black, antennæ, palpi and hypopygium fuscous, clasper (Fig. 133). Antennæ less than 3-4 length of the body in dried specimens. Coxæ and legs dusky yellow, tarsi darker, hind tibia and tarsi subequal. Wings grayish hyaline, veins dark (Fig. 236). Halteres brown with yellowish petiole.

Female. Colored like the male, hind tarsus slightly shorter than the tibia, antennæ about half the length of the body in dried specimens; lobes of the ovipositor dusky (Fig. 144). Both sexes, Montreal, Canada; Ithaca, N. Y.; Orono, Me. Larvæ in manure. Treesbank, Manitoba (N. Criddle.)

Var. a. Male and female. As above but petiole of the cubitus only .6 as long as the basal section of M, and halteres, coxæ and legs brighter yellow. Ithaca, N. Y.; Black Mts., N. C. (W.B.); Kas., and Col. (Tucker).

On examination of a slide of type material proves my specimens to be this species. Dr. Lintner's specimens were taken in a mushroom cellar at Albany, N. Y.

47. *Sciara caldaria* Lintner.

Rept. State Ent. X. 398. 1895.

Male. Length 2.5 mm. Head, thorax and abdomen black, the mesonotum shining; hypopygium black, in structure like the preceding species; antennæ and palpi fuscous, the intermediate flagellar joints nearly 3 times as long as wide, antenna over 3-4 as long as the body in dried specimens. Coxæ and legs brownish, the hind coxæ and sometimes also hind femora, dark brown; tarsi fuscous; hind tibia and tarsi subequal. Wings grayish hyaline, veins dark. Halteres fuscous.

Female. Similar to the male in coloring, antennæ shorter; terminal lobe of the ovipositor more elongate than in *S. coprophila* "Boise, Idaho." Captured in a green house.

An examination of a slide of the type material does not reveal any structural differences between this and the foregoing species, excepting that the antennæ in this appears to be a trifle longer.

Var. a. Similar to the above, but antennæ distinctly longer than in *S. coprophila* and the anterior wing veins heavier (Fig. 237). Ithaca, N. Y.

48. *Sciara ocellaris* Comstock.

Rept. of Comm. of Agr. 203. 1882.

Male. Length 1.5 mm. Head black, antennæ dark brown, basal joint light yellowish brown; pronotum light yellowish-brown; mesonotum yellowish brown in the center and darker at the edges; scutellum dusky brown; metathorax dark brown, almost black; abdomen with caudal portion of the segments, blackish, cephalic portions yellowish brown; clasper lighter brown. Poisers, with knob blackish, and base light brown. Tibiæ and tarsi dusky brown; femora lighter; coxæ still lighter. "N. Y., D. C." The figure given by the author of the wing shows that this species is closely related to *S. coprophila.*

An examination of the cotype material from the Cornell University collection shows that in structural characters including antennæ and wing venation the species is closely related to *S. coprophila* from which it differs in color characters and in the structure of the clasper which has on the dorsal-mesal margin 2 or 3 strong setæ in addition to the apical setæ (Fig. 263). This species was formerly supposed to cause the ocellate spots on maple leaves which are now attributed to a Cecidomyiid. Specimens from Buffalo, and Lancaster, N. Y., collected by Mr. M. C. Van Duzee do not differ from the types (Fig. 265).

The following descriptions by Say (Complete Writings I, II), Walker (List. Dipt. Brit. Mus. I) and Fitch (Second Rept. 484-487) are too brief and general to permit of a recognition of the species. The dimensions given have all been reduced to the metric system.

S. abbreviata Walker. "Length 2 mm. Body black; abdomen tawny; feelers piceous; thighs tawny; shanks and feet brown; wings colorless; veins pale brown; poisers tawny. Canada; N. J., N. H."

S. atrata Say. "Length less than 5 mm. Entirely deep black, polished, immaculate; wings dusky, iridescent; nervures dark fuscous; poisers black; thorax in a particular light somewhat pruinose; abdomen opaque, with short black hairs; spines of the tibia rather longer than the transverse diameter of the tibia. 'N. W. Terr.' The nervures of the wings agree with those of *S. Thomae.*" *S. thomae* has a venation of the type of *S. picea* but R_1 ends about opposite the forking of the media.

S. dimidiata Say. "Female. Length less than 5 mm. Thorax polished; wings fuliginous; costal margin blackish; middle nervure very distinct; poisers blackish; abdomen dull fulvous, with a few blackish hairs on the 3 basal joints, fourth a little darker; tip black; feet piceous black. Louisiana."

S. exigua Say. "Male. Length 1.2 mm. Black; thorax piceous at the anterior angles; poisers whitish at base; feet whitish, dusky at tip. Antennæ fuscous, with dark gray hairs; wings a little dusky, nervures fuscous; poisers elongated whitish, capitulum fuscous; abdomen fuscous, opaque. Female. A little larger with the base of the feet and of the poisers of a darker shade than those of the male. N. W. Terr."

S. exilis Say. "Male. Length .8 mm. Body dusky; antennæ as long as the body; stethidium yellowish white; thorax blackish; wings dusky, apical forked nervure wide, the inferior portion hardly arquated; halteres subclavate, about half as long as the abdomen, a little dusky; abdomen a little hairy; feet pale. Indiana."

S. femorata Say. "Length less than 2.5 mm. Wings hyaline, nervures fuscous; poisers large; coxæ and thighs pale or yellowish white; abdomen dirty yellowish obscure, lateral margin and posterior margins of the segments blackish. Pa."

S. fraterna Say. "Female and male. Length 2.5 mm., male smaller. Deep black, polished; abdomen black-brown, opaque. Antennæ dark fuscous, with dense grayish hair; eyes in contact above the antennæ; thorax polished; wings dusky, pale yellowish at base; poisers with a yellowish scapus and fuscous capitulum; feet dusky towards the tip. N. W. Terr."

S. fuliginosa Fitch. "Length 4.5 mm. Black with blackish brown shanks and pale thighs, their haunches being commonly white. Its wings are semi-transparent and smoky. The 16 cylindrical joints of its antennæ are more widely separated from each other by short intervening pedicles than in *S. mali.* N. Y." "N. J."

S. inconstans Fitch. "Length 2 mm. Black with the thorax smooth and slightly shining, the thighs pale and whitish, and the wings pellucid and glassy with an iridescent violet and red reflection. N. Y."

The species identified with this in entomological literature and reported from Ill., Ky., Me., Neb., N. J., N. Y., O., Ottawa, Pa. and Va., is in all probability a composite; = S. *prolifica* + *S. coprophila* Whether either one is identical with S. *inconstans* is problematical.

S. lurida Walker. (Dipt. Saund. 418). "Div. A, b. Meigen. VI. 305. Black. Abdomen piceous, tawny beneath. Legs tawny; tibiæ and tarsi brown. Wings brown; veins brown, tawny at the base. Halteres tawny. Length 4 mm. U. S."

S. mali Fitch. "Length 3.7 mm to the tips of the wings. Head and thorax black. Abdomen dusky, almost black, with a bright yellow band at each of the sutures. Legs are black as are the antennæ also, though of less deep tint than the head and thorax. Poisers dusky. Wings dull hyaline, tinged with smoky, and are a fourth longer than the abdomen. In the female the antennæ are half the length of the body. N. Y." Larvæ feed on apples following in the trail of the codling moth.

S. perpusilla Walker. "Length 1.5 mm. Body piceous, small and slender; feelers black; legs brown; thighs tawny; wings slightly gray; the costal veins dark brown, the rest paler and more slender; poisers tawny." Canada.

S. polita Say. "Female. Length less than 4 mm. Deep black, thorax and abdomen both highly polished. Body with numerous short hairs which are slightly sericeous; eyes without interval above the antennæ; wings dusky, pale yellowish at base; poisers whitish; feet dusky towards the tip; coxæ and thighs yellowish white. N. W. Terr."

S. punctata Walker. "Length 2.5 mm. Head black; feelers piceous; chest very dark piceous; abdomen dull red with a row of black spots on each side; legs tawny; wings gray; fore border veins dark brown, the rest as usual paler and more slender; poisers tawny. North Amer."

S. robusta Walker. "Length 4 mm. Body black, stout, pubescent; a dark red line along each side; feelers black, robust; legs dark piceous, rather thick; wings black, as are also the veins and the poisers. Canada."

S. rotundipennis Macq. Dipt. Exot. I. 2, 178. 1838. "Female. Length 4.5 to 6 mm. Black, abdomen fuscous testaceous. Wings fuscous, exterior margin, rotund. Antennæ with gray reflection. Cells C and R_1 more brown than the others; basal section of Rs far remote from the base of cell M_1. Carolina."

S. tilicola Loew. Mentioned in Professor Aldrich's catalogue. This is an European species not yet reported from North America.

S. vulgaris Fitch. Length 2.5 to 3 mm. Black with blackish brown legs and pale thighs. Its poisers are whitish and its wings hyaline. The sides of its thorax below the wings are tinged with pale, and the abdomen with brown, rarely pale. N. Y., N. H."

Type and Paratype Specimens of New Species.

The types and paratypes of the new species described in Parts I, II, III, and IV, of the "Fungus Gnats of North America" may be found in the collections noted below. The following abbreviations are used: J.M.A., (Prof. J. M. Aldrich's collection); O.A.J., (My own collection); A.M.N.H., (American Museum of Natural History); B.S.N.H., (Boston Society of Natural History); C.U., (Cornell University). The location of the type is given first, paratypes follow:

Palaeoplatyura aldrichii, JMA; P. johnsonii, BSNH.

Ceroplatus militaris, OAJ, BSNH.

Apemon nigriventris, OAJ, CU.

Platyura setiger, OAJ, JMA; P. minula, OAJ, JMA.

P. nigrita, JMA; P. moesta, JMA; P. moerens, OAJ, JMA; P. genualis, OAJ, AMNH; P. scapularis, OAJ, JMA.

Macrocera geminata, OAJ, CU; M. formosa, var. indigena, OAJ, CU.

Monoclona elegantula, OAJ, CU; M. furcata OAJ.

Sciophila galbana, OAJ, JMA; var. germana, AMNH; var. socia, BSNH; S. nugax, OAJ, AMNH; S. habilis, OAJ; S. incallida, OAJ, CU; S. hebes, OAJ, JMA; S. novata, OAJ, CU; S. impar, OAJ, AMNH, JMA; S. severa, OAJ; S. similis, OAJ.

Paratina recurva, OAJ.

Polylepta obediens, OAJ, AMNH, BSNH; P. nigellus, JMA.

Diomonus magnificus, OAJ, CU, BSNH; D. pulcher, CU.

Neoempheria macularis, OAJ, BSNH; N. impatiens, OAJ, JMA; N. indulgens, OAJ, CU, AMNH; N. illustris OAJ, CU.

Mycomyia littoralis, var. frequens, OAJ, AMNH, CU; M. sequax, OAJ, CU; M. marginalis, OAJ; M. imitans, OAJ, CU. AMNH; M. maxima, OAJ, BSNH; M. sigma, AMNH; M. mendax, OAJ, JMA, CU; M. nugatoria, OAJ, AMNH; M. recurva, OAJ, AMNH; var. chloratica, AMNH; M. incompta, OAJ, CU.

Gnoriste macra, OAJ, AMNH.

Neuratelia silvatica, OAJ; N. scitula, BSNH, OAJ; N. eminens, JMA; N. desidiosa, BSNH.

Leptomorphus ypsilon OAJ, CU.

Boletina obscura, OAJ, BSNH, CU; B. cincta, BSNH, OAJ; B. melancholica, OAJ, AMNH; B. imitator, JMA; B. gracilis, OAJ, AMNH; B. longicornis, JMA; B. notescens, OAJ, BSNH, JMA; B. sobria, OAJ, JMA; B. delicata, AMNH; B. obesula, OAJ; B. sedula, OAJ, JMA; B. nacta, OAJ, AMNH.

Leia nigra, OAJ, JMA; L. plebeja, OAJ, JMA, AMNH; L. dryas, AMNH, OAJ.

Phthinia curta, OAJ.

Coelosia gracilis, OAJ, AMNH; C. lepida, AMNH, JMA; modesta, JMA, AMNH.

Syntemna rejecta, BSNH; S. vittata var. fasciata, BSNH; S. separata, BSNH.

Megophthalmidia occidentalis, OAJ, JMA.

Anatella silvestris, OAJ.

Docosia nigella, OAJ; D. nitida, OAJ, JMA.

Trichonta cincta, BSNH; T. triangularis, OAJ, CU; T. bellula, BSNH; T. diffissa, OAJ, BSNH; T. patens, OAJ, CU.

Cordyla manca, OAJ; C. scita, OAJ, C. volucris, OAJ, CU; C. recens, OAJ, CU; C. neglecta, OAJ.

Brachypeza bisignata, var. divergens, OAJ, BSNH.

Rhymosia serripes, OAJ; R. inflata, OAJ, CU; R. imitator, OAJ, AMNH, CU; R. akeleyi, AMNH, BSNH; R. captiosa, OAJ, BSNH; R. diffissa, OAJ, JMA.

Allodia bulbosa, OAJ, BSNH, CU; A. actuaria, OAJ. BSNH; A. falcata, OAJ, AMNH, JMA; A. elata, OAJ, BSNH; A. bella, CU; A beata, OAJ, CU; A. callida, JMA, OAJ; A. delita, JMA, AMNH.

Phronia producta, BSNH; P. insulsa, OAJ; P. venusta, OAJ, JMA; P. difficilis, OAJ, CU; P. similis, OAJ.

Telmaphilus nebulosa, OAJ, BSNH.

Exechia perspicua, OAJ, AMNH; E. nugax, OAJ; E. nexa, OAJ; E. abrupta, OAJ; E. canalicula, OAJ, CU, JMA; E. cincinnata, OAJ, BSNH, CU; E. quadrata, OAJ, AMNH. BSNH, CU; E. satiata, OAJ, CU; E. nugatoria, OAJ, AMNH; E. nativa, OAJ, CU; E. palmata, OAJ, AMNH, JMA, CU; E. assidua, OAJ, JMA; E. auxiliaria, OAJ, AMNH,; E. bellula, OAJ, BSNH; E. bella, OAJ, AMNH; E. captiva, OAJ, BSNH; E. absoluta, OAJ, JMA, BSNH; E. capillata, OAJ, AMNH; E. obediens, JMA, AMNH; E. attrita, OAJ, AMNH, CU; E. repanda, OAJ, BSNH, CU; E. absurda, OAJ; E. casta, OAJ, AMNH.

Dynatosoma nigrina, OAJ; D. placida, OAJ.

Opistholoba ocellata, OAJ, CU.

Mycothera paradoxa, OAJ; M. mitis, AMNH; M. recta, OAJ; M. var. praenubila, OAJ, AMNH, JMA; M. impellans, OAJ, BSNH, JMA.

Mycetophila jucunda, OAJ; M. perita, OAJ, CU, AMNH; M. fastosa, OAJ; M. falcata, OAJ, JMA; M. lenis, OAJ; M. anomala, OAJ, AMNH; M. foecunda, OAJ, AMNH, CU, JMA; M. imitator, OAJ, CU, AMNH; M. perlonga, OAJ; M. pectita, OAJ, JMA; M. lassata, CU; M. lenta, OAJ, AMNH; M. fatua, OAJ, JMA; M. edura, OAJ, AMNH; M. exusta, OAJ, JMA, CU; M. jugata, OAJ; M. extenta, OAJ, CU; M. edentula, OAJ, BSNH; M. socia, OAJ, CU.

Sciara. All types in my collection. Paratypes as follows: S. dives, JMA; S. futilis, AMNH; S. imitans, JMA; S. hastata, CU; S. jucunda, CU; S. mutua, CU; S. parilis, E. S. Tucker; S. nigricans, CU, E. S. Tucker; S. varians, JMA; S. trivialis, AMNH.

Zygoneura flavicoxa, OAJ.

In the body of the work the type locality is indicated by an exclamation point.

Plate.

Details of hypopygia. Dorsal aspect of left half unless otherwise noted. Abbreviations used the same as in Part III. Figs. 24 to 29, *Phronia* species; figs. 31 to 57 *Exechia* species. 24, *P. producta* x 170. 25, *insulsa,* x 75. 26, *venusta,* x 60. 27, *difficilis,* x 60. 28, *similis,* x 300. 29, *rustica,* var. a, x 60. 30, *Telmaphilus nebulosa,* x 85. 31, *E. perspicua,* x 60. 32, *umbratica,* x 35. 33, *nugax,* x 60. 34, *nexa,* x 60. 35, *abrupta,* x 35. 36, *canalicula,* x 35. 37, *cincinnata,* x 35. 38, *quadrata,* x 35. 39, *satiata,* x 35. 40, *ditto,* va of apex of median margin. 41, *nugatoria,* x 35. 42, *nativa,* x 35. 43, *interrupta,* va of apex of median margin; after Lundström. 44, *palmata,* x 60 va. 45, *fungorum* va, after Lundström. 46, *assidua,* x 45. 47, *auxiliaria,* x 60. 48, *bellula,* va, x 60. 49, *bella,* x 35. 50, *captiva,* x 35, right hand members. 51, *absoluta,* x 60, b^1 is la of apex of b. 52, *capillata,* x 60, latero-dorsal aspect. 53, *obediens,* x 35. 54, *attrita,* x 35, b^1 la of b. 55, *repanda,* x 60. 56, *absurda,* x 60. 57, *casta,* x 60. 58, *Dynatosoma nigrina,* la of forceps, x 35. 59, *D. fulvida,* la of forceps, x 35. 60, *Opistholoba ocellata,* la of forceps, x 30. 61, *Epicypta trinotata,* x 35.

Plate.

Details of hypopygia. Figs. 62 to 67 Mycothera; figs. 68 to 95 Mycetophila; fig. 96 Sceptonia; figs. 97 and 98 Zygomyia. 62, *Mycothera paula,* va, x 35. 63, *paradoxa,* la of ovipositor, x 60. 64, *mitis,* x 60, la. 65, *recta,* x 170, la. 66, *fenestrata,* x 85, da. 67, *impellans,* x 170, la. 68, *Mycetophila exstincta,* x 85. 69, *jucunda,* x 85, la. 70, *perita,* x 45, da, b^1=b, x 85 la. 71, *fastosa,* x 60 da. 72, *punctata* forceps, x 60, da. 73, *falcata,* x 85, s, da, i, va. 74, *mutica,* x 60, s, da, i, va. 75, *mutica* var. a, x 85, va. 76, *lenis,* x 85, i, va, s, da. 77, *anomala,* x 35, la. 78, *bipunctata,* x 60, da. 79, *inculta,* x 60, s, ma, i, va. 80, *scalaris,* x 85, da. 81, *foecunda,* x 35, va, f^1 is f enlarged, x 85. 82, *scalaris,* var. a, x 60 la. 83, *perlonga,* x 60, ma. 84, *pectita,* x 60, da. 85, *lassata,* x 60, da. 86, *lenta,* x 85, la. 87, *fatua,* x 60, da. 88, *edura,* x 60, la. 89, *exusta,* x 60, i, va, s, da. 90, *jugata,* x 60, la. 91, *imitator,* x 60, la. 92, *extenta,* s, x 60, da, i, x 60, ma. 93, *edentula,* x 85, la. 94, *trichonota* var. a, x 60, ma. 95, *socia,* x 85, la. 96, *Sceptonia nigra,* x 60, la. 97, *Zygomyia ignobilis,* x 170 ma. 98, Z. *ornata,* x 170, da. 99, *Zygoneura flavicoxa,* clasper, va.

Plate.

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Plate.

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Plate.

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ADDENDA.

Sciara hartii n. sp.

Mr. Chas. A. Hart recently records (Forbes, 15th Rept. State Ent. Ill., pp. 95-98) a species of *Sciara* seriously injurious to cucumbers in forcing houses. At my request Mr. Hart kindly sent me a number of specimens taken at Morrison, Ill. These proved to differ from any of the species noted on the previous pages. This species somewhat resembles *S. cucumeris* but is more closely related to *S. fatigans* from which it differs in having a wider wing, broader cell R_1, Rs less curved, ending a little more distad. The hypopygium differs in having apical hairs on the clasper more dense but apparently lacking the 2 smaller apical setæ. Alcoholic specimens are dusky yellow, but in life they are probably more or less fuscous. Antennæ of the male about ¾ the length of the body. Length (in alcohol) about 1.5 mm. One male and many female specimens. This species will find a place in the key with *S. fatigans* from which it may be distinguished by its venation.

Quite recently a new genus belonging to the *Mycetophilinæ* has been described by Landrock (Wien. Ent. Zeit. XXX. 161) represented by an European species. It will fall in with *Neuratelia* in the dichotomic table in Genera Insectorum (Fasc. 93). It may be distinguished from that genus by the strongly produced costa and the absence of one of the anal veins.

The generic name *Meunieria* proposed by me (Genera Insectorum, Fasc. 93, p. 87.) must be changed. It is already twice preoccupied.

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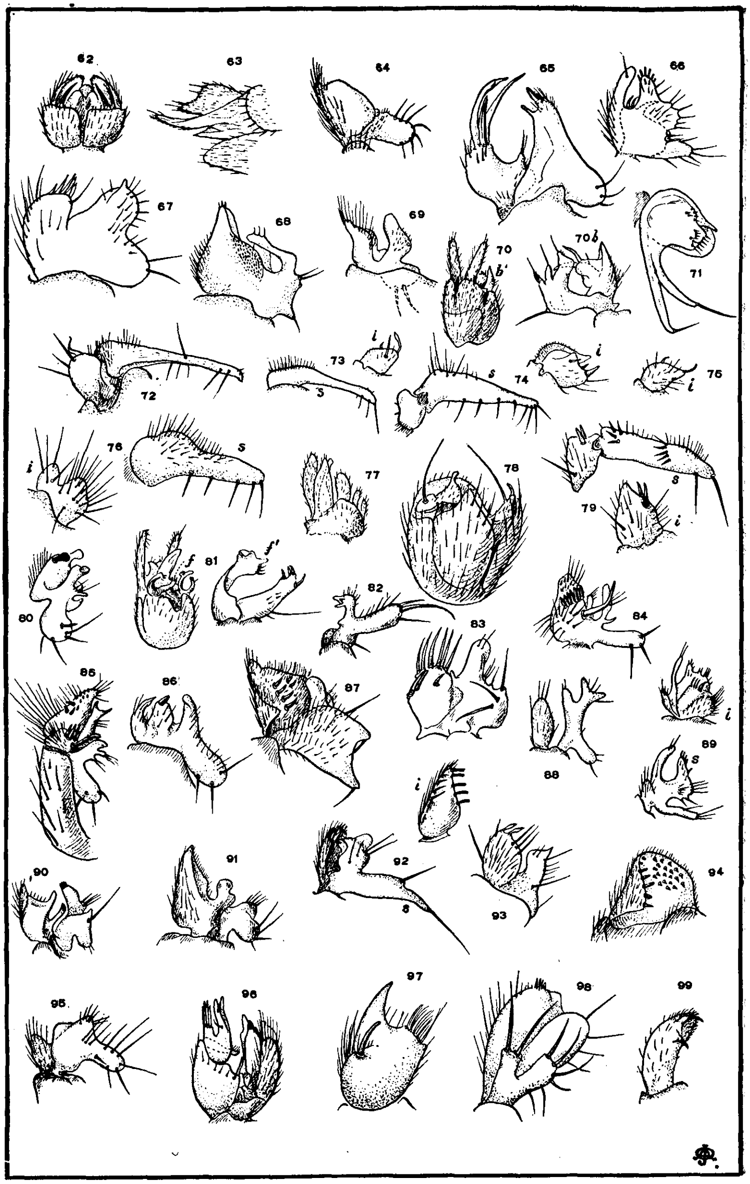

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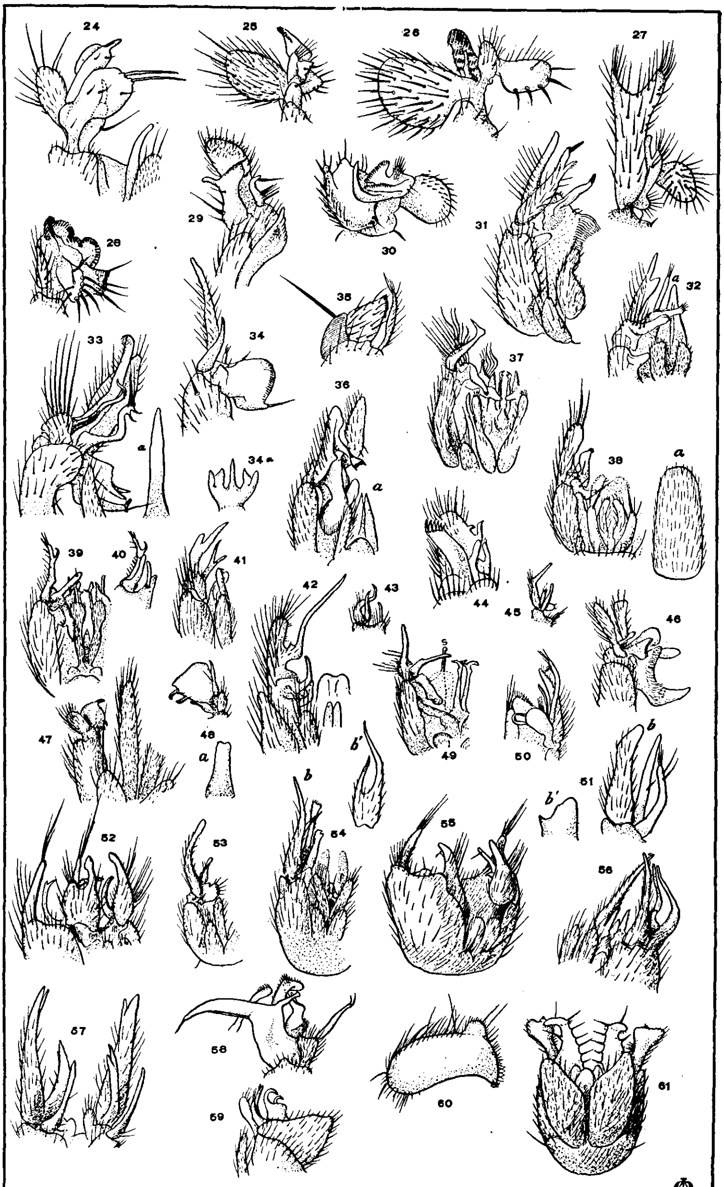

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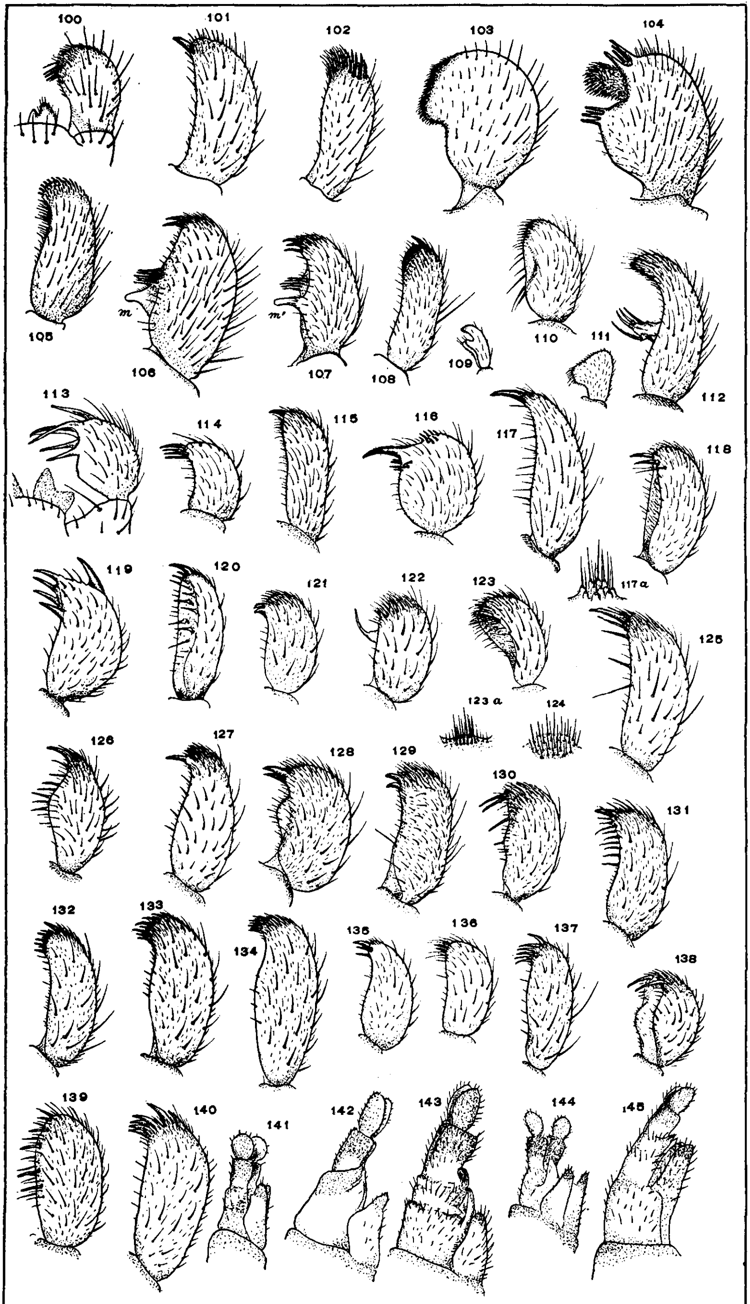

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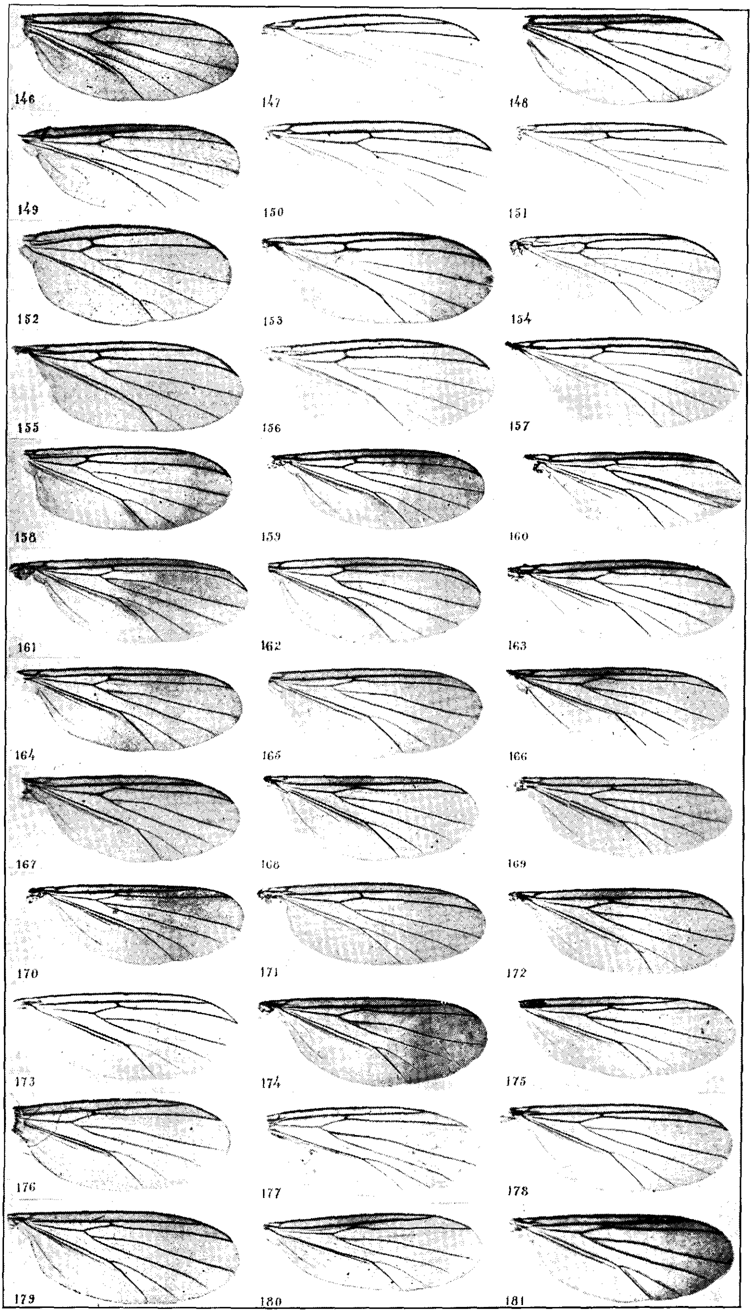

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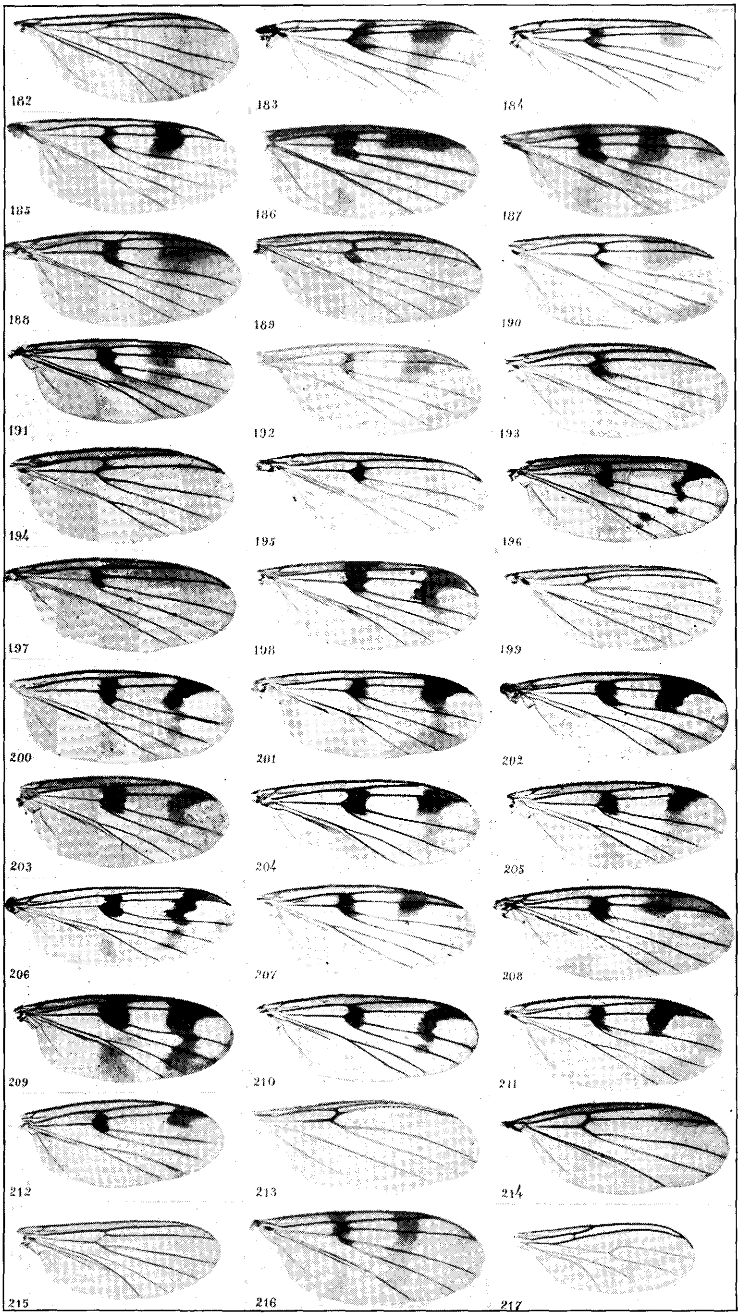

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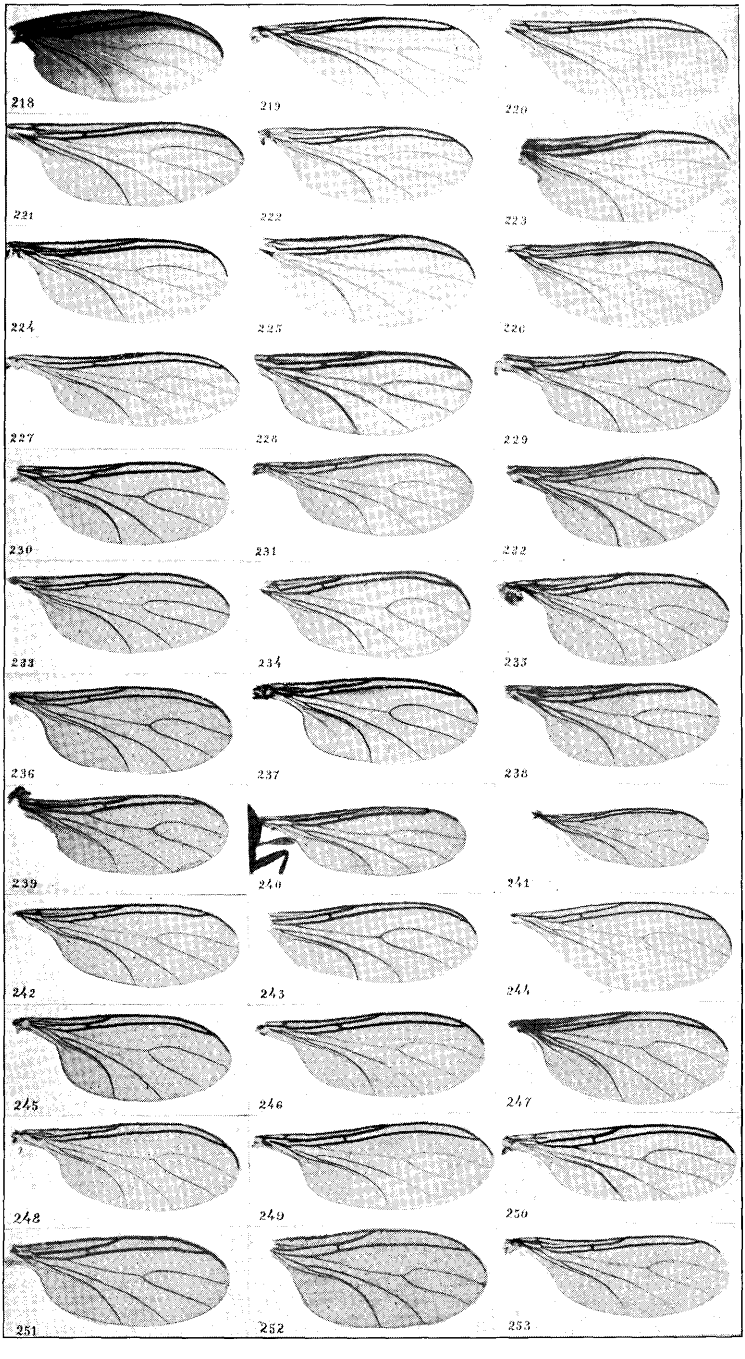

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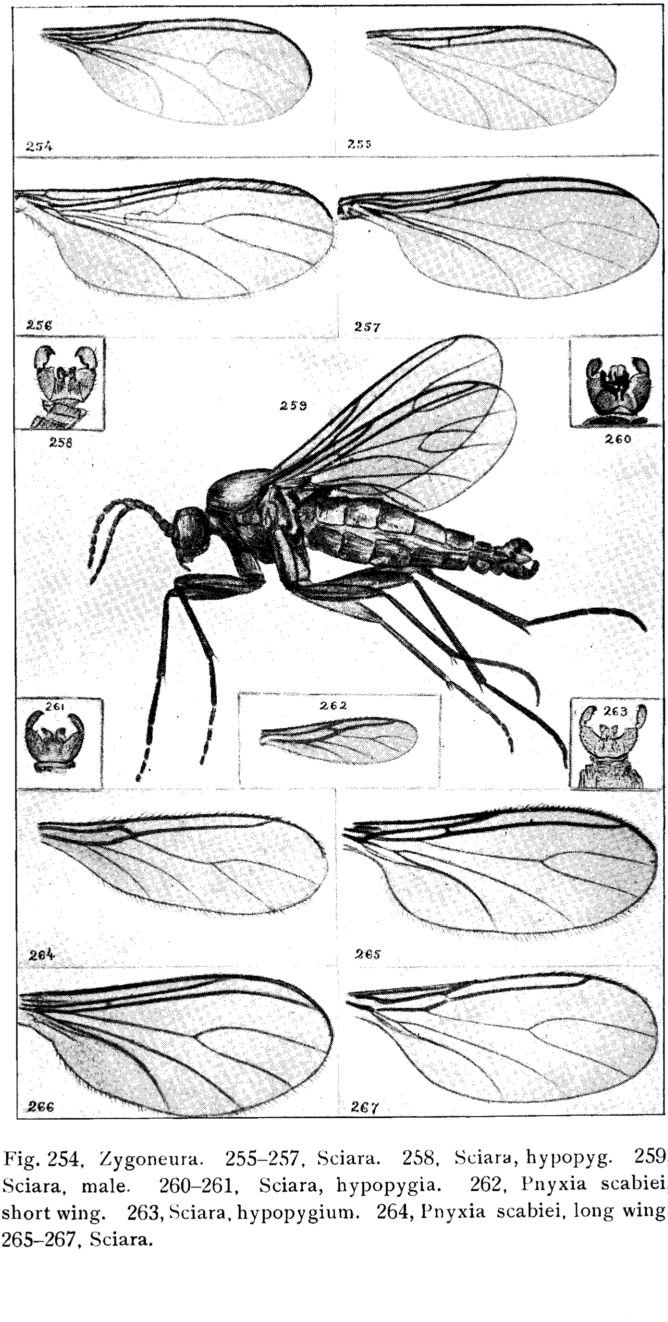

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BULLETIN 201.

THE DETERIORATION AND ASSAY OF SPIRIT OF NITROUS ETHER.

H. H. HANSON AND A. K. BURKE.

Spirit of Nitrous Ether, commonly called Sweet Spirit of Nitre, an alcoholic solution of ethyl nitrite, has been for a century and a half, or more, a preparation of importance in medicine. Strictly speaking, the preparation as it is now made is somewhat different from the original Sweet Spirit of Nitre. Different methods have been used in its preparation and different names have been applied to the product. At the present time it may be made in this country according to the method given in the eighth revision of the United States Pharmacopoeia (1900), or it may be prepared by diluting concentrated nitrous ether which may be purchased for the purpose in small sealed tubes or bottles.

DETERIORATION.

From the first it has been recognized as a very unstable compound, liable to deterioration and decomposition unless kept under the most favorable conditions. Upon standing, the ethyl nitrite (upon which this preparation is supposed to depend for its efficiency) gradually decreases in amount and, at the same time, undesirable compounds are, and even dangerous compounds may be, formed. The following list of possible decomposition products is taken from a well known authority;* Aldehyde, paraldehyde, ethyl acetate, ethyl nitrate, nitrous acid, acetic acid, ethyl oxide, ethyl formate, ethyl oxalate, cyanogen compounds, glyoxal, glyoxalic acid, oxalic acid, malic acid, saccharic acid, and nitro ethane. In order to reduce the liability of decomposition to the lowest degree the United States Pharmacopoeia directs that the preparation be kept in "small, well-stoppered, dark, amber-colored vials, in a cool place, remote from lights or fire." In order to test the value of these directions three lots were prepared from tubes of concentrated

* Allen's Commercial Organic Analysis Vol. I, p. 194.

nitrous ether according to directions. These samples were carefully tested and then stored as follows: Sample A was kept in a dark amber-colored bottle, full to the top, in the dark, in a refrigerator, strictly according to Pharmacopoeia directions. Sample B was kept in an amber-colored bottle tightly corked with a cork stopper, at ordinary room temperature in a dark cupboard. The bottle was full at the beginning of the experiment. Sample C was kept in a green colored bottle in the same cupboard with B but the bottle was only half full at the beginning. These three experiments were not made at exactly the same time and the intervals between the different assays were not the same in the three different cases. From table 25 it will readily be seen, however, that sample A, kept strictly according to directions, remained for two months at exactly the same strength found by the first test and that during the next month it lost only 0.23 per cent of ethyl nitrite. This sample when made up carried 4.06 per cent, and at the end of 90 days 3.83 per cent of ethyl nitrite. In order that the conditions under which sample A was kept approximate as near as possible the conditions existing in a drug store, each time the sample was opened and assayed two or three ounces were turned out in imitation of a sale.

Sample B was kept in an amber-colored bottle under the same conditions which surrounded A with the exception that it was kept at ordinary room temperature. Results of the assay of this sample show that the decrease in strength began at once and that the decrease was steady but not rapid. The sample at the beginning contained 4.21 per cent ethyl nitrite. In seventy days the strength had dropped to 3.93 per cent, and in one hundred and sixty-six days to 3.80 per cent ethyl nitrite.

Sample C, kept in a green bottle only half full, at room temperature, in the same closet with sample B, decreased in strength from 3.86 per cent at the beginning to 3.48 per cent of ethyl nitrite at the end of 170 days.

The results are given in Table 25. Sample A was stored as the preparation should always be kept and the result indicates that under these favorable conditions sweet spirit of nitre will keep for several months practically uniform. Samples B and C were stored as such material is often kept in drug stores and the result shows that under such circumstances decomposition begins at once and steadily continues.

It was not considered necessary to try samples kept under extremely unfavorable conditions as it is well known that exposure to light, high temperature, and free access of air contribute to rapid deterioration.

TABLE 25.

Deterioration of Samples of Sweet Spirit of Nitre Stored under Different Conditions.

DATE OF TEST.	Elapsed Time—Days.	Corrected Reading—C. C.	Ethyl nitrite. Per Cent.	Deterioration. Per Cent.
SAMPLE A.				
June 3	—	55.9	4.06	—
June 16	13	55.9	4.06	0.00
July 17	44	55.8	4.06	0.00
August 3	61	55.8	4.06	0.00
August 18	76	54.6	3.97	0.09
September 1	90	52.7	3.83	0.23
SAMPLE B.				
March 19	—	—	4.21	—
March 27	8	54.9	3.99	0.22
April 30	42	54.7	3.98	0.23
May 28	70	54.1	3.93	0.28
September 1	166	52.3	3.80	0.41
SAMPLE C.				
March 16	—	—	3.86	—
March 27	11	49.9	3.63	0.23
April 30	45	49.4	3.59	0.27
August 4	141	48.3	3.51	0.35
August 18	155	48.0	3.49	0.37
September 2	170	47.9	3.48	0.38

In Table 25 the first readings under samples B and C, 4.21 per cent and 3.86 per cent, may possibly be slightly high because these two samples, made from tubes of concentrated nitrous ether, were among the first investigated and it was shortly afterwards found that an analysis made immediately following the preparation of the sample might not give correct results unless unusual care had been observed in the mixing. This is a point of importance to the pharmacist as it indicates that the concentrated nitrous ether mixes but slowly with alcohol unless it is very thoroughly shaken.

METHODS OF ANALYSIS.

Three different methods of assaying spirit of nitrous ether have been proposed: that given in the seventh revision of the United States Pharmacopoeia, that given in the eighth revision of the same publication, and a modification or combination of the two which may be found outlined in Schimpf's Manuel of Volumetric Analysis.* These methods as given are as follows:

Method of Assay According to Seventh Revision of the U. S. P. 1890. "If 5 Cc. of recently prepared Spirit of Nitrous Ether be introduced into a nitrometer, and followed, first, by 10 Cc. of potassium iodide T. S., and then by 10 Cc. of normal sulphuric acid, the volume of nitrogen dioxide generated at the ordinary indoor temperature (assumed to be at or near 25° C., or 77° F.) should not be less than 55 Cc. (corresponding to about 4 per cent of pure ethyl nitrite)."

Method of Assay According to the Eighth Revision of the U. S. P. 1900. "Transfer about 30 Gm. of the Spirit of Nitrous Ether, which has been previously shaken with 0.5 Gm. of potassium bicarbonate, to a tared 100 Cc. measuring flask, and weigh it accurately. Add sufficient alcohol to bring the volume to exactly 100 Cc., and mix thoroughly. Introduce into a nitrometer (see Appendix, Gasometric Estimations) exactly 10 Cc. of the alcoholic solution, followed by 10 Cc. of potassium iodide T. S., and afterwards by 10 Cc. of normal sulphuric acid V. S. When the volume of gas has become constant (within 30 to 60 minutes), note the volume of gas collected. Multiply this volume in Cc. by 0.307, and divide the product by the original weight of the Spirit of Nitrous Ether. At standard temperature and pressure the quotient will represent the percentage of

* Fifth Edition, p. 683.

ethyl nitrite in the liquid. The temperature correction is one-third of one per cent of the total percentage just found for each degree, additive if temperature is below, subtractive if above, 25° C. (77° F.). The barometric correction is four-thirtieths of one per cent for each millimeter, additive if above, subtractive if below, 760.

When assayed according to the above method, Spirit of Nitrous Ether should yield not less than 4 per cent of ethyl nitrite."

Schimp Method. This determination, which is to be conducted with a nitrometer, is outlined thus: "Open the stop-cock of the measuring tube, raise the control-tube, and pour into the latter a saturated solution of NaCl until the measuring tube, including the bore of the stop-cock, is completely filled. Then close the stop-cock and fix the control-tube at a lower level. Now introduce into the funnel at the top of the measuring tube a weighed quantity (about 4 gms.)* of spirit of nitrous ether; open the stop-cock, and allow the spirit to run into the nitrometer, being careful that no air enters at the same time. 10 Cc. of potassium iodid T. S. are now added in the same manner, and followed by 10 Cc. of normal sulphuric acid V. S. Effervescence takes place immediately, and after 30 to 60 minutes, when the volume of gas becomes constant, the control-tube is lowered so as to make the level of the liquid in both tubes the same, and the volume of the gas in the graduated tube read off.

This volume, multiplied by 0.0030673 gm. gives the weight of ethyl nitrite in the spirit taken for analysis. The product multiplied by 100, and then divided by the weight of the spirit taken, gives the per cent of pure ethyl nitrite present."

Barometric and temperature corrections are to be made as usual.

A method similar to the latter was tried several years ago by one of the authors upon the theory that it was more accurate than the old and certainly easier of manipulation than the new U. S. P. method.

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* It is convenient to take 5 Cc. accurately measured, and calculate its weight by multiplying by the specific gravity.

In order to compare the accuracy of these three methods a large number of assays were made on samples of various ages and strengths and the results are given in Table 26.

TABLE 26.

Analysis of Sweet Spirit of Nitre by Three Methods.

STATION NUMBER.	Ethyl nitrite by U. S. P. method, 1890.	Ethyl nitrite by U. S. P. method, 1900.	MODIFIED METHOD.				
			Ethyl nitrite calculated from weight.	Ethyl nitrite calculated from Sp. Gr.	Specific gravity, 24° C.	Weight taken.	Weight calculated from Sp. Gr.
10,525	–	4.11	4.16	–	–	4.2080	–
10,527	3.48	–	3.56	3.59	0.8225	4.1280	4.1125
10,529	4.02	3.97	4.12	4.12	0.8183	4.0855	4.0915
10,531	4.34	–	4.46	4.47	0.8163	4.1055	4.0815
10,535	2.46	–	2.52	2.52	0.8224	4.1170	4.1120
10,538	3.06	–	3.16	3.16	0.8206	4.1060	4.1030
10,543	4.17	–	4.21	–	–	4.1895	–
10,544	2.60	2.61	2.67	2.69	0.8177	4.1240	4.0885
10,547	3.34	3.14	3.37	3.40	0.8288	4.1820	4.1440
10,549	4.40	4.25	4.52	4.56	0.8133	4.1000	4.0665
10,550	3.81	3.50	3.94	3.96	0.8133	4.0810	4.0665
10,552	3.52	3.50	3.63	3.62	0.8217	4.0925	4.1085
10,560 A	4.59	4.48	4.71	4.74	0.8160	4.1110	4.0800
10,560 B	4.50	4.56	4.62	4.64	0.8160	4.1040	4.0800
10,560 C	–	4.47	–	–	0.8160	–	–
10,561	3.89	3.58	4.01	4.03	0.8141	4.1185	4.0705
10,562	4.10	3.81	4.20	4.22	0.8201	4.1280	4.1005
10,563	3.10	3.01	3.19	3.21	0.8152	4.0935	4.0760
10,568 A	4.07	4.02	4.20	4.24	0.8118	4.1025	4.0590
10,568 B	4.07	3.75	4.19	4.23	0.8118	4.1040	4.0590
10,568 C	3.97	–	4.11	4.13	0.8118	4.0800	4.0590
10,568 D	4.07	–	4.22	4.23	0.8118	4.0730	4.0590

Referring to table 26 it will be seen that the result obtained by the new United States Pharmacopoeia method is in every case the lowest, and that the result obtained by the modified method is in each case the highest, when compared with the results by the other methods on the same sample. That this difference represents an actual gain in accuracy for the modified method seems apparent when the work and results are carefully analyzed.

The manner in which the determination is made by the modified method when absolute accuracy is desired is as follows: The nitrometer shown in the illustration, Fig. 268, is filled to the top of the stem of the thistle tube with a saturated salt solution, which is drawn down to the bottom of the ungraduated arm by means of the outlet tube at the bottom after the stop-cock at the top has been closed; thus leaving the graduated arm full but under reduced pressure. The bottle containing the sample is weighed and then five cubic centimeters are withdrawn in a pipette and the bottle again weighed. This five c. c. portion is placed in the thistle tube, drawn down, and washed in with a few drops of alcohol. Then in succession ten cubic centimeters of a ten per cent solution of potassium iodide and ten cubic centimeters of a five per cent solution of sulphuric acid are introduced in a like manner, taking care that no air is accidentally drawn in during the process. In order to obtain all of the five c. c. portion of the sweet spirit of nitre which was drawn from the bottle the potassium iodide solution is allowed to run through the pipette and wash out into the nitrometer every trace of the sample. Nitrogen dioxide gas, NO, is immediately formed, and, by means of the outlet tube at the bottom, the salt solution is drawn down so that the level of the liquid in the ungraduated branch is kept below that in the graduated. The reaction is rapid for the first two or three minutes and then proceeds slowly for an indefinite period. The process should be allowed to continue for one hour with frequent shaking and the volume of the gas is then read with the liquid in the two tubes at the same level. This volume multiplied by 0.0030673, the product multiplied by 100, and then divided by the weight of the sample taken, gives the per cent of ethyl nitrite present after the result is corrected for temperature and pressure.

When the assay is carefully made by this method every trace of the weighed sample is used and there is no chance for the escape of gas. That the result is more accurate than that obtained by the U. S. P. method of 1890 is evident from the fact that the sample is accurately weighed. Different samples vary in specific gravity as shown in Table 26 and, therefore, if volume alone is considered, as in the old U. S. P. method, the result can not be absolutely correct unless by accident. It is of interest to compare the percentage of ethyl nitrite found when the weight obtained by difference, as above, is used as a basis and when the weight is calculated from the specific gravity.

In the 19 results thus compared in Table 26 three are alike, the greatest difference is 0.04 per cent, and the average difference is only 0.02 per cent.

If the modified method is more accurate than the old U. S. P. method a study of Table 26 will show that it is more accurate than the new U. S. P. method, of 1900, as this gives the lowest average results of either of the three. Compared with the old U. S. P. method the modified method gives results ranging higher from 0.03 per cent to 0.25 per cent. Compared with the new U. S. P. the modified method gives results ranging higher from 0.05 per cent to 0.47 per cent. Comparing the old and new U. S. P. methods it is found that in twenty cases the old method gives the highest results, the differences running from 0.02 per cent to 0.32 per cent; while in three cases the new method gives the highest, running however only from 0.01 per cent to 0.06 per cent.

The modified method gives uniform results when tried several times upon the same sample, while among the results obtained by the new U. S. P. method will often be found variations similar to that noted in Table 26 under sample number 10568, A and B. Compared with the new U. S. P. method the modified method is less expensive in both time and chemicals. In eliminating the shaking out with potassium bicarbonate no error is introduced because if absolute accuracy is required any free acid present may be washed into the nitrometer with alcohol before it comes in contact with any reagent; while on the other hand the process is simplified thus reducing the chance for error or loss. That the use of potassium bicarbonate does not make any appreciable difference is shown in Table 27 which gives the results on the same samples, using the modified method, both with and without the reagent in question. It will be noted that in two cases slightly higher results were obtained when using the bicarbonate while in two other cases the reverse was true. These differences, however, are so small that they might occur when the determinations were made as nearly alike as it is possible to duplicate, and indicate no advantage obtained by the use of potassium bicarbonate. In these cases the shaking out was done directly in the sample bottle after the first determination had been made.

TABLE 27.

Analysis of Sweet Spirit of Nitre With and Without the Use of Potassium Bicarbonate.

NUMBER.	ETHYL NITRITE FOUND. PER CENT.	
	Modified Method.	Modified Method Using KHCO3
10,495	3.48	3.40
10,510	2.68	2.70
10,563	2.96	3.03
10,579	4.46	4.44

The sentence quoted below from the Pharmacopoeia of 1900, and which appears also in the Schimpf Method, "when the volume of gas has become constant (within thirty to sixty minutes) note the volume of gas collected" would lead one unfamiliar with this reaction to suppose that the volume of gas did become constant within an hour. As a matter of fact it very seldom or never does. Experiments were made to determine, if possible, when the volume of gas did finally become constant and also to determine, if possible, a factor which might be applied to correct for the volume of gas generated after the one hour period. Determinations were allowed to run for various periods up to three days and at the end of this 72 hours the volume of gas was still increasing very slowly. In Table 28 the results of these observations are given. In the second column is given the corrected reading taken after the hour period had elapsed and upon which was calculated the assay of that particular sample. That the reaction was not complete, however, is shown by the series of second readings taken after periods ranging from 16 to 72 hours after the first reading. The differences between the two readings, while ranging from 0.2 to 2.2 cubic centimeters do not correspond to the differences in time. For example, one sample after standing 24 hours had increased 0.8 cubic centimeter, while another sample after standing for the same period had increased 2.0 cubic centimeters. One sample standing 72 hours increased 2.2 cubic centimeters, while another for the same period increased only 1.3 cubic centimeters. This increase seemed never the same in any two cases and varied at different times during the periods themselves. The rate of increase depends on so many different factors, such as strength of the sample, its age, the amount of water present, compounds which may have been formed by decomposition, and not only the temperature and pressure at the time of beginning the experiment, but the variations while the test is being made, that it is impossible to apply any corrections and the best that can be done is to establish some uniform rule in regard to the time. One hour was finally adopted and if the apparatus is shaken several times during the interval so that the reagents are thoroughly mixed, the gas generated in sixty minutes is near enough to the total amount for all practical purposes.

TABLE 28.

Variation in the Rate at Which Nitrogen Dioxide Gas is Liberated in the Analysis of Sweet Spirit of Nitre under Different Conditions.

Number.	Corrected Readings, c. c.		Time Elapsed—Hours.	Difference, c. c.	Temperature, Degrees C.	
	First.	Second.			First Reading.	Second Reading.
1	55.9	56.1	16	0.2	21.0	20.0
2	55.5	56.4	17	0.9	23.5	22.0
3	56.8	57.8	22	1.0	20.3	21.0
4	53.9	54.7	24	0.8	21.0	22.0
5	48.3	50.3	24	2.0	22.2	20.5
6	55.4	56.7	48	1.3	–	20.0
7	49.9	51.2	72	1.3	–	22.3
8	44.2	46.4	72	2.2	21.5	21.5

Summary.

In conclusion emphasis should be given to four points which may be summarized as follows:

1. When Sweet Spirit of Nitre is made from concentrated nitrous ether the product should be shaken for several minutes to insure thorough uniformity.

2. A sample of Sweet Spirit of Nitre kept strictly in accord with Pharmacopoeia directions remained constant in strength for 60 days and deteriorated but slightly during the next 30 days. Under unfavorable conditions decomposition of samples began at once and steadily continued.

3. The Modified Method of analysis, as described in detail, gives more accurate results than either the old or the new Pharmacopoeia methods, and compared with the latter is more economical in time and reagents and is easier of manipulation, with less chance for error. For a quick method when extreme accuracy is not required the old U. S. P. method (1890) gives approximately correct results.

4. When determining the ethyl nitrite in sweet spirit of nitre by the liberation of nitrogen dioxide the volume of gas does not become constant in "from thirty to sixty minutes" as published directions would lead one to suppose, but increases slowly, and at a varying rate, which is influenced by numerous different conditions, sometimes at least, for several days. For this reason it is not practicable to attempt to obtain an absolutely constant volume, nor to apply a factor to correct for these last traces of gas, and a one hour period for the reaction to take place, with frequent shaking, may be used with practically correct results.

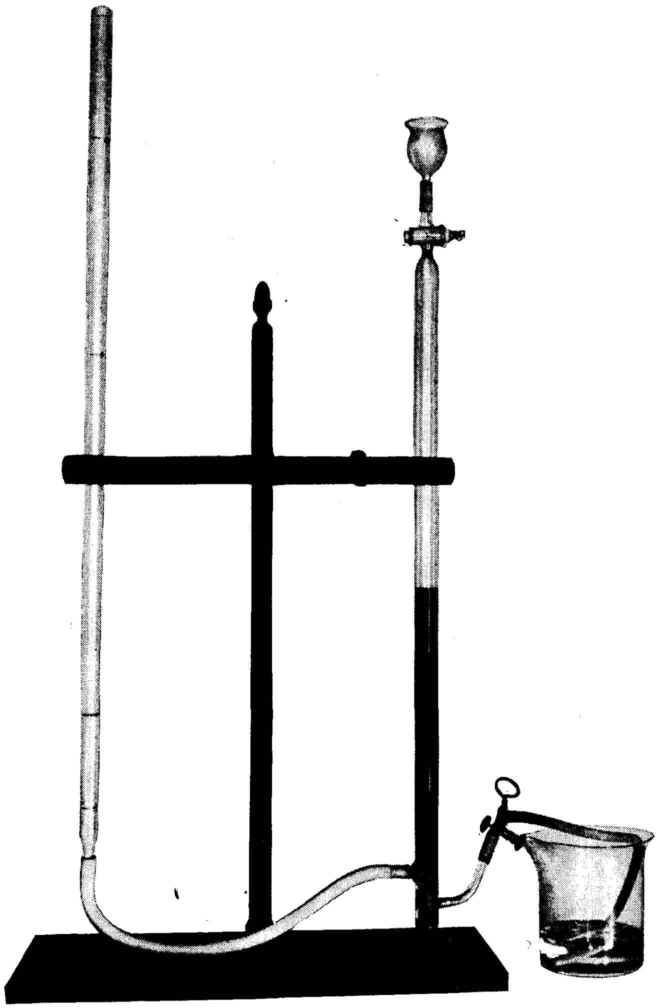

Fig. 268. Nitrometer used in assay of sweet spirit of nitre.

APHID PESTS OF MAINE.*

Edith M. Patch.

There are possibilities of control of certain species of plant lice or aphids by such methods as rotation of crops or the destruction of weeds which serve to maintain a species of aphids dangerous to neighboring crops; or the selection by the landscape gardener of ornamental shrubs and trees which are not susceptible to attacks of aphids common on native vegetation. In some cases circumventing the aphid by means of a knowledge of its food habits and migrations would be simpler and more effective than the direct methods of spraying which need to be repeated each year of attack.

The ornamental cut leaf maple, for example, can be made immune from attacks of the woolly aphid common on the leaves of this tree, by the destruction of neighboring alders on which the migrants develop, and infestations of some *Chermes* galls so troublesome to ornamental spruces could be escaped by omitting the alternate host from the immediate landscape.

But before advantage can be taken of these methods it is necessary to know the full food plant cycle. It happens of course that many species inhabiting plants of no economic value in themselves may be a distinct form of a species very injurious to a more valuable plant, and an economic review of even a local fauna can not omit the species from any native growth.

The importance of securing authentic food plant records for the large family of insects under consideration is emphasized by the fact that some species feed exclusively on a single or a few closely allied plants while other have so wide a range that it requires the collections of many years to include them all.

The reason for treating a local list of aphids with a view of the botanical sequence of the plants they infest is thus apparent

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* Papers from the Maine Agricultural Experiment Station: Entomology No. 53.

enough and needs no other explanation for the arrangement of the present paper. As a convenient bibliography, which at the same time throws into comparison collections from the same and related plants from other parts of the world, there is appended a host plant catalogue of the aphids of the world covering the corresponding group of plants.

The plant lice included in this paper are those infesting the Ferns, Conifers, and Monocotyledons.

Ferns.

But one species on ferns has as yet been chanced upon in the Maine collection and that is *Mastopoda pteridis* Oestlund, a peculiar species with atrophied tarsi taken on brake fern (*Pteris aquilina* L.) Aug. 6, 1906, near Orono. An account of this collection is given in Bulletin No. 182 of this Station.

Conifers.

Several genera of aphids occur upon Conifers in Maine and all are of economic importance. Of these *Mindarus abietinus* Koch is very troublesome upon the new tender growth of spruce and balsam fir in the spring of the year, producing a ruffled appearance of the needles on infested twigs. Accounts of this species are given in Bulletins 182 and 187.

Seven species of *Chermes* are injurious to spruces, pines and larches in Maine. *Chermes pinicorticis* Fitch has been dubbed "Pine blight" by virtue of the white secretions of a colony on the bark of infested pine, and is a serious enemy to young white pines both in nursery stock and in the open. *Chermes pinifoliae* Fitch (*abieticolens* Thomas) causes a cone shaped gall on black spruce, the migrants from which seek the white pine and deposit eggs upon the leaves so that the nymphs have the tender new growth of white pine to feed upon. They can be detected by the sickened appearance of the pine shoots and the flocculent secretion of the young *Chermes* when numerous. *Chermes abietis* Cholodkovsky inhabits the "pine-apple gall" of white and Norway spruces and is a common nuisance wherever these trees are used for ornamental purposes, for the affected branches become stunted and deformed. *Chermes lariciatus* Patch produces a "pine-apple gall" on white spruce very much like that of *abietis* though the needles are shorter and the gall has a general russet color. The migrants from this gall fly to the larch to deposit eggs and the young develop upon the larch. *Chermes consolidatus* Patch produces small pale pink or green galls on black spruce the migrants from which seek the larch as an alternate host. *Chermes floccus* Patch develops in galls on black and red spruce and migrates to the needles of the white pine to oviposit. Its food plants are thus the same as those of *pinifoliae* but both the galls and the insects are too distinct to be in any respect confused. *Chermes similis* Gillette, first described in Colorado, is found commonly on twigs of Norway, black, red, and white spruces in Maine, the infestation causing a scraggly appearance of the twig rather than a well defined gall. All these species are discussed and figured in Bulletin No. 173 of this Station.

There was also a collection of *Chermes* (No. 111-09) taken on fir (*A. balsamea* Mill) the trunk of which was covered with flocculent patches like those of *pinicorticis* on white pine. The collection comprised apterous females and their eggs and newly hatched nymphs, no winged forms being found.

The third group of coniferous aphids has not been previously worked up for Maine. These belong to the genus *Lachnus* and allied genera. To *Lachnus* belong the giants of the Maine aphids and the colonies are frequently exceedingly abundant at Orono. In June 1904 a whole hillside was covered with honeydew, the ground and the vegetation on it being sticky from the liquid dropped by *Lachnus* colonies feeding above. Much of this sweet liquid crystalized into whitish sugar so that the rocks in some places looked frosted. It was impossible to touch a branch without being heavily spattered with a shower of honeydew. Although these aphids have not been so plentiful any year since, they have been present each season on pine, larch, fir and the spruces.

Lachnus curvipes n. sp. Nos. 31-05; 92-08; 69-10. On *Abies balsamea* Mill. This distinctive species appears to be a not uncommon insect on the balsam fir in the vicinity of Orono.

Apterous oviparous female. Head dark brown or blackish. Antennæ yellowish brown hirsute. Prothorax black. Thorax black and slightly pulverulent. Legs with femora yellowish brown, tibiæ yellowish brown and distal tip black, tarsi black. 1st tibia straight and about 1.9 mm. long, 2nd tibia straight and about 2.25 mm long, 3rd tibia conspicuously bowed and about

4.2 mm long. Tarsus with first joint elongate (0.15 mm at longest dimension) subequal to half of second joint (0.15 mm) and claws measuring about 0.1 mm. Abdomen black, hirsute, and caudad of cornicles with short heavy white flocculency. Cornicles black and tuberculate.

This large form in life is conspicuous on account of the contrast of the dull black abdomen cephalad the cornicles and the flocculency, thick but not long, caudad the cornicles. They rest on four front legs and when disturbed wave the long bowed hind pair around in the air. They were abundant on branches of *Abies balsamea* Mill at Orono, Sept. 26, 1908 at which date many were in copulation. Specimens in the insectary deposited eggs on fir needles. The eggs are elongate, dark but covered with white pulverulency which gives them a gray appearance. They have a slight concavity on the side applied to the leaf.

Alate male. Head black, slightly pulverulent. Antennæ I, II, black; base of III pale, tip dusky; IV, V, VI dusky. III, IV, V and VI tuberculate with very numerous sensoria. Fig. 270. III 0.55 mm; IV 0.3 mm; V 0.425 mm; VI 0.225 mm. Total antennal length about 1.85 mm. Beak about 2.3 mm extending sometimes beyond caudal tip of abdomen. Prothorax and thorax black, slightly pulverulent. Wing 4.2 mm long. M and branches of M all very slender and delicate; the other three veins are very dark and heavy, stigma dense and dark. (Figs. 300 and 301) Legs with yellowish brown femora; tibiæ yellow at base, rest black; tarsi black, first joint elongate and subequal (at longest dimension) to half the second. Fig. 271. Abdomen black and slightly pulverulent, cornicles black and tuberculate. This form in life has a humpbacked appearance due to large thorax and relatively slender curving abdomen with convex dorsum and concave venter.

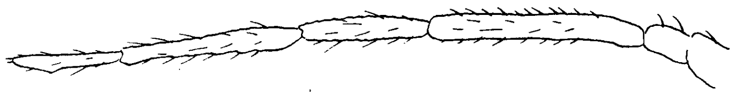


Fig. 269. *L. curvipes.* Antenna of male, showing relative length of joints.

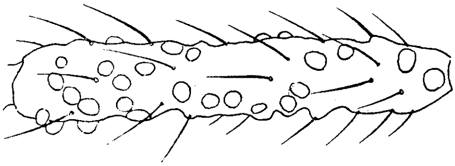


Fig. 270. Antennal joint IV of male, showing sensoria. Fig. 271 Tarsus of male.

Alate viviparous female. This form, together with nymphs, was collected at Orono, July 20, 1905, from *Abies balsamea.* The antennæ is about 2.15 mm total length; III 0.9 mm; IV 0.325 mm; V 0.45 mm; VI 0.25 mm. III with about 10 large sensoria; IV with 3 sensoria in a row; V with terminal sensorium and one other; VI with large sensoria in a group. The beak is about 2.53 mm long. The wing (Fig. 299) is about 5.75 mm long. The veins are heavy except M and branches which is very delicate as in the male.

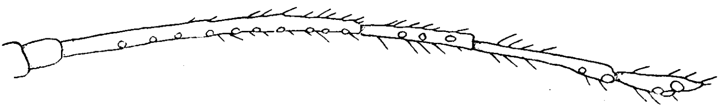
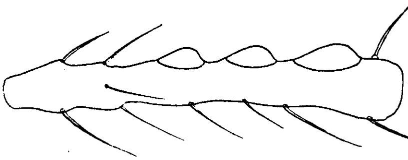
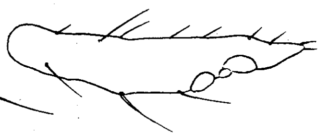


Fig. 272.





Figs. 272, 273 and 274. *L. curvipes.*. Antenna of alate viviparous female; and joints III and VI greatly enlarged.

Apterous viviparous female. A large colony of this form and nymphs was found on a young balsam fir about 1 1-2 inches in diameter. The size of the tree is given because this colony, unlike the others of this species collected at Orono, was on the trunk of the young tree one foot from the ground instead of the branches. The mature forms were dull black with dark reddish femora and black tibiæ. The newly dropped nymphs were pale red.

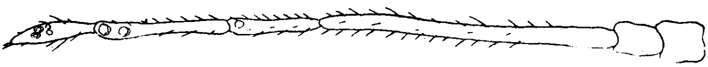


Fig. 275. *L. curvipes.* Antenna of apterous viviparous female.

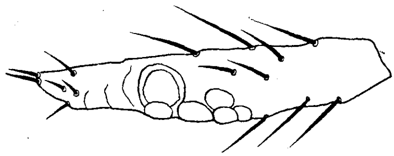


Fig. 276. Antennal joint VI of foregoing figure.

Lachnus laricifex Fitch. What is apparently this species of Fitch's is not uncommon on the larch (*L. laricina* Koch) in Maine. Packard (1890) quotes the original description and records scattered individuals from Augusta, Maine. No figures have been published for this larch aphid in America. Cholodkovsky (1899), however, figures a larch species, *maculosus* Cholodkovsky which is certainly closely allied to the Maine material and may perhaps be the same.

Apterous viviparous female. Head dark brown. Beak extends to about the middle of abdomen. Antennal total length about 1.3 mm. III 0.46 mm; IV 0.2 mm; V 0.26 mm; VI 0.17 mm; IV with one large circular sensorium at distal end; V with usual terminal sensorium and one other large circular sensorium near it; VI with group of sensoria. Prothorax and thorax dark brown with black markings. Head and thorax with white pulverulency both dorsally and ventrally. Femora dark, tibiæ pale proximal end, distal dark; hind tibia slightly bowed; tarsi black. Tarsus with first joint elongate and subequal (at longest dimension) to half the second joint; hind tarsus including claw about 0.5 mm; first joint 0.15 mm; second exclusive of claw 0.32 mm. Abdomen sparsely hirsute, dark brown and slightly pulverulent; there is a pale mid dorsal line, and the dorsum is decorated with black spots and dots, and dark transverse markings, cornicles dark. This form and nymphs common along small twigs and on leaf tufts of larch.

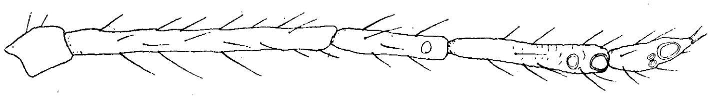


Fig. 277. *L. laricifex.* Antenna of apterous viviparous female.

Alate viviparous female. I have no color description of the winged form but the bodies in balsam accord with those of the apterous female. The wing is better characterized by the photograph, (Figs. 306 and 307), than by a description. The antennal measurements are,—I, 0.1 mm; II, 0.125 mm; III, 0.5 mm; IV, 0.225 mm; V, 0.29 mm; VI, 1.5 mm. III has a row of about 9 sensoria, IV has one near distal end, V has one besides the usual distal sensorium. (Fig. 278). Collection numbers 42-04; 9-05; 32-05; 3-08; 28-08; 27-09; 91-09; 55-10.

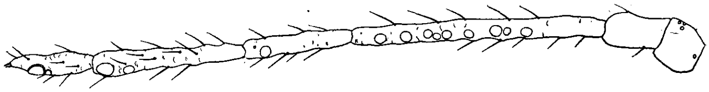


Fig. 278. *L. laricifex.* Antenna of alate viviparous female.

I have no authority for calling this species *laricifex* except that there is nothing in the description of Fitch or others to preclude its identity with that species, and the habitat and what habits are recorded for *laricifex* agree with this Maine species. There is, so far as I know, no authentic specimen of *laricifex* for comparison. This species is not so strongly hirsute as *curvipes,* and the hind tibia is relatively shorter and but weakly bowed. The tarsi of these two species are much alike.

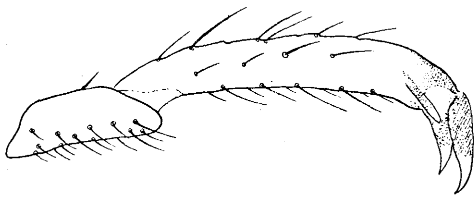


Fig. 279. *L. laricifex.* Tarsus.

Lachnus hyalinus Koch. A *Lachnus* common on Norway Spruce (*Picea abies*) is apparently *hyalinus* Koch. It falls to that species in the key of Cholodkovsky (1898, p. 48 (650)) and the most striking characters,—long fine hairs of entire body, the unusual flocculence of entire dorsum, and the double row of dark dorsal "dots" on abdomen of the Maine species are in accord with the descriptions of Koch, Buckton (for *macrocephalus*) and Cholodkovsky (1898). The Maine records for this species are given below.

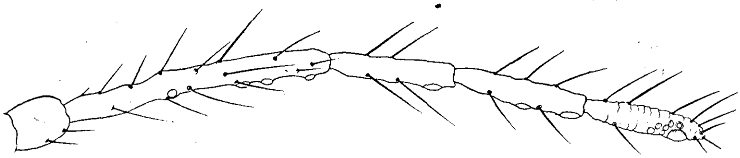


Fig. 280. *L. hyalinus.* Antenna of alate viviparous female.

Alate viviparous female. Head and thorax cinnamon brown. Dorsal lobes of thorax and ventral plate dark brown or black. Antennæ hirsute with segments measuring—I, 0.06 mm; II, 0.075 mm; III, 0.39 mm; IV, 0.16 mm; V, 0.2 mm; VI, 0.16 mm. III with about 4 sensoria in a row; IV with distal sensorium; V with 1 sensorium besides the usual distal one. (Fig. 280). Wings as shown in (Figs. 308 and 309). Legs hirsute. Tarsus with 1st joint not elongate, the longest dimension being 0.075 mm and 2nd joint exclusive of claw 0.36 mm. (Fig. 281). Abdomen hirsute, light brown,—paler than head and thorax. Cornicles tuberculate dark brown with varnished appearance. Body of recently molted individual is very densely flocculent being covered with white "wool" from head to tip of abdomen. The costal edge of the deflexed wings part this white substance on the abdomen so that there is a mid dorsal row of wool and two lateral rows, giving the body a three striped appearance. The flocculent matter rubs off from the older individuals so that they appear merely pulverulent. These were found on tender new growth of twig of *Picea abies* thickly packed among the new needles. This alate form was taken June 20, 1910; June 28, 1909; and July 12, 1906. *The pupa* is pulverulent and pale brown like the abdomen of the winged viviparous females. Cornicles darker than rest of abdomen. On dorsal abdomen 6 double rows of dark dots, (i. e. the wax pore plates), the 5th row being on a line with the cornicles.

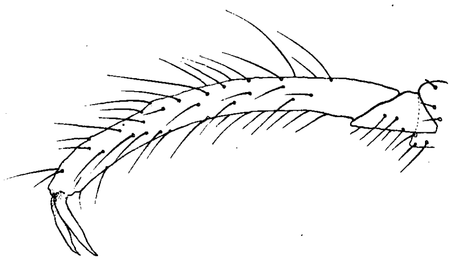


Fig. 281 *L. hyalinus.* Tarsus of alate viviparous female.

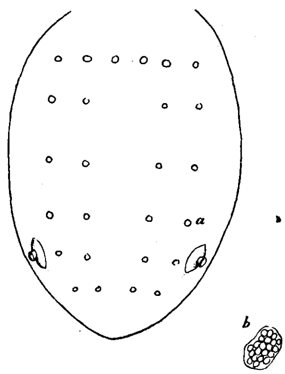


Fig. 282. *L. hyalinus.* Abdomen of apterous viviparous female, with wax-pore plates indicated.

Apterous viviparous female. Head and prothorax and abdomen medium brown, thorax and abdomen paler brown. Legs, antennæ and entire body hirsute. Abdomen pulverulent, and with longitudinal row of 2 black spots per segment on each side of dorso-mesal area, and two extra median ones on 1st abdominal segment. These are the wax-pore plates. See Fig. 282, *b* being an enlargement of area *a*. Cornicles dark brown. These are found thickly packed in new growth with beaks in twig of *Picea abies*. Collection Nos.—71-06; 36-09; 33-10. A small collection (33-11) of the same species was taken from *Picea canadensis* July 22, 1911.

Lachnus strobi Fitch. Since 1904 numerous collections of this species have been made in the vicinity of Orono where it is very common on the white pine. Weed (1890) describes and figures the true sexes of *strobi*. The following account will give the substance of the Maine records.

Apterous viviparous female. Entire body greenish black. Antennal measurements as follows: I, 0.08 mm; II, 0.06 mm; III, 0.32 mm; IV, 0.13 mm; V, 0.175 mm; VI, 0.16 mm. Except for a sensorium on V there are no sensoria on antenna other than the usual distal ones of V and VII. (Fig 283). Eyes prominent. Beak extends nearly to middle of the abdomen. Abdomen hirsute (hairs stiff), pulverulent on ventral surface. Cornicles black. The abdomen globular and glistening and bronzy.

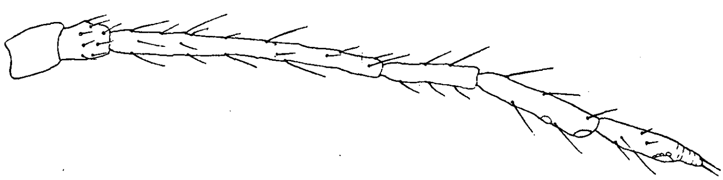


Fig. 283. *Lachnus strobi.* Antenna of apterous viviparous female.

Alate viviparous female. A dark brown nearly black *Lachnus* with a whitish pulverulency on ventral surface and a median whitish line, extending from front of head to cauda, which is interrupted in region of cornicles. The cornicles are black and situated in a black patch with a cephalad and caudad margin of white spots which are conspicuous. The white median line is sometimes broken into spots on the abdomen and sometimes rubbed off. The antennal measurements are I, 0.08 mm; II, 0.06 mm; III, 0.46 mm; IV, 0.17 mm; V, 0.2 mm; VI, 0.17 mm. III with about 10 sensoria in a row; IV with 2 sensoria; V with 1 besides the usual distal one. Fig. 284. The thoracic lobes are black. The wings with M very delicate and characterized as in Figs. 302 and 303. *Pupa* has same color markings as the alate female.

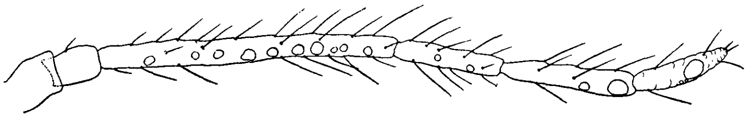


Fig. 284. *L. strobi.* Antenna of alate viviparous female.

The eggs of Lachnus strobi are very common on the white pine needles, where they occur in shining black rows. Those observed in 1908 hatched about the middle of May. Different collections of this species have contained individuals which varied much in size but the antennal measurements given will indicate relative proportions. Hairs of antennæ and legs are stiff.

Lachnus pini Weed. The oviparous female of a *Lachnus* on Scotch Pine was described and figured by Weed (1890) as *Lachnus pini* L. The apterous and alate viviparous females of apparently the same species is common on Scotch Pine about Orono. This species seems in accord with *Lachnus pineti* Koch as discussed and figured by Cholodkovsky (1898) and may prove to be that cosmopolitan species. For the present it seems sufficient to link it with the records given by Weed. Following is an account of the material taken in Maine.

Apterous viviparous female. Head, thorax and abdomen of about uniform color, varying shades of brown according to length of time from molt. Dorsal and lateral head, thorax and abdomen finely peppered with black dots. The whole insect covered with tawny hair. The antennæ with III pale, IV, V, VI darker to black. Measurements III, 0.625 mm; IV, 0.25 mm; V, 0.4 mm; VI, 0.23 mm. There are no sensoria except the usual distal ones of V and VI. The beak extends to middle of abdomen.

The abdomen is hirsute, sometimes cinnamon brown, sometimes reddish brown with a white pulverulency that gives a pinkish cast. There is less pulverulency at the caudal half and it is most conspicuous along the mid dorsal area. There are two longitudinal stripes of dark greenish bronze which sometimes appear as longitudinal rows of dark bronze green patches along the margin of the whitened mid dorsal area. The abdomens of the older individuals have very bronzy reflections. The cornicles are varnished brown in color. The cauda is ringed at base with black. This collection (47-09) was made June 30, 1909. The empty shells of the winter eggs from which they had hatched were still attached to the needles of the Scotch Pine. (*P. sylvestris*).

The newly dropped nymph is bright pale yellow on head and thorax and brownish yellow on abdomen. Antennæ and legs are pellucid white with yellow joints.

Alate viviparous female. This form was collected June 30, 1909, and June 20, 1910. In coloration they resemble the apterous form. The wings are shown in Figs. 304 and 305. The pulverulent dorso-mesal area is whiter and often appears as transverse bands of white. The antennal measurements are I, 0.1 mm; II, 0.1 mm; III, 0.55 mm; IV, 0.3 mm; V, 0.35 mm; VI, 0.225 mm. III has about 7 sensoria in a row. IV, 1 sensorium, V, 1 besides the usual distal one. Fig. 285.

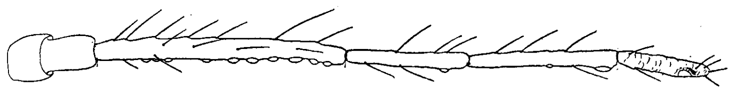


Fig. 285. *L. pini.* Antenna of alate viviparous female.

Essigella californicus Essig. An alert linear little species was taken from *Pinus strobus* June 30, 1909, at Stillwater, Maine (46-09). Mr. Essig's description of *californicus* which was received about that time showed so many resemblances to the Maine collection that Mr. Essig kindly sent me a good collection from California. The Maine material accords with that sent me from California.

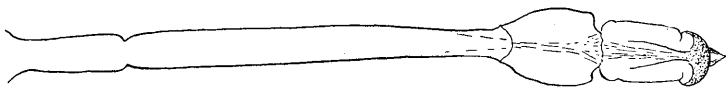


Fig. 286. *E. californicus.* Beak.

Winged viviparous form. Only one individual of this sort was obtained. Head light greenish brown with I and II of antennæ concolorous. III, IV, and V were each pale at proximal and dark at distal part. The antenna with but five joints and as figured by Essig. Eyes very red. Beak extends to caudal edge of dark brown heart-shaped plate of ventral thorax. Prothorax light greenish brown. Thorax green with lobes brown, and ventral plate dark brown, heart-shaped. Abdomen light but vivid green and thickly speckled with fine dark dots. This specimen was bred from pupal nymph collected June 30.

Pupa green with antennæ and legs with dusky tips. Antennæ with 5 joints, green at base but dusky over the rest. Beak extends to 3rd coxa. About 12 transverse rows of fine dots on abdomen arranged as follows: Alternate rows of 8 dots, the 2 lateral ones largest and alternate rows of 4 subequal dots.

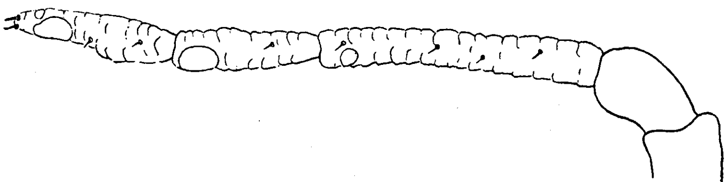


Fig. 287. *E. californicus.* Antenna of apterous viviparous female.

Apterous viviparous female. Color about as in pupa. Beak reaches 1st abdominal segment. The beak of apterous and alate forms is the same characteristic shape, shown in figure 286. The antennæ 5-jointed and usually with no sensoria, except the usual distal ones on the last and next to last joints. There was one exception in which III had a single large distal sensorium as shown in Fig. 287. The bases of the setal hairs on III and other segments frequently very distinct.

The eyes of the embryos are very red and give the abdomen of the viviparous forms a red spotted appearance.

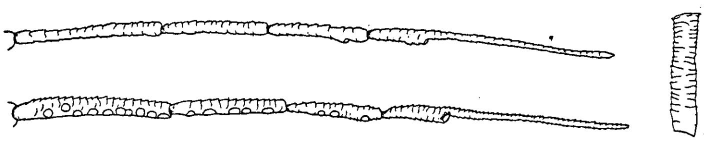
MONOCOTYLEDONS.

The species of aphids infesting the monocotyledonous plants of Maine include several widely distributed pests, among which are the especially troublesome European Grain Louse migrating from grains to apple, the corn leaf aphis, and the practically omnivorous *Myzus persicae.* Others no less interesting though of less economic significance occur as is recorded in the following discussion.

Aphis abbreviata n. sp. Some leaves of water plantain which were brought in for the sake of a large colony of *Rhopalosiphum nymphae* proved to be colonized also by a little pale green Aphis.

Alate viviparous female. Head and thorax black. Abdomen green. Antenna imbricated; III with from 8 to 12 large circular sensoria extending along the whole length, IV with 3 to 6 sensoria in a row, V with 2 or fewer sensoria besides the terminal one. Antennal total length about 1 mm; III, 0.22; IV, 0.175 mm; V, 0.125; VI, base 0.1 mm; spur, 0.25 mm. Prothoracic tubercles present. Wing about 2 mm long. Fig. 311. Cornicle imbricated, 0.2 mm; tarsus, 0.075 mm; cauda, 0.19 mm. Total body length about 1.25 mm. Figs. 289 and 290.

Apterous viviparous female. A pale green form. Antennæ imbricated. No sensoria except usual terminal ones of V and VI. Total antennal length about 1 mm. III, 0.2 mm; IV, 0.15 mm; V, 0.15 mm; VI base, 0.1 mm; spur, 0.26 mm. Fig. 288.



Figs. 288, 289, 290. *A. abbreviata.*

The pupæ of this collection were pale green with pale brown wing pads. The nymphs were pale green.

Cotypes collected on *Alisma Plantago-aquatica.* Sept. 14, 1910, at Orono, Maine, by W. C. Woods. No. 123-10.

Rhopalosiphum nymphaeae Linn. Several collections of this semi-aquatic species have been made at Orono from *Alisma Plantago-aquatica* by W. C. Woods. On July 14, 1909, No. 66-09 collection comprised apterous viviparous females, nymphs and pupæ from ventral leaf and crowded along blossom stalk. The big apterous viviparous females had very globular abdomens, dark olive green and mottled with greenish black. The collection 95-09 made July 20, 1909 contained alate as well as apterous viviparous females. Collection 122-10 taken Sept. 14, 1910, comprised alate and apterous viviparous females, nymphs and pupæ. These were all dark brownish green, the pupæ and apterous forms having a conspicuous white pulverulent bloom on ventral thorax. The alate viviparous form of this collection had a total body length of 2 mm and a wing 3.25 mm long, the cornicle was 0.425 mm long and the tarsus 0.150 mm. The cornicle (Fig. 291) is gently incrassate and the sparse and narrow imbrications have a fine saw-toothed edge. The prothoracic tubercle is distinct and two pairs of abdominal tubercles can be found as shown by Jackson (1908). The imbricated antenna of the alate viviparous female (Fig. 292) has a total length of about 1.75 mm. III is 0.4 mm with 17 more or less distinct but not very large sensoria. IV is 0.275 mm with 1 to 3 sensoria. V, 0.25 mm with usually no sensoria except the terminal one. For wing see Fig. 315.

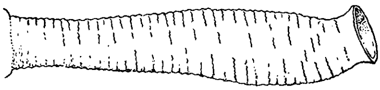


Fig. 291.

These Maine collections of this species accord for the most part with Jackson's drawings and account of *Aphis aquaticus* Jackson except that they run a little larger.

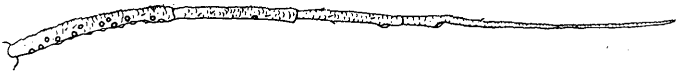


Fig. 292. *R. nymphaeae.* Antenna of alate viviparous female.

Siphocoryne avenae (Fab.) The European Grain Louse was abundant in the Station Insectary upon oats and barley the winter of 1909-1910. No. 1-10 was an Insectary collection, Jan. 5, 1910, comprising apterous and alate viviparous females and pupæ. This species also occurs in the apple in Maine. Fig. 310 gives a photograph of the wing. Sanderson (1901b 13th Ann. Rept. Delaware Col. Agr. Exp. Sta.) and Pergande (1904a Bul. 44 Div. of Ent., U. S. Dept. of Agr.) give figures, descriptions and discussions of this species which characterize it so well that further description is unnecessary here.

Collection 120-10 from leaf blades of cultivated corn at Orono, Maine, Sept. 14, 1910, comprised apterous and alate viviparous females, nymphs and pupæ of this species. *Avenae* has sometimes considerably affected the wheat crops of Illinois, Minnesota and other wheat growing localities. It has been considered in Canada one of the chief insect enemies of the wheat. Concerning the habits of this species Thomas in his Third Report (1879 p. 53) says "When the winter wheat appears above the ground in the fall, it passes from its hiding place at this time, wherever that may be, probably in the same way that it does from the winter wheat to the spring wheat and oats in the spring, that is by the winged individuals.

"Here they work upon the leaves and stalks singly, while the weather is not too cold, but when winter appears they move down towards the ground, some of them at least, entering the soil and feeding upon the sap of the roots. At any rate, I find the apterous ones at this time working upon the roots, but at the same time I find a winged individual above ground. I have also observed them heretofore at the root of the wheat, late in the winter, while snow was on the ground; and what somewhat surprised me, I found them busy at work under the snow, and the apterous females bearing well formed larvæ. I am, therefore, led to believe that in this latitude the species passes the winter in other than the egg state. This will also, probably, be found true wherever winter wheat is grown."

Aphis maidis Fitch. A badly infested lot of blades were sent to the Station from Cumberland Mills, Maine, Sept. 7, 1908, with the comment that the aphids were covering "every stalk of Kaffir, Broom Corn and Sugar Cane. Very few on other corn." This collection (75-08) comprised both apterous and alate viviparous females and nymphs on Sugar Cane (*Saccharum officinarum*).

A large collection (107-06) of this corn leaf aphis was made at Orono from field corn (*Zea Mays*) Aug. 30, 1906. Concerning this species Mr. Davis (Tech. Ser. No. 12, Part VIII, Bur. of Ent. p. 140) states "*Aphis maidis* has always been considered more or less injurious to corn, sorghum, and broom corn, although it seldom becomes seriously so. In some cases, however, it injures the corn ears by sucking the sap from the silk and killing it, thus preventing fertilization of the kernels. Only rarely, however, does it stunt the growth of the plant, at least in Illinois, the reason probably being that in this State the aphid does not commence its attacks upon the plant until the last part of June or the first of July, at which time the plant is strong enough to withstand the drain made upon its sap supply by the aphis. This aphis sometimes does considerable injury to the quality of the brush of broom corn by discoloring it, the discoloration being 'due to a bacterial affection following upon the plant-louse punctures' (Forbes).

"This aphis has a very wide distribution, being found in all parts of the United States where corn is grown; that is, from Maine to California and Texas. Prof. F. M. Webster has reported finding it on sorghum in Australia, where, he says, it is sometimes quite obnoxious, and in a recent circular he says that 'the insect is also known from Japan.'"

Myzus persicae Sulzer. On Dec. 6, 1911, a chrysanthemum heavily infested with this species of aphid was brought into the Station Insectary. Migrants from this colonized both young apple trees and sweet corn, abundantly accepting both for the winter months. This species has been so admirably figured by Miss Palmer (Gillette and Taylor 1908) that the Maine collections need no further illustrations for identification. Probably no aphid has a wider range of food plants than *persicae* and it is often a very serious pest.

Sipha glyceriae (Kaltenbach) Pass. The collection (29-08) of this remarkable aphid on rushes, *Juncus* sp., in Maine has been figured and discussed previously in Bulletin No. 182 of this Station.

Neoprociphilus attenuatus (Osborn and Sirrine). A collection (58-05) from *Smilax herbacea* made at Levant, Maine, Aug. 26, 1905, comprised winged and apterous viviparous females, nymphs and apterous oviparous females. This material was determined by Mr. Pergande as *Pemphigus attenuatus* and accords with the general account given by Osborn and Sirrine (1893). There are discrepancies in the measurements—that for joint I of the antennæ of the alate viviaprous form should probably read .05 mm instead of .5 mm as printed in Insect Life and quoted by Jackson (1908).

A second collection (121-09) was made from *Smilax* near Orono, Sept. 23, 1909. It is with some misgivings that I erect a genus for this single species. Of the five genera of the Tribe Pemphigina recognized by Tullgren (1909) *attenuatus* falls nearest to *Prociphilus* Koch but the antennal secondary sensoria would exclude it from that genus. I lack at present material suitable for an adequate study of the wax-pores; and the stem-mother from which Tullgren deduces certain generic characters, I have not collected.

The fact that this is the only example of the Pemphigina which has been recorded for the Liliaceae lends strength to a generic separation of the insect and a more detailed study of the species will doubtless show more accurately its affinities and distinctive characters.

Neoprociphilus, new genus. Alate viviparous female with the sensoria of III, IV and V broadly eliptical in shape. VI long with very short spur. Wings extending far beyond the stigma and Rs very long and only slightly curved, M is not branched. Young nymphs with 5-jointed antenna and large wax-pore plates on head, thorax and abdomen. Minute oviparous female beakless and with a 5-jointed antenna. Type: *Pemphigus attenuatus* Osborn and Sirrine.

Neoprociphilus attenuatus. This species appears to be more generalized than other known Pemphigina by virtue of the broadly elliptical sensoria of the antenna.

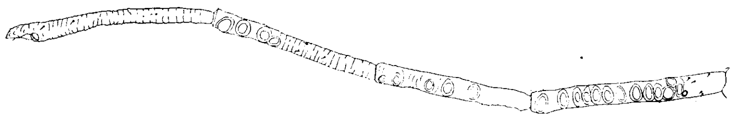


Fig. 293. *Neoprociphilus attenuatus.* Antenna of alate viviparous female.

The alate viviparous female with the antennal joints measuring about: I, 0.15 mm; II, 0.22 mm; III, 0.6 mm; IV, 0.5 mm; V, 0.55 mm; VI, 0.68 mm including spur which extends only about 0.08 mm. III, IV, V and VI being approximately subequal; and II subequal to 1-2 III. III with about 14 large broadly eliptical sensoria in a row on one side of segment and extending the whole length of segment except basal 1-4; IV with 4 or 5 similar sensoria on distal 2-3; V with 4 large sensoria on distal 1-2. V and VI with dentate imbrications. Body length about 3 mm and wing expanse about 10 mm. Wings are shown in Fig. 314.

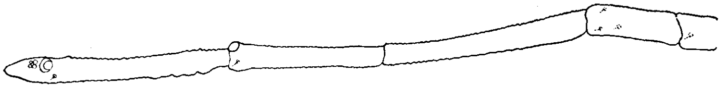


Fig. 294. *N. attenuatus.* Antenna of nymph.

Osborn and Sirrine give brief description of nymphs under caption "Apterous males or larvæ(?)" The stout beak extending nearly to tip of abdomen clearly indicates the nymph rather than one of the true sexes. The young nymphs are linear and well supplied with large wax-pore plates on head, (Fig. 295) thorax and abdomen. They have a 5-jointed antennæ.

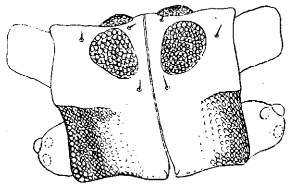


Fig. 295.

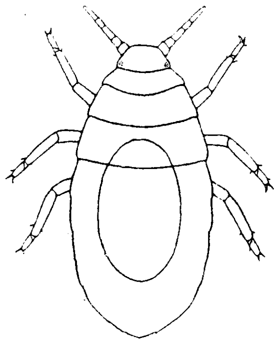


Fig. 296.

Fig. 297.

Oviparous female. This yellowish form is about 1.4 mm in length. It is beakless and the antenna is 5-jointed. Fig. 296.

Apterous viviparous female. Large dark form about 4.6 mm in length, and as woolly as *Pemphigus tessellata.* Antennæ with I subequal to 1-2 II; II subequal to 1-2 III; III, IV, V, VI approximately subequal.

Aphis gladioli Felt. Collection 84a-08 made from stalk of *Gladiolus* Orono, Sept. 15, 1908, comprised alate viviparous females of this species which accords in every detail with named examples of *gladioli* Felt given me by Dr. E. P. Felt.

Concerning the life history of this species Dr. Felt says (24th Report of the New York State Entomologist); "Gladioli bulbs are kept by growers in large ware houses, the temperature being maintained at about 40 degrees throughout the winter. This insect is evidently unable to breed under these conditions. As spring advances and the house begins to warm up in March, the aphids appear in large numbers, reproducing so abundantly that the window frames and sills may become literally covered with wings and bodies of plant lice. It is comparatively easy, in a badly infested house, to sweep up a gill of wings and exuviæ from under one window. This plant louse multiplies freely upon the bulbs, usually being massed around the origin of the roots and sometimes nearly covering the entire under surface. Breeding evidently continues from some time in March until July, with the production of numerous winged individuals the latter part of July, at least in the case of bulbs submitted for examination, though winged females undoubtedly occur earlier in the season under warehouse conditions. By

July 28 winged females had entirely disappeared in our breeding cages, though young were still numerous on the bulbs; later, all disappeared. An investigation about the middle of August resulted in finding no living aphids in the storage warehouse or upon the plants in the field. It is stated that when digging in October a few plant lice may be found upon the bulbs. These evidently remain in a dormant condition till the house warms up in the spring as described above."

Aphis rumicis Linn. Collection 84-08 made from stalk of *Gladiolus* Orono, Sept. 15, 1908, comprised apterous and alate viviparous females and pupæ of this general feeder. It can be distinguished from *gladioli* which is apparently closely allied by the following structural differences. *Rumicis* is a much larger species and the lateral tubercle of prothorax, and first abdominal segment (Fig. 297) and the lateral one between cornicle and cauda, are very large and pronounced, while in *gladioli* these are relatively small though distinct. The cornicle and antennæ of *rumicis* are figured by Gillette (1910, p. 406) and accord in essentials with those from the *Gladiolus* though Fig. 298 is given for the slight variation. It will be noticed that while basal VI of *gladioli* is nearly subequal to V and IV+V are shorter than III, neither being equal to 1-2 III; in *rumicis* basal VI is subequal to 1-2 V and IV+V are longer than III, each being longer than 1-2 III. III and IV in *gladioli* both bear more sensoria than *rumicis*. Figs. 312-313 give the wing of this collection. The following notes on *rumicis* (84-08) from *Gladiolus* are copied from my record sheets:

Alate viviparous female. Head black, antennal measurements—I, 0.1 mm; II, 0.1 mm; III, 0.35 mm; IV, 0.2 mm; V. 0.225 mm; VI, base 0.13 mm; spur, 0.35 mm. III with about 18 large sensoria, IV with 3 or less and V with none except distal one. The prothorax is shiny black with very prominent lateral tubercle. Thorax shiny black, veins of wings dark and slender. Abdomen blackish green with black intersegmental lines, and with irregular large black lateral spots on 2nd, 3rd and 4th segments; 1st with large lateral tubercle like that of prothorax and a similar one between cornicle and cauda. Cornicles black and shaped as in Gillette's figure (1910, p. 406). Cauda black at tip, base greenish brown. Wings are shown in Figs. 312 and 313.

Apterous viviparous female. Head, thorax and abdomen black. Abdomen with white transverse pulverulent dorsal patches,—a pair to each of 3 or 4 segments. Cauda black at tip, brown at base. Cornicles black.

Pupæ. Head and prothorax black,—lateral tubercles present. Thorax pale to dusky. Abdomen black with white pulverulent transverse dorsal patches,—about 3 pairs cephalad cornicles and 2 lines caudad cornicles.

Structurally *Aphis cookii* Essig (Essig 1911c) comes very close to this species.

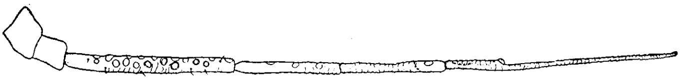


Fig. 298. *A. rumicis.* Antenna of alate viviparous female.

Macrosiphum solanifolii Ashmead. Collection 85-08 taken at Orono, Sept. 5, 1908, from stalk of *Gladiolus* comprised alate and apterous females which I am unable to separate from *solanifolii* from potato and take to be the same species. Collection 20-05 taken from cultivated *Iris* July 6, 1905 contained apterous females and nymphs of this species. Bulletins No. 147 and No. 190 of this Station are devoted to *solanifolii,* a species frequently troublesome in the large potato fields of Maine and in certain localities in Canada.

Explanation of Aphid Wing Plate.

Fig. 299 Lachnus curvipes, alate viviparous female; Figs. 300 and 301, L. curvipes, male; Figs. 302 and 303 L. strobi; Figs. 304 and 305 L. pini; Figs. 306 and 307 L. laricifex; Figs. 308 and 309 L. hyalinus; Fig. 310 Siphocoryne avenæ; Fig. 311 Aphis abbreviata; Figs. 312 and 313 A. rumicis; Fig. 314 Neoprociphilus attenuatus; Fig. 315 Rhopalosiphum nymphæ.

FOOD PLANT CATALOGUE OF THE APHIDAE OF THE WORLD.

PART I.*

(A Bibliographical Appendix to Aphid Pests of Maine.)

EDITH M. PATCH.

This catalogue aims to be a host plant bibliography rather than an Aphid bibliography. It maintains a systematic sequence of the families of host plants, but it is neither systematic nor critical from the aphid standpoint. It does not reflect the opinion of the compiler as to the validity of any aphid species; it merely selects such references as appealed to her as initially desirable in case a given species is to be worked up systematically or monographically. By "initially desirable" is not necessarily meant the best descriptions. In many cases it includes references to these; in many, however, it includes references to apparent contradictions and confused situations.

The synonomies given are those recorded by the publication quoted whether written in 1912 or one hundred years ago, but no attempt has been made to give the complete synomony and the original sources must be consulted for this. It would be a mistake for any one to expect more of this List than a record of what species of aphid have been *reported* on each species of plant with reference to the authority for the statement,—for that is all the List aims to do. Whether either the aphid or the plant is correctly determined or not has been no concern of the compiler. For it is the purpose of the catalogue to reflect the recorded condition of things, to show up the confusion and involved synonymy, and to expose the tangle which must be left to the monographing systematist to clear up.

EUMYCETES.

FUNGUS.

F. sp.

Schizoneura corni Fab. Williams, 1891, p. 11.
Schizoneura fungicola (Walsh). Thomas, 1879, p. 141.
Toxoptera graminum Rondani. Hunter, 1909, p. 103.

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* Papers from the Maine Agricultural Experiment Station: Entomology No. 54.

POLYPODIACEAE. FERN FAMILY.

ACROSTICHUM.

A. reticulatum Kaufl.
Idiopterus nephrelepidis Davis. Essig, 1911b, p. 541.
Macrosiphum kirkaldyi. Fullaway, 1909, p. 23.

ADIANTUM. Maidenhair.

A. pedatum L.
Aphis adianti Oestlund. Oestlund, 1887, p. 66.

CYSTOPTERIS. Bladder Fern.

C. montana (Lam.) Bernh.
Amphorophora ampullata Buckton. Lichtenstein, La Flore.
Rhopalosiphum staphyleae Koch? Buckton, 1, p. 188.

NEPHROLEPIS.

N. exaltata. Sword-fern.
Idiopterus nephrelepidis Davis. Davis, 1909c, p. 199. Essig, 1911b, p. 541.

ONOCLEA.

O. struthiopteris L. Ostrich Fern.
Rhopalosiphum ampullata (Buckton). Oestlund, 1887, p. 77.

PTERIS. Brake.

P. aquilina L. Common Brake.
Aphis (*Adactynus*) *pteris-aquilinoides* Rafinesque. Rafinesque, 1817.
Mastopoda pteridis Oestlund. Oestlund, 1887, p. 49.
Mastopoda pteridis Oestlund. Patch, 1910b, p. 246.

MARSILEACEAE.

MARSILEA.

M. quadrifolia L.
Rhopalosiphum nymphaeae (Linn.) Koch (A. butomi Schrank) (R. najadum Koch). Passerini, 1863, p. 21.

M. vestita Hook and Grey.
Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 36.

SALVINIACEAE.

SALVINIA.

S. natans L.
Rhopalosiphum nymphaeae (Linn) Koch (A. butomi Schrank) (R. najadum Koch). Passerini, 1863, p. 21.

PINACEAE. PINE FAMILY.

ABIES. Fir.

A. balsamea Mill. Balsam or Balm-of-Gilead Fir.
Aphrastasia pectinatae (Chol.) CB. (Chermes pectinatae Chol. 1888) (coccineus Chol. 1889 nec. Ratz 1843) (Dreyfusia pectinatae Chol. CB 1907-08). Börner, 1908a, p. 211. Börner, 1909a, p. 502.
Chermes coccineus Chol. Cholodkovsky, 1907, p. 22.
Chermes sp. Patch, 1912c.
Lachnus curvipes Patch. Patch 1912c.
Mindarus abietinus Koch. Nüsslin, 1910, p. 408.
Mindarus abietinus Koch (? Schizoneura obliqua Chol.) Tullgren, 1909, p. 61.
Mindarus abietinus Koch. Patch, 1910b, p. 243.
Pemphigus poschingeri Holzner. Zoölogical Record, 1874, p. 486.

A. concolor Lindl.
Lachnus abietis Fitch. Davidson, 1909, p. 299.
Mindarus abietinus Koch (? Schizoneura obliqua Chol.) Tullgren, 1909, p. 61.

A. fraseri Lindl.
Pemphigus poschingeri Holzner. Zoölogical Record, 1874, p. 486.

A. grandis Lindl.
Lachnus occidentalis Davidson. Davidson, 1909, p. 300.

A. nobilis Lindl.
Chermes piceae Ratz. Cholodkovsky, 1907, p. 27.
Dreyfusia nüsslini CB. (Chermes funitectus Chldk. 1907 nec Dreyfus 1888) (nordmannianae Eckstein 1890) (? obtectus Ratz. 1844) (piceae Nüsslin, and CB 1908). Börner, 1908b, p. 742.
Dreyfusia piceae Ratz. (Chermes piceae Dreyfus 1888, Nüsslin a. p.) (var. bouvieri Chldk 1903). Börner, 1908b, p. 745.

A. Nordmanniana Spach.
Chermes piceae Ratz "provisionally determined." Felt, 1910, p. 343.
Dreyfusia nüsslini CB. (Chermes funitectus Chldk. 1907 nec Dreyfus 1888) (nordmannianae Eckstein 1890) (? obtectus Ratz 1844) (piceae Nüsslin, and CB 1908). Börner, 1908b, p. 742.
Dreyfusia piceae Ratz. (Chermes piceae Dreyfus 1888, Nüsslin a. p.) (var. bouvieri Chldk 1903). Börner, 1908b, p. 745.
Mindarus abietinus Koch. Nüsslin, 1910, p. 408.

A. pectinata DC.
Chermes piceae Ratz. Cholodkovsky, 1907, p. 26.
Dreyfusia nüsslini CB. (Chermes funitectus Chldk. 1907 nec. Dreyfus 1888) (nordmannianae Eckstein 1890) (? obtectus Ratz, 1844). (piceae Nüsslin, and CB, 1908). Börner, 1908b, p. 742.

Dreyfusia piceae Ratz. (Chermes piceae Dreyfus 1888, Nüsslin a. p.) (var. bouvieri Chldk. 1903). Börner, 1908b, p. 745.
Lachnus pichtae Mordwilko. Mordwilko, 1899, p. 407.

A. sibirica Ledeb.
Aphrastasia pectinatae (Chol.) CB (Chermes pectinatae Chol. 1888) (Coccineus Chol. 1889 nec. Ratz 1843) (Dreyfusia pectinatae (Chol) CB. 1907-08). Börner, 1908a, p. 211. Börner, 1909, p. 502.
Chermes coccineus Chol. Cholodkovsky, 1907, p. 22.
Lachnus abieticola Chol. Cholodkovsky, 1899, p. 470.
Mindarus abietinus Koch. Nüsslin, 1910, p. 408.

A. Webbiana Lindl.
Chermes himalayensis Stebbing. (Ch. abietis Buckton Ind. Mus. Not. 3, pp. 5, 54.) (Ch. abietis-piceae Stebbing) Stebbing, 1910, p. 99.
Dreyfusia abietis-piceae Stebbing. Börner, 1908a, p. 211.

A. sp.
Prociphilus bumeliae Schrank. (poschingeri Holzner in part) "auf der Edeltanne." Nüsslin, 1910a, p. 294.
Prociphilus nidificus Löw. (poschingeri Holzner in part) Nüsslin, 1910a, p. 293.
Schizoneura costata Hartig. Hartig, 1841, p. 367. "auf der Rothtanne."

CEDRUS.

C. Libani Barrel. (Larix Cedrus).
Aphis sejuncta Walker. Walker, 1848c, p. 2247.

CRYPTOMERIA.

C. sp.
Lachnus greeni Schouteden. Schouteden, 1905, p. 184.

CUPRESSUS.

C. sempervirens L.
Lachnus cupressi Buckton. Cholodkovsky, 1910, p. 148.

JUNIPERUS. Juniper.

J. communis L. Common Juniper.
Aphis incerta Walker. Walker, 1849c, p. 45.
Aphis indecisa Walker. Walker, 1849c, p. 45.
Lachnus juniperi (Fab.). Buckton, 3, p. 45.
Lachnus juniperi (DeGeer) Kalt. Passerini, 1863, p. 65.
Lachnus juniperinus Mordwilko. Mordwilko, 1899, p. 407.

LARIX. Larch.

L. europaea DC. (L. decidua). (Pinus Larix). (L. communis).
Anisophleba hamadryas Koch. Kaltenbach, 1874, p. 702, and Koch, p. 320.

Aphis laricis Walker. Kaltenbach, 1874, p. 703.
Aphis tenuior Walker. Walker, 1849c, p. 49.
Chermes abietis L. Dreyfus. (geniculatus Ratz. 1843) (lapponicus Chldk. 1889) (laricis Hartig 1837) (pini, piceae Gleditsch 1774) (strobilobius Blochmann 1887) (viridis Chldk. 1895). Börner, 1908a, p. 207.
Chermes laricis Hartig. Buckton 4, p. 34.
Cholodkovskya viridana (Chol.) CB. (Chermes viridanus Chldk. 1896) (? Pineus viridanus CB. 1907-08). Börner, 1909a, p. 499.
? *Cnaphalodes affinis* Börner. Börner, 1908a, p. 211.
Cnaphalodes lapponicus (Chol.) (Chermes). Börner, 1909a, p. 555.
Cnaphalodes strobilobius (Kalt) CB. (laricis Vallot 1836) (hamadryas Koch 1857) (abietis L. 1761) (atratus Buckton 1883) (coccineus Ratz 1843) (geniculatus Ratz 1843) (lapponicus Chldk 1889 var. praecox Chldk. 1894 var. tardus Chldk. 1895) (lariceti Altum 1889) (pini, piceae et abietis Gleditsch 1774) Börner, 1908a, p. 208.
Lachnus maculosus Cholodkovsky. Schouteden, 1906a, p. 204.
Lachnus pinicolus Kalt. Buckton, 3, p. 53.
Pineus (?) *viridanus* (Chldk.) CB. (? orientalis Chldk 1904). Börner 1908a, p. 208.

L. laricina Koch. (americana). American Larch, Tamarack, Hackmatack.
Chermes consolidatus Patch. Patch, 1909d, p. 307.
Chermes laricialus Patch. Patch, 1909d, p. 307.
Chermes laricifoliae Fitch. Patch, 1909d, p. 296.
Lachnus laricifex Fitch. Oestlund, 1887, p. 32. Patch, 1912c.

L. sibirica Ledeb.
Chermes viridulus Cholodkovsky. Cholodkovsky, 1911, p. 175.
Lachnus maculosus Cholodkovsky. Cholodkovsky, 1899. p. 469.

L. sp.
Anisophleba hamadryas Koch. Koch, p. 320.
Chermes strobilobius Kalt. Cholodkovsky, 1907, p. 13. (var. tardoides Chd.) Cholodkovsky, 1911, pp. 174, 175.
Chermes viridanus Chol. Cholodkovsky, 1907, p. 19.
Chermes viridis Ratz (laricis Hartig). Cholodkovsky, 1907, p. 7.
Lachnus laricis Koch. Koch, p. 242.
Periphyllus laricae Haliday. Zoölogical Record, 1868, p. 416.

PICEA. Spruce.

P. Abies (L.) Karst, (excelsa Link) (Pinus abies) (Abies excelsa) (Abies picea) Norway Spruce.
Aphis abietaria Walker. Walker, 1852, p. 1035. (Host not recorded. Name indicates same host as *abietis* Walker.)
Aphis abietina Walker. Buckton, 2, p. 44. Walker, 1849a, p. 301. Theobald, 1911-12.

Aphis abietis Walker. Walker, 1848b, p. 100.
Aphrastasia pectinatae (Chol.) CB. (Chermes pectinatae Chol. 1888) (coccineus Chol. 1889 nec Ratz 1843) (Dreyfusia pectinatae (Chol.) CB 1907-08) Börner, 1908a, p. 211. Börner, 1909, p. 502.
Chermes abietis L. Dreyfus (geniculatus Ratz 1843) (lapponicus Chldk. 1889) (laricis Hartig 1837) (pini, piceae Gleditsch 1774) (strobilobius Blochmann 1887) (viridis Chldk. 1895) ("Picea excelsa u s w."). Börner, 1908a, p. 211.
Chermes abietis Cholodkovsky. Patch, 1909d, p. 307.
Chermes-Dreyfusia funitectus Dreyfus (nec Chldk. 1907) Börner, 1908a, p. 207.
(?) *Chermes-Dreyfusia piceae* Ratz. (funitectus Chldk. nec Dreyfus) (nordmannianae Eckstein) (piceae var bouvieri Chldk.) (? obtectus Ratz). Börner, 1908a, p. 211.
Chermes similis Gillette. Patch, 1909d, p. 307.
Cnaphalodes affinis CB. Börner, 1908a, p. 211.
Cnaphalodes strobilobius (Kalt.) CB. (laricis Vallot 1836) (hamadryas Koch. 1857) (abietis L. 1761) (atratus Buckton, 1883) (coccineus Ratz 1843) (geniculatus Ratz 1843) (lapponicus Chldk. 1889, var. praecox Chldk. 1894, var. tardus Chldk. 1895) (lariceti Altum 1889) (pini, piceae et abietis Gleditsch 1774) Börner, 1908a, p. 167.
Lachnus bogdanowi Mordwilko. Mordwilko, 1899, p. 404.
Lachnus fasciatus (farinosus Cholodk.) Mordwilko, 1899, p. 404.
Lachnus fasciatus Burm. (A. costata Zetterstedt?). Kaltenbach, 1843, p. 160.
Lachnus flavus Mordwilko. Mordwilko, 1899, p. 404.
Lachnus grossus Kaltenbach. Mordwilko, 1899, p. 405.
Lachnus hyalinus Koch. Patch, 1912c.
Lachnus macrocephalus Buckton. (hyalinus Koch?). Buckton, 3, p. 50.
Lachnus piceae Walk. (L. grossus Kalt.) (A. piceae Panzer). Buckton, 3, p. 58.
Lachnus piceae (Walker). Mordwilko, 1899, p. 405.
Lachnus piceicola Cholodk. Mordwilko, 1899, p. 406.
Lachnus piceicola Cholodkovsky. Schouteden 1906a, p. 207.
Lachnus pinicola (Walker) Kalt. (piniphila Ratz) Passerini, 1863, p. 65.
Lachnus pinicola (hyalinus Koch and Cholodk.). Mordwilko, 1899, p. 405.
Lachnus pinicola Kalt. Kaltenbach, 1843, p. 155.
Lachnus roboris (Linn) (L. fasciatus Burm.) (Cinara roboris Curtis). Kaltenbach, 1843, p. 149. (See also Buckton 3, p. 73.)

Lachnus viridescens Cholodkovsky. Schouteden, 1906a, p. 217.
Myzus abietinus Walker. Mordwilko, 1899, p. 404.
Pineus pini (L. Macqu.) CB. (Anisophleba pini Koch 1857) (? Chermes obtectus Ratz 1844) (orientalis Dreyfus 1888). Börner, 1908a, p. 211.
Pineus sibiricus (Chldk.) CB. (Chermes cembrae Chldk. 1888) Börner, 1908a, p. 211.
Pineus strobi var. pineoides (Chldk.) CB. Börner, 1908a, p. 187.
Pineus? viridanus (Chldk). ("? Picea excelsa") Börner, 1908a, p. 211.

P. canadensis (Mill.) B. S. P. (alba Link). White or Cat Spruce.
Chermes abietis Chol. Patch, 1909d, p. 307.
Chermes lariciatus Patch. Patch, 1909d, p. 307.
Chermes similis Gillette. Patch, 1909d, p. 307.
Cnaphalodes strobilobius (Kalt.) Börner, 1908a, p. 210.
Lachnus abietis Fitch. Williams, 1891, p. 24.
Mindarus abietinus Koch. Patch, 1909d, p. 243.
Mindarus obliquus Chol. Nüsslin, 1910, p. 408.
Pineus strobi (Htg.). ("? Picea alba") Börner, 1908a, p. 211.

P. Engelmanni Engelm.
Chermes cooleyi Gillette. Gillette, 1907b, p. 8.
Cnaphalodes strobilobius (Kalt.) CB. Börner, 1908a, p. 210.
Gillettea cooleyi (Gillette) CB. Börner, 1909a, p. 504.

P. mariana B. S. P. (nigra Link) (Abies nigra). Black or Bog Spruce.
Chermes consolidatus Patch. Patch, 1909d, p. 307.
Chermes floccus Patch. Patch 1909d, p. 307.
Chermes pinifoliae Fitch. (abieticolens Thomas). Patch, 1909d, p. 306.
Chermes similis Gillette. Patch, 1909d, p. 307.
Lachnus abietis Fitch. Thomas 1879, p. 117.

P. Morinda Link.
Chermes himalayensis Stebbing. (Ch. abietis Buckton Ind. Mus. Not. 3 pp. 5, 54) (Ch. abietis-piceae Stebbing.) Stebbing, 1910, p. 99.
Dreyfusia abietis-piceae Stebbing. Börner, 1908a, p. 211.

P. orientalis Carr.
Adelges orientalis Mordwilko. Schouteden, 1906a, p. 191.
Adelges sibiricus Cholodkovsky. Schouteden, 1906a, p. 192.
Chermes orientalis Dreyfus. Cholodkovsky, 1907, p. 30.
Cnaphalodes strobilobius (Kalt.) Börner, 1908a, p. 210.
Pineus pini (L. Macqu.) CB. (Anisophleba pini Koch 1857) (? Chermes obtectus Ratz 1844) (orientalis Dreyfus 1888). Börner, 1908a, p. 211.

P. pungens Engelm (parryana)
Chermes cooleyi Gillette. Gillette, 1907b, p. 5.
Chermes cooleyi var. coweni Gillette. Gillette, 1907b, p. 11.
Chermes montanus Gillette. Gillette, 1907b, p. 14.
Chermes similis Gillette. Gillette, 1907b, p. 16.
Cnaphalodes strobilobius (Kalt.). Börner, 1908a, p. 210.

P. rubra Dietr. Red Spruce.
Chermes consolidatus Patch. Patch, 1909d, p. 307.

Chermes floccus Patch. Patch, 1909d, p. 307.
Chermes pinifoliae Fitch (abieticolens Thomas). Patch, 1909d, p. 306.
Chermes similis Gillette. Patch, 1909d, p. 307.

P. sitchensis Trautv.
Cnaphalodes strobilobius (Kalt.). Börner, 1908a, p. 210.

P. sp.
Aphis abietina Walker. Kaltenbach, 1874, p. 703.
Calobates rhizomae Hartig. Judeich-Nitsche, 1895, p. 1357.
Chermes abietis Linn (Adelges gallarum abietis Haliday). Del Guercio, 1900, p. 82.
Chermes abietis Kalt. Cholodkovsky, 1907, p. 9.
Chermes abietis-laricis. Experiment Station Record 1894-5, p. 567.
Chermes coccineus Chol. Cholodkovsky, 1908, p. 693.
Chermes coccineus Chol. Cholodkovsky, 1907, p. 21.
Chermes funitectus Dreyfus. Cholodkovsky, 1908, p. 693.
Chermes funitectus Dreyfus. Cholodkovsky, 1907, p. 24.
Chermes lapponicus Chol. Cholodkovsky, 1907, p. 17.
Chermes piceae Ratz. Cholodkovsky, 1908, p. 693.
Chermes sibiricus Chol. Cholodkovsky, 1907, p. 27.
Chermes strobilobius Kalt. Cholodkovsky, 1907, p. 13. (var tardoides Chol.) Cholodkovsky, 1911, pp. 174, 175.
Chermes viridis Ratz. (laricis Hartig). Cholodkovsky, 1907, p. 3.
Cnaphalodes lapponicus (Chol.) (Chermes). Börner, 1909a, p. 555.
Lachnus fasciatus Burm. (? A. costata Zett.) Kaltenbach, 1843, p. 237.
Lachnus fasciatus Kalt. (Aphis costata Zett.). Kaltenbach, 1874, p. 702.
Lachnus grossa Kalt. Kaltenbach, 1874, p. 702.
Lachnus hyalinus Koch. Koch, p. 239.
Lachnus pinicola Kalt. Kaltenbach, 1874, p. 702.
Lachnus subterraneus Hartig. Judeich-Nitsche, 1895, p. 1357.
Lachnus viridescens Cholodkovsky. Mordwilko, 1899, p. 406.
Lachnus sp. (near agilis Kalt.) Gillette, 1909a, p. 385.
Pemphigus (Rhizomaria) piceae Hartig. Tullgren, 1909, p. 141.

PINUS. Pine.

P. abies. See Picea abies.

P. Cembra L.
Chermes sibiricus Chol. Cholodkovsky, 1907, p. 27.
Pineus sibiricus (Chol.) CB. (Chermes cembrae Chol. 1888) Börner, 1908a, p. 211.

P. contorta Dougl. (murrayana).
Chermes coloradensis Gillette. Gillette, 1907b, p. 16.
Pineus pini (L. Macqu.) CB. (Anisophleba pini Koch 1857). (? Chermes obtectus Ratz. 1844) (orientalis Dreyfus 1888). Börner, 1908a, p. 172.

P. divaricata Dum.-Cours (Banksiana Lamb.)
Pineus pini (L. Macqu.) CB. (Anisophleba pini Koch 1857) (? Chermes obtectus Ratz 1844) (orientalis Dreyfus 1888). Börner, 1908a, p. 172.

P. echinata Mill. (mitis). Yellow Pine.

Aphis marginipennis Haldeman. Hunter, 1901, p. 101.

P. edulis Engelm. Piñon pine.

Chermes coloradensis Gillette. Gillette, 1907b, p. 17.

P. halepensis Mill. (abchasica)

Pineus laevis (Mskl.)? Börner, 1908a, p. 211.

Schizolachnus agilis Kalt. Mordwilko, 1909, p. 93.

P. insignis Dougl. (radiata).

Lachnus pini-radiatae Davidson. Davidson, 1909, p. 299.

Mindarus (Schizoneura) pinicola (Thomas). Clarke, 1903, p. 248.

Pineus laevis (Mskl.)? Börner, 1908a, p. 211.

P. Larix L. See Larix europaea.

P. Laricio Poir (Austriaca) (nigricans) Austrian pine.

Chermes pinicorticis Fitch. Storment, 1895 and 1896, Appendix, p. III.

Schizoneura fuliginosa Buckton. (? A. pini maritimae Dufour) Buckton 3, p. 97.

P. montana Mill. (pumilio).

Chermes pini Koch. Cholodkovsky, 1907, p. 31.

Pineus pini (L. Macqu.) CB. (Anisophleba pini Koch 1857) (? Chermes obtectus Ratz 1844) (orientalis Dreyfus 1888). Börner, 1908a, p. 206.

P. palustris Mill. (australis) Southern pine.

Lachnus australi Ashmead. Ashmead, 1881, p. 68.

P. pinaster Ait. (maritima).

Chermes pinicorticis Fitch. Davidson, 1909, p. 299. (identity doubtful?)

Lachnus tomentosus DeGeer (pineti Fab.) (piniphila Ratzeburg) Schouteden, 1906a, p. 207.

P. pinea L.

Pineus pini (L. Macqu.) CB. (Anisophleba pini Koch 1857) (? Chermes obtectus Ratz 1844) (orientalis Dreyfus 1888) Börner, 1908a, p. 211.

P. ponderosa Dougl. (scopulorum) Bull pine. Yellow pine.

Chermes coloradensis Gillette. Gillette, 1907b, p. 16.

Lachnus flocculosa Williams. Williams, 1891, p. 20.

Lachnus pini Linn. Cowen, 1895, p. 117.

Lachnus ponderosae Williams. Williams, 1910 (1911), p. 24.

Schizoneura pinicola Thomas. Williams, 1891, p. 20.

P. Pumilio Haenke (uliginosa)

Anisophleba pini Koch. Kaltenbach, 1874, p. 702.

P. pyrenaica Lapeyr.

Schizoneura fuliginosa Buckton. (Aphis pini maritimae Dufour). Buckton, 3, p. 97.

P. strobus, L. White pine.

Chermes floccus Patch. Patch, 1909d, p. 307.

Chermes orientalis Dreyfus. Cholodkovsky, 1907, p. 31.

Chermes pinicorticis Fitch. Patch, 1909d, p. 303.

Chermes pinifoliae Fitch (abieticolens Thomas) Patch, 1909d, p. 306.

Essigella californicus Essig. Patch, 1912c.

Lachnus fasciatus Burmeister (A. costata Zetterstedt?). Kaltenbach, 1843, p. 160.

Lachnus rileyi Williams. Williams, 1910 (1911), p. 24.
Lachnus strobi Fitch. Weed, 1890, p. 116. Patch, 1912c.
Mindarus abietinus Koch (Schizoneura pinicola Thos.). Patch, 1910b, p. 242.
Pineus strobi (Hartig) CB. (Adelges corticalis Hardy 1850). (? Chermaphis pini var. laevis Maskell 1885) (pinicorticis Shimer 1865) (pinifoliae Shimer *not* Fitch, see Patch 1909d, p. 304.) (Coccus pinicorticis Fitch 1856.) Börner, 1908a, p. 211.
(*Schizoneura*) *pinicola* Thos. On roots. Felt, 1909, p. 80.
Schizoneura strobi Fitch. Thomas, 1879, p. 140. (Genus?)

P. sylvestris L. Scotch Pine.

Chermes corticalis Kalt. Kaltenbach, 1874, p. 702.
Chermes corticalis Kalt. (strobi Hartig?) (piceae (?) Ratz). Buckton 4, p. 24.
Chermes orientalis Dreyfus. Cholodkovsky, 1907, p. 31.
Chermes pini Koch. Cholodkovsky, 1907, p. 31.
Chermes pini Koch? (Anisophleba pini Koch). Buckton, 4, p. 41.
Chermes pinicorticis Fitch. Storment, 1895, and 1896. Appendix, p. III.
Glyphina pilosa Buck. Buckton, 4, p. 16.
Lachnus agilis Kalt. (A. agilis Walker). Buckton, 3, p. 47.
Lachnus fasciatus Burm. (A. costata Zetterstedt?). Kaltenbach, 1843, p. 160.
Lachnus fasciatus Burm. Burmeister, 1835, p. 93.
Lachnus hyperophilus Koch. Koch, p. 232 (Föhre).
Lachnus maculosus Cholodkovsky. Schouteden, 1906a, p. 204.
Lachnus nudus DeGeer. Schouteden, 1906a, p. 205.
Lachnus pineti (Schizoneura fulignosa Buckton?). Mordwilko, 1899, p. 398.
Lachnus pineti Koch (pineus Mordwilko) (piniphila Ratzeburg) Schouteden, 1906a, p. 207.
Lachnus pineti (Fab.) (A. tomentosa pini DeGeer). Kaltenbach, 1843, p. 162.
Lachnus pini (Linn) Kalt. (A. nuda pini DeGeer) (Pintyaphis Amyot). Buckton, 3, p. 50.
Lachnus pini Linn. Weed, 1890, p. 118. Patch, 1912c.
Lachnus pinicolus Kalt. Buckton, 3, p. 53.
Lachnus rileyi Williams. Williams, 1910 (1911), p. 24.
Lachnus roboris (Linn) (L. fasciatus Burm.) (Cinara roboris Curtis). Kaltenbach, 1843, p. 149. (See also Buckton, 3, p. 73).
Lachnus taeniatus Koch. Koch, p. 241 (Föhre).
Lachnus taeniatus Koch (? pinicola Walker). (cembrae Cholodkovsky). Schoutenden, 1906a, p. 207.
Lachnus tomentosus DeGeer. (pineti Fab.) (piniphila Ratzeburg) Schouteden, 1906a, p. 207.
Pineus laevis (Mskl.)? Börner, 1908, p. 211 (? sylvestris).

Pineus pini (L. Macqu.) CB. (Anisophleba pini Koch, 1857). (? Chermes obtectus Ratz 1844) (orientalis Dreyfus 1888). Börner, 1908a, p. 206.
Rhizobius pini Burmeister. Kaltenbach, 1843, p. 208.
Schizoneura fuliginosa (? A. pini maritimae Dufour). Buckton, 3, p. 97.

P. sp.
Aphis pilicornis Hartig. Hartig, 1841, p. 369. "Auf der Fichte."
Aphis? pinicolens Fitch. Thomas, 1879, p. 102.
Chaitophorus pinicolens (Fitch). Hunter, 1901, p. 88.
Essigella (Lachnus) californicus (Essig). Del Guercio. Essig, 1909, p. 74.
Holzneria (Pemphigus) poschingeri (Holzner) Licht. Lichtenstein, La Flore.
Lachnus agilis Kalt. Gillette, 1909a, p. 385.
Lachnus curtipilosus Mordwilko. Mordwilko, 1899, p. 399.
Lachnus pineus Mordwilko. Mordwilko, 1899, pp. 359, 399.
Lachnus pinihabitans Mordwilko. Mordwilko, 1899, pp. 48, 399.
Lachnus taeniatoides. Mordwilko, 1899, pp. 316, 526 and 399.
Lachnus sp. Gillette. Gillette, 1909a, p. 385.
Pemphigus degeeri, Kalt. Kaltenbach, 1843, p. 186.

PSEUDOTSUGA.

P. Douglasii Carr (mucronata). Red fir.
Chermes cooleyi Gillette. Gillette, 1907b, p. 6.
Chermes cooleyi var. coweni Gillette. Gillette, 1907b, p. 10.
Chermes coweni Gillette. Davidson, 1909, p. 299.

TAXUS. Yew.

T. baccata L. Irish Yew.
Chermes taxi Buckton. Buckton, 1886, p. 327. Schouteden 1906c, p. (6). 35. "a Coccid according to Cholodkovsky."

THUJA. Arbor vitae.

T. occidentalis L. Arbor vitae. White Cedar.
Lachnus juniperi Degeer. Essig, 1911b, p. 543.

TSUGA. Hemlock.

T. canadensis (L.) Carr (Abies canadensis Michx).
Chermes-Dreyfusia funitectus Dreyfus (nec Chldk. 1907). Börner, 1908a, p. 207.
Chermes funitectus Dreyfus. Cholodkovsky, 1907, p. 24.

TYPHACEAE. CAT-TAIL FAMILY.

TYPHA. (Thypha.) Cat-tail Flag.

T. angustifolia L.
Myzus persicae Pass. Passerini Flora.
T. latifolia L. (major). Common Cat-tail.

Rhopalosiphum nymphaeae (L.) Koch (A. butomi Schrank) (R. najadum Koch). Passerini, 1863, p. 21.

T. shuttleworthii Koch.
Myzus persicae Pass. Passerini`Flora.

SPARGANIACEAE. BUR-REED FAMILY.

SPARGANIUM. Bur-reed.

S. ramosum Curt.
Rhopalosiphum nymphaeae (L.) Koch. (A. butomi Schrank) (R. najadum Koch). Passerini, 1863, p. 21.

NAJADACEAE. PONDWEED FAMILY.

NAJAS. Naiad.

N. flexilis (Willd) Rostk. & Schmidt. (Naias flexilis).
Rhopalosiphum nymphaeae (Linn.). Williams, 1891, p. 18.

POTAMOGETON. Pondweed.

P. natans.
Rhopalosiphum nymphaeae (Linn.) Koch. Buckton, 2, p. 13.

P. sp.
Rhopalosiphum najadum Koch. Koch, p. 45.

ALISMACEAE. WATER-PLANTAIN FAMILY.

ALISMA. Water Plantain.

A. plantago-aquatica L.
Aphis abbreviata Patch. Patch, 1912c.
Rhopalosiphum nympheae (Linn.). Buckton, 2, p. 13. Patch, 1912c.
Rhopalosiphum nymphaeae (L.) Koch. (A. butomi Schrank) (R. najadum Koch). Passerini, 1863, p. 21.
Rhopalosiphum nymphaeae L. (Rh. alismae Koch in litt.). Koch, p. 26.

BUTOMUS.

B. umbellatus. L.
Rhopalosiphum nymphaeae (Linn.) Koch. Buckton, 2, p. 13.

B. sp.
Rhopalosiphum butomi Schrank. Lichtenstein, La Flore.

SAGITTARIA. Arrow-head.

S. latifolia Willd (variabilis Eng.)
Rhopalosiphum nymphaeae Linn. (Aphis aquaticus Jackson). Davis, 1910a, p. 245.

HYDROCHARITACEAE. FROG'S BIT FAMILY.

HYDROCHARIS.

H. Morsus-ranae L.
Rhopalosiphum nymphaeae (Linn.) Koch. Buckton, 2, p. 13.

ELODEA. Water-weed.

E. canadensis Michx. (Philotria canadense).
Rhopalosiphum nymphaeae Linn. (Aphis aquaticus Jackson). Davis 1910a, p. 245.

PHILOTRIA. See Elodea.

GRAMINEAE. GRASS FAMILY.

Agropyron.

A. glaucum. Colorado Blue-stem.
Brachycolus tritici Gillette. Gillette, 1911b, p. 441.
Chaitophorus agropyronensis Gillette. Gillette, 1911b, p. 443.

AGROSTIS. Bent Grass.

A. plumosa.
Tetraneura graminis Monell. Patch, 1910a, p. 210.
A. alba L. Fiorin or White Bent Grass (vulgaris Thurb, Red Top).
Brachycolus stellariae Hardy. (holci Hardy). Schouteden, 1906a, p. 212.
Macrosiphum cerealis (Kalt.); Pergande, 1904a, p. 20.
Siphonophora avenae Fab. Williams, 1891, p. 13.

AIRA (in part). See Deschampsia.

ALOPECURUS. Foxtail Grass.

G. geniculatus L. Floating Foxtail Grass.
Toxoptera graminum Rondani. Hunter, 1909, p. 102.

ANDROPOGON. Beard Grass.

A. furcatus Muhl.
Schizoneura corni Fab. (S. venusta Pass.) (E. cornicola Walsh) (E. fungicola Walsh) (S. panicola Thomas). Hunter, 1901, p. 81.

A. sorghum.
Toxoptera graminum Rondani. Hunter, 1909, p. 102.

ANTHOXANTHUM. Sweet Vernal Grass.

A. odoratum L.
Sipha graminis Kaltenbach. Schouteden, 1906a, p. 212.

ARRHENATHERUM. Oat Grass.

A. elatius (L) Beauv. (Avena elatior). Tall Oat Grass.
Toxoptera graminum Rondani. Hunter, 1909, p. 102.

ARUNDO.

A. Donax L. Giant Reed.
Aphis donacis Pass. Ferrari, 1872, p. 72.
A. phragmitis. See Phragmites communis.
A. sp.
Aphis arundinis Fab. Kaltenbach, 1874, p. 765.
Callipterus arundicolens Clarke. Clarke, 1903, p. 249.

AVENA. Oat.

A. elatior. See Arrhenatherum elatius.
A. fatua L.
Aphis evenae Fab. Kaltenbach, 1874, p. 735.
Aphis cerealis Kalt. Kaltenbach, 1874, p. 753.
Chaitophorus solicivora Pass. Ferrari, 1872, p. 76.
Siphonophora granaria (Kirby) (A. avenae Fab?) (A. hordei Kyber) (A. cerealis Kalt.) (Bromaphis Amyot) (S. cerealis Koch). Buckton, 1, p. 116.
Toxoptera graminum Rondani. Macchiati, 1883, p. 237.
A. pratensis L.
Geoica carnosa Buckton. Schouteden, 1902, p. 140.
A. sativa L. (Oats).
Amycla fuscifrons Koch. Koch, p. 302.
Aphis cerealis Kalt. Kaltenbach, 1874, p. 753.
Macrosiphum cerealis (Kalt.). Pergande, 1904a, p. 20.
Macrosiphum granaria Buckton (avenae Thos. in part). Pergande, 1904a, p. 15.
Macrosiphum trifolii Pergande. Pergande, 1904a, p. 21.
Pemphigus boyeri Pass. (Amycla fuscifrons Koch.) Ferrari, 1872, p. 83.
Pemphigus fuscifrons Koch. Buckton, 3, p. 115.
Sipha avenae Del Guercio. Del Guercio, 1900, p. 116.
Sipha (Chaitophorus) flava Forbes. Davis, 1909b, p. 157.
Sipha maydis Pass. Ferrari, 1872, p. 78.
Siphocoryne avenae (Fab.) (mali Fitch) (avenae Fitch) (prunifoliae Fitch) (annuae Oestl.) (fitchii Sanderson) (Siphonophora avenae Thos. in part). Pergande, 1904a, p. 8. Patch, 1912c.
Siphonophora cerealis Koch (Aphis cerealis Kalt.) (A. avenae Walker *non* Schrank). Passerini, 1863, p. 12.
Siphonophora granaria Kirby. Buckton, 1, p. 116.
Toxoptera graminum R. (Pass.). Hunter, 1909, p. 102.
A. strigosa Schreb.
Aphis cerealis Kalt. Kaltenbach, 1874, p. 753.
A. sp.
Amycla (Aphis) fuscifrons Koch. Kaltenbach, 1874, p. 757.
Aphis avena, Linn. Kaltenbach, 1874, p. 756.
Aphis dirhoda Walker. Walker, 1849a, p. 43.
Sipha (Aphis) graminis Kalt. Kaltenbach, 1874, p. 757.
Siphonophora avenae Walker. Lichtenstein, La Flore.
Toxoptera graminum Rondani. Buckton, 3, p. 135.

BAMBUSA.

B. arundinacea Willd.
Oregma bumbusae Buckton. Schouteden, 1905, p. 187.

BROMUS. (Ceratochloa) Brome Grass.

B. arenarius Labill. (australis).
Schizoneura venusta Pass. Passerini, 1863, p. 69.

B. hordeaceus L. Soft Chess.
Aphis cerealis Kalt. Kaltenbach, 1874, p. 745.

B. maximus Df.
Toxoptera graminum Rondani. Macchiati, 1883, p. 237.

B. mollis L.
Pentaphis pawlowae Mordwilko. Mordwilko, 1899, p. 83.
Siphonophora granaria (Kirby) (avenae Fab?) (hordei Kyber) (cerealis Kalt.) (Bromaphis Amyot). Buckton, 1, p. 116.
Toxoptera graminum Rondani. Hunter, 1909, p. 102.

B. racemosus L.
Siphocoryne avenae (Fab.) (mali Fitch) (prunifoliae Fitch) (avenae Fitch) (annuae Oestl.) (fitchii Sanderson) Siphonophora avenae Thos. in part). Pergande, 1904a, p. 9.

B. secalinus L. Cheat or Chess.
Aphis cerealis Kalt. Kaltenbach, 1874, p. 753.
Macrosiphum cerealis (Kalt.). Pergande, 1904a, p. 20.
Siphonophora avenae Fab. Williams, 1891, p. 13.

B. unioloides H. B. (Ceratochloa australis) (Schraderi).
Schizoneura venusta Pass. Passerini, 1860, p. 38.
Siphocoryne avenae (Fab.) (mali Fitch) (prunifoliae Fitch) (avenae Fitch) (annuae Oestl.) (fitchii Sanderson) (Siphonophora avenae Thos. in part). Pergande, 1904a, p. 8.

B. sp.
Aphis dirhoda Walker. Walker, 1849a, p. 43.
Aploneura lentisci Pass. Lichtenstein, La Flore.
Schizoneura fodicus Buckton. Buckton, 3, p. 96.

CALAMAGROSTIS. Reed Bent Grass.

C. epigeios Roth.
Hyalopterus arundinis (Fab.) Koch. (A. pruni Walker partim). Passerini, 1863, p. 27.

CHAETOCHLOA.

C. glauca. See Setaria glauca.

COIX.

C. Lacryma-Jobi L.
Pemphigus boyeri Pass. (A. radicum Boyer) (Amycla fuscifrons Koch). Passerini, 1863, p. 74.

Pemphigus fuscifrons Koch (Amycla fuscifrons Koch) (P. boyeri Pass.) (P. zeae maidis Löw?) (A. radicum Boyer?) Buckton, 3, p. 116.
Tychae setariae Pass. Passerini, 1863, p. 82.

CYNODON. Bermuda Grass.

C. Dactylon Pers.
Pemphigus boyeri Pass. (Amycla fuscifrons Koch). Ferrari, 1872, p. 83.
Pemphigus zeae maidis Dufour (A. radicum Boyer) (P. boyeri Pass.) (A. fuscifrons Koch) (Endeis bella Koch?) (Endeis rorea Koch) Macchiati, 1883, p. 265.
Sipha avenae Del Guercio. Del. Guercio, 1900, p. 116.
Tetraneura ulmi De Geer (Pemphigus fuscifrons Buckton) (P. saccharata Del Guercio). Del Guercio, 1900, p. 93.
Tychea trivialis Pass. Passerini, 1860, p. 40.

DACTYLIS. Orchard Grass.

D. glomerata L.
Aphis cerealis Kalt. Kaltenbach, 1874, p. 750.
Chaitophorus salicivora Pass. Ferrari, 1872, p. 76.
Hyalopterus dactylidis Hayhurst. Hayhurst, 1909a, p. 107.
Macrosiphum cerealis (Kalt.). Pergande, 1904a, p. 20.
Siphocoryne avenae (Fab.) (mali Fitch) (prunifoliae Fitch) (avenae Fitch) (annuae Oestl.) (fitchii Sanderson) (Siphonophora avenae Thos. in part). Pergande, 1904a, p. 8.
Siphonophora granaria (Kirby) Koch. (avenae Fab?) (hordei Kyber) (cerealis Kalt.) (Bromaphis Amyot). Buckton, 1, p. 116.
Toxoptera graminum Rondani. Hunter, 1909, p. 102.

D. sp.
Aphis dirhoda Walker. Walker, 1849a, p. 40.

DANTHONIA. Wild Oat Grass.

D. airoides Nees.

DENDROCALAMUS.

D. giganteus Munro.
Oregma bambusae Buckton. Schouteden, 1905, p. 187.

DESCHAMPSIA.

D. ambigua Beauv. (Aira caespitosa).
Tetraneura graminis Monell. Williams, 1891, p. 13.

D. caespitosa (L) Beauv. (Aira caespitosa).
Tetraneura graminis Monell. Patch, 1910a, p. 210.
Tetraneura ulmi De Geer. Cholodkovsky, 1889, p. 474.

D. flexuosa (L.) (Aira flexuosa). Common Hair Grass.

Forda viridana Buckton. Buckton, 4, p. 86.
Sipha berlesei Del Guercio. Schouteden, 1906a, p. 212.

DIGITARIA. Finger Grass.

D. filiformis (L.) Koeler.
Pentaphis trivialis Passerini. Schouteden, 1906a, p. 193.
D. humifusa Pers. (Panicum glabrum).
Pemphigus boyeri Pass. (Aphis radicum Boyer). Kaltenbach, 1874, p. 768.
Schizoneura corni Fab. (S. graminis Del Guercio). Del Guercio, 1900, p. 103.
Schizoneura panicola Thomas. Thomas, 1879, p. 138.
Schizoneura venusta Pass. Kaltenbach, 1874, p.. 768.
Tychea panici Thomas. Thomas, 1879, p. 170.
Tychea setariae Pass. Kaltenbach, 1874, p. 768.
D. sanguinalis (L.) Scop. (Panicum sanguinale) (Syntherisma sanguinalis). Crab Grass.
Aphis (Siphocoryne) avenae Fab. (mali Fitch) (prunifoliae Fitch) (avenae Fitch) (annuae Oestl.) (fitchii Sanderson) (Siphonophora avenae Thos. in part). Pergande, 1904a, p. 8.
Aphis maidis Fitch. Davis, 1909b, p. 145.
Sipha (Chaitophorus) flava Forbes. Davis, 1909b, p. 157.
Toxoptera graminum Rondani. Hunter, 1909, p. 102.
Aphis padi Kalt. (A. avenae Fab. Kalt.) Mordwilko, 1897, p. 283.

ECHINOCHLOA.

E. Crus-galli (L.) (crus-corvi) (Panicum crus-galli L.) Barnyard Grass.
Aphis annuae Oestlund. Williams, 1891, p. 13.
Aphis maidis Fitch. Davis, 1909b, p. 145.
Aphis setariae Thomas. Gillette and Taylor, 1908, p. 42.
Geoica squamosa Hart. Hart, 1891 and 1892, p. 100.
Pemphigus boyeri Pass. (Amycla fuscifrons Koch). Ferrari, 1872, p. 83.
Schizoneura corni Fab. (S. venusta Pass.) (E. fungicola Walsh) (E. cornicola Walsh) (S. panicola Thomas). Hunter, 1901, p. 81. Williams, 1910 (1911). p. 19.
Schizoneura corni Fab. (S. graminis Del Guercio). Del Guercio. p. 19.
Schizoneura corni Fab. (S. graminis Del Guercio). Del Guercio, 1900, p. 103.
Sipha (Chaitophorus) flava Forbes. Davis, 1909b, p. 157.
Siphonophora setariae Thomas (Siphonophora panicola Thomas) Thomas, 1878, p. 6.
Tetraneura ulmi De Geer (Pemphigus fuscifrons Buckton) (P. saccharata Del Guercio) Del Guercio, 1900, p. 93.

ELEUSINE. Goose Grass.

E. Indica Caertn.
Aphis setariae Thomas. Sanborn, 1910, p. 6.
Rhizobius eleusinis Thomas. Thomas, 1878, p. 15.

ELYMUS. Wild Rye.

E arenarius L.
Hyalopterus arundinis (Fab.) Koch (A. pruni Walker partim) Passerini, 1863, p. 27.
Hyalopterus pruni (Fab.) Koch. (Walker partim). Passerini, 1863, p. 27.
E. canadensis L.
Myzocallis (?) sp. Osborn. Osborn, 1892, p. 129.
E. geniculatus.
Aphis padi Kalt. (A. avenae Fab. Kalt.). Mordwilko, 1897, p. 283.
E. virginicus L.
Macrosiphum cerealis (Kalt.). Pergande, 1904a, p. 20.
Macrosiphum granaria Buckton (avenae Thos. in part). Pergande, 1904a, p. 15.

ERAGROSTIS.

E. megastachya Link (major Host.).
Colopha ulmicola (Fitch) (eragrostidis Middleton). Patch, 1910, p. 205.
Pemphigus boyeri Pass. (A. radicum Boyer) (Amycla fuscifrons Koch). Passerini, 1863, p. 74.
Pemphigus caerulescens Pass. Passerini, 1863, p. 74.
Schizoneura corni Fab. S. graminis Del Guercio). Del Guercio, 1900, p. 103.
Schizoneura venusta Pass. Passerini, 1860, p. 38.
Tychea eragrostidis Pass. Passerini, 1860, p. 39.
E. minor Host. (poaeoides).
Colopha eragrostidis Middleton. Williams, 1891, p. 13.
E. pectinacea Michx.
Schizoneura panicola Thomas. Oestlund, 1887, p. 29.
E. sp.
Pemphigus fuscifrons (Koch) (P. boyeri Pass.) (P. zeae maidis Löw?) (A. radicum Boyer?). Buckton, 3, p. 116.

FESTUCA. Fescue Grass.

F. elatior L. Taller or Meadow Fescue.
Tychea trivialis Pass. Passerini, 1860, p. 40.
F. ovina L. (duriuscula L.) Sheep's Fescue.
Forda formicaria Heyden (Rhizoterus vacca Hartig). Passerini, 1863, p. 79.
Paracletus cimiciformis Heyden. Buckton, 3, p. 67.
Tychea trivialis Pass. Kaltenbach, 1874, p. 753.

GLYCERIA. Manna Grass.

G. (Poa) aquatica L.
Sipha glyceriae Kaltenbach. Theobald, 1911-12.
G. distans Wahlenb.
Dryopeia (endeis) rosea Koch. Schouteden, 1906a, p. 193.
G. fluitans (L.) R. Br.
Sipha glyceriae (Kalt.) Pass. Passerini, Flora.
Siphonophora granaria (Kirby) (avenae Fab?) (hordei Kyber) (cerealis Kalt.) (Bromaphis Amyot). Buckton, 1, p. 116.
G. nervata (Willd) (Panicularia nervata). Fowl Meadow Grass.
Amphorophora howardii Wilson. Wilson, 1911, p. 59.

HIEROCHLOE. Holy Grass.

H. australis Roem. (Holcus australis).
Schizoneura venusta Pass. Kaltenbach, 1874, p. 768.

HOLCUS.

H. mollis L.
Aphis holci Ferrari. Ferrari, 1872, p. 63.
Brachycolus stellariae Hardy (holci Hardy). Buckton, 2, p. 148.
Forda formicaria Heyden (Rhizoterus vacca Hartig). Buckton 4, p. 84.
Siphonophora cerealis Kalt. Ferrari, 1872, p. 56.
H. sp.
Aphis dirhoda Walker. Walker, 1849a, p. 43.
Aphis cerealis Kalt. Kaltenbach, 1874, p. 758.
Brachycolus stelleriae Hardy. (holci Hardy). Schouteden, 1906a, p. 212.
Sipha maidis Pass. Lichtenstein, La Flore.
Sipha schoutedeni Del Guercio. Schouteden, 1906a, p. 212.
Siphonophora granaria (Kirby) (avenae Fab?) (hordei Kyber) (cerealis Kalt.) (Bromaphis Amyot). Buckton, 1, p. 116.

HORDEUM. Barley.

H. distichon L.
Aphis avenae Fab. Kaltenbach, 1874, p. 735.
H. jubatum L. Squirrel-tail Grass.
Siphonophora avenae Fab. Williams, 1891, p. 13.
Schizoneura corni? (Fab.). Williams, 1891, p. 13.
H. murinum L.
Aphis cerealis Kalt. Kaltenbach, 1874, p. 753.
Sipha elegans Del Guercio.
Siphonophora cerealis Kalt. Ferrari, 1872, p. 56.
Siphonophora granaria (Kirby) (avenae Fab?) (hordei Kyber) cerealis Kalt.) (Bromaphis Amyot) Buckton, 1, p. 116.

Toxoptera graminum Rondani. Hunter, 1909, p. 102.

H. vulgare L. (sativum).

Aphis avenae Fab. Kaltenbach, 1874, p. 735.

Aphis maidis Fitch. Davis, 1909b, p. 145.

Brachycolus korotnevi Mordwilko. Cholodkovsky, 1910, p. 147.

Siphocoryne avenae (Fab.) Patch, 1912c.

Siphonophora granaria (Kirby) (avenae Fab?) (hordei Kyber) (cerealis Kalt.) (Bromaphis Amyot). Buckton, 1, p. 116.

H. sp.

Aphis dirhoda Walker. Walker, 1849a, p. 43.

Endeis (Aphis) bella Koch. Kaltenbach, 1874, p. 735.

Sipha maidis Pass. Lichtenstein, La Flore.

KOELERIA.

K. cristata L.

Aphis padi Kalt. (A. avenae Fab. Kalt.). Mordwilko, 1897, p. 283.

LEERSIA. Cut-grass.

L. oryzoides Sw. (Oryza clandestina). Rice Cut-grass.

Sipha glyceriae (Kalt.) Pass. Passerini, 1863, p. 63.

L. virginica Willd. White Grass.

Tetraneura graminis Monell. Patch, 1910a, p. 210.

LEPTOCHLOA.

L. filiformis Beauv.

Aphis maidi-radicis Forbes. Vickery, 1910, p. 101.

LOLIUM. Darnel.

L. multiflorum Lam. Italian Rye Grass.

Sipha maydis Pass. Macchiati, 1883, p. 261.

L. perenne L. Common Darnel, Perennial Ray or Rye Grass.

Pemphigus boyeri Pass. (Amycla fuscifrons Koch). Ferrari, 1872, p. 83.

Pemphigus Zeae maidis Dufour (A. radicum Boyer) (P. boyeri Pass.) (A. fuscifrons Koch) (Endeis bella Koch?) (Endeis rorea Koch) Macchiati, 1883, p. 265.

Sipha (Aphis) maydis Pass. Kaltenbach, 1874, p. 768.

Toxoptera graminum Rondani. Hunter, 1909, p. 102.

L. temulentum L. Bearded Darnel.

Sipha maydis Pass. Passerini, 1860, p. 38.

L. sp.

Brachycolus korotnewi Mordwilko. Mordwilko, 1899, p. 350.

Pemphigus (Amycla) fuscifrons (Koch) (boyeri Pass.) (zeae maidis Löw?) (A. radicum Boyer?) Buckton, 3, p. 116.

MELICA. Melic Grass.

M. baulimi All. Auct. Pedem.
Aphis padi Kalt. (A. avenae Fab., Kalt.). Mordwilko, 1897, p. 283.

M. penicillaris Boiss. & Bal.
Aphis padi Kalt. (A. avenäe Fab., Kalt.) Mordwilko, 1897, p. 283.

MUHLENBERGIA.

M. racemosa Michx.
Schizoneura corni Fab. (S. venusta Pass.) (E. fungicola Walsh) (E. cornicola Walsh) (S. panicola Thomas). Hunter, 1901, p. 81.

M. Schreberi Gmelin. Drop-seed, Nimble Will.
Aphis setariae Thomas. Sanborn, 1910, p. 6.

ORYZA.

O. sativa L. (montana).
Pemphigus boyeri Pass. (A. radicum Boyer) (Amycla fuscifrons Koch). Passerini, 1863, p. 74.
Sipha glyceriae (Kalt.) Pass. Passerini, 1863, p. 63.
Tetraneura ulmi DeGeer (Pemphigus fuscifrons Buckton) (P. saccharata Del Guercio). Del Guercio, 1900, p. 93.
Tychea setuosa Pass. Buckton, 4, p. 88.

O. sp.
Pemphigus (Amycla) fuscifrons Koch. (P. boyeri Pass.) (zeae maidis Löw?) (A. radicum Boyer?). Buckton, 3, p. 116.

PANICULARIA.

P. nervata. See Glyceria nervata.

PANICUM. Panic Grass. (In Part See Digitaria.)

P. capillare L. Old-witch Grass.
Schizoneura corni Fab. (S. venusta Pass.) (E. fungicola Walsh) (E. cornicola Walsh) (S. panicola Thomas). Hunter, 1901, p. 81.

P. Crus-galli. See Echinochloa Crus-galli (L.).

P. glabrum Gaud. See Digiaria humifusa Pers.

P. glaucum. See Setaria glauca.

P. polyanthes Schultes.
Aphis setariae Thomas. Sanborn, 1910, p. 6.

P. proliferum Lam.
Aphis seturiae Thomas. Gillette and Taylor, 1908, p. 42.
Aphis setariae (Thomas) (Siphonophora setariae Thomas) (S. panicola Thomas). Monell, 1879, p. 23.
Rhizobius spicatus Hart. Hart, 1891 and 1892, p. 105.
Schizoneura corni Fab. Williams, 1891, p. 13.

P. sanguinale L.
Aphis setariae Thos. Sanborn, 1910, p. 6.
Schizoneura corni Fab. (S. venusta Pass.) (E. fungicola Walsh) (E. cornicola Walsh) (S. panicola Thomas). Hunter, 1901, p. 81.

P. sp.

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

Colopha ulmicola (Fitch) (eragrostidis Middleton). Patch, 1910a, p. 205.

Pemphigus (*Amycla*) *fuscifrons* Koch (boyeri Pass.) (zeae maidis Löw?) (A. radicum Boyer?) Buckton, 3, p. 116.

Schizoneura panicola Thos. Hart, 1891 and 1892, p. 87.

Sipha (*chaitophorus*) *flava* Forbes. Davis, 1909b, p. 157.

Siphonophora panicola Thomas. Thomas, 1878, p. 6.

Trama erigeronensis Thos. (Tychea radicola Oestlund). Hart, 1891 and 1892, p. 93.

Tychea panici Thomas. Thomas, 1879, p. 138.

PHALARIS. Canary Grass.

P. arundinacea L. Reed Canary Grass.

Aphis glyceriae Kalt. Kaltenbach, 1874, p. 751.

Aphis lonicerae Sieb. Kaltenbach, 1874, p. 406.

P. canariensis L.

Siphonophora avenae Fab. Williams, 1891, p. 13.

PHLEUM.

P. pratense L. Timothy, Herd's Grass.

Sipha (*Chaitophorus*) *flava* Forbes. Davis, 1909b, p. 157.

Siphocoryne avenae (Fab.) (mali Fitch) (prunifoliae Fitch) (avenae Fitch) (annuae Oestl.) (fitchii Sanderson) (Siphonophora avenae Thos. in part). Pergande, 1904a, p. 8.

PHRAGMITES. Reed.

P. communis L. Trin. (Phragmites Phragmites) (Arundo phragmites).

Hyalopterus arundinis (Fab.) Koch (A. phragmitidicola Oestl.) Oestlund, 1887, p. 48.

Hyalopterus arundinis (Fab.) (pruni Fab.) Osborn-Sirrine, 1893, p. 236.

Hyalopterus arundinis (Fab.) Koch (A. calamaphis Amyot). Buckton, 2, p. 112.

PHYLLOSTACHYS.

P. sp.

Aphis bambusae Fullaway "on bamboo (Phyllostachys?)." Fullaway, 1909, p. 36.

POA. Meadow Grass.

P. annua L. Low Spear Grass.

Aphis annuae Oestlund. Oestlund, 1887, p. 66.

Aphis glyceria Kalt. Kaltenbach, 1874, p. 751.

Aphis padi Kalt. (A. avenae Fab., Kalt.). Mordwilko, 1897, p. 282.

Endeis pellucida Buckton. Buckton, 4, p. 91.
Rhizobius poae Buckton. Buckton, 4, p. 93.
Rhizobius poae Thomas. Thomas, 1879, p. 167.
Rhizobius poae Thomas. Davis, 1910, p. 408.
Siphonophora avenae Fab. Williams, 1891, p. 13.
Siphonophora longipennis Buckton. Buckton, 1, p. 148.
Siphonophora poae Macchiati. Del Guercio, 1900, p. 164.
Tychea eragrostidis Buckton. Buckton, 4, p. 89.

P. compressa L. Canada Blue Grass, Wire Grass.
Aphis setariae Thomas. Sanborn, 1910, p. 6.
Rhopalosiphum dianthi var. *poae* Williams. Williams, 1891, p. 7.
Siphocoryne avenae (Fab.) (mali Fitch) (prunifoliae Fitch) (avenae Fitch) (annuae Oestl.) (fitchii Sanderson) (Siphonophora avenae Thos. in part). Pergande, 1904a, p. 8.

P. megastachya. See Eragrostis.

P. pratensis L. June Grass, Spear Grass, Kentucky Blue Grass.
Forda formicaria Heyden (Rhizoterus vacca Hartig). Passerini, 1863, p. 79.
Forda occidentalis Hart. Hunter, 1901, p. 69
Geoica squamosa Hart. Hunter, 1901, p. 76
Macrosiphum cerealis (Kalt.). Pergande, 1904a, p. 20.
Pemphigus boyeri Pass. Amycla fuscifrons Koch). Ferrari, 1872, p. 83.
Rhopalosiphum poae Gillette. Gillette, 1908a, p. 61.
Siphocoryne avenae (Fab.) (mali Fitch) (prunifoliae Fitch) (avenae Fitch) (annuae Oestl.) (fitchii Sanderson) (Siphonophora avenae Thos. in part). Pergande, 1904a, p. 8.
Toxoptera graminum Rondani. Hunter, 1909, p. 103.

P. trivialis L. Rough-stalked Meadow Grass.
Aphis padi Kalt. (A. avenae Fab., Kalt.). Mordwilko, 1897, p. 282.
Tychea trivialis Pass. Passerini, 1860, p. 40.

P. sp.
Aphis dirhoda Walker. Walker, 1849a, p. 43.
Aphis poae Hardy. Walker, 1852, p. 1038.
Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 35.
Rhopalosiphum dianthi var *poae* Williams. Williams, 1910 (1911), p. 70.
Schizoneura venusta Pass. Kaltenbach, 1874, p. 753.
Sipha (Chaitophorus) flava Forbes. Davis, 1909b, p. 157.
Siphonophora granaria (Kirby) (avenae, Fab?) (hordei Kyber) (cerealis Kalt.) (Bromaphis Amyot). Buckton, 1, p. 116.

SACCHARUM.

S. officinarum L. Sugar Cane.
Aphis adusta Zehntner. Zoölogical Record, 1898, p. 269.
Aphis maidis Fitch. Patch, 1912c.

Aphis sacchari Zehntner. Fullaway, 1909, p. 35.
Tetraneura lucifuga Zehntner. Jahresbericht Pflanzenkrankheiten, 1901 (1903), p. 229.

S. sp.
Oregma (Ceratovacuna) lanigera Zehntner. Schouteden, 1905, p. 184.

SECALE.

S. cereale L. Rye.
Aphis dirhoda Walker. Walker, 1849a, p. 43.
Macrosiphum cerealis (Kalt.). Pergande, 1904a, p. 20.
Siphocoryne avenae (Fab.) (avenae Fitch) (mali Fitch) (prunifoliae Fitch) (annuae Oestl.) (fitchii Sanderson) (Siphonophora avenae Thos. in part). Pergande, 1904a, p. 8.
Siphonophora granaria (Kirby) (avenae Fab?) (hordei Kyber) (cerealis Kalt.) (Bromaphis Amyot). Buckton, 1, p. 116.
Toxoptera graminum Rondani. Hunter, 1909, p. 103.

SETARIA. Bristly Foxtail Grass.

S. glauca Beauv. (Panicum glaucum) (Chaetochloa glauca). Foxtail, Pigeon Grass.
Aphis maidis-radicis Forbes. Davis, 1909b, p. 124.
Aphis maidis Fitch. Davis, 1909b, p. 145.
Aphis (Siphonophora) setariae Thomas. Gillette and Taylor, 1908, p. 42.
Schizoneura corni Fab. (S. graminis Del Guercio). Del Guercio, 1900, p. 103.
Schizoneura panicola Thomas. Oestlund, 1887, p. 29.
Schizoneura venusta Pass. Passerini, 1860, p. 38.
Sipha (Chaitophorus) flava Forbes. Davis, 1909b, p. 157.
Tychea eragrostidis Pass. Buckton, 4, p. 89.
Tychea panici Thomas. (Schizoneura?). Hunter, 1901, p. 69.
Tychea setariae Pass. Passerini, 1863, p. 82.

S. italica Beauv. (Setaria germanica).
Aphis maidis-radicis Forbes. Davis, 1909b, p. 124.
Schizoneura corni Fab. (S. graminis Del Guercio). Del Guercio, 1900, p. 103.
Schizoneura venusta Pass. Passerini, 1860, p. 38.

S. viridis L. Green Foxtail, Bottle Grass.
Aphis maidi-radicis Forbes. Davis, 1909b, p. 124.
Aphis maidis Fitch. Williams, 1891, p. 14.
Aphis setariae (Thomas). Williams, 1891, p. 14.
Macrosiphum cerealis (Kalt.). Pergande, 1904a, p. 20.
Schizoneura corni Fab. (S. graminis Del Guercio). Del Guercio, 1900, p. 103.
Schizoneura corni (Fab.) (S. venusta Pass.) (E. fungicola Walsh) (E. cornicola Walsh) (S. panicola Thomas). Hunter, 1901, p. 81.

Schizoneura venusta Pass. Ferrari, 1872, p. 82.
Tychea setariae Pass. Passerini, 1860, p. 40.

S. sp.
Tetraneura rubra Licht. ("nach Mordwilko identisch mit Pemphigus Zeae-maydis Boyer"). Cholodkovsky, 1910, p. 149.

SORGHUM.

S. Dora Griseb.
Aphis maidi-radicis Forbes. Davis, 1909b, p. 124.
Aphis maidis Fitch. Davis, 1909b, p. 145.
Sipha (Chaitophorus) flava Forbes. Davis, 1909b, p. 157.

S. halepense L. (glycychylum). Johnson Grass.
Aphis avenae Fab. Passerini, 1863, p. 35.
Pemphigus boyeri Pass. (A. radicum Boyer) (Amycla fuscifrons Koch). Passerini, 1863, p. 74.
Sipha maydis Pass. Passerini, 1860, p. 38.
Tetraneura ulmi De Geer (Pemphigus fuscifrons Buckton) (P. saccharata Del Guercio). Del Guercio, 1900, p. 93.

S. saccharatum.
Aphis avenae Fab. Passerini, 1863, p. 35.
Aphis maidi-radicis Forbes. Davis, 1909b, p. 124.
Aphis maidis Fitch. Davis, 1909b, p. 145.
Pemphigus boyeri Pass. (A. radicum Boyer) (Amycla fuscifrons Koch). Passerini, 1863, p. 74.
Sipha (Chaitophorus) flava Forbes. Davis, 1909b, p. 157.
Sipha maydis Pass. Passerini, 1860, p. 38.
Siphonophora caianensis Del Guercio. Del Guercio, 1900, p. 167.
Tetraneura ulmi De Geer (Pemphigus fuscifrons Buckton) (P. saccharata Del Guercio). Del Guercio, 1900, p. 93.

S. vulgare Pers. Broom Corn.
Aphis avenae Fab. Passerini, 1863, p. 35.
Pemphigus boyeri Pass. (A. radicum Boyer) (Amycla fuscifrons Koch). Passerini, 1863, p. 74.
Tetraneura ulmi De Geer (Pemphigus fuscifrons Buckton) (P. saccharata Del Guercio). Del Guercio, 1900, p. 93.

S. sp.
Aphis sorghella Schouteden. Zoölogical Record, 1906, p. 423.
Aphis sorghi Theobald. Zoölogical Record, 1904, p. 337.
Pemphigus fuscifrons (Koch) (P. boyeri Pass.) (zeae maidis Löw?) (A. radicum Boyer?). Buckton, 3, p. 116.
Schizoneura panicola Thomas. Hart, 1891 and 1892, p. 87.
Toxoptera graminum Rondani. Buckton, 3, p. 135.

SPARTINA. Cord Grass.

S. cynosuroides Willd. Salt Reed Grass.
Schizoneura corni Fab. S. venusta Pass.) (E. fungicola Walsh) (panicola Thomas). Hunter, 1901, p. 81.

S. patens (Ait.) (juncea Willd).

Aphis laburni Kalt. Ferrari, 1872, p. 71.
Aphis medicaginis Koch. Ferrari, 1872, p. 68.

SYNTHERISMA.

S. sanguinalis. See Digitaria sanguinalis (L.) Scop.

TRIDENS.

T. seslerioides (Lichex) Nash.
Aphis setariae Thos. Sanborn, 1910, p. 6.

TRIODIA.

T. seslerioides Benth. (Tricuspis seslerioides Torr).
Hyalopterus dactylidis Hayhurst. Hayhurst, 1909a, p. 107.

TRITICUM.

T. dicoccum Schrank.
Aphis padi Kalt. (A. avenae Fab., Kalt.). Mordwilko, 1897, p. 283.
T. repens L.
Forda formicaria Heyden. Buckton, 4, p. 85.
Toxoptera graminum Rondani. Hunter, 1909, p. 102.
T. sativum Lam. Wheat.
Macrosiphum avenivorum Kirkaldy. (S. granaria Buckton). Kirkaldy, 1905a, p. 132.
Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 35.
Siphonophora granaria (Kirby) (avenae Fab?) (hordei Kyber) (A. cerealis Kalt.) (Bramaphis Amyot). Buckton, 1, p. 116.
T. Spelta L.
Sipha maydis Pass. Passerini, 1860, p. 38.
Toxoptera graninum Rondani. Hunter, 1909, p. 102.
T. villosum P. B.
Toxoptera graminum Rondani. Macchiati, 1883, p. 237.
T. vulgare Vill.
Aphis cerealis Kalt. Kaltenbach, 1874, p. 753.
Brachycolus korotnevi Mordwilko. Cholodkovsky, 1910, p. 147.
Macrosiphum cerealis (Kalt.). Pergande, 1904a, p. 20.
Macrosiphum granaria (Buckton) (avenae Thos. in part.) Pergande, 1904a, p. 15.
Macrosiphum trifolii Pergande. Pergande, 1904, p. 21.
Schizoneura venusta Pass. Passerini, 1863, p. 69.
Siphocoryne avenae (Fab.) (avenae Fitch) (fali Fitch) (prunifoliae Fitch) (annuae Oestl. (fitchii Sanderson) (Siphonophora avenae Thos. in part). Pergande, 1904a, p. 8.
Siphonophora cerealis Koch (Aphis cerealis Kalt.) (A. avenae Walker *non* Schrank). Passerini, 1863, p. 12.
Toxoptera graminum Rondani. Hunter, 1909, p. 102.
Tychea trivialis Pass. Kaltenbach, 1874, p. 753.

T. sp.

Aphis cerealis Kalt. Kaltenbach, 1874, p. 744.
Aphis dirroda Walker . Walker, 1849a, p. 43.
Aphis glyceriae Kalt. Kaltenbach, 1874, p. 744.
Aphis maidi-radicis Forbes. Davis, 1909b, p. 124.
Aphis mali Linn. Williams, 1891, p. 26.
Aphis sp. Williams, 1891, p. 26.
Brachycolus tritici Gillette. Davis, 1910b, p. 414.
Callipterus sp. Williams, 1891, p. 26.
Colopha rossica Chol. Cholodkovsky, 1897, pp. 1-3.
Endeis bella Koch. Kaltenbach, 1874, p. 744.
Megoura sp. Williams, 1891, p. 26.
Rhopalosiphum sp. Williams, 1891, p. 26.
Sipha (*Chaitophorus*) *flava* Forbes. Davis, 1909b, p. 157.
Toxares sp. Williams, 1891, p. 27.
Tychea eragrostidis Pass. Lichtenstein, La Flore.
Tychea amycli Koch. Kaltenbach, 1874, p. 744.

ZEA.

Z. Mays L. Maize. Indian Corn.

Aphis maidi-radicis Forbes. Davis, 1909b, p. 124.
Aphis maidis Fitch. Davis, 1909b, p. 145. Patch, 1912c.
Aphis papaveris Fab. (A. fabae Scopoli) (A. aparines Schrank). Passerini, 1863, p. 46.
Aphis zeae Bonafous. Lichtenstein, 1885.
Forda occidentalis Hart. Hart, 1891 and 1892, p. 95.
Geoica squamosa Hart. Hart, 1891 and 1892, p. 99.
Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 35. Patch, 1912c.
Pemphigus boyeri Pass. (A. radicum Boyer) (Amycla fuscifrons Koch). Passerini, 1863, p. 76.
Pemphigus (*Amycla*) *fuscifrons* (Koch) (P. boyeri Pass.) (P. zeae maidis Löw?) (A. radicum Boyer?). Buckton, 3, p. 116.
Rhizobius spicatus Hart. Hart, 1891 and 1892, p. 104.
Rhopalosiphum diantri (Schrank). Williams, 1891, p. 9.
Sipha (*Chaitophorus*) *flava* Forbes. Davis, 1909b, p. 157.
Sipha maydis Pass. Ferrari, 1872, p. 78.
Tetraneura ulmi De Geer (Coccus zeae maydis Dufour) (Pemphigus fuscifrons Buckton) (P. saccharata Del Guercio). Del Guercio, 1900, p. 93.
Toxoptera graminum Rondani. Hunter, 1909, p. 102.
Trama erigeronensis Thos. (Tychea radicola Oestlund). Hart, 1891 and 1892, p. 93.
Tychea brevicornis Hart. Hart, 1891 and 1892, p. 97.
Tychea setariae Pass. Passerini, 1860, p. 40.

GRAMINEAE.

G. sp.

Atheroides serrulatus Haliday. Haliday, 1839, p. 189.
Forda formicaria Heyden (vacca Hartig). Schouteden, 1906a, p. 193.

Forda formicaria Kalt. Koch, p. 309.
Forda marginata Koch. Koch, p. 311.
Paracletus cimiciformis Heyden. Schouteden, 1906a, p. 200.
Schizoneura corni var. *venusta* Passerini. Schouteden, 1902, p. 137.
Siphonophora dirhoda Walker. Theobald, 1911, p. 17.
? *Tetraneura coerulescens* Pass. Schouteden, 1902, p. 138.
Tetraneura setariae Passerini. Schouteden, 1902, p. 138.
Tychea graminis Koch. Koch, p. 298.

CYPERACEAE. SEDGE FAMILY.

CAREX. Sedge.

C. arenaria Linn.
Aphis bufo Walker. Walker, 1848b, p. 46.
C. dioica L.
Endeis formicina Buckton. Buckton, 4, p. 91.
C. Nebraskensis.
Brachycolus ballii Gillette. Gillette, 1908a, p. 67. Gillette, 1909c, p. 119.
C. pseudocyperus L.
Aphis caricis Schouteden. Schouteden, 1906a, p. 218.
C. sp.
Callipterus flabellus Sanborn. Gillette, 1909c, p. 120.
Carolinaia caricis Wilson. Wilson, 1911, p. 62.
Forda formicaria Heyden. Schouteden, 1902, p. 137.
Toxoptera caricis Fullaway. Fullaway, 1909, p. 33.

CYPERUS. Galingale.

C. laevigatus L. (distachyos).
Aphis papaveris Fab. Macchiati, 1883, p. 256.
Aphis polyanthis Sulzer (A. tuberosae Boyer). Macchiati, 1883, p. 256.
C. rotundus L. Nut Grass.
Aphis papaveris Fab. Macchiati, 1883, p. 256.
Myzocallis cyperis Macchiati. Macchiati, 1883, p. 259.
C. virens Michx.
Geoica cyperi Schouteden. Schouteden, 1902, p. 138.
C. sp.
Aphis cyperi Walker. Walker, 1848b, p. 45.

ERIOPHORUM. Cotton Grass.

E. vaginatum L.
Hyalopterus eriophori (Walker) Haliday. Buckton, 2, p. 117.

SCIRPUS. Bulrush.

S. cernuus Vahl. (Savii).
Toxoptera scirpi Pass. Macchiati, 1883, p. 237.
S. lacustris L.
Toxoptera scirpi Pass. Passerini, 1874, p. 1.

PALMAE.

CALAMUS.

C. sp.
Cerataphis lataniae Lichtenstein. Lichtenstein, La Flore.

LATANIA.

L. Commersonii J. F. Gmel. (borbonica) (rubra).
Cerataphis lataniae Licht. (Coccus? lataniae Boisduval 1867) (Boisduvalia lataniae Signoret 1868) (Asterolecanium orchidearum Westwood 1879) (Ceratovacuna brasiliensis Hempel, 1901). Embleton, 1903, p. 91.

PRITCHARDIA.

P. sp.
Cerataphis lataniae (Boisd.) Licht. Fullaway, 1909, p. 46.

ARACEAE. ARUM FAMILY.

ACORUS. Sweet Flag.

A. Calamus L.
Rhopalosiphum nymphaeae (L.) Koch. (A. butomi Schrank) (R. najadus Koch). Passerini, 1863, p. 21.

AMORPHOPHALLUS.

A. sp.
Siphonophora circumflexus Buckton. Lichtenstein, Flore Supplement.

ARUM.

A. esculentum Linn. See Colocasia antiquorum.
A. italicum
Rhopalosiphum nymphaeae (Linn) Koch. Macchiati, 1883, p. 233.
A. sp.
Siphonophora circumflexa Buckton. Theobald, 1911, p. 17.

CALADIUM. See Colocasia.

CALLA. Water Arum.

C. Indica.
Rhopalosiphum dianthi (Schrank) (R. callae Koch. in litt.) Koch, p. 43.
C. sp.
Siphonophora malvae Mosley. Lichtenstein, Flore Supplement.

COLOCASIA.

C. Antiquorum (esculenta) Schott.
Aphis gossypii Glover. Fullaway, 1909, p. 40.
Aphis malvae (Walker). Williams, 1891, p. 8.
Rhopalosiphum dianthi (Schrank). Williams, 1891, p. 8.

RICHARDIA.

R. Africana Kunth (Aethiopica). Calla Lily.
Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 35.
Rhopalosiphum nymphaeae Linn. Davis, 1910a, p. 245.
R. sp.
Rhopalosiphum dianthi Schrank. Williams, 1891, p. 8.

LEMNACEAE. DUCKWEED FAMILY.

LEMNA. Duckweed.

L. gibba L.
Rhopalosiphum nymphaeae (Linn.) Koch. Buckton, 2, p. 13.
L. minor L.
Rhopalosiphum nymphaeae Linn. Williams, 1891, p. 10.
L. polyrrhiza Linn.
Rhopalosiphum nymphaeae Linn. Williams, 1891, p. 10.
L. sp.
Rhopalosiphum nymphaeae Linn. (Aphis aquaticus Jackson). Davis, 1910a, p. 245.

PONTEDERIACEAE. PICKEREL-WEED FAMILY.

PONTEDERIA. Pickerel-weed.

P. sp.
Rhopalosiphum nymphae Linn. Lichtenstein, Flore Supplement.

JUNCACEAE. RUSH FAMILY.

JUNCUS. Rush.

J. articulatus L.
Atheroides hirtellus Haliday. Haliday, 1839, p. 189.
J. lampocarpus Ehrh. (lamprocarpus).
Aphis glyceriae Kalt. Kaltenbach, 1874, p. 751.
J. sp.
Rhopalosiphum nymphaeae Linn. Williams, 1891, p. 16.
Sipha glyceriae (Kalt.). Patch, 1910b, p. 242.

LUZULA. Wood Rush.

L. albida DC.
Aphis luzulae Kalt. Kaltenbach, 1874, p. 726.

LILIACEAE. LILY FAMILY.

ALLIUM. Onion.

A. sp.
Aphis allii Licht. (ined.). Lichtenstein, La Flore.

ASPARAGUS.

A. officinalis L. Garden Asparagus.
Aphis indistincta Walker. Walker, 1849c, p. 46.

Aphis rumicis Linn. (? aquilegiae nigra Kittel) (atriplicis Fabricius) (armata Hausman) (aparines Schrank) (dahliae Mosley) (evonymi Fabricius) (fabae Scopoli) (hortensis Fabricius) (papaveris Fabricius) (? solani Kittel) (thlaspeos Schrank). Schouteden, 1906a, p. 227.

Rhopalosiphum dianthi (Schk.). Williams, 1891, p. 5.

A. plumosus Baker.

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

A. sp.

Aphis papaveris Fab. Kaltenbach, 1874, p. 723.

Myzus mahaleb (Boyer) (Phorodon humuli var. mahaleb Buckton) (Ph. mahaleb Monell) (? Siphonoprora achyrantes Monell). Hunter, 1901, p. 108.

Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 35.

FUNKIA.

F. subcordata Spreng.

Aphis polyanthis Sulzer. (A. tuberosae Boyer). Passerini, 1863, p. 41.

HEMEROCALLIS. Day Lily.

H. sp.

Aphis sambuci Auct. Kalt. Ferrari, 1872, p. 71.

HYACINTHUS.

H. orientalis L.

Rhopalosiphum dianthi (Schrank) Koch. (persicae, Puceron du pecher Morren) (rapae Curtis, floris rapae Curtis, dubia? Curtis) (vastator Smee) (persicaecola Boisduval) (persicae Pass. *not* Sulzer, *not* Boyer, *not* Kalt.). Buckton, 2, p. 17.

Rhopalosiphum persicae (Sulzer) Pass. (A. dianthi Schrank) (A. vulgaris Kyber) (A. rapae Curtis) (A. dubia Curtis) (A. vastator Smee). Passerini, 1863, p. 20.

LILIUM. Lily.

L. candidum L.

Aphis lilicola Williams. Williams, 1910 (1911), p. 44.

Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 35.

L. sp.

Aphis lilii Licht. (ined.). Lichtenstein, La Flore.

Rhopalosiphum dianthi (Schrank). Williams, 1891, p. 16.

Siphonophora lilii Monell. Comstock, 1879 (1880), p. 221.

RUSCUS.

R. androgynus. See Semele androgyna.

SEMELE.

S. androgyna Kunth. (Ruscus androgynus).
Aphis dianthi Schrank. Walker, 1850a, p. 394.

SMILAX. Green Brier.

S. herbacea L. Carrion flower.
Pemphigus attenuatus Osborn (*Lachnus smilacis* Williams.) Williams, 1910, p. 25.
S. rotundifolia L. Common Green Brier. Horse Brier.
Neoprociphilus attenuatus (Osborn & Sirrine). Patch, 1912c.

TULIPA.

T. Gesneriana L.
Rhopalosiphum dianthi (Schrank). Williams, 1891, p. 25.
Rhopalosiphum tulipae Thomas. Thomas, 1879, p. 80.
Siphonophora tulipae Monell. Williams, 1891, p. 25.
T. sp.
Aphis tulipae Boyer. Lichtenstein, La Flore.
Macrosiphum tulipae Monell. Davidson, 1910, p. 380.
Myzus persicae (Sulzer). Gillette and Taylor, 1908, p. 35.
Rhopalosiphum dianthi (Schrank) Koch (persicae, Puceron du pecher Morren) (rapae Curtis) (A. floris rapae Curtis) (dubia? Curtis) (persicaecola Boisduval) (Rh. persicae Pass.). Buckton, 2, p. 17.
Rhopalosiphum persicae (Sulzer) Pass. (A. dianthi Schrank) (A. vulgaris Kyber) (A. rapae Curtis) (A. dubia Curt.) (A. vastator Smee). Passerini, 1863, p. 20.

VERATRUM. False Hellebore.

V. album L.
Aphis veratri Walker. Walker, 1852, p. 1041.
V. Californicum Durand.
Aphis veratri Cowen. Cowen, 1895, p. 122.
V. sp.
Aphis veratri Cowen. Cockerell, 1903b, p. 114.
Aphis veratri Walker. Kaltenbach, 1874, p. 719.

YUCCA. Bear Grass.

Y. glauca Nutt. (angustifolia).
Aphis yuccae Cowen (yuccicola Williams?). Cowen, 1895, p. 122.
Aphis yuccicola Williams. Williams, 1910 (1911), p. 62.
Y. sp.
Aphis yuccae Licht. (ined.). Lichtenstein, La Flore.
Myzus roseum Macchiati. Lichtenstein, Flore Supplement.
Myzus rubrum Macchiati. Del Guercio, 1900, p. 151. Macchiati, 1883, p. 236.

ZYGADENUS.

Z. Nuttallii Coult.
Nectarophora martini Cockerell. Cockerell, 1903a, p. 170.

LILIACEAE.

L. sp.
Aphis sinensis Del Guercio. "Sopra un Giglio della China non ancora classificato." Del Guercio, 1900, p. 137.

DIOSCOREACEAE. YAM FAMILY.

DIOSCOREA. Yam.

D. bulbifera L. Air (Aero) Potato.
Aphis minuta Wilson. Wilson, 1911, p. 60.

AMARYLLIDACEAE. AMARYLLIS FAMILY.

AGAVE. American Aloe.

A. sp.
Aphis sambuci Auct. Kalt. Ferrari, 1872, p. 71.

NARCISSUS.

N. sp.
Aphis dianthi Schrank. Walker, 1850a, p. 394.
Rhopalosiphum persicae Sulzer. Lichtenstein, La Flore.

POLIANTHES.

P. tuberosa L. Tuberose.
Aphis polyanthis Sulzer. (A. tuberosae Boyer). Passerini, 1863, p. 41.
Rhopalosiphum dianthi (Schrank). Williams, 1891, p. 25.

IRIDACEAE. IRIS FAMILY.

CROCUS.

C. sp.
Rhopalosiphum dianthi (Schrank) Koch (persicae, Puceron du pecher, Morren) (rapae Curtis) (A. floris rapae Curtis) (dubia? Curtis). (vastator Smee) (persicaecola Boisduval). Buckton, 2, p. 17.
Rhopalosiphum persicae Sulzer. Lichtenstein, Flore Supplement.

GLADIOLUS.

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

G. sp.

Aphis gladioli Felt. Felt, 1908 (1909), p. 19. Patch, 1912c.
Aphis rumicis Linn. Patch, 1912c.
Macrosiphum solanifolii Ashmead. Patch, 1912c.
Myzus achryrantes Monell. Sanborn, 1904, p. 71.

IRIS. Fleur-de-lis.

I. florentina L.

Aphis iridis Del Guercio. (A. cirsii? Pass.) (A. candicans Pass?) Del Guercio, 1900, p. 129.

I. pumila L.

Rhopalosiphum dianthi (Schrank). Williams, 1891, p. 16.

I. sp.

Macrosiphum solanifolii Ashmead. Patch, 1912c.

SPIRAXIS.

S. sp.

Siphonophora circumflexa Buckton. Buckton, 1, p. 131.

MUSACEAE.

MUSA.

M. Ensete J. F. Gmel.

Aphis musae Schouteden. Schouteden, 1906a, p. 223.

M. sapientum L. Banana.

Pentalonia nigronervosa Coquerel. Wilson, 1909b, p. 346.

CANNACEAE.

CANNA.

C. indica L.

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

ORCHIDACEAE. ORCHIS FAMILY.

CATTLEYA.

C. Loddigesii Lindl. (Harrisoniana).

Cerataphis lataniae Licht. (Coccus? lataniae Boisduval 1867) (Boisduvalia lataniae Signoret 1868) (Asterolecanium orchidearum Westwood 1879) (Ceratovacuna brasiliensis Hempel 1901). Embleton, 1903, p. 94.

COELIA.

C. albiflora.

Cerataphis lataniae Licht. (Coccus? lataniae Boisduval 1867) (Boisduvalia lataniae Signoret 1868) (Asterolecanium orchidearum Westwood, 1879) (Ceratovacuna brasiliensis Hempel, 1901). Embleton, 1903, p. 94.

CORALLORHIZA. Coral Root.

C. multiflora Nutt.

Nectarophora corallorhizae Cockerell. Cockerell, 1903a, p. 167.

CYPRIPEDIUM. Lady's Slipper.

C. sp.

Cerataphis lataniae Licht. (Coccus? lataniae Boisduval, 1867) (Boisduvalia lataniae Signoret, 1868) (Asterolecanium orchidearum Westwood, 1879) (Ceratovacuna brasiliensis Hempel, 1901). Embleton, 1903, p. 92.

DENDROBIUM.

D. sp.

Cerataphis lataniae Licht. (Coccus? lataniae Boisduval, 1867) (Boisduvalia lataniae Signoret, 1868) (Asterolecanium orchidearum Westwood, 1879) (Ceratovacuna brasiliensis Hempel, 1901). Embleton, 1903, p. 92.

EPIDENDRUM.

E. sp.

Cerataphis lataniae Licht. (Coccus? lataniae Boisduval, 1867) (Boisduvalia lataniae Signoret, 1868) (Asterolecanium orchidearum Westwood, 1879) (Ceratovacuna brasiliensis Hempel, 1901). Embleton, 1903, p. 94.

OPHRYS.

O. aranifera Huds.

Myzus cerasi Fab. Macchiati, 1883, p. 234.

SOBRALIA.

S. sp.

Cerataphis lataniae Licht. (Coccus? lataniae Boisduval, 1867) (Boisduvalia lataniàe Signoret, 1868) (Asterolecanium orchidearum Westwood, 1879) (Ceratovacuna brasiliensis Hempel, 1901). Embleton, 1903, p. 92.

ORCHIDACEAE.

O. sp.

Siphonophora lutea Buckton. Buckton, 1, p. 120.

PIPERACEAE. PEPPER FAMILY.

SAURURUS. Lizard's Tail.

S. cernuus L.

Rhopalosiphum nymphaeae (L.) Koch (A. butomi Schrank) (R. najadum Koch). Passerini, 1863, p. 21.

ADDENDA.

The succeeding Parts of this Food Plant List are ready for press and will be published from time to time as opportunity offers. At their conclusion will be given the Bibliography of all references indicated, a Plant Index including genera and common names, and an Aphid Index arranged alphabetically according to the specific names which will serve as a check list to the Aphids of the World.

NOTES ON PSYLLIDAE:*

EDITH M. PATCH.

The present paper is a record of species many of which have been kindly lent me for study. For the most part the available data are very meagre and for this reason the accession numbers are usually given together with what collection notes have been preserved, in the hope that more biological information may be added by others. Detailed descriptions have been avoided as the distinguishing characters are shown more clearly in the illustrations.

Lot 1339 includes those specimens lent by Cornell University; Lot 1347, by Doctor C. Gordon Hewitt; Lot 1348, by Professor C. P. Gillette; Lot 1440, by Doctor W. E. Britton.

APHALARA.

Very little biological information concerning the species *Aphalara* in this country seems to be available. It is possible that when more collections of the nymphal stages have been made with the accompanying host plant data the species will be more easily defined. But at present from large series of specimens in several widely separated collections it has not been apparent to me in all cases which variations are of specific and which of individual significance. The shape of the wing from elongate to rotundiform; the breadth of the arch of Cu; the length of the branches of M; the presence, absence or degree ot wing maculation; the length of the caudal segment of the female; all these are certainly subject to much individual variation in closely allied species and the resulting confusion indicates that systematic work with this group should be undertaken only when a background of ecological data is at hand.

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* Papers from the Maine Agricultural Experiment Station: Entomology, No. 55.

A few species are placed on a dependable footing, however. Mally separated a *Rumex* species from a *Polygonum* species (1894-95) and gave characteristic figures of immature stages as well as excellent figures of the wings which clearly distinguish the two species he discusses. In order to avoid reverting to previous mix-ups including these species, I have chosen to attempt to trace them no farther back than Mally's paper.

Aphalara polygoni Mally (Foerster?)

On October 18, 1911, large numbers of nymphs and adults were found on *Polygonum* along the Stillwater river at Orono. The nymphs were most numerous at the leaf axle. Many of the pupæ present molted after they were collected so that bred material was obtained. Both the nymphs and adult specimens accord exactly with the *Polygonum* species figured by Mally. Lot 1341 Sub 7. Figures 370, 379, 383 and 387.

Crawford (1911) follows Loew in his synonomy for the *Polygonum* of Foerster. Material already determined as *calthae* in the collections I have worked over I have left as such with due respect for that determination. Enough variation is present, however, among these specimens to make me hesitate in absence of authentic host plant data to merge the *polygoni* of Mally with them. Figures 364, 378, 382, and 384, represent named *"calthae"* from the Colorado collection. Lot 1348 Sub 53, and Sub 47.

Literature.

1894 ('95) Mally, C. W. Psyllidae found at Ames, Iowa. Proc. Iowa Acad. of Sc., Vol. II. Plate XV. Figs. 1, 2, 3, Plate XVII. Figs. 3.

1911 Crawford, D. L. American Psyllidae IV. Pomona Journal of Entomology, Vol. III, p. 495.

Aphalara nubifera sp. nov.

Ten specimens are at hand with data "Ft Collins Col., 6-13-99. Foothills, C. P. G. On *Sisymbrium canescens*, causing abnormal development of foliage in dense mass." This collection can be separated from the *polygoni* by slight differences only for the two are certainly very closely allied. The head and genitalia of both sexes resemble those of *polygoni*, though there are distinctions. The forceps of the male are longer and the smaller of the two terminal tooth-like projections is at a slightly greater distance from the tip in *nubifera* and the female genital segment is relatively longer, the lower plate being subequal to the two preceding segments while in *polygoni* it is subequal to but the one preceding segment.

The wing of *nubifera* is broader than that of *polygoni* and the cloudiness of the wings is differently disposed. Lot 1348 Sub 48. Figure 369.

Aphalara rumicis Mally.

Lot 1341 Sub 6 was collected at St. Louis, Mo., Sept. 22, 1911, by Mr. J. T. Monell who says of them;—"On *Rumex*, the broad leaved common one, I found a colony curling the leaves longitudinally into a pseudogall which turned scarlet—from these I reared a few which I mail to you."

This species is closely allied to those developing on *Polygonum* and *Sisymbrium*, Mally's description and figures definitely and sufficiently characterize the nymphs. The specific characters of the wing and forceps are shown in figures 372 and 377.

LITERATURE.

1894 ('95) Mally, C. W. Psyllidae found at Ames, Iowa. Proc. Iowa Acad. of Sc., Vol. II, p. 166. *A. exilis* Web. and Mohr., var, *rumicis*, var nov.

1911 Crawford, D. L. American Psyllidae IV. Pomona Journal of Entomology, Vol. III, p. 496. *A. calthae maculipennis* Loew.

Aphalara picta Zetterstedt.

A large species with wing 3.55 mm. long in the Colorado collection I take to be *picta* as figured by Crawford (1911). Figures 380, and 388 represent the forceps and the caudal segment of the female. Lot 1348 Sub 29.

LITERATURE.

1911 Crawford. Pomona Journal of Entomology, Vol. III, p. 501.

Aphalara fascipennis sp. nov.

Collections from Canada and New York are at hand of a beautiful species which comes close to *picta*. The genitalia of both sexes resemble *picta* closely. The abdomen of the male is constricted just cephalad the genital segment which is large and prominent; the forceps are long and from the lateral aspect are spatulate and attenuate at base; the lateral arms are long and tapering. The wing is broad and rotund and is decorated with a dusky band. Figure 366. Lot 1347 Sub. 30 includes 21 specimens with data "Ottawa, Ont. 7-VI-1903 B. Meadow—W. Metcalfe," and 3 specimens with data "27-VI-1903, W. Metcalfe." Lot 1339 and Sub. 24 includes 3 males with data "17-20 June, 1904. Mud Creek, Tompkins Co., N. Y."

The early stages are not known and the food plant is not recorded.

Aphalara artemisiae angustipennis Crawford.

This species as it exists in collections has a puzzling range of variation which biological data may sometime help to clear up. Fgures 363, 375, 376, and 386 are photographs of apparently typical details.

LITERATURE.

1911 Crawford, D. L. Pomona Journal of Entomology, Vol. III, p. 499.

Aphalara communis Crawford.

Figures 365, 374, and 389 show a species as maddening in its elastic variations as *artemisiae*. This is close to *veaziei* Patch and biological data are needed to put on a satisfactory basis either many closely allied species or a few species with a broad and catholic taste in variation.

Aphalara sp.

Figures 371 and 390 represent collections with rotundiform wings that merge by gentle degrees too nearly with the *communis* group to deal with in the absence of biological information.

Aphalara sp.

In the other direction traveling toward narrow winged specimens with long branches of M and Cu is a series which also is too flexible to separate satisfactorily and treat until ecological information is forth coming An extreme of this series is represented by figures 367, 373 and 381.

Aphalara nebulosa americana Crawford.

This pretty winged species is easily distinguished from the other species of the genus mentioned in this paper by the lateral arms of the male genitalia. Figures 368 and 385 represent details of Lot 1348 Sub 65 with data "Colo. 2204. 7-4-96. Larimer Col. C. P. G."

LITERATURE.

1911 Crawford, D. L. Pomona Journal of Entomology, Vol. III, p. 503.

PSYLLA.

Psylla annulata Fitch

The "Annulated Psylla" of Fitch can not possibly be a variety of *carpini*. The most conspicuous characteristic of this straw-yellow species on maple is the ringed appearance of the black and yellow antennae. The original description is certainly meagre but applies perfectly so far as it goes to this common maple species and not to the species occuring on horn beam.

A large collection from Rock maple *Acer saccharum* Marsh was made at Middletown, Conn., in May, 1911. The nymphs were sometimes on the upper side of leaf but occurred most numerously on the under side of the leaves and are nearly a leaf green in color. They were collected at various times from May 17-31. The adults are paler than the nymphs and were abundant May 30-31.

Me. 1345 Sub 2. Numerous nymphs, pupæ and adults, collected by Mr. William C. Woods at Middletown, Conn., from Rock Maple, *Acer saccharum* Marsh. Figs. 395, 411, 421.

Me. 1347. Sub 29. One male with data "Ottawa, Ont. 14-VI-1903. W. Metcalfe."

Me. 1347. Sub 40. Fourteen specimens with data "Ottawa, Ont. 14-VIII-1904. W. Metcalfe, B. Meadow, Maple, and one specimen with data "Ottawa, Ont. I-VII-1904. W. Metcalfe."

LITERATURE.

1851 Fitch, Asa. Catalogue, with references and descriptions of the insects collected and arranged for the State Cabinet of Natural History. *"Annulated Psylla, * P. annulata.* Straw-yellow; legs white; elytra hyaline, nerves straw yellow; antennæ black, basal half straw-yellow annulated with black. Length, 0.15. Occurs on the sugar-maple. No. 834, male; 835, female."

1881 Ashmead, Wm. H. Can. Ent. Vol. 13, p. 222. Listed.
1890 Packard, A. S. Forest Insects, p. 417. Listed.
1893 Riley, C. V. in Lintner IX, p. 411, "Probable var. carpini."
1894 Mally, C. W. Pro. Iowa Acad. Sc., Vol. 2, p. 153. Listed. Fig. 4, Plate 16.
1906 Felt, E. P. Woodland Trees II, p. 728.
1909 ('10) Smith, J. B. Insects of N. J., p. 109. Listed.

Psylla negundinis Mally.

This species is certainly closely allied to *annulata* Fitch and the differential characters seem difficult to define. Mally, however, does not mention nor figure the antennal stripes characteristic of *annulata* as being present in *negundinis* and the pinned material in the collections at hand ofthis species do not show annulated antennae. Figures 393, 409, and 420 picture the head, wing and forceps of this species.

Me. 1339 Sub 46. Two specimens with data "Colo. 1605. Cornell U. Lot. 157. Sub 35. Received by exchange from Carl F. Baker."

Me. 1348 Sub 11. One female with data "Colo. 1981. 9-2-95. Ft. Collins C. P. G.," and one female with data "Colo. 1769, 9-26-94. C. F. B. Ft. Collins, on Box Elder."

Me. 1348 Sub 18. Five specimens with data "Colo. 1979. 9-31-95 Ft. Collins C. P. G. on Box Elder," and one specimen with data "Colo. 1769. 9-26-94. C. F. B. Ft. Collins. On Box Elder."

Me. 1348 Sub 24. One male with data "Colo. 1915. 7-5-94. Santa Fe. N. M., T. D. A. Cockerell."

Literature.

1894 (1895) Mally, C. W. Proc. Acad. of Sci., Vol. 2, p. 155.

Psylla breviata n. sp.

Three females with data "Ottawa, Ont. Dows Swamp. 14-VI-1903 W. Metcalfe" comprise Me. 1347 Sub 36. The host-plant is not yet known.

This species comes close to *annulata* and *negundinis* both in wing and cauda of female. The antennae are short, joints 3 to 10 inclusive being subequal to width of cephalic aspect of head across the eyes. The frontal cones are rather straight at their medial margin but curved along the lateral edge. The head, wing and cauda are given in figures 397, 405, and 424, and will serve to make the species recognizable until enough ecological information is obtained to make this species deserving of more attention.

Psylla gilletti n. sp.

Psylla gilletti Riley, MS. seems to be well represented in collections though not accompanied by ecological data. The wing is characterized by the short acute stigma, the distinct heavy dark spot between tip of clavûs and margin of wing, and the four distinct linear dark marginal dashes as indicated in Fig. 396. The head of the female is well represented in Fig. 414. The female cauda (Fig. 428) is rather heavy and about subequal in length to the two preceding segments The male forceps (Fig. 422) end in two short rather blunt projections and the terminal inner setal spines are strong and stiff.

Me. 1339 Sub 42. One specimen with data "Colo. 1456. Cornell U. Lot 157. Sub 33. Psylla ribis Riley MS. Received by exchange from Carl F. Baker."

Me. 1348 Sub 6. One female with data "*Psylla gilletti* Riley MS. Colo. 1887, 6-11-95. Ft. Collins, C. P. G." One female with data "Colo. 2078, 4-22-96, C. P. G. Ft. Collins."

Me. 1348 Sub 20. One specimen with data "Onagra Ks. 5-26-92, C. P. G. Trinidad, Colo. *Psylla gilletti* Riley, MS." One specimen with data "464 Onagra Ks. 5-27-92, C. F. B." One specimen with data "Colo. 427. 5-19-92 Soldier Canyon, Colo. C. P. G." One specimen with data "Col. Ac. Cat. 28. Mrs. P. Gillette, Ft. Collins." Twenty-two specimens with data "Colo. 2075 4-22-96. C. P. G. Horse tooth Gulch (near Ft. Collins) Bloom of Salix." One specimen with data "Colo. 1887. 6-11-95 Ft. Collins. C. P. G." Two specimens with data "Colo. 2078. 4-22-96 C. P. G. Ft. Collins. Two specimens with data "Colo. 2195. 7-4-96 Larimer County C. P. G. One specimen with data "Colo. 2096. 5-9-96. Dixon Canyon (near Ft. Collins) C. P. G." One specimen with data "Colo. 2805. 10-22-97, Belvue, Colo. Emma Gillette." One specimen with data "Colo. 2138. 6-15-96 Camp Carter, Colo. C. P. G. One specimen with data "Colo. 2094. 5-7-96 Howes Gulch (near Ft. Collins) C. P. G." One specimen with data "Ft. Collins, Colo. 6-17-'99 E. D. Ball, Horsetooth Gulch."

Psylla pyricola.

This economic species was present in large number in 1910 upon pear in Camden, Maine. The leaves were badly discolored. Figures 398 and 434 show the wing and male cauda of this insect. Me. 1326 Sub 4.

LITERATURE (for America).

1884	Riley, C. V. Pro. Biol. Soc. Wash. Vol. 2.
1892	Slingerland, M. V. Bul. Cornell Univ. No. 44.
1893	Riley and Howard Insect Life, Vol. 5, p. 226.
1893	Lintner 9th Rept. p. 317.

1894 ('95) Mally Proc. Iowa Acad. Sci. Vol. 2, p. 153, Listed.
1895 Marlatt, C. L. U. S. D. A. B. E. Circ. No. 7.
1896 Smith, J. B. Economic Entomology, p. 137.
1909 (1910) Smith, J. B. Insects of New Jersey, p. 109. Listed.
1911 Patch, Edith M. Me. Agr. Exp. Sta. Bul. No. 187, p. 11. Recorded for Maine.

Psylla ribis n. sp.

Psylla ribis Riley, MS. is a species existing numerously in collections under its manuscript name. The wing (Fig. 392) is immaculate and the vein and stigma rather heavy. The head (Fig. 407) is with prominent eyes, moderately long antennæ and the cones subequal in length to the third antennal segment. The caudal segment of female (Fig. 430) is thick at base and about equal in length to the other abdominal segments. The upper plate is straight along dorsal line and is much longer than the lower plate. The male forceps (Fig. 417) are erect and simple with hairs very short, sparse and inconspicuous. There seem to be no food plant records available but the name is suggestive.

Me. 1348 Sub 7. One specimen with "Psylla ribis Riley, MS. Colo. 1556."

Me. 1348 Sub 25. Specimens with data "Marsll. Pas. Col. 8-27-99." "Ft. Collins, Col. 4-21-99," "Colo. 2074," "Colo. 2094," "Colo. 2204."

Psylla brevistigmata n. sp.

Two specimens in the Cornell collection which bears data "Alta Meadows Seq. Nat. Park, Cal. 19 July 1907. 9,000 ft. J. C. Bradley," seem distinctive enough to describe as new. The cauda (Fig. 427) is about the length of two preceding segments. The upper plate is thickly armed with short stout conical setulæ and scattered with a few long setæ. The facial cones are swollen at base and very divergent with rounded tips. Fig. 413. The broad wings are pale with pale shading (not heavy) along tips of veins. The stigma is broad at proximal edge but narrows suddenly and acutely as is shown in Fig. 399. Me. 1339 Sub 31.

Psylla hartigii Flor?

A species common on birch (*Betula populifolia*) in the vicinity of Orono comes too near to *hartigii* Flor as characterized by Sulc (1910) to descibe as new. Me. 1340 Sub 1 comprised

2 females collected from birch June 15, 1911; Lot 1340 Sub 2 comprised 4 males and 20 females collected from birch July 1, 1911; Lot 1340 Sub 7 was a collection of 2 females taken with *P. striata* on birch June 25, 1910.

The antenna is conspicuously shorter than in *galeaformis;* and the wings are yellow. The caudal segment of female is much like *galeaformis* except for the constant downward curve of the long upper plate. Figs. 394, 408, 423, 429, 432, and 433, sufficiently characterize this species to prevent its confusion with other birch psyllids in this country. The nymphs were not taken.

LITERATURE.

1910 Sulc, Dr. Karel. Prispevky Ku Poz nani Psyll. Tab. XII.

Psylla cerasi n. sp.

A species new to this country and for which I can find no place in European records, was taken on September 14, 1911, at Stillwater, Me., on wild cherry. Psyllid eggs, probably of this species were found on the same date tucked between leaf bud and twig of the same little tree.

This brilliant species had dorsal head and thorax rosy, dorsal abdomen almost vermillion, a black spot on dorsum of 1st abdominal segment, 5 vivid black transverse bands across the abdominal dorsum, the last coming just cephalad the genital segment. Antennal joints I, II, III rosy, rest black. Eyes bright black and bulging to width of thorax or slightly more. Wings clear and a little brownish. Ventral body pale.

A female distended with eggs had a total length, exclusive of wings and antennæ, of 3.8 mm. The wing (Fig. 400) with M and Rs approximating to give a pinched appearance. Wing without stigma. Head (Fig. 412) with large triangular facial cones rather acute at tip. Antennal length more than 2 1-2 times the breadth of head. The caudal segment (Fig. 431) with upper plate armed with large short blunt setulæ which give it a distinctly noduled appearance. Me. 1341 Sub 4.

Psylla coryli n. sp.

A species under the manuscript name of *Psylla coryli* Riley, MS. is sufficiently characterized by distinct large tooth-like projections on the inner side of the male forceps (Fig. 419) to distinguish it from any other described species of America. The wing (Fig. 391) is heavily veined and darkly shaded especially near the veins. The head (Fig. 406) is probably better characterized by the accompanying illustration than by a description. Me. 1348 Sub 61 with data "Colo. 1114."

PACHYPSYLLA.

It is with reluctance that I name as new species of this group but without a certainty of linking them with the galls described by Riley it is apparently the only thing to do with collection specimens. The figures will characterize these species it is hoped, and later biological data will probably be forthcoming to throw a light on the synonomy. *Pachypsylla C. mammae* Riley seems to be common in collections. This species has been figured in detail by Stough (1910) so that nothing except a wing (Fig. 401) is given here, for the sake of comparison with the other species.

Pachypsylla tridentata n. sp.

A species easily characterized from other described species by the wings is here described as new. The wings (Fig. 402) have a row of irregular dark spots extending across the veins on distal third of wing. The branches of M and the approximate branch of the Cu are tipped with an angular mark which gives the wing the appearance of being decorated with three tridents. The head (Fig. 415) is characteristic of the genus with rounded lobes and short, stout antennæ. The female cauda (Fig. 425) is long and stout and is subequal in length to the four preceding segments. The male cauda (Fig. 437) is preceded by a short constriction. The forceps are shown in Fig. 418. Me. 1339 Sub 40 is a single specimen from the Cornell collection and Me. 1348 Sub 67 comprises 4 specimens with data "Colo. 2049, 3-4-96. Canon City, Colo. From galls on *Celtis*."

Pachypsylla dubia n. sp.

Specimens from *Celtis* galls in the Cornell collection agree with the description of *C. gemma* so far as the shape of the wing goes, but that species is characterized by Riley as having wings "uniformly immaculate" which precludes the finely but densely mottled wing of *dubia* (Fig. 404). The head (Fig. 416) has the broad rounded lobes and short antennae of the allied specimens.

Pachypsylla pallida n. sp.

Material bearing the data "Arizona C. U. Lot 34; Cornell U. Lot 45 Sub 469" is apparently a new *Pachypsylla*. The wing (Fig. 403) is wide at the basal third and broad for its length. It is more or less shaded especially at the distal marginal band, proximad which is a pale path extending transversely across the wing. From the form of both the wing and the head this species seems allied to *dubia* though easily distinguishable from it and the female cauda is also similar. The antenna is subequal in length to the width of the head across the eyes. The cones are broad and thick and bluntly rounded. (Fig. 410.) Me. 1339 Sub 51. Me. 1339 Sub 55 and 56.

TRIOZINAE.

Trioza aylmeriae sp. nov.

This species is easily distinguished from previously described members of this genus in America. The head (Fig, 330) is of an ordinary *Trioza* type with large divergent cones rather acutely rounded apically. The wing (Fig. 316) measures about 3 mm. in length, and is rather evenly elongate with tip rounded. They are clear and unmarked except for the three marginal spots common for this genus. The branches of M and Cu are relatively long.

The female caudal segment (Figs. 343 and 346) is large and the slender tip of the upper plate extends beyond the lower plate. The lateral arms of the male cauda (Fig. 345) are conspicuously long and heavily supplied with long setæ. The forceps are enlarged and blunt at the tip (Fig 344), Lot 1347 Sub 19. Eleven specimens with data, "Bilberry. Aylmer, Ottawa, Ont. 20-V 1906 W. Metcalfe."

Trioza collaris Crawford.

Lat 1348 Sub 74. A single female with data "Ariz. 2217, 5-20-96 Dr. R. E. Knize, Tuscon," is apparently *collaris* Crawford. The cauda is shown in Fig. 358 and the wing is not distinguishable from that of *longistylus* which is shown in Fig. 320. It measures about 3.5 mm.

LITERATURE.

1910 Crawford, D. L. American Psyllidae I, p. 229.
1910 Crawford, D. L. American Psyllidae II, p. 347.
1911 Crawford, D. L. American Psyllidae III, p. 435.

Trioza diospyri (Ashmead).

The head, wing and female cauda of this species are shown in Figs. 331, 318, and 357. The wing is clear with the veins slender and distinct. It measures about 3.8 mm. The three marginal dashes are especially narrow.

Lot 1339 Sub 47. One male and one female with the data "Trioza diospyra Le Baron? River Des Peres, St. Louis, Mo. June 2, '77. Persimmon. Cornell U. Lot 62. Collected by Theo. Pergande and determined by Uhler. Given J. H. C. by Pergande."

LITERATURE.

1881 Ashmead, Wm. H. Canadian Entomologist. Vol 13, p. 222. *Psylla diospyri.*
1894 ('95) Mally, C. W. Proceedings of the Iowa Academy of Sciences. Vol. 2, p. 154. *Trioza diospyri* Ashmead, listed.
1909 ('10) Smith, J. B. Insects of New Jersey, p. 110, listed.
1910 Crawford, D. L. American Psyllidae II, p. 352. *Trioza diospyri* Ashmead (*latipennis* Crawford.)

Trioza dubia sp. nov.

Lot 1339 Sub 17. Two females and one male with data "S. Francisco dunes. Cal. 11 Nov. 1907. Bradley." Lot 1339 Sub 19. One female lent by Cornell University with data "Berkeley, Cal. 5 Nov. '06. J. C. Bradley."

The name of this species indicates the amount known concerning it at time of description. The wing measures about 2.75 mm in length. It is clear and unmarked except for the three marginal dashes common in this genus. The venation as shown in Fig. 319 is much like that of *maura*. The head with moderately long dark facial cones contiguous in basal two-thirds, distal third divergent, subacute at tip, is of the same general type as *maura*. The caudal segment of male has long slender forceps strongly curved cephalad when viewed laterally.

The chief character separating these specimens from the spcies to which it seems to be very closely allied is the female cauda which terminates in a subacute tip, as shown in Fig. 352. There is a distinct downward curve of the distal portion of the upper plate.

Trioza forcipula sp. nov.

This species, like *dubia,* is apparently closely allied to *maura.* The head (Fig. 338) with moderately long dark cones subacute at tip, and the wings (Fig. 317) are especially like those of that species. Wing length about 2.75 mm. The female cauda (Fig. 355) is distinctive, both upper and lower plates being rather broad and elongate. The upper plate has a downward curve. The male (Figs. 342 and 350) has the forceps strongly bowed in caudal aspect with tip ending rather bluntly and highly chitinized. The inner surface is supplied with long but not comparatively heavy setæ, the terminal group, however, are stiff and approximate.

Lot 1339 Sub 21. One female with data "Ithaca, N. Y. 16 May 1900."

Lot 1347 Sub 22. One male and one female with data "Hull, Ottawa, Ont. 17-V-1903, W. Metcalfe." Two males with data "Hull, Ottawa, Ont. 26-VII-1903, W. Metcalfe." One female with data "Ottawa, Ont. 17-V-1903, W. Metcalfe." One female with data. "Ottawa, Ont. 29-V-1904, W. Metcalfe." One female with data, "Elm, Ottawa, Ont. 5-VI-1904, W. Metcalfe."

Lot 1348 Sub 72. Seven specimens with data "Ft. Collins, Col. 5-12-99, E. D. Ball."

Trioza longistylus Crawford.

This species is closely allied to *collaris* and in some characters hardly to be distinguished from it.

Figs. 320 and 361 show the wing and female cauda. The wing of specimens at hand is about 3.45 mm long.

The forceps of the male cauda are from the lateral aspect, long and slender and rather strongly curved cephalad. On the inner surface are two longitudinal ridges, one bearing relatively few pointed setæ and the other thickly set with several irregular rows of large flat blade-like setæ.

Lot 1339 Sub 14. One female with data "S. Francisco dunes, Cal. Nov. 11, 1907, Bradley."

Lot 1339 Sub 15. Two males and one female with data "Felton, St. Cruz Mts., Cal. 15-19, May, '07. 300-500 ft. Bradley."

Lot 1339 Sub 16. One female with data "Blue Lake, Hmbldt Co., Cal. July 20-27, 1907, Bradley."

LITERATURE.

1910 Crawford, D. L. American Psyllidae I, p. 233.
1911 Crawford, D. L. American Psyllidae III, p. 434.

Trioza marginata Crawford.

The head and female cauda of this species come exceedingly close to *T. maura*. The length of branches of M and Cu are different and a smoky caudal margin of the wing further characterizes this species. The wing specimen at hand is 2.85 mm long. Figs. 321, 332, and 360.

Lot 1348 Sub 75. Two females with data "Ariz. 2217. 5-20-96. Tuscon, Ariz. R. E. Kinze."

LITERATURE.

1910 Crawford, D. L. American Psyllidae I, p. 232.
1910 Crawford, D. L. American Psyllidae II, p. 356.

Trioza maura Foerster?

Twelve collections are either *maura* Foerster as figured by Sulc 1911 or remarkably close to that species. Included here are pale specimens with white faces and cones which are easily separated from black coned specimens in the collection by color characters, but as they show no specific structural differences I am of the opinion that the paler individuals are teneral and that the darker ones are those with a more mature coloring.

Wing measures about 2.85 mm in length. Figs. 322, 323, 337, 349, 351, 359. Fig. 322 is a wing taken from a specimen with black cones and Fig. 323 from one with white cones.

Lot 1339 Sub 18. One female with data "Mesa Grande Russian R. Cal. 30 Sept. '06. J. C. Bradley."

Lot. 1339 Sub 20. One female with data "Algonquin, Ill. 12 July 1895."

Lot 1348 Sub 38. Six specimens with data "Colo. 2220. 8-6-96. Ft. Collins C. P. G. Caught flying around light." Five specimens with data "Colo. 2199. 7-8-96, Larimer Co. C. P. G."

Lot 1348 Sub 76. Two females with data "Colo. 1680. *Trioza striola* Foerster." One female with data "Colo. 1681, 7-13-94. Steamboat Springs. C. F. Baker. On willow."

Lot 1348 Sub 77. One specimen with data "det. C. V. R. Colo. 1733. 7-12-94, C. P. G. Estes Park, Colo."

Lot 1348 Sub 78. Eight specimens with data "Colo. 2176. 7-18-96 Denver, C. P. G."

Lot 1348 Sub 79. Five specimens with data "Colo. 2173. 7-18-96. Denver, Colo. C. P. G. On willow. *Trioza* near *albiventris*." The facial cones of this lot were white.

Lot 1348 Sub 80. Two specimens with data "Colo. 2173. 7-18-96 Denver, Colo. C. P. G. On willow." The face and facial cones of this lot were black.

Lot 1348 Sub 81. Seven specimens with data "Colo. 2785. 9-25-97. New Windsor, Colo. C. P. G. Taken in sweeping wet ground." Cones and face black in this lot.

Lot 1348 Sub 82. Two specimens with data "Colo. 2785. 9-25-97 New Windsor, Colo. C. P. G. Taken in sweeping ground." Cones white.

Lot 1348 Sub 83. Seven specimens with data "Colo. 2767. 8-15-97 Ft. Collins, C. P. G. On willow." Jet black head, and dorsal thorax.

LITERATURE.

1911 Sulc, Dr. Karel. Monographia Generis Trioza Foerster. Part II, p. 10.

Trioza quadripunctata Crawford.

Photographs of this species are given in Figs. 324, 333, 347, and 353. The most striking feature is the heavy maculation of the wing at the three marginal dashes and at tip of clavus. As the species is pale in color these dark spots are particularly conspicuous. The cephalic margin of wing is strongly bowed. The wing of specimen at hand is about 2.25 mm long.

Lot 1342 Sub 3. Four specimens (male and female) given me by Mr. J. J. Davis with data "Ft. Collins, Colo. 11, Nov. 1910 collected from common nettle *Urtica*, by Prof. C. P. Gillette."

Lot 1348 Sub 21. Six specimens with data "Boulder."

Lot 1348 Sub 71. One specimen with data "Ft. Collins, Col. 5-12-99, C. D. Ball."

Lot 1348 Sub 86. One specimen with data "Colo. 2248. 8-12-96. Palmer Lake, Colo. C. P. G.

Lot 1348 Sub 88. Probably this species, though dashes are not as heavy as usual. One female with data "Colo. 2220. 8-6-96 Ft. Collins. C. P. G. caught flying around light."

LITERATURE.

1910 Crawford, D. L. American Psyllidae I, p. 233.
1911 Crawford, D. L. American Psyllidae III, p. 433.

Trioza stylifera sp. nov.

The yellow wing of this species is broadly and bluntly rounded and the heavy veins of an ordinary *Trioza* type of branching as shown in Fig. 325. It measures about 2.4 mm in length. The cones are moderately long and rather bluntly pointed, and divergent. The cuticular thickenings of the frontal plates from the middle ocellus to eye are flat and scale-like (Figs. 344 and 335). The female cauda (Fig. 356) is relatively long and acutely pointed. The upper plate extends a bit beyond the ovipositor and is slender at tip. The male cauda is characterized by the peculiar forceps, the distal part of each arm being broad, thick, hollowed, and hood-shaped. This aspect is shown in Fig. 362.

Lot 1347 Sub 20. Six specimens with data "Brockville, Ont. W. Metcalfe. Oct. 25, 1903; Oct. 29, 1903; Nov. 1, 1903; Nov. 15, 1903."

Lot 1348 Sub 85. One female without data.

Trioza tripunctata (Fitch).

This beautiful species has attracted some attention on account of its conspicuous occurrence on blackberry bushes. Photographs of the head and wing are given in Figs. 326 and 336. The wing is about 3 mm long.

Lot 1342 Sub 2. Nymphs and pupæ pellucid and yellowish. Head and prothorax deeper yellow than other parts. Eyes dark red. Mesothorax and metathorax sometimes clear pale green. Wing pads and abdomen pale. In flocculent white fluff on ventral surface of blackberry leaf. Collection at Orono, Maine, Aug. 31, 1911, comprised both nymphs and imagoes.

Lot 1342 Sub 4. Pupæ and imagoes collected at Sebago Lake, Maine, Aug. 19, 1904, from wild blackberry bushes.

Lot 1339 Subs 1 and 2. Two named specimens received from Doctor Felt with data "Lot 125. Karner, N. Y. April 15, 1902. N. Y. S. Coll."

Lot 1339 Sub 13. Specimens with data "Adiron, Mts. Axton, N. Y. 12-22 June, 1901. Cornell U. Lot. 235 Sub 34." Nineteen pinned specimens with data "Sea Cliff, L. I."

Lot 1339 Sub 41. One specimen with data "Uhler Nov. 77, D. C. on Pine, Mar. 16, '73. Cornell U. Lot 62. Collected by Theo. Pergande in D. C. and determined by Uhler. Given J. H. C. by Pergande."

Literature.

1851 Fitch, Asa. Catalogue *Psylla tripunctata.*

1869 Walsh and Riley. Am. Ent. Vol. 1, p. 225. *Psylla rubi.*

1879 Thomas, C. 3rd Rept. p. 17 account after Walsh and Riley.

1880 Fuller, A. S. Am. Ent. Vol. 3, p. 62. *Psylla rubi.*

1880 Riley, C. V. Am. Ent. Vol. 3, p. 62. foot note. ***Psylla** tripunctata* Fitch (*P. rubi.*)

1884 Riley, C. V. Pro. Biol. Soc. Wash. Vol. 2. *Trioza tripunctata* Fitch (*rubi* Walsh and Riley.)
1890 Packard, A. S. Forest Insects, p. 805. Reference to Riley (1880).
1894 ('95) Mally, Proc. Iowa Acad. Sc. Vol. 2, p. 154. *Trioza tripunctata* (*Phylloplecta tripunctata?*)
1900 Lugger, Otto. Report p. 141. Mention.
1909 ('10) Smith, J. B. Insects of New Jersey, p. 110. Listed.
1910 Crawford, D. L. American Psyllidae I, pp. 231 and 232.
1911 Crawford, D. L. American Psyllidae III, p. 430.

Allotrioza arbolensis (Crawford).

Lot 1348 Sub 16. Three specimens with data "Colo. 2294. 8-22-96 Cimarron, Colo.," I think to be *arbolensis*.. Figs. 327 and 339. The wing measures 3.4 mm.

Literature.

1911 Crawford, D. L. American Psyllidae III, p. 444.

Neotriozella ottawanensis sp. nov.

A species with wings like *laticeps* Crawford and cones like *immaculata* Crawford and evidently exceedingly close to those species. Thorax red in pinned specimens and narrower than head with eyes. Long slender tapering cones not divergent in pinned specimens but approximate to tip. They spread by pressure in balsam mounts (Fig. 341). The female cauda (Fig. 354) is long and tapering at distal end. The upper plate extends beyond other parts. The male forceps (Fig. 348) have clavate arms blunt at distal part. The wing (Fig. 328) measures 2.5 mm in length.

Paratrioza cockerelli (Sulc).

This species has been well described and figured by Sulc, and is receiving economic attention in Colorado. Figures of head and wing 329 and 340 are given here with accession numbers of the material at hand merely by way of including this species.

Lot 1348 Sub 5. Specimens with data "Ft. Collins, Col. 7-30-06 Potatoes," "Ft. Collins, Col. 10-2-06 Potatoes. Collected by S. A. Johnson," "Ft. Collins, Col. 3-24-09 Pepper. Breeding Cage A."

Lot 1348 Sub 23. Thirteen specimens with data "Colo. 2256," three specimens with data "Colo. 2786," one specimen with data "Colo. 2787."

Literature.

1909 Sulc, Dr. Karel. Casopisu (Ceske) Spolecosti Entomologicke, p. 102. *Trioza cockerelli.*

1911 Crawford, D. L. American Psyllidae III, p. 448. *Paratrioza cockerelli.*

1911 Johnson, S. Arthur. News Notes. The Tomato Psyllid.

Explanation of Figures.

The photomicrographs were taken by Mr. Royden Hammond from balsam mounts prepared for study. The frontal cones are in some cases spread apart more in these mounts than in pinned specimens or in life; and, as is evident enough, in order to bring the cones into correct focus, the occipital aspect is sometimes brought into view where the preparation is particularly transparent.

Fig. 316. Trioza aylmeriae. Fig. 317. T. forcipula. Fig. 318. T. diospyri. Fig. 319. T. dubia. Fig. 320. T. longistylus. Fig. 321. T. marginata. Figs. 322 and 323. T. maura? Fig. 324. T. quadripunctata. Fig. 325. T. stylifera. Fig. 326. T. tripunctata. Fig. 327. Allotrioza arbolensis. Fig. 328. Neotriozella ottawanensis. Fig. 329. Paratrioza cockerelli.

Fig. 330. Trioza aylmeriae. Fig. 331. T. diospyri. Fig. 332. T. marginata. Fig. 333. T. quadripunctata. Figs 334 and 335. T. stylifera. Fig. 336. T. tripunctata. Fig. 337. T. maura? Fig. 338. T. forcipula. Fig. 339. Allotrioza arbolensis. Fig. 340. Paratrioza cockerelli. Fig. 341. Neotriozella ottawanensis.

Fig. 342. Trioza forcipula. Figs. 343-346. T. aylmeriae. Fig. 347. T. quadripunctata. Fig. 348. N. ottawanensis. Fig. 349. T. maura? Fig. 350. T. forcipula. Fig. 351. T. maura? Fig. 352. T. dubia. Fig. 353. T. quadripunctata. Fig. 354. N. ottawanensis. Fig. 355. T. forcipula. Fig. 356. T. stylifera. Fig. 357. T. diospyri. Fig. 358. T. collaris. Fig. 359. T. maura? Fig. 360. T. marginata. Fig. 361. T. longistylus. Fig. 362. T. stylifera.

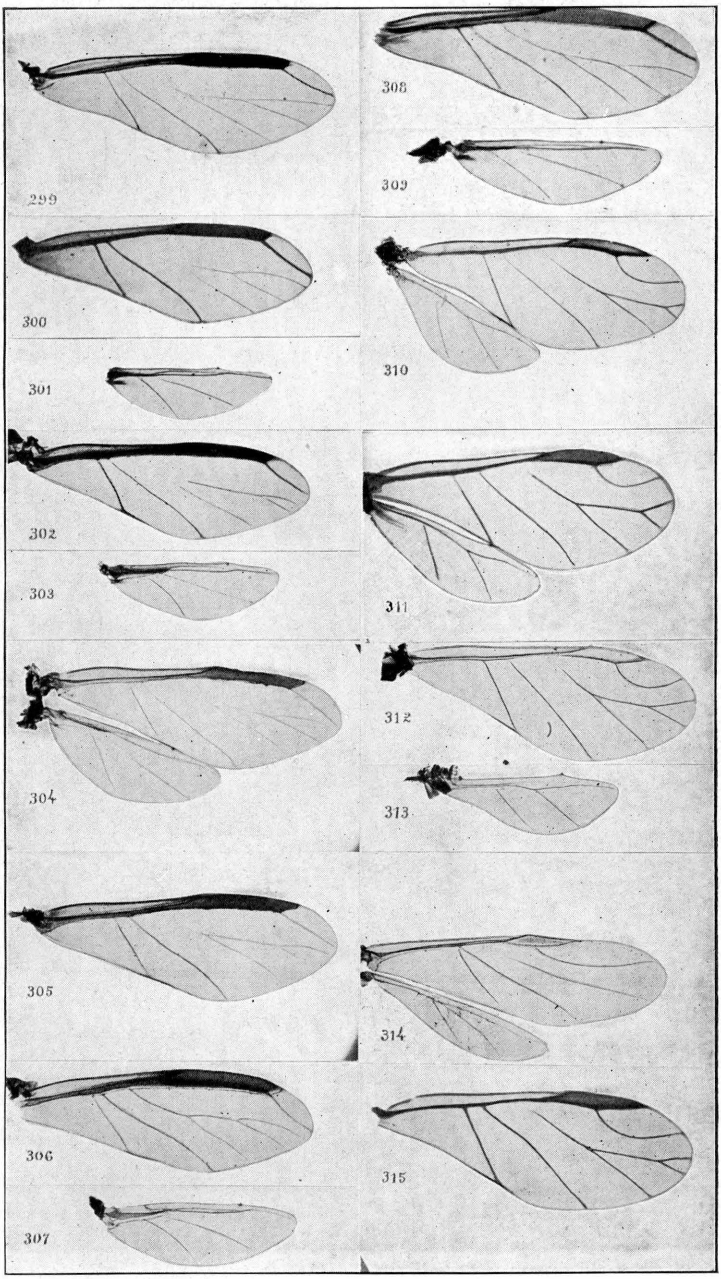
Fig. 363, A. artemisiae angustipennis, Lot 1348-41; Fig. 364, A. calthae? Lot 1348-53; Fig. 365, A. communis, 1348-39b; Fig. 366, A. fascipennis, Lot 1339-24; Fig. 367, A. sp., Lot 1347-39; Fig. 368, A. nebulosa americana, Lot 1348-65; Fig. 369, A. nubifera, Lot 1348-48; Fig. 370, A. polygoni, Lot 1341-7; Fig. 371, A. sp., Lot 1347-38; Fig. 372, A. rumicis, Lot 1341-6; Fig. 373, A. sp., Lot 1347-39; Fig. 374, A. communis, Lot 1347-37; Figs. 375 and 376, A. angustipennis, Lot 1347-24; Fig. 377, A. rumicis, Lot 1341-6; Fig. 378, A. calthae? Lot 1348-53; Fig. 379, A. polygoni, Lot 1341-7; Fig. 380, A. picta, Lot 1348-29. Fig. 381, A. sp., Lot 1347-39; Fig. 382, A. calthae? Lot 1348-53; Fig. 383, A. polygoni, Lot 1341-7; Fig. 384, A. calthae? Lot 1348-47; Fig. 385, A. nebulosa americana, Lot 1348-65; Fig. 386, A. angustipennis, Lot 1348-41; Fig. 387, A. polygoni, Lot 1341-7; Fig. 388, A. picta, Lot 1348-29; Fig. 389, A. communis, Lot 1347-32b; Fig. 390, A. sp., Lot 1347-38.

Fig. 391, Psylla coryli, Lot 1348-61; Fig. 392, P. ribis, Lot 1348-25; Fig. 393, P. negundinis, Lot 1348-11; Fig. 394, P. hartigii, Lot 1340-2; Fig. 395, P. annulata, Lot 1345-2; Fig. 396, P. gilletti, Lot 1348-20; Fig. 397, P. breviata, Lot 1347-36; Fig. 398, P. pyricola, Lot 1326-4; Fig.

399, P. brevistigmata, Lot 1339-31; Fig. 400, P. cerasi, Lot 1341-4; Fig. 401, Pachypsylla mammae, Lot 1339-53; Fig. 402, P. tridentata, Lot 1339-40; Fig. 403, P. pallida, Lot 1339-51; Fig. 404, P. dubia, Lot 1339-56.

Fig. 405, Psylla breviata; Fig. 406, P. coryli; Fig. 407, P. ribis; Fig. 408, P. hartigii; Fig. 409, P. negundinis; Fig. 410, P. pallida; Fig. 411, P. annulata; Fig. 412, P. cerasi; Fig. 413, P. brevistigmata; Fig. 414, P. gilletti; Fig. 415, Pachypsylla tridentata; Fig. 416, Pachypsylla dubia; Fig. 417, Psylla ribis; Fig. 418, Pachypsylla tridentata; Fig. 419, Psylla coryli; Fig. 420, P. negundinis; Fig. 421, P. annulata; Fig. 422, P. gilletti; Fig. 423, P. hartigii.

Fig. 424, Psylla breviata; Fig. 425, Pachypsylla tridentata; Fig. 426, Pachypsylla dubia; Fig. 427, Pachypsylla brevistigmata; Fig. 428, Psylla gilletti; Fig. 429, P. hartigii; Fig. 430, P. ribis; Fig. 431, P. cerasi; Figs. 432 and 433, P. hartigii; Fig. 434, P. pyricola; Figs. 435 and 436, Pachypsylla dubia; Fig. 437, P. tridentata.



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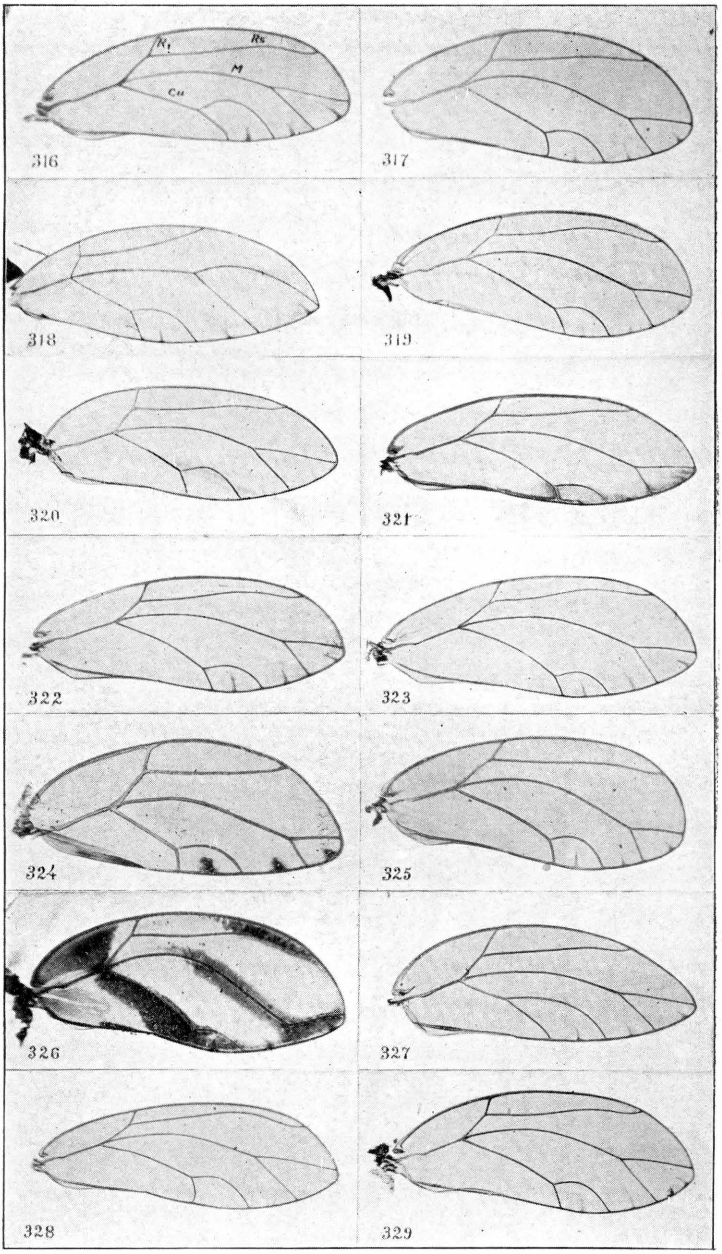
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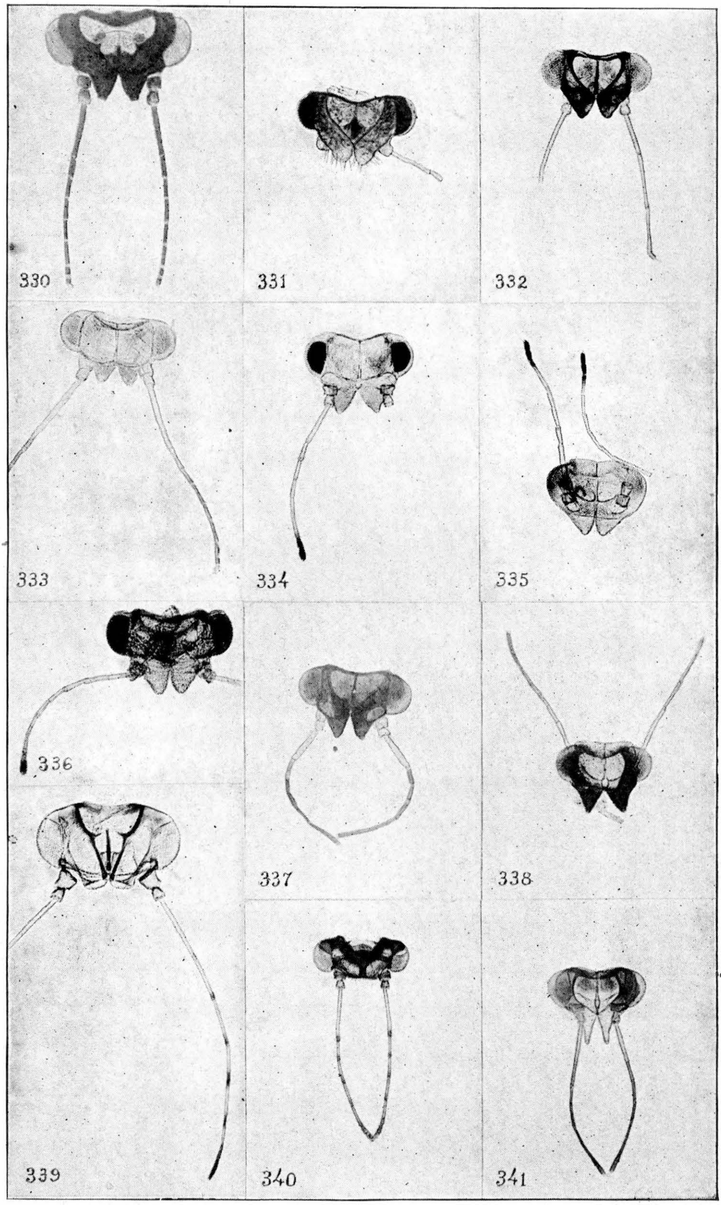
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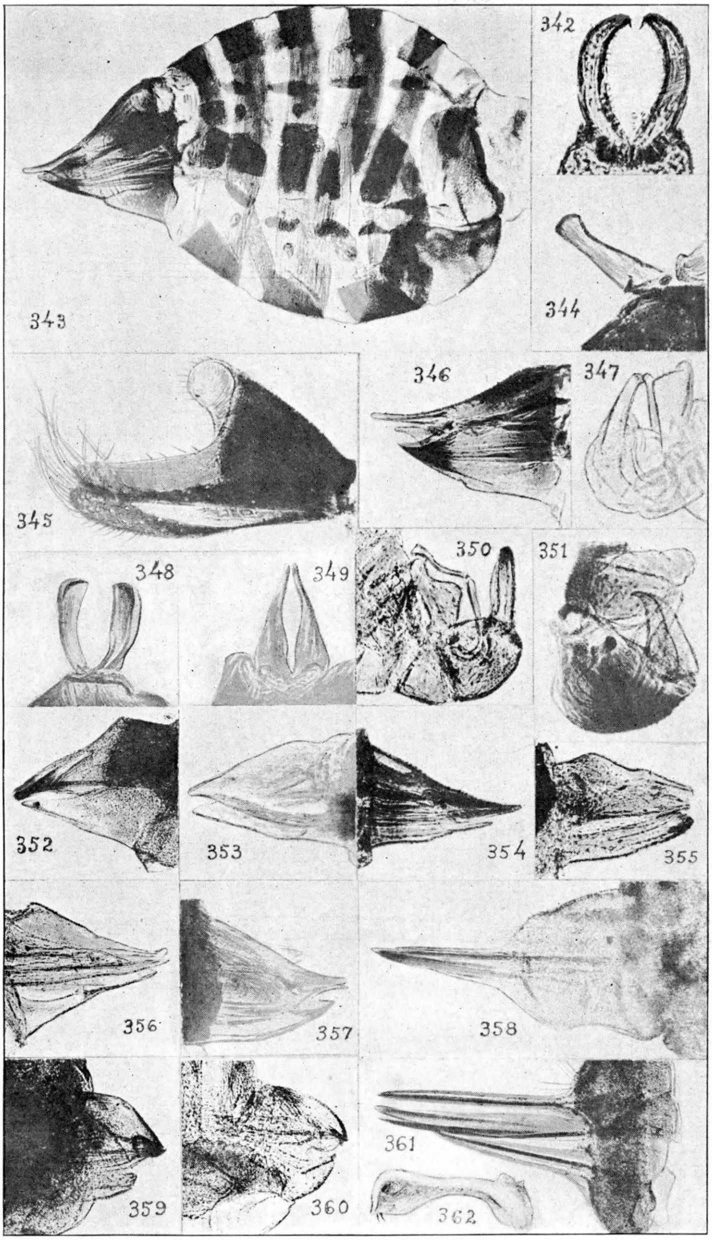
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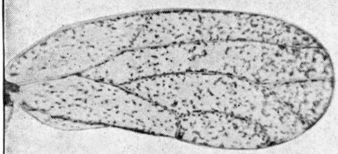

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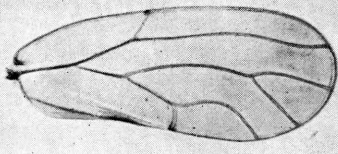

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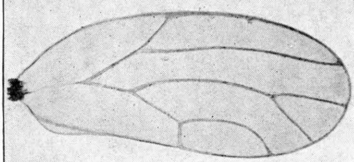

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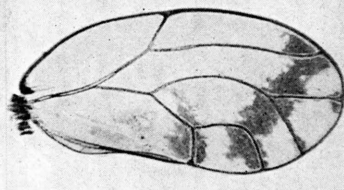

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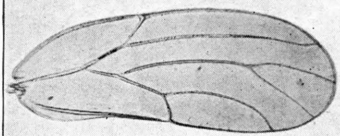

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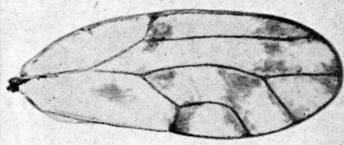

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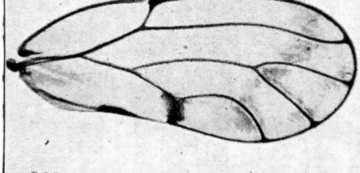

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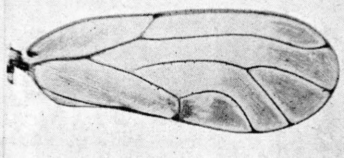

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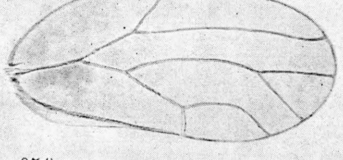

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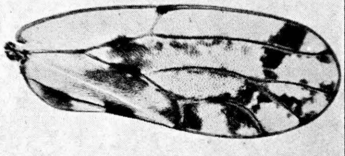

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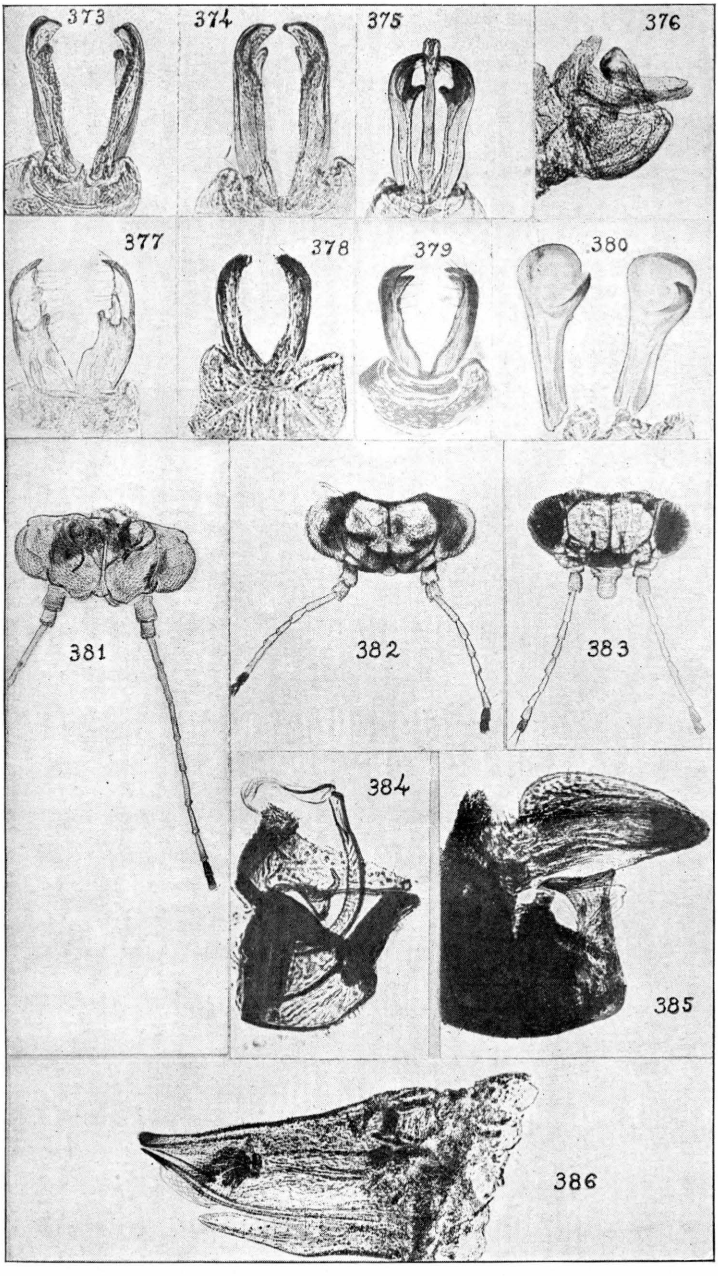
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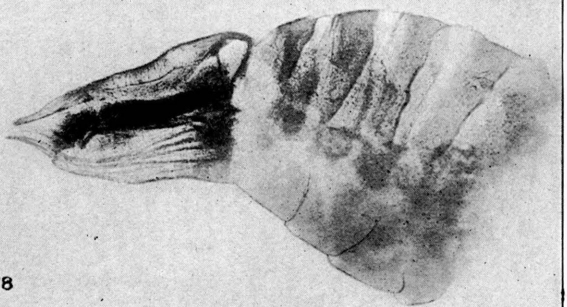
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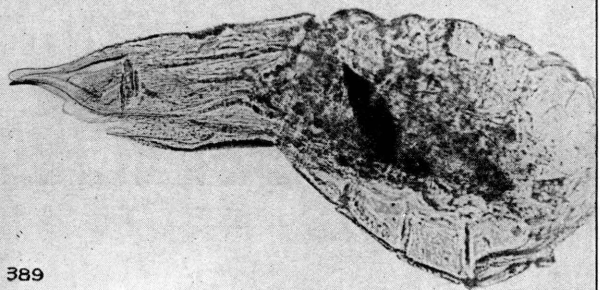
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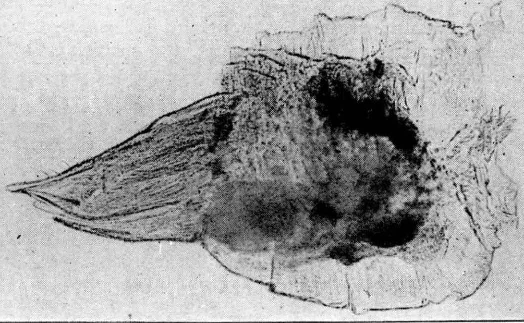
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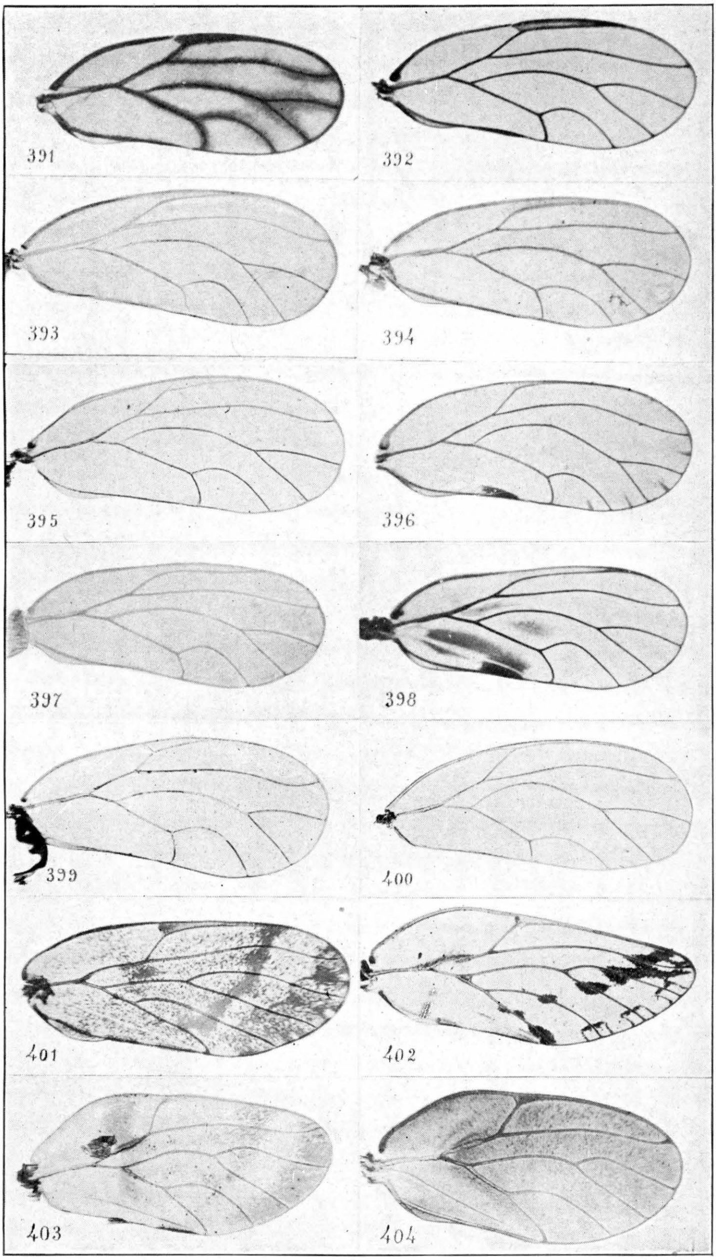
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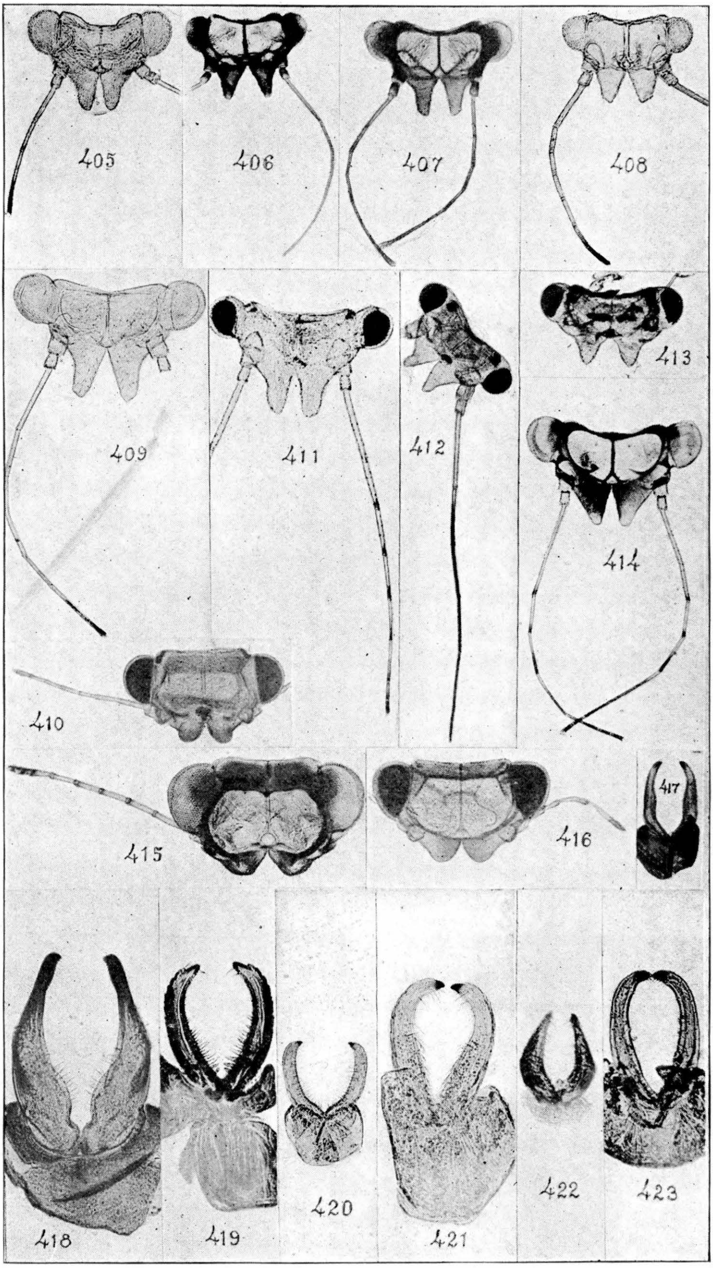
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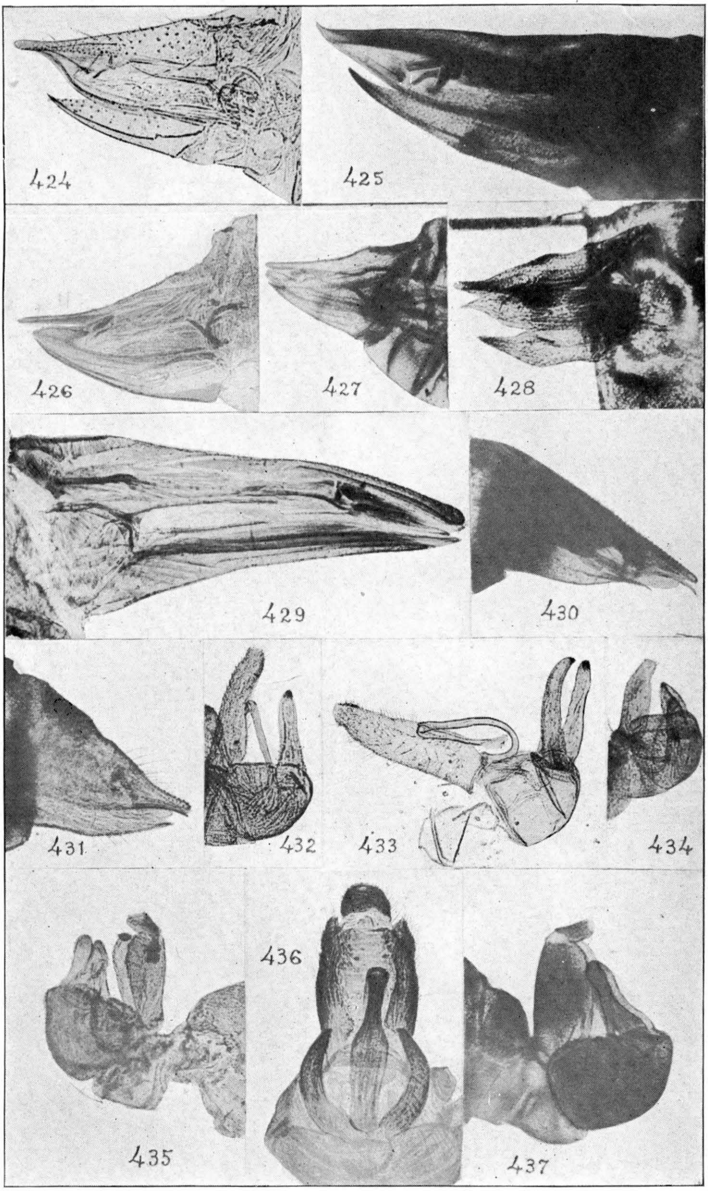
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BULLETIN No. 203.

ELM LEAF CURL AND WOOLLY APPLE APHID.*

EDITH M. PATCH.

The dual personality of certain aphid species is a condition which, before it is detected, betrays the economic entomologist into many futile combative attempts; but on the other hand the same duality may reveal, when once discovered, the most vulnerable point of attack. It is not necessary to go out of our own state for illustrations. The discovery that *Chermes abieticolens* Thomas 1879 which makes cone-like galls on black and red spruce is the same species as *Chermes pinifoliae* Fitch 1858,** which lays eggs on new growth white pine for progeny that render the pine shoots weakened and unthrifty, gives the landscape gardener his clue. If he treasures the beauty of a group of white pines he would do well to exclude red and black spruces from the vicinity, or conversely if he wishes to grow black spruces with normal branches it is an indiscretion to place them near white pines. Again, when once it was ascertained that the common Alder Blight, *Pemphigus tessellata* Fitch 1851, was masquerading on the maple (*Acer saccharium* L.—*dasycarpum* Ehrh. and cultivated varieties) as *Pemphigus acerifolii* Riley 1879,† the owner of ornamental cut leaved maples had a theretofore unsuspected means of protecting their foliage by the control of the pest on its alternate food plant, the alder, which in many circumstances is an easy point of control.

The economic application of the case in hand is apparently as direct and simple as the two just cited and since we are here concerned with one of the most serious of the apple tree pests,

* Papers from the Maine Agricultural Experiment Station: Entomology No. 58.

** Bulletin 173 Maine Agricultural Experiment Station.

† Entomological News, 1908, p. 484; Journal of Economic Entomology 1909, Vol. II, p. 35; Bulletin No. 195 Me. Agr. Exp. Sta., Feb. 13, 1912.

the significance of the recent discovery * that the elm leaf curl harbors the "wolf in sheep's clothing" is an important factor to be taken into consideration in dealing with the woolly aphid of the apple.

While working over some elm aphides several winters ago I found that I was unable to separate on structural characters certain collections of *Schizoneura americana* (causing and inhabiting elm leaf curl) from certain collections of *Schizoneura lanigera* (the troublesome woolly aphid of the apple). Collections could be selected which showed apparently significant antennal differences but others could be selected which could only be separated by reference to the tree from which they had been taken. Notice in this connection antennal figures 449 to 459. (As a study of the antennal variation in 1,000 individuals of this species is nearly ready for press, further discussion of this point is not necessary here.)

This circumstance brought no real conviction, for *lanigera* (described in 1802) has been under economic surveillance for more than 100 years and Riley (1879) gives descriptions of seven consecutive generations of *americana,* from the stem mother to the true sexes inclusive, all on the elm. On the other hand spring and return migrants of *americana* had been recorded from the widely separated localities of Idaho (Aldrich 1901), Kansas (Sanborn 1904) and Maine (Patch 1910) and their summer residence was still a mystery. Moreover the overwintering of *lanigera* on the apple roots was, though confusing, no argument against another host for the winter egg, for, as was shown for the Alder Blight, the all year presence of apterous forms on the alder was coincident with a migration to the maple for the deposition of the true sexes and the winter eggs. (Bulletin No. 195 of this Station).

Field observations were made during two seasons with this problem in mind but brought no solution, the summer occurence of *rileyi* which I consider to be an elm bark form of *americana* (See Me. Sta. Bul. 181, p. 237) complicated the situation, while the fact that both hosts were under out door conditions, not easy of control, left too much room for doubt.

This past winter, however, material under control conditions was secured by raising seedling apples in the greenhouse where

* Science, Vol. 36, p. 30. "Elm Leaf Curl and Woolly Aphid of the Apple."

infestation from the woolly aphid was rendered impossible. Leaf curl from elm with pupae and alate forms were secured from the south some time before material at the same stage would be available here, and migration tests were made. The winged forms from the elm were caged over seedling apples, and their progeny, growing along creases where the thin bark is scaling back, in the axils of the leaves and on exposed roots of the apple seedlings, covered by typical flocculent white secretion, are unmistakably the woolly aphid of the apple. (Fig. 448). The colony in the figure just cited was started May 12-13, by migrants from elm leaf curl. Their progeny thrived from the first and the photograph was taken May 29, the day on which the first apterous generation on the apple began to give birth to young.

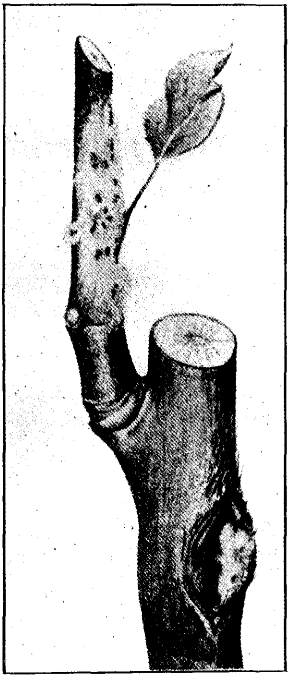

Fig. 438. Bark colonies of Woolly Aphid on apple. (From Alwood.)

On part of the seedlings similar tests were unsuccessful, the nymphs dying very soon or in one case after about two weeks tardy growth. This was probably due to aphid resistant seedlings, the apples from which the seeds were planted being from several different varieties, and as is well known all apples are not alike susceptible to attacks from the woolly aphid.

Habits.

The woolly aphid occurs upon the apple as a bark feeder and is found upon branches, roots, and tender places on the trunk. These insects are covered by a white flocculent waxy secretion given off as fine filaments through pores in the skin and their colonies are thus readily detected by the masses of white "wool" which renders them conspicuous. (Figs. 438 and 448.)

On the roots its attacks induce enlargements or galls or swellings, and in the creases of these malformations the root form occurs in clustered masses. The injury to the trees is due both to the sucking up and exhaustion of the vital plant juices and to the poisoning of the parts attacked, as indicated by the consequent abnormal growths. Fig. 439.

The damage is particularly serious in the case of nursery stock and young trees and is less often important after the tree has once become well established and of some size. Where this insect is abundant all the roots of a young tree to the depth of a foot or so become clubbed and knotted by the gowth of hard fibrous enlargements with the results in a year or two of the dying of the rootlets and their ultimate decomposition with attendant disappearance of the galls and also of the lice, so that after this stage is reached the cause of the injury is often obscure.

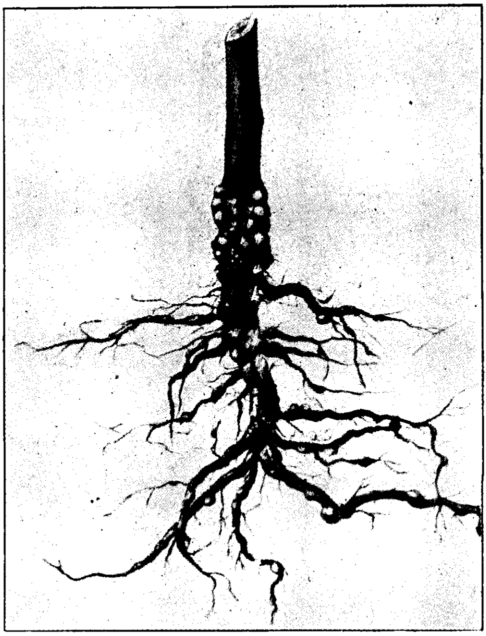

Fig. 439. Crown and root of young apple tree, showing characteristic swellings or galls produced by the root lice. (From Alwood.)

On the trunks the presence of the lice results in the roughening of the bark or a granulated condition which is particularly noticeable about the collar and at the forks of branches or on the fresh growth around the scars caused by pruning, which latter is a favorite location. On the water shoots, they collect particularly in the axils of the leaves, often eventually causing them to fall, and on the tender growth of the stems. The damage above ground, though commonly insignificant, is useful as an indication of the probable existence of the lice on the roots. A badly attacked tree assumes a sickly appearance and does not make satisfactory growth, and the leaves become dull and yellowish, and even if not killed outright it is so weakened that it becomes especially subject to the attacks of borers and other insect enemies.

The common forms both on the roots and above ground are wingless lice, not exceeding one-tenth of an inch in length, of a reddish-brown color, and abundantly covered, especially in those above ground, with a flocculent waxy secretion. (Fig. 441.)

In autumn, among the wingless ones, winged females, Fig. 440, appear in abundance. They are little, clear-winged, gnat-

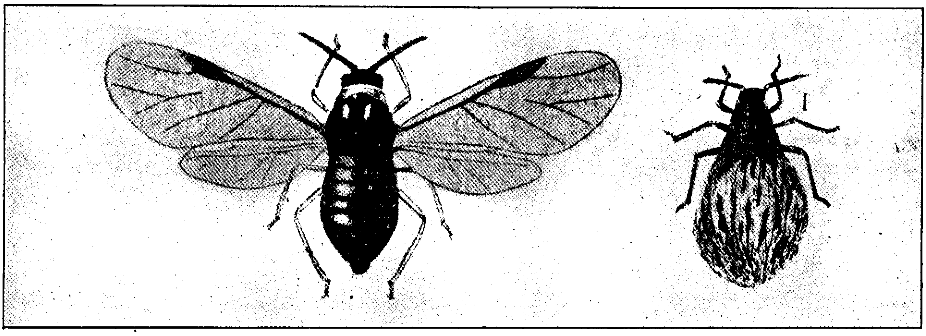

Fig. 440. Fig. 441.
Woolly Aphid. Winged and wingless forms. Greatly enlarged.
(From Marlatt.)

like objects, greenish-brown, almost black in color, with the body covered with more or less of the cottony secretion. These are the fall or return migrants that seek the elm bark to give birth to the generation of true sexes,—minute wingless, beakless creatures, the female of which deposits a single "winter egg" within a crevice of the elm bark.

On the elm the stem mother, which hatches from the overwintering eggs sheltered in rough crevices of the bark, appears early in the spring and may be found in Maine before the middle of May stationed on the partly opened leaf buds.

By the last of May the earliest of these wingless stem mothers (Fig. 443) are mature and found in the leaf curl (Fig. 442) or rosette (Fig. 462, when a group of terminal leaves are affected) which they cause, producing the next generation, which are also wingless.

In the summer great numbers of winged individuals are developed. From the fact that Riley recorded 7 consecutive generations on elm and the occurence of what seems to be the elm bark feeding generations of the same species (known as *rileyi*) during the summer on tender elm bark, it would seem either that the migration from the elm leaves of these summer migrants

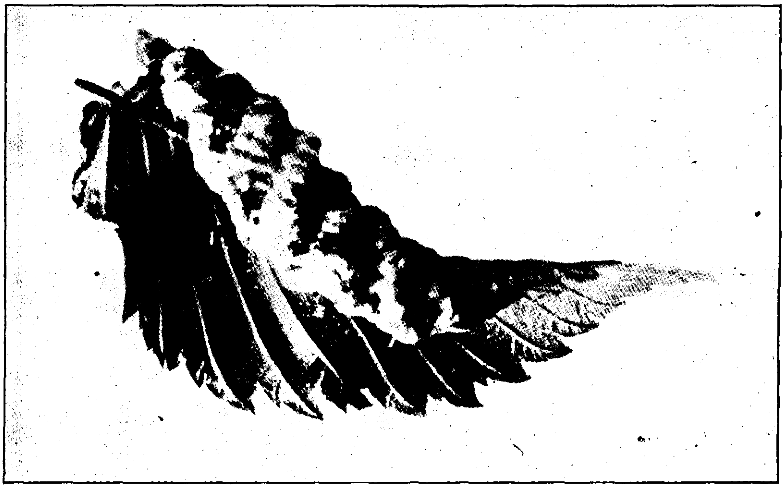

Fig. 442. Elm leaf curl, in which the alate spring migrants develop before taking flight to apple bark.

is partly to apple bark and partly to elm bark or that elm bark colonies as well as leaf curl may be established by the first or second apterous generations. Such a life cycle is indicated in the accompanying table. This does not account for the generations resulting from the overwintering forms on the apple roots as their sequence yet remains to be studied. The fall migration of the woolly aphid from apple and the mountain ash I have observed but I have not yet from observation linked it with the true sexes on elm. That inference, however, from the evidence of the spring migration to apple is unmistakable.

There are still several important details to be worked out for the woolly aphid of the apple and elm. Whether the elm bark colonies are originated by the stem mother, or by migrants from the leaf curl or both; whether the mid June (in Maine) winged forms from the elm bark colonies migrate to apple or scatter to other elm bark, or both; the significance of the difference in antennal types of migrants from elm leaf curl (Figs. 451, 452, 454, and 458), whether indicating locality or conditional variation; and complete sequence upon each food plant;—are subjects for further study.

These points can for the most part be watched only with colonies upon seedling stock of the food plants in confinement under such conditions that perfect control of the material can be secured. While I have further work along these lines already under way, some of the problems will need extended observations and it has seemed desirable not to wait until all tangles are straightened out before publishing the main fact of the migration test from elm leaf curl to apple bark as this point has an important bearing for young trees in nurseries and new orchards and the economic significance of the migration data will not, so far as can be anticipated, be influenced by further detailed study of the different generations.

The Spring Migration.

The fact of the migration from elm leaf to apple and mountain ash under normal out of door conditions was established during the summer of 1912. The migrants from the elm leaves settle on the under side of the apple leaves of water shoots and there produce nymphs which seek the stem at leaf axils and there congregate in woolly masses. The mountain ashes (*Pyrus americana* and introduced species) are favorite summer hosts in Maine. From one native mountain ash at Orono more than 400 such migrants were removed July 2 to July 12 from the ventral surface of the leaves, and about 150 thriving clusters of woolly aphid nymphs, the immediate progeny of these migrants, were established on the shoots of this single tree.*

In this connection it may be of interest to record a forced migration test. On June 21, 1912, I placed several hundred elm

* A more detailed account of this occurrence is to be published in the October issue of the Journal of Economic Entomology.

leaf migrants at the base of water shoots of an uninfested mountain ash on the Campus. As the migrants are much more docile about sundown than earlier in the day this was done about 7 P. M. They moved but little, most of them creeping to the ventral side of a leaf and remaining there; and during the night producing nymphs which sought the leaf axils of the water shoots so that by the afternoon of June 22, the tiny nymphs had already fed enough and secreted enough white wax to give the typical "woolly" appearance to the young colonies. These and the progeny thrived on the mountain ash in a perfectly normal way.

SEQUENCE OF GENERATIONS. DESCRIPTIVE.

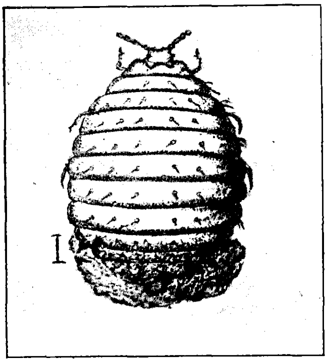

Fig. 443. Stem mother. (From Riley.)

Egg 0.5 mm. long, gamboge-yellow, inclining to brown in color, with no especial external sculpture. In crevices under elm bark.

Stem mother: Pale yellowish-red, with black members when first hatched; the red deepening and becoming purplish or livid with age. When mature, averaging 3.5 mm. in length, globose or pyriform, with subobsolete honey-tubes and six dorsal rows of darker piliferous and tuberculous spots. Antenna 5-jointed, joint 3 more than equaling 4 and 5 together in length. Causing and inhabiting elm leaf curl.

Second generation. Apterous viviparous forms which do not become so large as the stem mother. The antenna is normally 6-jointed (Fig. 461). Inhabiting leaf curl and giving birth to migrants.

Third generation. Winged viviparous female: Body dusky, the abdomen slightly reddish; legs either dusky or yellowish red. Antennæ as long as head and thorax together, dusky, rarely yellowish, not pilose, but with a few short setous points; 6-jointed. The annulation of the joints in different collections and from different localities varies greatly. Figs 451, 452, 454, and 458, cover the ordinary range. The absolute size of this generation is subject to considerable variation. These develop within and migrate from the elm leaf curl, and settling on apple produce young which inhabit apple.

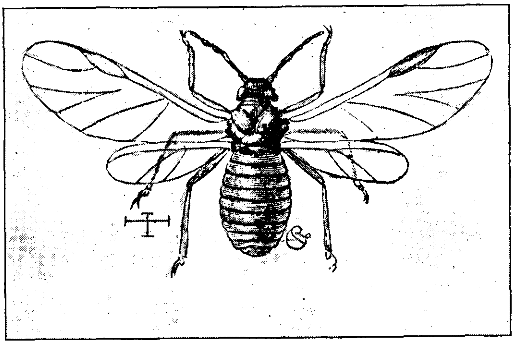

Fig. 444. Third generation. (From Riley.)

Fourth generation. That from the first winged females: Differs from the preceding in the promuscis being much longer. The antennæ have 6 joints, with no annulated constrictions. The color is sometimes decidedly orange. When newly hatched, the thickened end of the promuscis often extends one-half the length of the body beyond caudal extremity. It is born with an enveloping pellicle or pseudovum, and though of a bright red with pale legs at first soon becomes brownish, with dark members. Deposited on apple by the spring migrants and developing there in flocculent masses. Fig. 448. When mature, if the colony is crowded, some of the individuals move to a new cite on the apple bark before giving birth to the nymphs which settle near and establish thus new colonies. In other cases the nymphs themselves scatter to new cites.

Fifth generation. The second apterous generation on apple bark. Practically like the fourth generation.

Sixth? generation. From about the first of September until frost the winged fall migrants develop in the woolly colonies on apple, mountain ash, and *Crataegus* whence they migrate to elm bark to deposit their progeny, the true sexes. Figs. 455, 456, 457 and 459 give the antennæ of the fall migrant.

Together with these in the same woolly colonies develop apterous viviparous females that give birth to nymphs which seek the roots of the trees and hibernate there, surviving the winter if the conditions are favorable.

True sexual individuals: Born within an egg-like pellicle; the antennæ 5-jointed, with the joints subequal. Orange in color. Undergoing one molt, and then being at once distinguished from the other forms by the brighter orange-yellow color, the rudimentary mouth, the more simple eyes (composed of three facets), by the shorter, 5-jointed antennæ, the joints subequal in length, by the shorter legs, with smaller claws to the tarsi, and more distinct terminal capitate hairs or pulvilli. The skin is transparent, the body filled more or less with fatty globules. The female is nearly pyriform, and averages 0.4 mm. in length. A single egg is visible through the translucent skin and occupies nearly the whole of the body. The male is narrower and smaller. Figs. 446 and 447.

This generation seems to have no object in life except the deposition of eggs, since they can not eat or fly. The eggs are placed in the deepest crevices of the bark, especially those that are tangential to the tree, and are not easy to find. The small lice perish after depositing eggs leaving only the latter to survive the winter.

Economic Status.*

The danger from the woolly aphid is greatest to nursery stock and young orchards. Mr. Marlatt (Journal of Economic Entomology, Vol. 4. pp. 116-117) in recording the use of American-grown apple seedlings says:—"Mr. F. W. Watson, of Topeka,

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* "Mr. W. S. Griesa, proprietor of Mt. Hope Nurseries, Lawrence, Kan., has established the Griesa Research Fellowship in Entomology in memory of his father, the late A. C. Griesa. In establishing this fellowship it was the wish of the founder that the holder should devote himself to a fundamental investigation of one of the several entomological problems ever present with nurserymen.

"Upon consultation, it was decided to select for the theme of this research the Woolly Aphis. Mr. H. W. Lohrenz, A. B., McPherson College, and a graduate student at the University of Kansas, was elected by the regents of the university to this fellowship.

"The purpose of this research is, after careful experimentation in remedy and prevention, and investigation into the life cycle of this Aphis, to devise a practical means whereby nurserymen can properly deal with this economic problem in such a way as to eliminate the losses now attending the existence of this insect on nursery stock.

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"It is worthy of note as showing the interest of nurserymen generally in foundations of this nature that the Western Nurserymen's Association, an organization of nurserymen of the Middle Western States, passed resolutions commending the founder of this fellowship for the work he has instituted." Journal of Economic Entomology. Vol. 4, p. 161.

Kans., in an article in the *National Nurseryman* for January, 1910, p. 437, on "American-grown Apple Seedlings," states that from twenty to forty million of American-grown apple seedlings are used in this country every year, the production of about a dozen nursery firms. The bulk of the seed used comes from France, and therefore is of the same stock as the imported French seedlings."

Mr. Lohrenz (1911) in recording observations on two-year-old nursery stock made at three nurseries containing respectively about 30,000; 45,000; and 300,000 trees, states that he found from 20 per cent to 25 per cent of the trees infested by the woolly aphid.

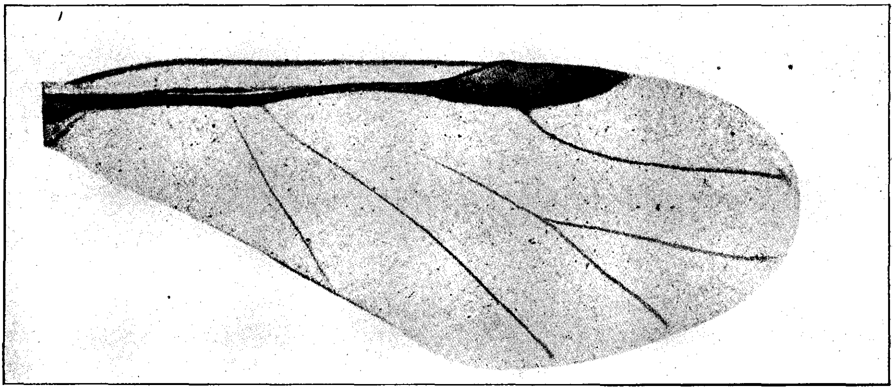

Fig. 445. Fore wing of migrant from elm leaf curl to apple. Third Generation.

In circular No. 20, Bureau of Entomology, U. S. Department of Agriculture (revised edition 1908) the woolly aphid of the apple is characterized as "one of the worst enemies of the apple."

Mr. Alwood (1904) of the Virginia State Crop Pest Commission in his excellent account of this insect states "On nursery stock the woolly aphis is a most serious pest, and under some circumstances it ruins a large percentage of the apple trees in the nursery."

On page 5 of Bulletin 133 of the Colorado Experiment Station the following statement is made:

"If Colorado orchardists should vote their opinion as to what ought to be called the worst orchard pest in the state, it is very doubtful whether the codling moth, or the woolly aphis, would carry off the honors."

Although it would be easy to compile testimony of this character against the woolly aphid as an enemy to young apple trees from numerous and widely separated parts of our country, they would be chiefly a repetition of what has already been said.

That the elm leaf curl renders the foliage of this stately tree unsightly during years of heavy infestations is well enough known in all parts of the country where the American elm is grown. Professor Gillette (Journ. Ec. Ent. Vol. 2, p. 356)

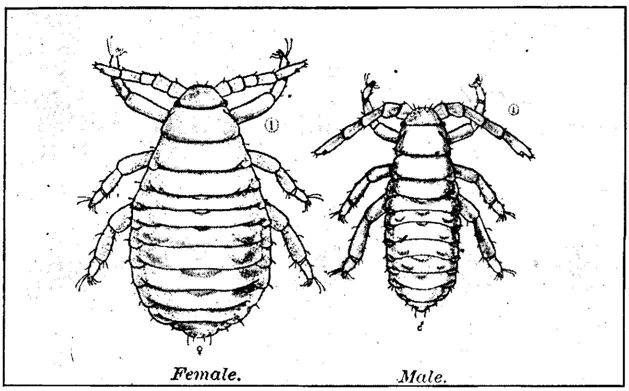

Fig. 446 and Fig. 447. Mature sexual individuals of the Woolly Aphid,—the oviparous female and male. (From Alwood.

states of this insect,—"This louse is a real pest upon white elm nearly everywhere that this tree is grown in Colorado."

In Montana where the white elm (*Ulmus americana*) is being established as a shade tree the insects of the elm leaf curl have taken up their abode but have found no cordial welcome for Professor Cooley says of them (Cooley 1904, p. 44).

"Altogether they are a decidedly obnoxious pest. Not only do they distinctly injure the trees but they disfigure them as well and furnish an attraction for ants, flies and other insects which visit them for the sweet liquid."

LIFE CYCLE OF WOOLLY APHID OF APPLE.

ELM: Primary Host.	APPLE: Alternate Host.
EGGS. (Under bark all winter)	NYMPHS. (From hibernating forms on roots, etc.) migrating to trunk or branches in early spring.
STEM-MOTHER. (first generation in leaf curl. Apterous viviparous females).	
SECOND GENERATION. (apterous viviparous females in leaf curl).	SEVERAL GENERATIONS.
SPRING MIGRANTS Migrate to apple . . . . > (third generation. Alate viviparous).	
	FOURTH GENERATION. (apterous viviparous females).
SUMMER GENERATIONS. ON ELM BARK.	
	FIFTH GENERATION. (apterous viviparous females).
Migrate to elm <	FALL MIGRANTS. Alate viviparous parthenogenetic females, mature Sept.-Oct. sexuparae. — APTEROUS VIVIPAROUS PARTHENOGENETIC FEMALES, mature in Sept.-Oct.
APTEROUS OVIPAROUS FEMALES AND APTEROUS MALES.	
EGGS. (under bark all winter).	HIBERNATING FORMS ON APPLE ROOT.

Preventive and Remedial Measures.

The foregoing account of the habits and characteristics of the woolly aphid will suggest certain measures to control it.

The protection of seedling apples from infestation by the woolly aphid while still in the nursery has heretofore been an exceedingly difficult matter it would seem from the amount of infested stuff that is yearly condemned. But with the knowledge that the source of danger lies in the migrants from the previously unsuspected elm curl, it is seen to be possible to control the nursery stock by establishing nurseries at a safe distance from susceptible elm trees or clearing out the elms from the vicinity of large nurseries. As there are many places in the country where the elm is not at all abundant this would often be entirely practicable and where so would be the simplest and most effective method of protection. As it is the seedling trees that are most susceptible to injury and when attacked most seriously damaged by the woolly aphid a method of protection for the young trees while in the nursery is the most desirable.

The raising of the elms and apples in the same nursery is thus seen to be a hazardous proceeding and should be avoided.

Again young orchards of clean stock set in parts of the country where the elm is not grown should be successfully protected by excluding elms from the choice of shade trees. Indeed, the matter of alternate hosts of the aphid enemies concerned should always be borne in mind in planning the trees for an estate, and only one of the two hosts necessary for the life cycle of a migratory aphid planted, where the pest is a serious one.

It is desirable that data concerning the relative susceptibility of different varieties of apple should be accumulated with a view to using the more resistant for root stock, if otherwise practicable.

In dealing with infested apple trees the aphid masses on trunk and branch present no especial difficulty, and can be very readily exterminated by the use of any of the washes recommended for plant-lice, such as tobacco decoction, kerosene emulsion, a strong soap wash (Formulas a, b, c, d), the only care necessary being to see that the wash is put on with sufficient force and thoroughness to penetrate the covering and protecting cottony secretion. If the wash be applied warm, its penetration will be considerably increased.

The much more important root feeders, however, are more difficult to reach and exterminate. The common recommendations are of applications of strong soap or tobacco washes to the soil about the crown, or soot, ashes, or tobacco dust buried about the roots; also similarly employed are lime and gas-lime.

Badly infested nursery stock should be destroyed, since it would be worth little even with the aphides removed.

Proper cultural methods can hardly be overestimated in their value as a protection of young trees, as neglected orchards not only suffer heavily but serve as a breeding ground, dangerous to the neighboring trees.

Formula A—Tobacco Decoction.

Tobacco stems or tobacco dust.................	2 pounds
Water	4 gallons

Put the tobacco in the water, enough to cover, which may be either cold or hot. Place over the fire and when the water has reached the boiling point, remove some of the fire and allow the water to simply *simmer* for fully one hour, when the liquid is ready to be drained off, diluted to the above proportions and applied. Boiling violently drives off the nicotine.

If whole-leaf tobacco is used, prepare as above, using one pound of tobacco to each four gallons of water.

No lime or other alkaline substance should be added to the tobacco *while cooking*. Apply at once, or within a few days after making if possible.

Certain reliable extracts such as *"Black Leaf," "Black Leaf 40,"* and *"Nikoteen"* are on the market and can be secured through local druggists. (The Black Leaf preparations are manufactured by *The Kentucky Tobacco Product Company,* Louisville, Ky., and are carried by the Collins Hardware Company, 97 Friend St., Boston, Mass. *Nikoteen* is manufactured by The Nicotine Manufacturing Company, St. Louis, Mo., and can be secured from Joseph Brick & Sons, 47-54 N. Market St., Boston, Mass.).

Directions for use come with the products. There is nothing to do in the preparation of these extracts except to stir the contents of the can before pouring out any quantity for dilution. In most cases one gallon of the *Black Leaf* will be found sufficient for each seventy gallons of water. But if in the treatment of any louse this does not seem sufficient it may be used in preparation of one gallon to sixty or sixty-five gallons of water. Careful sprayers have usually succeeded in killing plant lice with this preparation in the proportion of one gallon to each one hundred gallons of water. Thoroughness of application is of as much importance as the strength of the material used.

Nikoteen is a more concentrated abstract, 1 part being used with from 400 to 600 parts of water.

Black Leaf 40 is a concentrated solution of nicotine-sulphate and is widely and successfully used in large western orchards, at the rate of 1 part to 700 or 900 parts of water.

It is the common practice to add soap,—whale oil soap or good laundry soap at the rate of 2 bars to 50 gallons. This is to lessen the formation of drops, causing the spray to cover surfaces more in the form of thin film.

Better success is obtained by some by using a little lime instead of soap, the inert solid in suspension aiding the extract to "wet" and "stick" to the bodies of the aphides. For this purpose 1 pound of stone lime, slaked and strained into 50 gallons of tobacco extract as prepared for application, is sufficient.

Formula B.—Kerosene Emulsion.

Hard Soap	1-2 pound
Boiling Water	1 gallon
Kerosene	2 gallons

To prepare, dissolve one-half pound of soap in one gallon of soft water by boiling; when well dissolved and still boiling hot, remove from the fire and add two gallons of kerosene, and agitate at once as briskly as possible. The emulsion is more readily made if the kerosene first be heated by immersing the vessel containing it in a larger vessel of boiling water. *Never* heat the kerosene over a direct fire.

If large quantities are being made, a good way to emulsify is to use a force pump and spraying nozzle and pump the mixture as forcefully as possible back into the vessel containing it. If the emulsion is properly formed, the whole mass will appear much like whipped cream and will mix readily in water without a film of oil rising to the top.

As soon as emulsified, add twenty-seven gallons of water and use at once. This will make thirty gallons of the mixture, and such an emulsion will be one-fifteenth oil (or a 7 per cent emulsion). This is the strength ordinarily used for the destruction of insects upon plants. For larger or smaller quantities, prepare in the same proportions.

Sometimes the emulsion is not perfect and a little oil rises to the top. In such cases, if the last in the barrel or tank is pumped out upon the foliage, it is likely to burn it. So it is advisable, unless the emulsion is of good quality, to throw out the last few gallons, making no use of it.

It is best to dilute and apply kerosene emulsion as soon as it is prepared.

Avoid using alkali or any hard water in making the emulsion, as it will cause the oil to separate and rise to the top. Any clean, soft water will usually give good results.

Formula C.—Miscible Oils.

There are several miscible oils upon the market which may be added directly to water forming a milky emulsion at once. In the preparation of any of these, such as "Scalecide," or "Target Brand Scale Destroyer" or "Killoscale," add the oil directly to the water with a little stirring. One gallon of the miscible oil in 30 to 50 gallons of water will make a mixture, which in most cases will be strong enough to kill plant lice, if thoroughly applied.

FORMULA D.—WHALE-OIL OR FISH-OIL SOAPS.

The so-called whale-oil or fish-oil soaps which are quite extensively used for the destruction of plant lice, will usually be effective if thoroughly applied in the proportion of one pound of the soap to each six or eight gallons of water. There are numerous brands of these soaps upon the market. Among those that have been used quite successfully are Good's Whale-Oil Soap and Bowker's Tree Soap.

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In recent years tobacco extracts have rapidly taken the place of other remedies for aphides, and well informed apple growers are using them almost to the exclusion of other insecticides. It should be remembered that this is a contact insecticide and kills only the insects actually touched. It is, therefore, necessary to be very thorough in the spraying.

Insect Enemies of the Woolly Aphid.

So far as the natural enemies of this pest are concerned its residence in the elm leaf curl is a vulnerable period strongly subject to attack. Very abundant in Maine working on the aphides while in the elm leaf curl are a predaceous capsid, (*Camptobrochis nitens*), flocculent larvæ of a Coccinellid and syrphus maggots. So numerous are all these insects in certain years that it has sometimes been difficult for me to secure enough of this aphid for experimental purposes,—a search through many emptied leaf curls being necessary before aphides could be found.

In other parts of the country also this aphid is preyed upon while in the elm leaf curl and frequently the only living arrivals in material sent me from other states has been the predaceous insects within the leaf curl.

Riley (1879) records as follows:—"Among the more prominent of the natural enemies of this species I have noticed, of Coleoptera, *Coccinella 9-notata, Coccinella sanguinea* (*munda*) Say, *Hippodamia convergens,* and several species of *Scymnus.* I also found feeding upon them the perfect beetle of *Podabrus modestus,* and the Hemipterous *Cyllocoris scutellatus* Uhler, and *Capsus linearis* Beauv. A Lepidopterous inquiline, namely, the larva of *Semasia prunivora* Walsh is also quite common within the curled leaves, feeding both on the lice and on the substance of the leaf. A large green *Syrphus* larva and several *Chrysopa* larvæ also prey upon them."

While on the apples the woolly aphid is subject to the attacks of a number of insect enemies, those recorded by Marlatt (1897) including "the parasitic chalcis fly, *Aphelinus mali* Haldemann, and the larva of a syrphus fly, *Pipiza radicum* Walsh and Riley, and also the larva and adult of several species of lady birds, the larvæ of lace-wing flies, and spiders, etc. In the East a very small brown species of ladybird, *Scymnus cervicalis* Muls., is often present in some numbers, and the common nine-spotted ladybird, *Coccinella 9-notata* Hbst., is also an active enemy of the woolly aphid.

"The most active natural enemies of the woolly aphis in Colorado have been predaceous insects. We have reared no parasite from it, but, Aug. 21, 1908, Mr. L. C. Bragg brought into my office a female *Aphelinus mali* busily ovipositing in apterous females of this louse. Among the Coccinellids, *Hippodamia convergens* is by far the most abundant destroyer of this louse both upon the eastern and western slopes of the mountains. Mr. E. P. Taylor also took *H. sinuata, Coccinella 9-notata, C. monticola* and *C. transversalis* feeding on this louse in the orchards about Grand Junction, and we have noted *H. transvcralis, C 9-notata, C. monticola, C frigida,* and *C. 5-notata* (*transversalis* and *transversoguttata*) feeding upon it in eastern Colorado.

"Mr. Taylor also reared two syrphus flies at Grand Junction on this louse, namely, *Catabomba pyrastri* Linn, and *Eupeodes volucris* O. S.

"Lace-wing flies are also very destructive to *Schizoneura lanigera* in Colorado, and especially upon the western slope in the Grand Valley, where Mr. Taylor concluded that they did more than all else to subdue the unusually severe outbreak of this louse in that valley during the early summer of 1907. The Capsid, *Camptobrochus nebulosus* Uhl, we have found a common feeder upon this and some other plant lice in Colorado." (Gillette 1908).

Food Plants.

Crataegus Crus-galli (lucida). *Schizoneura crataegi* Oestlund. Davis, 1910, p. 412.

Crataegus punctata Jacq. *Schizoneura crataegi* Oestlund. Oestlund, 1887, p. 28. (Now considered *lanigera* by Professor Oestlund).

Crataegus tomentosus L. *Schizoneura crataegi* Oestlund. Williams, 1910, p. 20.

Crataegus sp. *Schizoneura lanigera.* Patch, 1912a, p. 236.

Pyrus malus L. *Schizoneura lanigera* Hausmann. Alwood, 1904. Gillette and Taylor, 1908, p. 28.

Pyrus sitchensis. *Schizoneura lanigera.* Patch, 1912a, p. 236. (Also on two other cultivated species of mountain ash).

Ulmus americana L. *Schizoneura americana.* Riley and *Schizoneura rileyi* Thomas (*Eriosoma ulmi* Riley). Patch, 1910a. Williams, 1910.

Ulmus campestris L. *Schizoneura ulmi* L. (*americana* Riley). Gillette, 1909, p. 356.

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Ulmus campestris L. *Schizoneura ulmi* (Linn). (*A. foliorum* De Geer) (*S. americana* Riley?) Buckton, Vol. 3, pp. 98, 100.

Ulmus sp. *Schizoneura ulmi* Linn (*fodiens* Buckton) Tullgren, 1909. p. 169.

Ribes sp. *Schizoneura ulmi* Linn. (*fodiens* Buckton) Tullgren, 1909, p. 169.

Synonymy and Literature.

A complete bibliography for this species is not desirable here as the accounts which throw original light upon the life history would be lost in a mass of publications compiled for economic purposes.

1802. *Aphis lanigera,* Hausmann, Beiträge zu den materialien für eine kunftige Bearbeitung der Blattlause. Illigers Magazine. T. I.
Coccus mali. Bingley (Thomas 1879, p. 126).
Eriosoma mali. (Leach MSS.) Samouelle. (Thomas, 1879, p. 126).
Myzoxylus mali. Blot. (Thomas, 1879, p. 126).

1841. *Eriosoma (Aphis) lanigera,* Harris. Report on the Insects of of Mass. injurious to vegetation, p. 193.

1841. *Schizoneura lanigera,* Hartig, Germar's Zeit. Ent. III, p. 359.

1851. *Eriosoma pyri,* Fitch. Fourth Report of the N. Y. State Cabinet of Nat. Hist., A. D. 1851, p. 68.

1856. *Pemphigus pyri.* Fitch. First Report on the Noxious, Beneficial and other Insects of the State of New York, p. 5. An account of the work upon the roots and a description of the young nymph and winged individuals, the latter evidently either with abnormal venation or an accidental migrant of a different species as this form is described with the venation of a *Pemphigus.*

1858. *Pemphigus americanus?* Walker. List of the specimens of Homopterous Insects in the collection of the British Museum.

1862. *Eriosoma (Aphis) lanigera,* Harris. Insects Injurious to Vegetation, p. 242.

1869. *Eriosoma (Pemphigus) pyri,* Riley. Insects of Missouri I, p. 118. Economic account of work on apple roots.

1869. *Eriosoma ulmi,* Riley. Insects of Missouri I, p. 123. Description of winged forms and nymphs, and account of work on elm bark.

1879. *Schizoneura americana,* Riley. Bul. U. S. Geol. and Geograph. Survey, Vol. V, No. 1, pp. 4-9 and Plate I and Fig. 2. Description of seven generations on elm, with an account of the work on elm.

1879. *Schizoneura americana,* Thomas, (III), Report of the State Entomologist Ill. VIII, p. 202. Quotes Riley's description of seven generations, and concludes (p. 204): "This as admitted by Professor Riley is very closely allied to *Schizoneura ulmi,* Linn, and it is doubtful whether it should be considered as distinct."

1876-1879. *Schizoneura rileyi,* Thomas. Trans. Ill. Hort. Soc., 1876, p. 191; id. Rept. Ent. Ill. 8: 136, 137, 1879, nom. nov. for *Eriosoma ulmi* Riley. Systematic discussion and description of work. Description of insect quoted from Riley.

1879. *Schizoneura lanigera,* Thomas, III. Report of the State Entomologist Ill. VIII, p. 126. Important historical discussion.

1879. *Schizoneura ulmi,* Linn., Thomas (III) Rept. of the State. Ent. Ill., VIII, p. 140.

1885. *Schizoneura rileyi,* Forbes. Rept. Ent. Ill. 14: 114.

1887. *Schizoneura americana,* Oestlund, O. W. Aphid. Minn. p. 27. Description of winged form and pseudo gall.

1887. *Schizoneura crataegi,* Oestlund. Aphid. Minn. p. 27. Description of winged form and account of attack on *Crataegus punctata.* (Now considered to be the same as *lanigera* by Professor Oestlund.)

1888. *Schizoneura rileyi*, Lintner. 3rd Report, p. 125.

1890. *Schizoneura rileyi,* Packard. Fifth Rept. U. S. Entom. Com. Wash. Original description of insect quoted.

1890. *Schizoneura americana,* Packard. Fifth Rept. U. S. Entom. Com. p. 279. Extract from Riley Bul. U. S. Geol. and Geograph. Survey, Vol. V, No. 1.

1897. *Schizoneura americana,* Gillette, C. P. Bul. Div. Ent. U. S. Dept. Agric. 9 (n. s.) : 78-79. Description of work.

1897. *Schizoneura lanigera,* Marlatt, C. L. Circ. 20, Second Ser., Div. of Ent.

1898. *Schizoneura americana,* Gillette, C. P. Bul. A. E. S. Colo. 47: 35-36. Account of work. Economic treatment. Fig. 32 photo of work.

1899. (1900). *Schizoneura americana,* Harvey. Bul. Me. Agr. Exp. Sta. No. 61. *Indem.* Ann. Rept. of Me. Agr. Exp. Sta. for 1900, p. 32. Mentioned as abundant. Photograph of leaf curl.

1900. *Schizoneura americana,* Lugger. Bul. No. 69. Minn. Agr. Exp. Sta. Id. 6th Ann. Rept. St. Ent. of the St. Exp. Sta. Univ. of Minn. pp. 168, 169. Fig. 148 after Riley.

1901. *Schizoneura americana,* Aldrich. Idaho Agric. Exp. Sta. Feby. Bul. 26, pp. 20-22. Records summer and fall (return) migration and describes true sexes. Suggests that alternate host plant may be grass.

1901. *Schizoneura rileyi,* Hunter. Aphid. of N. A., p. 84. Bibliography in part.

1902. *Schizoneura americana,* Weed, C. M. Bul. No. 90. N. H. Agr. Exp. Sta. p. 37. Brief account and photograph of curled leaf.

1902. *Schizoneura americana,* Cook, M. T. Galls and Insects Producing Them. Ohio Naturalist. Vol. II, No. 7, p. 265 and Fig. 12. Discussion of structure of gall.

1904. *Schizoneura americana,* Sanborn, C. E. Kansas Aphid. pp. 25-26, Plate VI, Fig. 37. Description of winged form and record of migration from elm.

1904. *Schizoneura lanigera,* Sanborn, C. E. Kansas Aphid. pp. 26-27. Fig. 36.

1904. *Schizoneura americana,* Cook, M. T. Galls and Insects Producing Them. The Ohio Naturalist, Vol. IV, No. 6.

1904. *Schizoneura lanigera,* Alwood, Wm. B. Circular in Relation to Some Injurious Insects and Plant Diseases. Special Bulletin (C. P. C. 45), Va. Exp. Sta. An excellent account of the insect and its work, with figures. A study of the true sexes in confinement is recorded followed by this significant statement: "We have not thus far been able to trace the migrant forms accurately, and watch the development of their young in normal situations. They behave in a very aberrant manner, and we are led to doubt the statements that their young are deposited in old colonies among the agamic forms. Definite search has not revealed them, nor have we been able to find the sexual egg in these old colonies. It is possible that there is here an unsettled problem which may have important bearing upon the distribution of the species."

1904. *Schizoneura americana,* Cooley, R. A. 10th Ann. Rept. Mont. Agr. Exp. Sta. pp. 43-45. Records this insect as a decidedly obnoxious pest in some parts of Montana on *Ulmus americana.*

1905. *Schizoneura americana,* Felt, E. P. N. Y. St. Mus. Memoir 8: pp. 172, 177-178. Description of leaf curl, and life history adapted from Riley.

1905. *Schizoneura rileyi,* Felt, E. P. N. Y. St. Mus. Memoir 8: pp. 172, 192. Brief description of work and remedies.

1907. *Schizoneura lanigera,* Smith, R. I. Bul. 23, Ga. State Board of Ent. An account after Alwood, with original photographs of work.

1908. *Schizoneura lanigera,* Gillette and Taylor. A Few Orchard Plant Lice. Bul. 133, Agr. Exp. Sta. of the Colorado Agr. College, pp. 5-23. Ecological and economic account with original figures.

1908. *Schizoneura lanigera,* Gillette, C. P. Journal of Economic Entomology, Vol. 1, pp. 306-308. Of the migrants and true sexes he writes: "We have had no trouble to get the alate females to deposit the true sexual forms in confinement. We have been utterly unable to keep these alate females upon the apple trees to deposit their young. They seem possessed of a controlling instinct to get away from the tree, so that the sexual forms have always been deposited upon the walls of the breeding cages. . . . . Since writing the above, I have succeeded in obtaining numerous examples of light orange yellow sexual females and the smaller dusky brown males, and a few yellow eggs upon leaves and bark of twigs that had been enclosed six weeks before in small cheese cloth sacks in the orchard."

1909. *Schizoneura rileyi,* Gillette, C. P. Journal Ec. Ent. Vol. 2, p. 357. Suggests that it may be same species as *Schizoneura ulmi* (*americana*). "Of common occurrence at Fort Collins and other places in Colorado.

1909. *Schizaneura lanigera*, Gillette, C. P. Journal Ec. Ent. Vol. 2, p. 356 and Fig. 15. "This is one of the most serious and generally distributed insect pests of apple orchards in Colorado.

1909. *Schizoneura ulmi* L. (*americana* Riley) Gillette, C. P. Journal Ec. Ent. Vol. 2, p. 356 and Fig. 16. "This louse is a real pest upon white elm nearly everywhere that this tree is grown in Colorado."

1910. Davis, J. J. A List of the Aphididae of Illinois with notes on some of the species. Jour. of Ec. Ent. Vol. 3, p. 412.
Schizoneura americana. "Not infrequently injuriously abundant."
Schizoneura crataegi. "A serious pest of the hawthorns used in ornamental plantings in Chicago."

1910. *Schizoneura americana,* Patch, Edith M. Gall Aphids of the Elm. Me. Agr. Exp. Sta. Bul. 181, pp. 223-235.

1910. *Schizoneura rileyi.* Patch, Edith M. Gall Aphids of the Elm. Me. Agr. Exp. Sta. Bul. No. 181, pp. 235-238.

1910. *Schizoneura americana.* Williams, T. A. The Aphididae of Nebraska, p. 16.

1910. *Schizoneura crataegi.* Williams, T. A. The Aphididae of Nebraska, p. 19.

1910. *Schizoneura lanigera.* Williams, T. A. The Aphididae of Nebraska, p. 20. Mere mention.

1910. *Schizoneura rileyi.* Williams, T. A. The Aphididae of Nebraska, pp. 20-21. "It causes a curling of the leaves similar to *S. americana,* but the galls can be readily distinguished as those of this species are much more tightly curled than those of *S. americana.* This latter species is often to be found on the same tree. They can be easily separated, as they differ in size, antennae, venation and other minor points."

1911. *Schizoneura lanigera.* Lohrenz, H. W. Jour. Ec. Ent. Vol. 4, pp. 162-170. Ecological and economic study.

1912a. *Schizoneura lanigera.* In Bul. No. 195 Me. Agr. Exp. Sta. Recorded on *Crataegus* and three species of mountain ash.

1912b. *Schizoneura lanigera* (*americana*). Patch, Edith M. Science, Vol. 36, p. 30. Progeny of spring migrants from elm reared on apple. . . .

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If the elm species of America and Europe are the same, this insect will revert to *Schizoneura ulmi* L. (*lanigera* Hausmann) and according to European Aphidists *ulmi* migrates to the roots of currant for the summer generations where it was described by Buckton as *Schizoneura fodiens.* Are there two species in Europe known as *ulmi,* one migrating to currant and the other to apple?

1909. *Schizoneura ulmi* L. (*S. fodiens* Buckton). Tullgren. Aphidologische Studien, pp. 163-169.

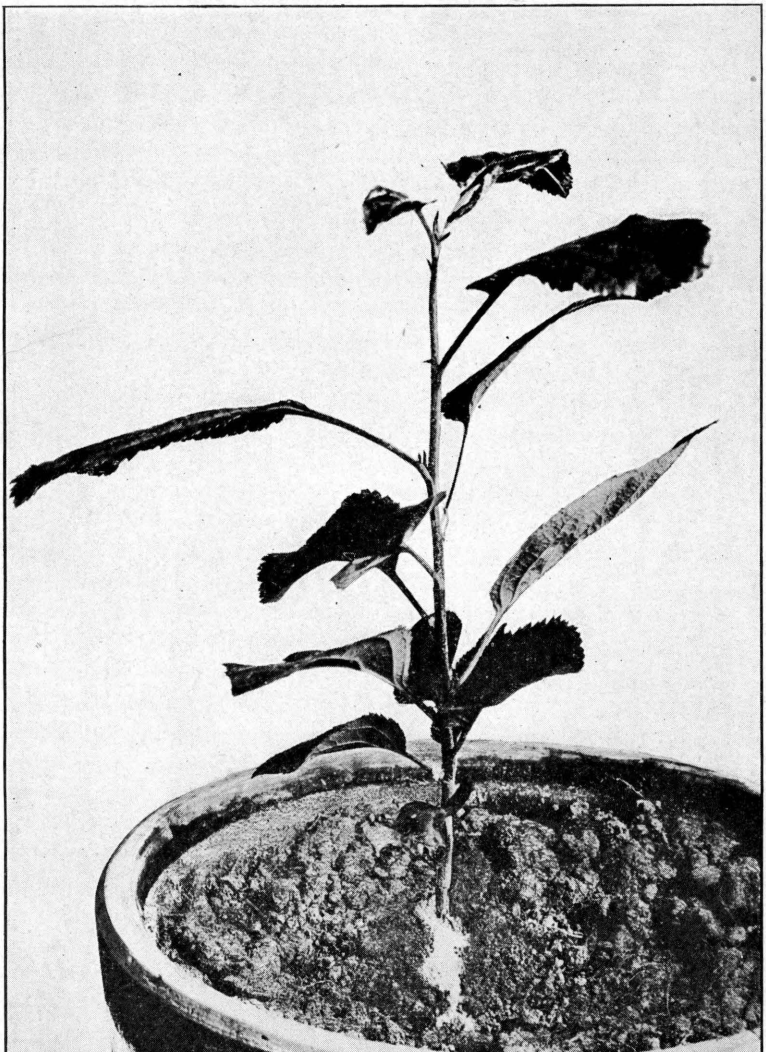

Fig. 448. Seedling apple photographed May 29, 1912, to show colony of woolly aphids which are the progeny of migrants from elm leaf curl received from the south May 12, 1912.

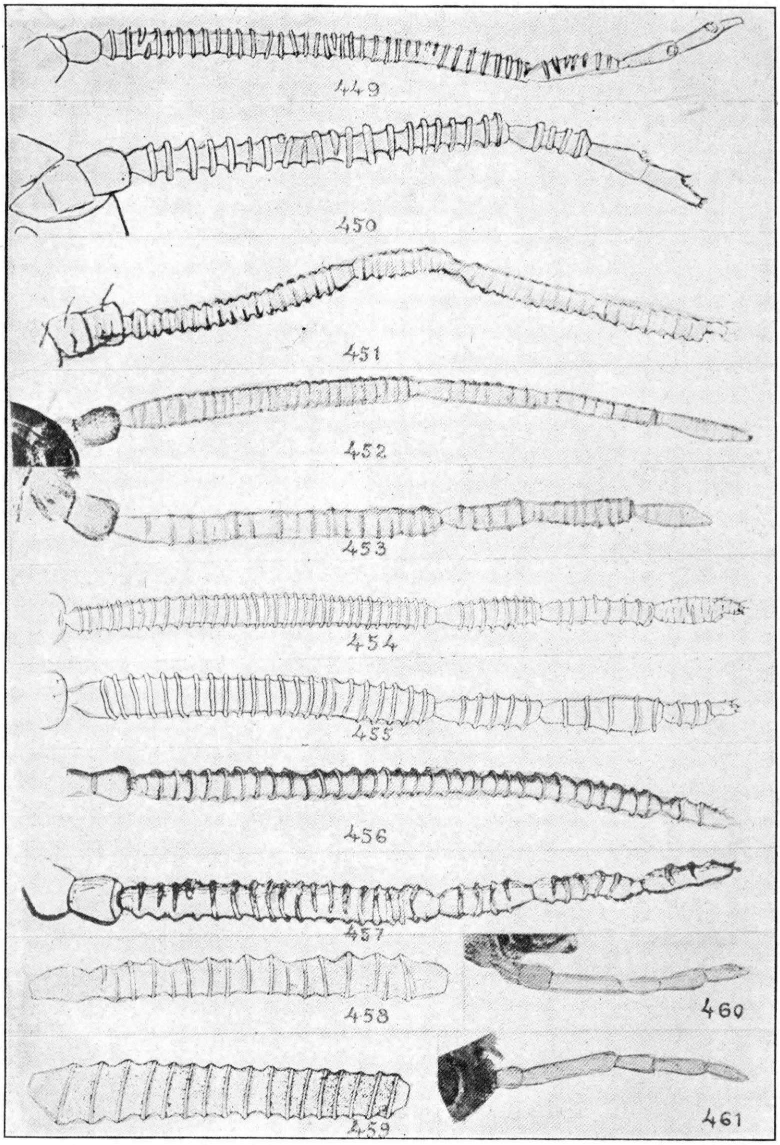

Fig. 449, *Schizoneura ulmi*. Spring migrant (Tullgren 1909). Fig. 450. *S. ulmi*. Fall migrant (Tullgren 1909). Fig. 451. *S. americana* (Riley 1879). Fig. 452. *S. americana* and Fig. 453 *S. rileyi* (Patch 1910). Fig. 454. *S. ulmi* and Fig. 455 *S. lanigera* (Gillette 1909). Fig. 456 *S. lanigera* (Alwood 1904). Fig. 457 *S. lanigera* (Marlatt 1897). Fig. 458 *S. americana* and Fig. 459 *S. lanigera* (Sanborn 1904). Fig. 460 *S. rileyi* and Fig. 461 *S. americana*, apterous viviparous forms. (Patch 1910).

Fig. 462. Terminal leaf curl or rosette of elm leaves. The habitat of the stem mother, the second generation, and the third generation previous to their migration.

BULLETIN No. 204.

A CASE OF TRIPLET CALVES: WITH SOME GENERAL CONSIDERATIONS REGARDING MULTIPLE GESTATION IN NORMALLY UNIPAROUS ANIMALS.[1]

By RAYMOND PEARL.

INTRODUCTION.

Some five years ago the writer became interested in the general subject of the occurrence of multiple gestation in animals normally bearing but one young at a birth, through having his attention called to a case of triplet calves. A brief preliminary notice of the case was published at the time.[2]

It was then intended immediately to follow this note with a more detailed discussion of the case. As material was collected in the preparation of that paper, however, it soon became evident that such cases of multiple pregnancy presented a number of features of interest in connection with certain general problems of biology. As time went on it seemed desirable to extend the scope of the inquiry. Accordingly I have been collecting notes and data on the general subject during the past four years. It seems desirable now to put some of these notes together for publication.

There are four general biological problems to which cases of multiple gestation relate and upon which we may reason-

[1]Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 39.

[2]Pearl, R. A Case of Triplet Calves with Peculiar Color Inheritance. Science, N. S. Vol. 26, p. 760, 1907.

ably expect light to be thrown by the analysis of such cases. These problems may be briefly designated as follows:

1. The physiological problem.
2. The problem of sex determination.
3. The problem of secondary sexual characters.
4. Certain problems of inheritance.

The mere fact of the occurrence of multiple pregnancies in forms normally bearing but one young at a time presents a deeply interesting problem in the physiology of reproduction. It means that the reproductive mechanism is not functioning in the normal or usual manner. But just where and what is the change from normal? Is the occurrence of twins and triplets due to a departure from the normal in the functioning of the ovary, or of the tubes and uterus? Or in a word what is the *physiological* basis of the occurrence of multiple gestation? It is, of course, an observation as old as history itself, that in the great majority (if not all) mammals where one young at a birth is the normal condition multiple gestations occasionally occur. Even in man, nearly the slowest in rate of reproduction of all mammals, there are occasionally as many as 4, 5, or 6 young at a single birth.[3]

Yet in spite of the fact that the phenomenon of multiple pregnancy is so well known, data are wanting as to the underlying physiological causes upon which such occurrences depend. It is not to the point to contend that normally uniparous animals showing an occasional multiple gestation are descendants (in the course of evolution) from forms normally multiparous, and that the occurrence of multiple gestations now is an "ancestral reminiscence". This may all be true but it tells us noth-

[3]It is not necessary to cite the literature on this subject here *in extenso*. I merely give, by way of illustration for those who may be curious about the matter, a few references from recent literature.

Wilkins, S. V., Birth of Quadruplets Jour. Amer. Med. Assoc. Vol. 49, p. 43, 1907.

Berheim, A., Quintuplets. New York Med. Jour. Oct. 22, 1904, pp. (of reprint) 1-6.

Miknovski, Yu. I., [Quintuplets] J. akush i jensk. boliez., St. Petersburg. Vol. 22, pp. 79-85. 1908.

Wickersheimer, E., Une observation inédite de grossesse sextuple. Bull. soc. d'obst. de Paris. T. xii, p. 320, 1909.

ing about the physiological causes which determine that in the breeding history of a particular individual, twins are born at, let us say, the fourth pregnancy, while from all other pregnancies in the life of the animal only single young come. From whatever angle we approach the matter it is clear that there must be a definite (and presumably determinable) set of causes in the physiology of either the ovaries or Fallopian tubes and uterus, or both which leads to the production of twins. In the hope of getting light on this problem the collection of the most complete information possible in regard to multiple gestation in normally uniparous forms is to be desired. This is a matter in which stock breeders may give valuable aid.

2. The problem of sex determination is one very much in the foreground of biological interest at this time. The work of the last 10 years seems to have made some really definite progress towards the final solution of the problem. A number of different lines of research just now being prosecuted vigorously all lead to the same general view as to the basis of the causation of sex. In the first place the cytological researches of McClung, Wilson, Stevens and Morgan,[4] and others indicate that in many forms of life, at least, there are constant and characteristic differences between the sexes in respect to the number, form and size of the chromosomes and that further the behavior of the chromosomes of the reproductive cells during their maturation and fertilization is of the sort which would be expected to occur if, in the first place, sex were inherited and, in the second place, this inheritance were controlled by certain of the chromosomes. Supplementing this cytological evidence and leading to the same conclusion that sex is a definitely inherited character, are the experimental researches in which sex is shown to behave in the same manner that structural char-

[4]It is not necessary to cite in detail here references to all papers of the workers in this field. An extensive bibliography is given in Morgan, T. H., "A Biological and Cytological Study of Sex Determination in Phylloxerans and Aphids." Jour. Exper. Zoöl. Vol. vii, pp. 239-352, 1909. Summary accounts of the cytological work on sex determination are to be found in Wilson, E. B. "Recent Researches on the Determination and Heredity of Sex," Science, N. S. Vol. 29, p. 53, 1909 and in Doncaster, L., "Recent Work on the Determination of Sex." Science Progress, No. 13, pp. 90-104, July 1909. See also the more recent summary by Professor Wilson, "The Sex Chromosomes," Arch. mik. Anat. Bd. 77, pp. 249-271, 1911.

acters do in Mendelian crossings. As pioneer work in this field stand the brilliant experiments of Doncaster and Raynor with *Abraxas,* those of Bateson and Punnett with the silky fowl, and those of Miss Durham on canaries.[5]

More recently sex-limited inheritance (in which sex behaves as a Mendelian character) has been further studied in fowls by Goodale, Hagedoorn, Sturtevant and others.[6]

The same type of inheritance has been shown by Morgan[7] to hold for a number of characters in the pomace fly, *Drosophila.*

The evidence, now considerable in amount, from both the cytological and experimental lines of investigation, indicates clearly that sex determination is not, as it was long supposed to be, primarily an epigenetic phenomenon. Rather does it appear that the sex of the individual, into which a particular pair of united germ cells will develop, is definitely and unalterably fixed in the hereditary constitution of these germ cells themselves.

In view of these well established conclusions the facts regarding the distribution of sex in cases of multiple gestation take on a peculiar interest. It has long been a well known statistical fact that the sex ratios of offspring resulting from multiple gestation in animals normally uniparous present distinct deviations from the normal. Thus it has recently been shown by Nichols,[8] after careful analysis of the available sta-

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[5]References to this earlier work are given in Bateson, W., Mendelian Principles of Heredity, Cambridge, 1909, pp. 174-188.

[6]Goodale, H. D. Sex and its Relation to the Barring Factor in Poultry. Science, N. S. Vol. 29, No. 756, pp. 1104, 1105, 1909.
Hagedoorn, A. L., Mendelian Inheritance of Sex. Roux's Archiv. Bd. 28, pp. 1-34.
1909.
Pearl, R. and Surface, F. M. On the Inheritance of the Barred Color Pattern in Poultry. Roux's Archiv. Bd. 30. pp. 45-61, 1910.
——— ——— Studies on Hybrid Poultry. Rept. Maine Experiment Station, 1910, pp. 84-116.
——— ——— Further data regarding the Inheritance of the Barred Color Pattern. Science, N. S. Vol. 32, pp. 870-874, 1910.

[7]Morgan, T. H. Sex Limited Inheritance in Drosophila. Science, N. S. Vol. 37, 1910.
An Attempt to Analyze the Constitution of the Chromosomes on the Basis of Sex-Limited Inheritance in Drosophila. Jour. Exper. Zoöl. Vol. 11, 1911. Also a number of other papers on this subject.

[8]Nichols, J. B. The Numerical Proportions of the Sexes at Birth. Mem. Amer. Anthropol. Assoc. Vol. I, Part 4, pp. 249-300, 1907.

tistics for man, that here the number of sons for a thousand daughters drops from 1057 for single births to 548 for quadruple births. That this decline is progressive is shown by the table given by this author (*loc. cit.* p. 298) which is here reproduced.

	Number of Sons for 1000 Daughters.
Single births	1057
Twin births	1043
Triple births	1007
Quadruple births	548

Such a preponderance of females in multiple births is not confined to the human species. The same thing is true of multiple births in sheep and other usually uniparous animals. The obvious explanation which suggests itself to account for these deviating ratios is a prenatal mortality which is differential in respect to sex. It is well known, from statistical studies of the matter in man, that the prenatal rate of mortality is greater for males than for females. If, as seems reasonable *a priori,* the conditions of foetal existence become more severe as the number of young borne in the uterus at the same time increases, any inherent differences in respect to foetal mortality rate between males and females might be expected to be accentuated by these conditions. The figures quoted from Nichols show exactly the trend which would be expected if there were an increasing proportion of deaths of male embryos with multiple gestations of advancing order. There are, however, certain facts which make it very doubtful indeed whether any significant portion of the observed disturbances in the sex ratio in multiple gestations are due to differential prenatal mortality. In the first place the same change in the sex-ratio is observed in multiple gestations in domestic animals where the prenatal mortality is insignificant in amount. In the second place the known facts regarding the distribution of the sexes in multiple births do not accord with the sex-differential prenatal mortality hypothesis.

The preponderance of females is not the only disturbance of the normal single birth sex ratios which occurs in multiple gestations. Another, and probably even more significant deviation is that which concerns the distribution of individuals of the two sexes in the sets of offspring born together. If individuals born as twins, for example, exhibited the same distribution in respect to sex as do random pairs of individuals born singly, it would be expected that twins would show the following sex relations.

Sex of twins:	♂♂	♂♀	♀♀
Frequency of occurrence:	*n* :	*2n* :	*n*

Actually multiple births in man and the domestic mammals show nothing of the kind. For example, Nichols (*loc. cit.*) gives the following figures for human twins.

Sex of twins:	♂♂	♂♀	♀♀
Observed frequency of occurrence:	234,497	: 264,098	: 219,312
Expected frequency if the distribution of sex within the pair was a random one:	179,476.75	: 358,953.50	: 179,476.75

A discussion of this curious phenomenon of sex distribution will be published in a later paper.

In addition to such disturbances of the sex ratio there also occur in connection with multiple gestation cases of apparently incomplete sex determination, such as those leading to the production of so-called "free-martins."

3. Mention has been made of free-martins. Not only do these animals furnish interesting data in regard to the determination of primary but also of secondary sexual characters. In many cases free-martins have been considered to be hermaphrodites, on the basis of their external appearance. In other cases such individuals are notably feminine in their characteristics, so much so indeed as to be used for show or demonstration purposes because they are so typical of the females of the race.

A classical example of this kind is found in the Short Horn breed in the case of the famous "White Heifer that Travelled." [9]

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[9]For an account of this animal see Sanders, A. H., "Short-Horn Cattle." Second Edition, Chicago, 1901, pp. 41 and 42. This account is evidently copied, almost verbatim, from that given in Allen, L. F., "History of the Short-Horn Cattle. Their Origin, Progress and Present Conditions." Buffalo. (publ. by the Author). 1872. p. 52. This "white heifer," which was widely exhibited about 1806 as a typical specimen of the breed, was a free-martin. She was one of a pair of twins of which the other was a bull, and she herself did not breed. She was a very heavy animal, her weight at slaughtering having been estimated to be not less than 2300 lbs. The picture of this "White Heifer" given by Sanders (*loc. cit.*), presumably copied from some contemporary print, shows her to have been typically feminine in appearance. This agrees with the statements regarding this specimen which have come down to us.

The relation between primary and secondary sexual character in these free-martins obviously presents a problem of considerable interest.

4. Cases of multiple gestation present two interesting problems in inheritance. One of these concerns the degree to which a tendency toward multiple gestation in a normally uniparous form may be inherited. Are the offspring of a mother having this tendency likely to show it also? Comparatively little detailed work has been done upon this subject though a general impression appears to prevail that such tendencies are inherited. Thus Wilder[10] says regarding one particular sort of multiple gestation, viz., the production of duplicate twins. (*loc. cit.* p. 368:) "As the tendency to produce duplicate twins and other sorts of abnormal cosmobia seems inherent in certain organisms, and to be transmitted by heredity, it is quite possible that we may be able to breed certain of the viable forms."

There have been a few detailed studies on the inheritance of the tendency towards multiple pregnancies. In man Weinberg[11] and Oliver[12] have recently investigated the influence of heredity on twin bearing. Weinberg's paper is by far the most thorough study of the subject which has yet appeared. From a careful analysis of copious statistics he concludes that the tendency towards multiple pregnancies is inherited in Mendelian fashion, this character apparently behaving as a recessive. He regards heredity as having a greater influence in the production of multiple gestation than any other one factor. It was found impossible to account satisfactorily for the facts on the assumption of blending inheritance. While any single external factor certainly has less influence than heredity in causing multiple gestation, still the sum total of all such external influences must outweigh heredity in affecting observed variations in the num-
outweigh heredity in bringing about observed variations in the

[10]Wilder, H. H. The Morphology of Cosmobia; Speculations concerning the Significance of Certain Types of Monsters. Amer. Jour. of Anat., Vol. 8, pp. 355-440, 1908.

[11]Weinberg, W. Die Anlage zur Mehrlingsgeburt beim Menschen und ihre Vererbung. Arch. f. Rass. u. Gesellsch. Biol. Bd. 6, pp. 322-339, 470-482, 609-630. 1909.

[12]Oliver, James. The Hereditary Tendency to Twinning, with some Observations concerning the Theory of Heredity generally. Part I. Eugenics Rev. Vol. IV, pp. 39-53, 1912.

number of young per birth in the breeding history of the *same individual* female, unless one is prepared to assume a very complicated mechanism of heredity for this character.

The relation of heredity to multiple gestation in man has also been discussed by Wakley,[13] Lop,[14] Naegeli-Akerblom,[15] and Rosenfeld[16] particularly, and by a number of other medical and and anthropological writers incidentally.

An interesting case of apparent inheritance of a tendency to twin bearing in cattle has recently been reported by Wentworth.[17] The family of cattle concerned has been bred on an old farm near Cocheco, New Hampshire. "The foundress of the family was a grade Holstein cow, herself a twin about seven years old. She has been on the farm ever since she was dropped and has given birth to seven calves. Her first service was to a Guernsey bull and resulted in a pair of yellow and white heifers one of which is now in the herd. Her second mating to a red Shorthorn bull resulted in a single black and white bull calf that was vealed. An Ayrshire bull sired her third calves, twin black and white bulls, but neither of these were good enough to raise. Her fourth service was to a Holstein bull and from it she produced twin black and white heifers that promise well as milkers."

"The yellow and white twin first produced by the old cow is now four years old and has twice borne twins. To an Ayrshire bull she produced a pair of yellow and white bull calves that early went to the butcher, and to a Holstein bull she gave birth to twin black and white heifers last December."

The further collection of accurate data bearing upon this question of the inheritance of a tendency to multiple gestation is greatly to be desired.

Data on a second problem in inheritance are presented by cases of multiple gestation, namely that of the limits of heredi-

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[13]Wakley, Thomas. The Influence of Inheritance on the Tendency to have Twins. Lancet, 1895, Vol. II, pp. 1289-1290.

[14]Lop. Quelques chiffres sur l'hérédité de la grossesse jumellaire, Congrès périodique de gyn. obstétr. et de pédiatrie. Marseille, 1899.

[15]Naegeli-Akerblom. Die Geminität in ihren erblichen Beziehungen, Virchow's Arch. Bd. 170, 1902.

[16]Rosenfeld. Zur Frage der vererblichen Anlage zur Mehrlingsgeburten. Zeitschr. f. Geburtsh. u. Gynäk. Bd. 50, 1903.

[17]Wentworth, E. N. Twins in Three Generations. Breeder's Gazette, Vol. lxii, p. 133, July 24, 1912.

tary control. An important question in all such cases concerns the germinal genesis of the individuals included in the multiple pregnancy. Did the individuals thus growing together in the uterus arise from the separated blastomeres of a single ovum, or from several distinct ova? In most cases the only data which can be obtained on this matter arise from an examination of the external somatic characters of the individuals concerned to see whether or not they are identical.

It should be understood that the preceding, somewhat detailed, statement of the more important general biological problems to which cases of multiple gestation relate, is made for purposes of general orientation in regard to specific data discussed in this paper. It is also hoped that it may serve to indicate the kind of information that it is desirable to have recorded by those who may chance to be able to observe cases of multiple birth in the domestic animals. It is evident from the discussion given above that cases of this sort have significance for the biologist and the stockbreeder quite beyond the merely casual curiosity which they excite as "freak" occurrences. From the standpoint of the practical breeder it is highly important that the phenomenon of multiple gestation in normally uniparous animals be carefully studied. Any definite and heritable increase in the fecundity and fertility of the domestic animals, if it can be gained without loss of other desirable qualities, is greatly to be desired. Cases of multiple gestation are the "favorable variations' which must serve as the foundations for the creation of more fertile breeds and races. What may be accomplished in this direction has been splendidly demonstrated by the work of Dr. Alexander Graham Bell with sheep (see footnote p. 275).

Finally it should be said that this general introduction is distinctly not to be regarded as a statement of problems which are to be definitely and completely solved by the data presented in this paper.

Description of a Case of Triplet Calves.

This study has to do with a family of triplet calves[18] born near Waldoboro, Maine in 1907.

The facts regarding the birth and subsequent history of these calves are as follows:

1. *Birth.* The birth of the triplet calves occurred at Mr. L. A. Starrett's farm during the forenoon of June 20, 1907. There were present two other witnesses besides Mr. Starrett. On account of the previous breeding behavior of the mother of these calves (cf. p. 276 *infra*) there was thought to be considerable likelihood of a multiple birth in this case, and the cow was closely watched as the time of parturition approached. No exact record was kept as to the time taken in the parturition of these triplets, but it occupied several hours. There was a rest for a considerable time after the birth of the first two of the calves. The parturition was natural no aid in delivery being necessary. The birth order was ♀ : ♂ : ♀.

2. *Description of Calves.* As has been indicated two of the calves were females and one a male. They were stated to have been small at birth (as would of course be expected), but entirely normal in appearance and in activity. Unfortunately no record was made of the weights of the individuals at birth, so that it is impossible to determine how much below the average size for single calves these were. It is certain however, that while each individual was noticeably smaller than a normal single calf the *aggregate* weight at birth of the triplets was much above that of a normal single calf. All existing evidence regarding cases of multiple birth in species where unit births are normal points to the conclusion that while there is a reduction of size of individuals in the multiple births this reduction is not proportionate to the number of individuals. Thus it has been shown by Mumford[19] that in the case of sheep the

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[18]The writer is under great obligation to Mr. James S. Walter of Waldoboro, Maine, the second owner of these calves, and to Mr. L. A. Starrett of Pleasant Point, Maine, who was the original owner, for the aid which they have freely and kindly given in this work.

[19]Mumford, F. B. Breeding Experiments with Sheep. I. Some Factors Influencing the Weight of Lambs at Birth. II. Milk and Food Records of Ewes. Missouri Agr. Expt. Stat. Bull. 53, pp. 167-188. 1901.

average birth weight of single lambs (of both sexes taken together) is 7.8 lbs. while the average birth weight of twin lambs is reduced only to 7.07 lbs. Vierodt[20] gives for the normal weight of the new-born human infant in round numbers 3250 gm. and for the weight of a single twin (regardless of sex) 2501 gm. (Fesser's data) or 2185 gm. (Recht's data). Again to consider multiple gestations of higher order, Wilking (*loc. cit.*)gives the following birth weight[21] for his case of quadruplets

Birth order and sex	Weight
1. ♀	1347 gm.
2. ♀	1247 "
3. ♂	1347 "
4. ♀	1332 "
Total	5273 "

Corresponding data for Bernheim's (*loc. cit*) case of quintuplets are:

Birth order and sex	Weight
1. ♂	1814 gm.
2. ♂	1928 "
3. ♂	1928 "
4. ♂	1928 "
5. ♂	2268 "
	9866 "

In these cases the single individual is obviously heavier than it should be if it were to be strictly proportional inversely to the number of young born together. In the case of the quintuplets the total weight is more than 3 times that for a normal single birth infant, as given by Vierordt.

Similar relations hold for multiple births in cattle. In an interesting paper based on data taken from the Simmenthal Herd Book Strebel[22] gives the following data:

Mean birth weight ♂ calves	44 kg.
" " " ♀ "	40 "
" " " twins	70 "

[20]Vierordt, H. Anatomische, Physiologische und Physikalische Daten und Tabellen zum Gebrauche für Mediziner. Dritte Auflage. Jena (Fischer) 1906. pp. vi. and 616.

[21]I have transferred the weights as given in the original in pounds and ounces to grams in this and the Bernheim quintuplet case, in order to make the figures more readily comparable with that from Vierordt for the single birth.

[22]Strebel, Die Tauglichkeit von Zwillingskalbern zur Zucht. Deutsche Landw. Presse, Jahrg. xxxvl, No. 84, pp. 897, 898, 1909.

This author further states that in cases of twins of opposite sex the male individual weighed at birth from 5 to 13 kg. more than the female.

The triplet calves here under discussion grew and developed in an entirely normal fashion. They were seen by the writer in October, 1907, and at that time were not individually much under sized. In a letter dated February 3, 1908, Mr. Walter states that the calves were weighed January 14, 1908, with the following results:

Individual	Weight
♂	304 lbs.
♀	278 "
♀	280 "

The close similarity of the two heifers in weight at this age is noteworthy. Commenting on the condition of the calves at the time of this weighing Mr. Walter says: "Farmers admit they are more [= larger] than the average calf about here. They are not fat but in good condition."

In a letter of November 17, 1908, Mr. Walter estimates the weight of the three animals to be at that time between 1400 and 1500 pounds. The two heifers of the triplets were killed and used for beef early in April, 1910. They weighed about 1000 lbs. Mr. Walter stated that the bull was considerably larger than the heifers, but was unable to give the exact weight.

The only detailed statement I have been able to find in the literature regarding the growth of triplet calves is that of Leathers.[23]

This is as follows (*loc. cit.*): "On September 23, 1883, my three-quarter grade Short-horn cow dropped three male calves from a very fine registered Short-horn bull. When six months old the three weighed 940 lbs; at nine months 1680 lbs, and when yearlings, even 2200 lbs., and had nothing but ordinary tame pasture since May 10, 1884."

These are rather meager data but it is of some interest to compare them with figures for the normal growth of Short-horn cattle. Such data have been given by Meek.[24] This author

[23]Leathers, F. F. [Growth of Triplet Calves.] Breeder's Gazette, Vol. 6, p. 609, 1884.

[24]Meek, A. Growth of the Farm Ungulates. I. Approach from a Study of the External Characters. Veterinarian, Vol. LXXIV (XLVII Fourth Series) pp. 121-126. 1901.

has prepared a table (*loc cit.* pp. 122, 123) showing the weight of Short-horn cattle at various stages from birth up to 3 years and 176 days for males and 7 years and 58 days for females. In this table the bulls and steers are lumped together, and the weights of cows are given in another column. Leathers (*loc. cit.*) gives the weight of his triplet calves at three ages; namely six months, nine months and one year. From data given in the column headed "Bulls and Steers" in Meek's table I have endeavored to calculate the weight of normal (i. e., single birth) Short-horn cattle at the same ages. As a necessary consequence of the method of collection Meek's data represent rather uneven intervals in age. The best it seems possible to do from this table in approximating normal mean weights of Short-horn males at the three specified ages is to take the records closest (on either side) to the required number of days and average the weights given for those ages. The table gives the weights of four individuals ranging in age from 173 to 201 days. Two of these individuals were 176 days old, one 173 days and the other 201 days. Averaging these four together to get an approximation to the normal mean weight at six months (180 days) of age, the result is 351.5 pounds. Similarly the table gives the weights of five individuals ranging in age from 265 days to 292 days. Averaging these together to get an approximation to the mean weight for age nine months (270 days) I get 505.6 pounds. The weights given range from 486 to 540 pounds. Finally to get an approximation to the normal weights of Short-horn males one year of age I have averaged together the weights of six individuals in the table ranging in age from 350 days to 1 year and 13 days. The weights of these individuals range from 672 pounds to 718 pounds and the average weight is 698.3 pounds. Putting all these data together for comparison with the figures of Leathers for the triplets we have the result shown in the following table. The figures tabled for the triplets are the mean weight per individual at each age, obtained by dividing the value given by Leathers by 3 in each case.

Weight of Calves in Pounds.

Age	Normal Short-horn Males. (Meek)	Triplet Short-horn Males. (Leathers)
Six months	351.5	313.3
Nine "	505.6	560.0
Twelve "	698.3	740.0

From these figures it is to be noted in the first place that although the triplet calves were at six months of age some 38 pounds below the normal in weight, by the time they had reached the age of nine months the mean weight per individual of the triplets was not only equal to the normal weight for Short-horn calves of the same age, but exceeded it by about 55 pounds. About this same degree of excess in weight was maintained during the next three months so that at one year of age the mean weight per individual of the triplets was 42 pounds above the normal as determined from Meek's data. It appears then in the case of triplets, just as is known to obtain with twins, that while the individuals start their free life at a lower weight than is normal for single animals yet this defect is compensated for in the subsequent growth. By the time the adult condition is reached there is no difference in regard to size relations between the individuals which originate from multiple and those which originate from single pregnancies.

These facts seem to me to be of considerable interest in connection with the dynamical hypothesis regarding growth recently published by Hatai.[25] It is to be presumed that in the case of twins coming from two ova the original endowment of the fertilized egg in respect to "potential growth energy" is the same as in the case of a single offspring. Further, at the end of the growth process both the twins and the single individual attain the same bodily size (or volume). But the curve of growth *up to the time of birth* must be considerably different in the case of the twin individuals from what it is in the single individual. During this period *do* the twins "grow at maximum

[25]Hatai, S. An Interpretation of Growth Curves from a Dynamical Standpoint. Anat. Record, Vol. 5, pp. 373-382. 1911.

rate with least loss of growth energy?" This point would seem well worth investigation in the light of Hatai's valuable hypothesis. It can, of course, be tested, as he has pointed out, by finding whether a logarithmic curve will fit the observed growth during the prenatal life of the twins. If so the hypothesis will be satisfied.

Still more interesting in the same connection is the case of enzygotic twins, where the two individuals originate from the same fertilized ovum. Such twins, so far as may be judged from the meager evidence available, grow to the same end adult size as individuals each developing from a single ovum and occupying the uterus alone during gestation. But if this is so it seems to raise a difficulty respecting the original endowment of potential growth energy in the fertilized egg cell from which the enzygotic twins arose. Did this fertilized egg have twice the usual amount of potential growth energy? If not, what is the source of the additional supply which makes each of the enzygotic twins go on growing to normal full adult size? It seems certain that the study of the growth, both prenatal and postnatal, of multiple young in animals normally bearing but a single offspring at a time, cannot fail to yield results of fundamental importance to the analysis of the normal physiology of growth.

We may turn next to a description of the color characteristics of the triplet calves. The three individuals were not all alike in color. The two females were very nearly alike but not absolutely identical. The male calf was quite different in color and color pattern from his two sisters. The general characteristics of the triplets in respect to color pattern are shown in figures 448 and 449. It is unfortunate that the photographs from which these figures are reproduced were not better. but they were the best it was possible to obtain.

The male was a typical Guernsey in respect to coat color and showed a very close approximation to the precise color pattern exhibited by his mother. The color of that part of his coat bearing pigmented hairs was a light yellowish fawn of the sort frequently seen in Guernseys and exactly the same as that of his mother. The similarity in color pattern between the male calf and his mother is shown in Fig. 448. The mother had a white triangle on the forehead like that of the bull calf; in the same position and of relatively the same size. She also had on the right hind quarter a splash of white similar to that which is shown on the flank of the calf in Fig. 448. The coat color of this bull calf did not change substantially during life.

Both of the heifers of the triplets were typical Herefords, both as to color coat and to color pattern. The hair on the pigmented portions of the body was red in color. Both individuals showed the white face which is typical for Herefords. One of these heifers resembled her sire very closely in respect to details of color pattern. Although in Figures 448 and 449 these two heifers look very much alike, as a matter of fact they were not absolutely identical in respect to color pattern. Particular attention was paid to this point in studying these calves because of the possibility, if not probability, that the two females might be identical or enzygotic twins; that is that they might have arisen from the two first blastomeres of a single egg. Whether or not this was the case, at any rate the two individuals were not absolutely identical, quantitatively, in respect to color pattern. The coat color of the heifers darkened considerably during their lives. This darkening was not equally great in amount in both cases. In a letter of January 10, 1910, Mr. Walter had the following to say in regard to the condition of the triplets in respect to coat color at that time when they were nearly 3 years old. "One (of the heifers) is red and a perfect beauty. The other just a little taller, shades on the brown. Still they look very much alike. The bull is a typical Guernsey, larger than the heifers, well made and getting fine stock."

Externally the triplets gave no evidence of any abnormality or defect in the sexual organs. The bull was typically masculine in appearance and the heifers typically feminine. There was nothing whatever in the appearance of the heifers to suggest hermaphroditism. The bearing of this statement will be apparent when the breeding history of the triplets is completed.

3. *Description of Parents of Triplets.* The sire of these triplets was a grade Hereford showing the white face and body of nearly solid color typical for that breed. In his ancestry there was said to be a small admixture of Holstein "blood." Presumably in consequence of this arose the fact that his coat

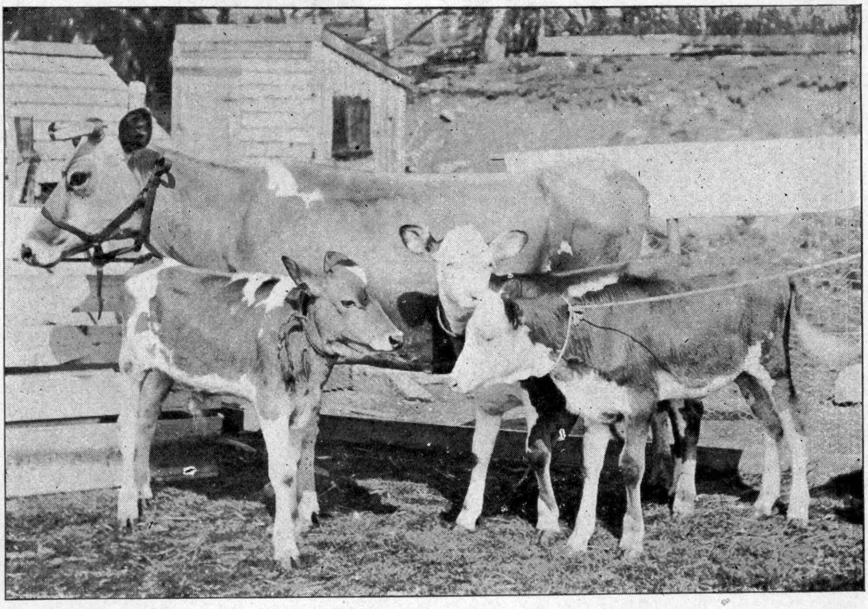

Fig. 448. Photograph of triplet calves and dam.

Fig. 449. Photograph of triplet calves. Male calf in middle.

was black instead of dark red as is usual for the pure bred Hereford. He was an ordinary bull presenting no noteworthy characteristics of any kind. The owner stated to the writer that this bull had usually been prepotent in the matter of marking his calves. What this presumably meant, however, was that the calves of his get were in most cases white faced. This is probably to be regarded merely as an expression of the fact that Hereford white face is dominant in the Mendelian sense over most other types of coloration of the head region found in cattle.[26]

The sire was a relatively young bull. Particular inquiry was made when he was examined as to whether he had been known to get twin or triplet calves with relatively high frequency. The owner stated that this was distinctly *not* the case; that during the period this bull had been heading his herd twin calves had occurred, but not more frequently than was in general to be expected in breeding an equal number of cows. I was not able to obtain a photograph of the sire.

The dam of the triplets was a grade Guernsey, in conformation and color typical of the breed. She was born in 1900, and was, therefore, about 7 years old at the time the triplets were born. She bore her first calf when 2 years old. Her color was a light yellowish fawn splashed with white. She had a white triangle on the forehead and bands of white over the shoulders and rump. She was not a large cow even for a Guernsey. Some idea of her general conformation and color pattern may be gained from Fig. 448. Mr. Walter purchased the cow after acquiring the calves and states that she has proved to be a very good cow from the milking standpoint. It is of interest to note that this cow has two posterior, very small, supernumerary mammae. It is, of course, impossible to say whether this occurrence of supernumerary mammae is directly connected with the high degree of fecundity exhibited by this cow (see next section), but this may fairly be regarded as probably the case because of the fact that these two things are known to be associated in other forms. For example this is so in the sheep which Dr. Alexander Graham Bell[27] is breeding

[26]Cf. Spillman, W. J. Report of Committee on Hybridizing Animals. Rept. Amer. Breeder's Assoc. Vol. III, pp. 184-189, 1907.
[27]Bell, A. G. Sheep-Breeding Experiments on Beinn Breagh. Science. N. S. Vol. 36, pp. 378-384. 1912.

for increased fecundity at Beinn Breagh, Nova Scotia. Other examples of the same relationship might be cited.

TABLE I.

Breeding History of Dam of Triplets.

YEAR	BULL	Number of calves	SEX OF CALVES. ♂	♀	REMARKS.
1902	Grade "Durham"[28]: dark red........	1	-	1	Calf like mother in color and color pattern.
1903	Grade Jersey: dark red body, black head and shoulders.	1	-	1	Calf black; white spot on forehead, white on end of tail. Kept 3 years and then killed.
1904	"Mongrel Jersey and Durham."	1	-	1	Calf resembled sire. Light color.
1905	Grade "Durham": red and white.	2	1	1	Calves red; premature birth in pasture, 1 dead when found. Other killed.
1906	Grade Holstein: black.	2	2	-	Calves black with white patches. Like father. Born dead.
1907	Grade Hereford: black, white face.	3	1	2	Present case.
1909[29]	Registered "Durham": Bates strain.	1	-	1	Calf had head and neck red with white star in face; body mixed with red but mostly white.
1910[30]	Grade Guernsey: the bull used in this case was the ♂ member of the set of triplets described in this paper.	3	1	2	Premature birth by two months. Thought to have been caused by cow falling on ice. All 3 calves alike in color and color pattern.
Totals...	....	14	5	9	

[28]"Durham" in this part of the country means actually Short-horn.
[29]Calf born March 21, 1909.
[30]Calves born in February, 1910.

4. *Breeding Record of Dam.* The complete breeding history of the mother of these triplet calves is given in Table I.

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

(a) During the life time of this cow she has been eight times pregnant. From these pregnancies there have been born 14 calves. This is certainly an unusually high, though by no means unique, degree of fecundity. It is an average production of one and three-quarters young per birth over the whole breeding life of the mother up to 1910.

In the literature of stock-breeding there are many records of cases of high fecundity in cattle. It is unnecessary to attempt any extensive review of these cases here. Of continuous high fecundity the following[31] case is of interest: A grade cow bore and raised 9 calves within 36 months. She had twins three times in succession, and in the next pregnancy triplets. The first twins were dropped in January 1876, and the triplets in December 1878. This gave an average of 2.25 young per birth. The highest continued record of fecundity for a cow which has come to my notice is that given by McGillivray in his "Manual of Veterinary Science and Practice" (1857) and later copied in many other veterinary works. The cow was of "the black polled breed" and is said to have been "small." Her breeding record was as follows:

Year	Number of calves at a birth.
1842	1—This was the cow's first calf.
1843	3—All lived to adult age.
1843	4—One died. (Seven calves in one year).
1844	2—Lived to maturity.
1845	3—Lived to maturity.
1846	6—All died prematurely.
1847	2—Came to maturity.
1848	4
Total	25—Mean number per birth = 3.125

(b) As regards the sex distribution of the offspring there is evidently a preponderance of females, taking the whole breeding life of the dam together. As the data are more carefully studied, however, it becomes apparent that the preponderance of females is a phenomenon due to the single rather than to the multiple births.

If the four multiple gestations in the life of this cow be taken together (that is, the pregnancies terminating in 1905,

[31]National Live Stock Jour. Vol. 10, p. 163, 1879.

1906, 1907 and 1910) it appears that of the 10 young born from these four pregnancies, 5 were males and 5 were apparently females. That is to say, they were females so far as external sexual characters were concerned. It is a curious fact that in all of the single births which this cow had the offspring were females. Whether this is merely a coincidence or has some deeper significance with reference to sex determination is not apparent.

(c) During the breeding history of this cow there has apparently been a steady increase in her rate of fecundity. The first three pregnancies resulted in single offspring, then came in succession two pairs of twins followed by triplets, and then, with a single pregnancy between another set of triplets. This would seem to indicate that as this cow is successively bred her tendency towards multiple gestation comes more and more into expression.

(d) The breeding history of this cow indicates that she has a definite and innate constitutional tendency towards multiple gestation, not due primarily to the action of external circumstances. If a normally uniparous animal has multiple births more than two or three times out of every ten births it is good evidence that the occurrence of such multiple gestation is not fortuitous but rests on an innate physiological tendency of the individual. In the present case there are four multiple births out of eight pregnancies. If there had been triplets but once in the breeding history of this cow, the occurrence might very well have been taken to be accidental. It is apparent, however, that for some reason this cow possesses a definite tendency to bear more than one young per birth. The tendency towards multiple gestation in this case cannot be due to rich or forced feeding. Neither of the two men who have owned the cow during her life have ever fed her heavy or rich rations. On the contrary she has been nourished during the greater part of her life on a relatively small amount of grain and a large amount of roughage.

(e) It is interesting to note that the sire of the last set of triplets (these born in 1910) was the male member of the former set of triplets borne by the same cow. It is in many ways unfortunate that this last set of triplets was born prematurely. There would otherwise have been an excellent opportunity in this experiment of breeding the son back to the dam, when the son was a member of one set of triplets and the dam evidently had a definite and innate tendency towards multiple gestation, to get some interesting data in regard to the inheritance of this tendency towards high fecundity.

5. *The breeding record of the triplets.* The breeding records and sexual behavior of the individuals resulting from multiple gestation in cattle are of interest because of the fact of the occurrence of free-martins (infertile females) in the case of twin calves. Is the sterility and malformed or infantile condition of the genitalia in the free-martin casually related to the fact of multiple gestation, or do these things depend upon other and unrelated causes? Any information regarding the breeding behavior of individuals arising from multiple gestations is welcome in this connection. The writer asked Mr. Walter, the owner of the calves here described, to pay particular attention to the sexual behavior of these triplets. This was done. As has already been implied in what has gone before the male individual of the triplets was entirely functional sexually. He was used in service locally; got good calves; and apparently got as high a proportion of calves as would be expected from a bull of his age. In regard to the sexual history of the female individuals of the triplets, Mr. Walter has the following to say in a letter dated April 11, 1910. After noting the fact that these two supposed heifers had been killed and sold in the village market he says:—"Neither of them had ever been in heat and the man that dressed them said that they would never have bred." In earlier letters Mr. Walter on several occasions said that these calves never showed the slightest signs of being in heat. From the account given by the butcher who killed these animals[32] it appears probable (though, of course, too much weight cannot be put upon such information) that in both individuals the conditions were such as have been described for many free-martins. Neither uterus or tubes were recognized but the vagina apparently ended at its anterior

[32]Unfortunately it was not possible for the writer to be present at this time.

end as a blind sack. Although detailed anatomical data are lacking, there can be little doubt, I believe, because of both the physiological fact of absence of oestrus and the lack (?) or minute, infantile condition of uterus and Fallopian tubes, that these two supposed female individuals were really free-martins.

6. *Color Inheritance in the Triplets.* The coat color and pattern exhibited by these triplets are matters of considerable interest. The essential points in regard to color inheritance in this case are:

(a) That the two females were not at all like the male in either color or pattern. They were of the Hereford type of color and pattern, while the bull was of the Guernsey color and pattern.

(b) While the two females were in general alike in coat color and pattern they were very far from being identical. Especially as they grew older they came to differ quite considerably in color. From the beginning they were distinctly different in pattern.

The sire and dam of these triplets were both grade animals of very mixed ancestry. This makes impossible any attempt to interpret precisely the color inheritance. It is possible, however, by making one or two not improbable assumptions to reach a simple Mendelian interpretation[33] of the inheritance of color and color pattern in these triplets. Such an interpretation can be, of course, only hypothetical, but it is not without interest.

The most striking difference between the sire and dam in regard to color pattern is that the sire had the Hereford white face, and the dam did not. The Hereford white face is known to be dominant over colored face. From the data regarding the breeding of the sire it is reasonable to suppose that he was heterozygous with reference both to head pattern, and to coat color (cf. p. 274 *supra*). The case regarding the dam is not so clear. From the meager data available in regard to her calves born before the present triplets (*vide* Table 1.) it seems probable that with regard to

[33]The essential features of this interpretation were first suggested to the writer by Mr. W. J. Spillman, in the course of some correspondence in regard to the case.

head pattern she is homozygous for the absence of white face. Let us assume this to be the case, and also assume[34] that she is heterozygous, with reference to body color, the Guernsey fawn being the assumed dominant over red.

Then we may suppose the male of the triplets to be a homozygous recessive with reference to colored face, and a heterozygous dominant in respect to body color (Guernsey). The females of the triplets on this assumption would be heterozygous with reference to face pattern (the dominant white face showing) and pure recessives relative to body color. The only way, of course, to have tested the validity of these assumptions would have been to have bred the triplets and examined their progeny. While the male was bred back to his dam, I was not able to get any information as to the color or pattern of the progeny except that all were alike in these respects. This would be expected on the hypothesis made so far as face color is concerned since the son and his dam were supposed pure recessives with reference to colored face. In regard to body color the case is more difficult but it is useless to speculate in the absence of more detailed data regarding the offspring.

Summary.

In the introductory portion of this paper there is presented a discussion of the general biological problems on which cases of multiple gestation in normally uniparous animals bear. The essential purpose of this discussion is to suggest points on which information should be collected by those having an opportunity to observe such cases. These are:

(a) The physiology of multiple gestation.

(b) The determination of sex. Young from multiple gestations in normally uniparous animals exhibit marked and regular deviations from the sex ratios observed in single births of the some species. This fact is of significance in connection with the question of the degree to which sex determination is an epigenetic phenomenon.

[34]It is difficult to get data to test this assumption because of the rarity with which pure Guernseys and pure Shorthorns or Herefords are cross-bred.

(c) The development of secondary sexual characters.

(d) The inheritance of fecundity and fertility. It is well established that a tendency to multiple gestation in normally uniparous forms may be inherited, and may be made the basis of building up more fertile strains or breeds.

The discussion of problems is followed by a detailed description of a case of triplet calves, borne by a cow apparently having an innate inherited tendency towards multiple gestation.

The triplets were the progeny of a grade Guernsey cow that produced 14 calves in her first eight pregnancies, bearing triplets twice, twins twice, and single young four times.

The growth of multiple as compared with single young is discussed with reference to certain general laws of growth.

The triplets described consisted of two females and one male. The latter was sexually normal in every particular, and was used in service, getting normal offspring. The females never came in heat and probably were free-martins.

In color and pattern inheritance the triplets exhibited the following peculiarities: The male was typically a Guernsey, resembling closely his dam. The females were of quite different color and pattern, resembling more closely their sire, a grade Hereford. A possible Mendelian interpretation of these facts is discussed.

BULLETIN No. 205.

THE MODE OF INHERITANCE OF FECUNDITY IN THE DOMESTIC FOWL[1].

RAYMOND PEARL

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[1] Papers from the Biological Laboratory of the Maine Agricultural Experiment Station No. 37. An abstract of this paper was presented at the meeting of the American Society of Naturalists in Princeton, N. J., December, 1911. The present paper was first published in the Journal of Experimental Zoölogy, Vol. 13, No. 2, August 1912, pp. 153-268.

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INTRODUCTION

During the course of an investigation into the inheritance of fecundity in the domestic fowl, which has now involved thirteen generations and several thousand individuals, and has occupied the major portion of the writer's time during the past five years, two definite and clear-cut results have come to light.[2] These are:

First: that the record of egg production or fecundity of a hen is not of itself a criterion of any value whatsoever from which to predict the probable egg production of her female progeny. An analysis of the records of production of large numbers of birds shows beyond any possibility of doubt that, in general, there is no correlation between the egg production of individuals and either their ancestors or their progeny.

[2] For a complete list to date of the publications, in which the results of the investigation referred to have appeared, see the bibliography at the end of this paper. Throughout this paper numbers in parentheses refer to titles in the bibliography.

Second: that, notwithstanding the fact just mentioned, fecundity is, in some manner or other, inherited in the domestic fowl. This must clearly be so, to mention but a single reason, because it has been possible to isolate and propagate from a mixed flock 'pedigree lines' or strains of birds which breed true, generation after generation, to definite degrees of fecundity. Some of these lines breed true to a high condition or degree of the character fecundity; others to a low state or degree of this character.

Definite as these results are they give no clue as to how fecundity is inherited; what the mechanism is. Plate (43) has recently said: "Das Ziel der Erblichkeitsforschung muss die Aufstellung von 'Erbformeln' für alle untersuchten Merkmale sein." This expresses the case precisely. To determine the 'Erbformeln' of fowls with respect to fecundity has been the goal towards which every part of the present investigation has been directed and urged. It is believed that a first approximation to the solution of the problem has now been reached. While there remain obscure points still to be cleared up, yet the results now in hand appear to indicate pretty clearly the general character of the mechanism of the inheritance of fecundity, and to show what lines further investigation of the problem may most profitably take. It is the purpose of this paper to present an account of the results mentioned. In doing this it will be necessary to bring forward evidence of several distinct sorts, anatomical and physiological as well as genetic. Only by approaching this problem of the inheritance of fecundity from all angles has it been possible to gain that understanding of the character itself which, in this instance certainly, is absolutely essential to a correct interpretation of any results respecting its inheritance.

BIOLOGICAL ANALYSIS OF THE CHARACTER FECUNDITY

At the outstart it will be well to understand clearly what is meant by the term fecundity as here used. In a former paper (34) the terms 'fecundity' and 'fertility' were defined as follows, and have been used as there defined throughout the course of the investigation:

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.

Taking fecundity as above defined it is obviously a character depending upon the interaction of several factors. In the first place the number of ova separated from the body by a hen must depend, in part at least, upon an anatomical basis, namely, the number of ova present in the ovary and available for discharge. Further there must be involved a series of physiological factors. The mere presence of an anatomically normal reproductive system, including a normal ovary with a full complement of ova, and a normal oviduct, is not enough to insure that a hen shall lay eggs, that is, exhibit actual as well as potential fecundity. While comparatively very rare, cases do occur in which a bird possesses a perfect ovary and perfect oviduct and is in all other respects entirely normal and healthy, yet never lays even a single egg in her life time. Such cases as these prove (*a*) that what we may call the anatomical factor is not alone sufficient to insure that potential fecundity shall become actual, and (*b*) that the anatomical and physiological factors are distinct, in the sense that the normal existence of one in an individual does not necessarily imply the co-existence of the other in the same individual.

A case of this kind is found in hen no. 8051 hatched March 29, 1909, and killed for autopsy record August 24, 1911. This bird had the secondary sexual characters of the female perfectly developed, and was entirely normal in other respects (body weight, 2366 grams). This bird never laid an egg during its life. The ovary was normal (fig. 450) and was of about the size proper to a fully developed pullet just reaching the point of beginning to deposit yolk rapidly in certain oöcytes in preparation for laying. While counts were not made this ovary appeared to carry a normal number of oöcytes. In general it was anatomically normal, but physiologically in the state of development appropriate to a five or six months old pullet just about to lay. The same was true of the oviduct. In this case the physiological factor or factors necessary to the bringing about of ovulation were simply totally lacking, in an otherwise perfectly normal bird.

Some other cases demonstrating the same thing might be cited from our records, but this will suffice for present purposes.

Turning now to the physiological factors involved in fecundity it would appear that there are at least two such factors or

Fig. 450. Photograph (about twice natural size) of ovary of hen No. 8051. Note the presence of a large number of oöcytes; none of which is enlarging in preparation for laying. See text for further explanation.

groups of factors. The first of these may be designated as the 'normal ovulation' factor. By this is meant the complex of physiological conditions which taken together determine the laying of about such a number of eggs as represents the normal reproductive activity of the wild Gallus bankiva. Under conditions of domestication the activity of this normal ovulation factor will mean the production of more eggs than under wild conditions. Continued egg production involves certain definite and rather severe metabolic demands, which under wild conditions will not always, or even often be met. Further, as has been especially emphasized by Herrick (18, 19, and other papers), egg laying in wild birds is simply one phase of a cyclical process. If the cycle is not disturbed in any way the egg production is simply the minimum required for the perpetuation of the race. If, however, the cycle is disturbed, as for example, by the eggs being removed from the nest as fast as they are laid, a very considerable increase in the total number of eggs produced will result. This, of course, is what happens under domestication. What an effect in increasing the actual expressed fecundity of a wild bird the simple removal of eggs as fast as they are laid may have, may be illustrated by three cases from the literature. Austin (1) shows that whereas the wild Mallard duck in a state of nature lays only 12 to 18 eggs in the year, it will lay from 80 to 100 if they are removed as fast as laid and the bird is kept confined in a pen at night. Hanke (16) by regularly removing the eggs got 48 in succession from a common wryneck (Inyx torquilla[3]). Wenzel (53) in the same way brought a house sparrow's productivity up to 51 eggs.

With the domesticated Gallus the 'normal ovulation' factor may be taken as inducing a production of anything up to from forty to eighty eggs in a year, this production being spread over the period of from sometime in February to September or October. In this physiological complex are involved the elaboration and deposition of yolks, the rapid growth of a few oöcytes just preceding ovulation, ovulation itself, the activation of the oviduct, etc. The details of some of the processes involved have been described elsewhere (cf. Rubaschkin (44), Sonnenbrodt (48), Pearl and Curtis (33) and Pearl and Surface (37)) and do not concern us here. The essential point to be noted is that in this normal ovulation factor we are dealing with the basic physiological processes of normal 'unimproved' laying. To make a normal laying hen it is necessary to have present both the anatomical basis discussed above and the physiological basis, which has been designated the normal ovulation factor.

It is a fact well known to poultrymen, and one capable of

[3] I give this scientific name with much hesitation, not knowing what pranks the rule of priority or other nomenclatorial disturbers of the peace may have played with it in recent years. In any event the common name will quite sufficiently indicate what bird it is that is here under discussion.

easy observation and confirmation, that different breeds and strains of poultry differ widely in their laying capacity. In saying this the writer would not be understood to affirm that a definite degree of fecundity is a fixed and unalterable characteristic of any particular breed. The history of breeds shows very clearly that certain breeds now notably poor in laying qualities were once particularly good. One of the best examples of this is the Polish fowl. But, in spite of this, inheritable breed and strain differences in fecundity exist, and probably always have existed. Such inheritable differences are independent of feeding or any other environmental factors. Thus the strain of Cornish Indian Games with which I have worked are poor layers, regardless of how they are fed or handled. This is merely a statement of particular fact; it does not imply that there may not exist other strains of Cornish Indian Games that are good layers.

The difference between this strain of Cornish Indian Games and Barred Plymouth Rocks, when kept under the same conditions and managed in the same way, is shown in tables 1 and 2, which give the frequency distributions and constants respectively, for flocks of these breeds kept at the Maine Station. The birds included in table 1 were all pullets, hatched at approximately the same time, and reared, housed, fed and cared for in all respects similarly. The Plymouth Rock distribution includes birds of both high and low fecundity strains. The low producing birds lower the mean in what is really an unfair manner, so far as concerns breed comparisons. The point is that, in the work of the Station, low-producing lines have been propagated for experimental purposes to a much greater extent than would be the case in purely random breeding of the Maine Station's stock of the Barred Plymouth Rock breed. To make a perfectly just comparison between Cornish Indian Games and Barred Rocks, the strains of the latter deliberately bred for low egg production should be excluded. It has, however, in the present case been deemed best to take the whole flock of Barred Rock pullets for the laying year 1910-11, without any selection. The comparison is sufficiently striking even on this basis.

TABLE I

Frequency distribution of winter egg production of the Barred Plymouth Rock and Cornish Indian Game breeds

Eggs Laid in Winter Period	Barred Plymouth Rocks Laying the Specified Number of Eggs.		Cornish Indian Games Laying the Specified Number of Eggs.	
	Absolute number	Per cent. of flock	Absolute number	Per cent. of flock
0–5	43	14.4	32	48.5
6–11	22	7.4	8	12.1
12–17	28	9.4	9	13.6
18–23	19	6.3	6	9.1
24–29	25	8.4	7	10.6
30–35	26	8.7	1	1.5
36–41	19	6.4	3	4.5
42–47	27	9.0		
48–53	16	5.4		
54–59	21	7.0		
60–65	14	4.7		
66–71	10	3.3		
72–77	9	3.0		
78–83	3	1.0		
84–89	3	1.0		
90–95	0			
96–101	8	2.6		
102–107	0			
108–113	4	1.3		
114–119	2	0.7		
Total...	299	100.0	66	99.9

From tables 1 and 2 it will be noted that:

1. The mean winter production of the Cornish Indian Games is less than one-third that of the general flock of Barred Plymouth Rocks, under uniform environmental conditions.

2. The winter production of the Games is considerably less than a fourth of that of the high producing lines of the Barred Rocks.

3. The variabilities in both cases are high, but relatively not significantly different. It is of interest to note that the observed coefficients of variation for winter production here given are of the same order of magnitude as the mean coefficients for the laying of the four winter months, November, December, Janu-

ary and February. Taking the mean of the coefficients of variation for these four months as given by Pearl and Surface (37, table 5, p. 96) we get 95.15.

TABLE 2

Constants for variation in winter egg production of the Barred Plymouth Rock and Cornish Indian Game breeds

BREED	Mean	Standard deviation	Coefficient of Variation
	Eggs	*Eggs*	*Per cent.*
Barred Plymouth Rock	36.35 ± 1.04	26.69 ± 0.74	73.42 ± 2.92
Cornish Indian Game	11.64 ± 0.88	10.61 ± 0.62	91.15 ± 8.73
Differences	+24.71 ± 1.36	+16.08 ± 0.97	—17.73 ± 9.21
Barred Plymouth Rock:			
All High Lines in 1908–09[1]	54.16		
All High Lines in 1909–10[1]	47.57		
All High Lines in 1910–11[1]	50.58		

[1] Figures taken from Pearl (28).

The inferiority in egg production of the Cornish Indian Games is most strikingly shown by the integral curves from table 1. In table 3 the integral curves are given (in inversed form) for the winter production of Barred Rock and Cornish fowls.

The data of table 3 are shown graphically in figure 451.

This diagram is to be read in the following manner. The percentages of the flock laying a specified number of eggs are plotted on the abscissal axis. The different egg productions are plotted as ordinates. From the diagram it appears (for example) that whereas 47 out of every 100 birds in the Barred Rock flock each produced 35 or more eggs in the winter period, only 4 and a fraction birds out of every 100 in the Cornish Indian Game flock were able to produce as many eggs as this—35—in the same period.

Now in individuals which are high layers, and have this characteristic in hereditary form, there must be involved some further physiological factor in addition to the normal ovulation factor already discussed. An analysis of extensive statistics has shown (36, 37) that high fecundity represents essentially an addition of two definite seasonal, laying cycles to the basic, nor-

TABLE 3

Showing the percentage of the whole flock producing in the winter period more than certain specified numbers of eggs, in the case (a) of Barred Plymouth Rocks and (b) of Cornish Indian Games

The Indicated Percentage of the Flock Produces in the Winter Period	Barred Plymouth Rock	Cornish Indian Game
6 or more eggs	85.6	51.5
12 or more eggs	78.2	39.4
18 or more eggs	68.8	25.8
24 or more eggs	62.5	16.7
30 or more eggs	54.1	6.1
36 or more eggs	45.4	4.6
42 or more eggs	39.0	0
48 or more eggs	30.0	0
54 or more eggs	24.6	0
60 or more eggs	17.6	0
66 or more eggs	12.9	0
72 or more eggs	9.6	0
78 or more eggs	6.6	0
84 or more eggs	5.6	0
90 or more eggs	4.6	0
96 or more eggs	2.0	0
102 or more eggs	2.0	0
108 or more eggs	0.7	0
114 or more eggs	0.7	0
120 or more eggs	0	0

mal reproduction cycle. These added periods of productivity are what may be called (cf. 37, 28, 30) the winter cycle and the summer cycle. The winter cycle is the more important of these. It is the best practical measure of relative fecundity which we have and has been used as the chief unit of fecundity in these studies. It constitutes a distinct and definite entity in fecundity curves. The existence of this added fecundity, in high laying birds must depend upon some additional physiological factor or mechanism besides that which suffices for the normal reproductive egg production. Given the basic anatomical and physiological factors the bird only lays a large number of eggs if an additional factor is present.

As to the nature of this physiological mechanism we can only speculate. It probably involves fundamentally such matters as

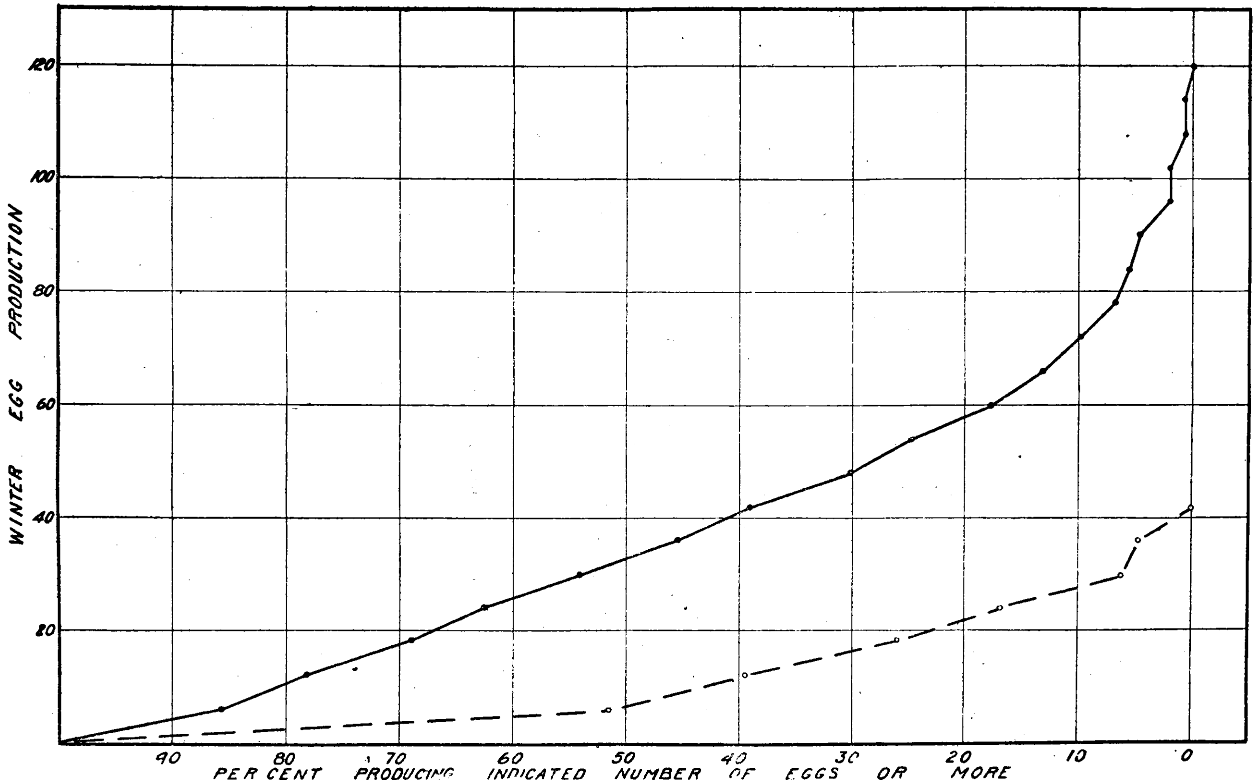

Fig. 451. Integral curves of winter egg pro duction of Barred Plymouth Rock and Cornish Indian Game pullets. Solid line—Barred Plymouth Rocks. Broken line—Cornish Indian Games.

more perfect metabolism, including the distribution of substance and energy to the ovary, on which very heavy demands are laid in a high fecundity record. Immediately it involves a control of the process by which the supply of oöcytes on the ovary in the final stages of rapid growth by yolk deposition is kept at a relatively high level for long periods of time. Sonnenbrodt's (48) work suggests that the interstitial cells of the ovary may be connected with the process. Thus he says (loc. cit., p. 421): "Bei älteren Hühnern findet man die Zwischenzellen immer noch, und besonders in der Nähe der Gefässe. Sie liegen hier gruppen-und nesterweise zwischen den Follikeln und *vor allem auch in den Stielen der grösseren Follikel*,[4] immer dort, wo besonders starke Blutzufuhr günstige Ernährungsbedingungen bietet."

It is quite conceivable that the presence of numerous interstitial cells on the stalks of the follicles of rapidly growing oöcytes is a cause of the rapid growth rather than an effect, as Sonnenbrodt suggests. The whole subject of the intimate physiology of the ovary needs more study.

Whatever the precise nature of the factor under discussion, which is a matter for future investigation, the main points which appear clear at present are that: (*a*) high fecundity represents a definite addition to the normal egg production sufficient in amount for purposes of reproduction. This added fecundity has been shown (cf. 28, 30) to be definitely inherited in certain cases at least and may be regarded as dependent on or determined by some physiological factor or complex of factors not present in birds which exhibit a low degree of fecundity.[5]

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[4] My italics.—R. P.

[5] Throughout this discussion it is presumed that the reader will understand without repeated specific statements that attention was paid to environmental factors in the experimental work. That is, when the statement is made that one bird or set of birds exhibits high fecundity and another low fecundity it is to be understood that both sets were hatched, reared, fed and cared for in all respects in as nearly precisely the same way as is possible, considering that fowls are, in some degree, free agents and cannot be absolutely controlled. The extent both in time and space, and the manifoldness in respect to method, of the experiments upon which this discussion is based are so great and the checks on this point have been so numerous as to make it quite certain that the results are not influenced by a differential effect of the environment, arising from individual preferences of birds for particular sorts of food, or other similar peculiarities of behavior. When a result is stated to be due to inheritance the reader may assume, even though a specific statement is not made to that effect, that careful, critical consideration has been given to possible environmental influences.

This physiological complex may be designated as the 'excess production' factor in fecundity.

We may next consider in greater detail these factors influencing fecundity, taking first

The Anatomical Basis of Fecundity

Since, as already pointed out, egg production obviously depends in part upon the presence of ova in a normal ovary, a question which demands consideration is the following:

To what extent are observed variations in fecundity (i. e., in the number of eggs laid) to be referred to anatomical differences? In other words, does the ovary of a high producing hen, with for example, a winter record of from 75 to 115 eggs, contain a larger number of oöcytes than does the ovary of a hen which is a poor producer, laying no eggs in the winter period and perhaps but 10 or 15 eggs in the year?

To get light upon this question the observations to be described have been made. The object was to arrive at as accurate a relative judgment as possible regarding the number of oöcytes in the ovaries of different individual birds. It is, of course, impossible practically to determine accurately the total absolute number of oöcytes in the ovary. What can be done, is to count the number of oöcytes which are visible to the unaided eye. While such results do not tell us, nor enable us to estimate with great accuracy, the total number of oöcytes in the ovary, they do nevertheless throw interesting and useful light on the question raised above.

The counts of the visible oöcytes for a number of birds are given in table 4. These counts were made at my suggestion by my assistant, Miss Maynie R. Curtis, to whose painstaking care and skill in carrying through the tedious business of counting it is a pleasure to acknowledge gratefully my indebtedness. Prof. W. F. Schoppe of the University of Maine is carrying this work forward and later we hope to be able to publish more extensive data. So far as I am aware the counts here given are the first attempt yet made at anything more than the roughest sort of a guess at the number of eggs in a bird's ovary. While these counts do not give the total numbers they do establish minimum values. A given ovary certainly does not carry any less than the number of visible ova.

A word should be said as to the method of making the counts, and the meaning of the subdivisions of the table. The counts were made in some cases on fresh, and in other cases on preserved ovaries. There was found to be little difference in the two methods, as regards the ease and accuracy of counting. In making the counts small pieces of ovary were cut off, and teased apart with needles under water and the visible oöcytes on the small fragments counted. In delimiting boundaries where a number of small oöcytes were closely packed together, a hand lens was used. No oöcyte was counted, however, which could not be seen with the unaided eye. In other words the lens was not used to find oöcytes which might otherwise be missed, but merely to aid in the dissecting of the material.

In the oöcyte counts given in the table it will be noted that these are grouped into four categories. The first class includes ruptured follicles from which the ova have been discharged. A ruptured follicle which is large at the moment the ovum leaves it gradually shrinks in size and is more or less completely absorbed. On the ovary of a hen which has laid, however, there will always be found a certain number of these discharged follicles not yet absorbed. When such follicles get very small it is exceedingly difficult to distinguish them from small oöcytes (i. e., undischarged follicles). Undoubtedly there are errors in classification in this respect in the counts, but for present purposes this is not a matter of great importance. If the eye were sharp enough it might perhaps be possible to distinguish a ruptured follicle for every egg which has ever been laid, since it is doubtful if the absorption is ever so complete as to leave absolutely no scar. It is of interest to note that in the counts there is a reasonably close relation between the follicle count and the record of eggs laid.

The oöcytes proper are divided in the counting into three classes: those 1 cm. or over in diameter, those between 1 mm. and 1 cm. in diameter, and those less than 1 mm. in diameter. The first of these classes includes the large yolks nearly ready to leave the ovary and pass into the oviduct. They are in pro-

TABLE 4

Showing the number of visible oöcytes in the ovary of certain birds

Case No.	Bird No.	Breed.	Date of Hatching.		Date Killed.		Total number of eggs laid in life.	Winter production.	Discharged follicles.	Oöcytes 1 cm. or over in diameter.	Oöcytes 1 mm. to 1 cm. in diameter.	Oöcytes under 1 mm. in diameter.	Total visible oöcytes.
1	8021	Barred Ply. Rock.......	June	1, '10	March	28, '11	10	3	17	9	53	1149	1228
2	8017	Barred Ply. Rock.......	June	2, '10	March	30, '11	10	0	12	7	51	1596	1666
3	8030	Barred Ply. Rock.......	June	1, '10	March	10, '11	7	0	8	5	62	839	914
4	8005	Barred Ply. Rock.......	June	2, '10	March	14, '11	17	5	12	8	68	1096	1174
5	1367	Barred Ply. Rock.......	April	28, '10	April	4, '11	34	3	49	7	29	2121	2306
6	8018	Barred Ply. Rock.......	June	2, '10	March	24, '11	16	0	23	6	42	1123	1194
7	8009	Barred Ply. Rock.......	June	2, '10	March	24, '11	15	0	17	6	49	2029	2101
8	8010	Barred Ply. Rock.......	May	19, '10	March	17, '11	19	5	24	5	92	1455	1576
9	425	Barred Ply. Rock.......	March	30, '09	July	7, '10	23	0	21	12[1]	142	1346	1521
10	3546	White Leghorn[2].........	May	18, '09	December	20, '10	198	54	75	[3]	231	2146	2452
11	2067	White Leghorn..........	May	28, '09	December	15, '10	197	32	217	1	108	3279	3605
12	3453	White Leghorn..........	May	21, '09	December	13, '10	10	0	11	[3]	75	1626	1701
13	3833	White Leghorn..........	June	14, '09	December	22, '10	2	0	43	[3]	80	2022	2145
14	52	Cornish Ind. Game......	April	21, '09	July	12, '10	52	13	54	6	167	1323	1550
15	71	F1 Cross................	March	31, '10	March	20, '11	124	106	50	5	70	1875	2000
16		Guinea hen.............		?	January	'11	?		9	3	36	717	765
17		Guinea hen.............		?	January	'11	?			3	38	545	586

[1] This includes 8 yolks in process of absorption.

[2] For this and the three following birds I am indebted to Prof. James E. Rice of Cornell University, who very kindly gave me these trap-nested individuals for use in the present study. The egg records in these cases are not the records for life, but the records up to November 1, 1910. The figures represent practically the total production.

[3] Birds not in laying condition when killed.

cess of rapid enlargement by the deposition of yolk. The next class includes those oöcytes in which yolk deposition is started but is proceeding at a slow rate. It is from this class that the first class of rapidly growing yolks is constantly being recruited. Finally the "under 1mm." class represents the make-up of the bulk of the ovary. It will be understood that these size classes are only roughly delimited, the diameter of each oöcyte having been estimated but not carefully measured.

Columns in the table are devoted to "Total number of eggs laid in life" and "Winter production." The first of these has no particular significance since obviously it depends on when the bird was killed in order to make the oöcyte count. Winter production, however, represents a definite entity in fecundity as already pointed out above (p. 292).[6] Winter production records are directly comparable with one another. It is the inheritance of this fecundity unit that is primarily being studied in these investigations.

From this table a number of points are to be noted. In the first place it is clear that the number of visible oöcytes in the ovary of a hen is very large; much larger, I think, than has generally been supposed. While to be sure there are for the most part only vague statements respecting this point in the literature, usually these statements are to the effect that the birds ovary contains 'several hundred' ova. The only direct statement as to the actual number of oöcytes in a hen's ovary which I have been able to find is given by Matthews Duncan (8) on the very dubious authority of Geyelin (11) to the following effect (loc. cit., p. 36): "It has been ascertained that the ovarium of a fowl is composed of 600 ovula or eggs; therefore, a hen during the whole of her life cannot possibly lay more eggs than 600, which in a natural course are distributed over nine years in the following proportion." This statement is followed by an utterly preposterous and presumably entirely imaginary table from Geyelin, supposed to show the laying of hens at different ages. How far from the truth the table is is indicated

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[6] For general discussion of "winter production" as a unit of fecundity, see (28), (30), (34), (37), (38). It comprises the egg production up to March 1 of the laying year.

by the fact that according to it the pullet year is the least productive of any of a hen's life, save only for the ninth year when the last remnants of the original 600 eggs are being tardily and, one must suppose, sorrowfully ejaculated![7] As a matter of fact repeated trap-nest and other tests in all parts of the world have shown again and again that, on the average, the pullet year is the most productive of a hen's life.

From the figures given in table 4 it is furthermore apparent that the absolute number of oöcytes in the hen's ovary is very much larger than the number of eggs which any hen ever lays. A record of 200 eggs in the year is a high record of fecundity for the domestic fowl, though in exceptional cases it may go even a hundred eggs higher than this (cf. 29). But even a 200-eggs record is only a little more than a tenth of the average total number of visible oöcytes in a bird's ovary, to say nothing of the probably much larger number of oöcytes invisible to the unaided eye, but capable of growth and development. In other words it is quite evident from these figures that the potential 'anatomical' fecundity is very much higher than the actually realized fecundity. This is true even if we suppose the bird to be allowed to live until it dies a natural death. Experience shows that birds which make a high fecundity record in the first year of their life, generally speaking, never do so thereafter. In general an examination of what long period records are available in the statistics of this Station, and also in the literature, indicates that probably only relatively few birds of the American or Asiatic breeds at least, would lay many more than 400 to 500 eggs in their natural life time, if they were allowed to live it out. Records of '1000-egg' birds are in existence, but such birds are rare.

One of the longest continuous egg records of an individual bird, which may be considered accurate, with which I am acquainted is that given by Handrik (15) (for a Leghorn). This bird was hatched in 1901. Its egg record was as follows:

[7] It is difficult to understand how so acute an investigator as F. H. A. Marshall could have been so imposed upon by this wonderful table of Geyelin's as to republish it in his valuable and interesting book on the "Physiology of Reproduction."

Calendar year	*Eggs laid*
1902	105
1903	163
1904	138
1905	159
1906	160
1907	133
1908	111
Total	969
Average per year	138 3-7

Heier (17) gives a four-year record for a Braekel hen, which is distinctly higher than would usually be obtained over so long a period. The figures are as follows:

Laying Year	*Eggs laid*
First	153
Second	139
Third	152
Fourth	162
Total	606
Average per year	151 1-2

In this connection the paper of Dackweiler (5) is of interest. Both of the cases here cited are of fowls of the Mediterranean type, in which the tendency to accumulate body fat with advancing age is not marked. I know of no records comparing with these in extent for Plymouth Rocks or other American or Asiatic breed. After two years the fecundity of Plymouth Rocks, in all cases which have been observed at the Maine Experiment Station, becomes greatly reduced.

An examination of table 4 in detail indicates that there is no very close or definite relationship between the number of visible number of oöcytes on the ovary and the winter production of a bird. Thus no. 1367 and no. 3546 each have about the same number of visible oöcytes, yet one has a winter production record 18 times as great as the other. Again no. 71 with the extraordinarily high winter record of 106 eggs has only a little more than one-half as many visible oöcytes as has no. 2067, whose winter production record is only 32 eggs. Again no. 71 with its 106 record has very nearly the same oöcyte count as no. 8010 with a winter record of zero. In general it may be said that the present figures give no indication that there is any correlation between fecundity as measured by winter production, and the number of oöcytes in the ovary. Of course, the present statistics are meager. More ample figures are needed (and are being collected) from which to measure the correlation between actual and 'anatomical' fecundity.

But the data now in hand, even at the very lowest valuation which may be placed upon them, indicate clearly, it seems to me, that there must be some other factor than the anatomical one involved in the existence of different degrees of actual fecundity in the domestic fowl. It clearly is the case from table 4 that when one bird has a winter record of twice what another bird has it is *not* because the first has twice as many oöcytes in the ovary. On the contrary it appears that all birds have an anatomical endowment entirely sufficient for a very high degree of fecundity, and in point of fact quite equal to that possessed by birds which actually accomplish a high record of fecundity. Whether or not such high fecundity is actually realized evidently depends then upon the influence of additional factors beyond the anatomical basis. As has already been indicated in the preceding section it is reasonable to suppose that these factors are physiological in nature. The record of hen no. 71 shows most clearly and distinctly the reason why we must assume that there are definite physiological factors at work in determining relative degrees of fecundity, as measured by winter production.

While there are no oöcyte counts yet available for wild birds it is possible that when made they will show the same point as is here brought out, namely that there is no close or definite relation between the anatomical endowment and actually realized fecundity. In this connection a statement made by Jenner (20) a century and a quarter ago regarding the cuckoo is of interest. He says:

That the cuckow actually lays a great number of eggs, dissection seems to prove very decisively. Upon a comparison I had an opportunity of making between the ovarium, or racemus vitellorum, of a female cuckow, killed just as she had begun to lay, and of a pullet killed in the same state, *no essential difference appeared.*[8] The uterus of each contained an egg perfectly formed and ready for exclusion; and the ovarium exhibited a large cluster of eggs, gradually advanced from a very diminutive size to the greatest the yolk acquires before it is received into the oviduct.

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[8] Italics not in original.

The Mechanism of the Inheritance of Fecundity

With so much by way of introduction we may proceed to the subject in hand, namely a detailed account of the manner in which fecundity is inherited. In this account for reasons which have been stated above, and in earlier papers on this subject, attention will be confined to winter egg production.

A. Observed types of winter egg production. A study of numerous statistics shows that hens fall into three well defined classes in respect to winter production. These classes include (*a*) those birds which lay no eggs whatever in the winter period (up to March 1 of the laying year); (*b*) those that lay but have a production during the period of something under about 30 eggs; and finally (*c*) those whose production exceeds 30 eggs in the winter period. The division point between classes (*b*) and (*c*) is not sharply defined in every case, but it is plainly (as will appear later) at about 30 eggs. Since in the analysis some fixed point must be taken for this boundary a production of 30 has been chosen for this purpose and will be used throughout. This is an arbitrary choice only in the sense that it is a convenient round number lying near where the biological division point falls, at least in the strains of domestic fowls used in these experiments. The analysis could doubtless be carried through nearly or quite as well by taking the division point at a production of 29 or 31, but 30 is a more convenient figure.

In making the division of winter egg production into three groups it must be remembered that this is a character subject to purely somatic fluctuations and environmental influence. Allowance for these factors must be made in interpreting and classifying results. In particular the following points must be kept in mind throughout.

(1) A zero winter production may be due to genetic causes or to purely somatic (physiological) ones, and there is nothing in a single record of this sort, taken by itself, to indicate to which category it belongs. A bird may carry the factor or factors for winter production, yet owing to purely physiological causes, such as a disturbance of metabolism, or of the ovary in respect to its physiology, or to disease, patent or obscure, it may never actually lay during the winter period. Usually it will be possible to tell from other considerations than the record itself, whether a given zero record is 'somatic' or 'genetic.'

(2) The upper limit of the winter period at March 1 is arbitrary, and only approximately coincides with the biological reality. Actually with most birds the spring or reproductive cycle of production (cf. 37) begins in the latter part of February. In handling the material it has been found necessary (for reasons which will be obvious upon consideration of the matter) to take a fixed date for the beginning of the spring cycle of laying and the ending of the winter cycle. The records of the Station prior to 1908 are tabulated only for months (the daily records unfortunately having been destroyed before I took charge of the work), and on this account it is necessary to take the working limit of the winter cycle at the end of a calender month. Since March 1 comes the nearest to the biological limit of any date which is also the beginning of a calendar month it has been chosen. The error introduced by taking this arbitrary date for a point which really shifts within rather narrow limits is, on the average, small. However, it must be recognized as a disturbing element in the individual case. Thus, some birds which really lack any genetic factor for winter production will begin to lay in the last days of February, and consequently on the arbitrary 'March 1' basis will actually be credited with a small winter production. This will tend to make the number of zero birds observed smaller than that expected on theory.

(3) Owing to the factors of environmental influence and somatic fluctuations it is difficult to classify birds in respect to fecundity, which have winter records near the boundary point, 30 eggs. Some birds bearing genes for a production of under 30 eggs will actually lay 31, or 32, or 33, etc. The point considered under (2) again comes into play here. A bird may bear the genes for an 'Under 30' record, and actually make such a record during the true biological winter cycle or period. But if it begins the spring cycle early (i. e., before March 1) it gets credited on its winter record with the eggs which it lays in the last days of February, but which biologically belong with the spring production, and in this way its apparent winter record becomes something over 30, while its real winter production was under 30.

All these factors obscure and render difficult the critical classification and interpretation of the results. Allowance must be made for their influence.

B. Symbolic analysis. After some consideration it has seemed advisable to undertake the presentation of what is at best a complicated matter in the following order. First a symbolic analysis of the inheritance of winter egg production will be given. Then the actual statistics of production covering a period of four years will be given, and it will be shown that these objective data are in substantial accord with the symbolic account. The facts can be presented in this way much more clearly and simply, than if the reverse order is followed. Without the clue of the symbolic analysis to guide one through the maze of figures, one would be hopelessly lost. It scarcely needs to be said that while the order suggested seems undoubtedly the best for the presentation of the results, it is precisely the opposite of that by which the conclusions here set down were reached.

Let us turn to the symbolic analysis. As has been pointed out already there are to be distinguished, on purely biological grounds, three factors involved in fecundity in the female fowl. These are:

(1) An anatomical factor. This is basic. It consists in the presence of a normal ovary, the primary organ of the female sex. In the following analysis a separate letter will not be used for the designation of this factor but instead it will be understood to be included in the letter denoting the presence of the female sex. That is, F will denote the presence of the female sex or its determiner, and the presence of the ovary. The letter f will denote presence of the male sex (the absence of the female sex determiner, from the symbolic standpoint) and the absence of an ovary. Obviously a separate letter is not needed for this 'anatomical factor' since the presence of an ovary is the objective criterion of the existence of the female sex, and its absence of the existence of the male sex.

(2) The first production factor. This is the primary physiological factor which in coexistence with F makes the bird lay eggs during the winter period. Quantitatively it may be taken as determining a winter production of more than zero eggs and less than 30. The presence of this factor will be denoted by L_1 and its absence by l_1

(3) The second production factor. This is a second physiological factor, which in coexistence with F and L_1 leads to

high fecundity. The presence of this factor will be denoted by L_2 and its absence by l_2. When F and L_1 are present the addition of L_2 makes a winter production of over 30 eggs. If F is present and L_1 absent (l_1) the presence of L_2 leads to a winter production of under 30 eggs. Thus either L_1 or L_2 alone makes a record of 30 eggs. They are independent determiners of this degree of production. It should be pointed out, however, that in spite of their equivalence in this regard, the factors L_1 and L_2 are not qualitatively the same. That is, the increased production when L_1 and L_2 are both present, is not because there are present two 'doses' of the same determiner. The proof of this is found in the fact that when there are two 'doses' of L_1 present in a bird it does not make her a high producer. L_2 may be considered an excess production factor, which erects a superstructure on the foundation furnished by L_1. In the absence of L_1 L_2 lacks the foundation from which to start and hence only can build about as high as L_1 would alone. One L_1 cannot, however, build a superstructure on another L_1; nor can an L_2 build one on another L_2. Of course it will be understood that with f (absence of female sex and ovary) these physiological fecundity factors L_1 and L_2 are simply latent.

Using the letters in the manner defined above, and with the usual Mendelian method of writing gametic and zygotic formulae, the data indicate the existence of Barred Plymouth Rock and Cornish Indian Game males and females of the constitutions set forth below. The only point needing particular attention in reference to these formulae is that the factor L_2 behaves in inheritance as a sex-limited character precisely like the barred color pattern of the Barred Rock (40, 41). In consequence gametes of the type FL_2 are never formed. Any gamete which bears F does not, under any circumstances, ever carry L_2.

It is not desirable to take the space to consider here all the consequences which flow from the circumstance of the high fecundity factor L_2 being a sex-limited character. These matters will be fully discussed farther on in the paper after the data themselves have been presented. Here it need only be said that since L_2 is a sex-limited character corresponding in behavior to the barred color pattern, it means that ♂ ♂ may be formed with any combination of the factors L_1 and L_2, whereas ♀ ♀ which bear L_2 at all, must be heterozygotic in respect to it. Females may, however, be either homozygotic or heterozygotic in respect to L_1, it not being a sex-limited character, and hence not in any way coupled with or repelled by the factor F. That the female fowl is heterozygotic in respect to the sex factor was suggested by Spillman (50, 51) and has been demonstrated by the experimental studies of Bateson (3), Goodale (12, 13), Hagedoorn (14), Sturtevant (51) and Pearl and Surface (40, 41).

Tables 5 to 8 inclusive show the constitution in respect to fecundity of males and females of the breeds used in this work, as indicated by the results obtained from breeding experiments. These constitutions represent the 'Erbformeln which flow from the facts, and, in determination of their adequacy, are to be tested against the facts. In these tables the columns headed 'Gametes produced' have been made up in accord with the general Mendelian principle that in gametogenesis all possible com-

TABLE 5

Constitution of Barred Plymouth Rock males in respect to fecundity

Class	Zygote	Gametes Produced
1	$fL_1L_2 . fL_1L_2$	fL_1L_2
2	$fL_1L_2 . fL_1l_2$	fL_1L_2, fL_1l_2
3	$fL_1L_2 . fl_1L_2,$	fL_1L_2, fl_1L_2
4	$fL_1L_2 . fl_1l_2$	$fL_1L_2, fL_1l_2, fl_1L_2, fl_1l_2$
5	$fL_1l_2 . fL_1l_2$	fL_1l_2
6	$fL_1l_2 . fl_1l_2$	fL_1l_2, fl_1l_2
7	$fl_1L_2 . fl_1L_2$	fl_1L_2
8	$fl_1L_2 . fl_1l_2$	fl_1L_2, fl_1l_2
9	$fl_1l_2 . fl_1l_2$	fl_1l_2

TABLE 6

Constitution of Barred Plymouth Rock females in respect to fecundity

Class	Zygote	f-Bearing (♂ Producing) Gametes	F-Bearing (♀ Producing) Gametes	Probable Winter Egg Production of ♀ of Indicated Zygotic Constitution
1	$fL_1L_2 . Fl_1l_2$	fL_1L_2, fl_1L_2[1]	Fl_1l_2, FL_1l_2	Over 30 eggs
2	$fL_1L_2 . FL_1l_2$	fL_1L_2	FL_1l_2	Over 30 eggs
3	$fL_1l_2 . Fl_1l_2$	fL_1l_2, fl_1l_2	Fl_1l_2, FL_1l_2	Under 30 eggs
4	$fL_1l_2 . FL_1l_2$	fL_1l_2	FL_1l_2	Under 30 eggs
5	$f\,l_1l_2 . Fl_1l_2$	$f\,l_1l_2$	Fl_1l_2	Zero eggs
6	$f\,l_1L_2 . Fl_1l_2$	$f\,l_1L_2$	Fl_1l_2	Under 30 eggs

[1] The reason that gametes of the type fL_1l_2 and fl_1l_2 are not formed here will be evident on consideration. Since no gametes of type FL_2 can, by hypothesis, be formed this implies that an interchange of the factors L_2 and l_2 between F and f gametes cannot occur. The experimental proof of the truth of this conviction has been furnished in the case of the inheritance of the barred color pattern.

binations of the factors present will be formed, within the bounds of any limitation which may be imposed by such phenomena as coupling, repulsion or linkage. The limitation of these possibilities in the present instance has been set forth above: it consists simply in the fact that F and L_2 are never

TABLE 7

Constitution of Cornish Indian Game males in respect to fecundity

CLASS	Zygote	Gametes Produced.
1	$fL_1l_2 . fL_1l_2$	fL_1l_2
2	$fL_1l_2 . f\,l_1l_2$	fL_1l_2, fl_1l_2
3	$f\,l_1l_2 . f\,l_1l_2$	$f\,l_1l_2$

TABLE 8

Constitution of Cornish Indian Game females in respect to fecundity

CLASS	Zygote	f-Bearing (♂ Producing) Gametes	F-Bearing (♀ Producing) Gametes	Probable Winter Egg Production ♀ of Indicated Zygotic Constitution
1	$fL_1l_2 . FL_1l_2$	fL_1l_2	FL_1l_2	Under 30 eggs
2	$f\,l_1l_2 . FL_1l_2$	$f\,l_1l_2, fL_1l_2$	FL_1l_2, Fl_1l_2	Under 30 eggs
3	$fL_1l_2 . Fl_1l_2$	fL_1l_2, fl_1l_2	Fl_1l_2, FL_1l_2	Under 30 eggs
4	$f\,l_1l_2 . Fl_1l_2$	$f\,l_1l_2$	Fl_1l_2	Zero eggs

It will be noted that C. I. G. ♀ classes 2 and 3 are gametically identical. Both are left in the table, however, since the whole table is so short that no confusion can be caused, and this example may make clear to some readers the nature of the compression (by omission of duplicate classes) which was practised in tables 5 and 6.

borne in the same gamete. It should be said that these tables do not show at all the proportions in which the several gametic types might be expected to occur. Further all duplicates have been omitted, so that only the different possible types are shown in these tables.

It will be noted from table 6 that two classes of females (1 and 2) carry both L_1 and L_2 and hence are to be expected, on the hypothesis developed, to be high layers. One class (class 5) carries neither L_1 nor L_2 and hence should make zero winter records. It should be said that observations indicate that while such class 5 birds occur with expected frequency, they usually do not produce any offspring. A zero winter layer usually gets very few chicks of any kind and almost never has any adult ♀ progeny.

Turning our attention to the Cornish Indian Games, we have the gametic constitutions set forth in tables 7 and 8. The only special point to be noted here is that the factor L_2 does not appear at all in either males or females. All the evidence indicates that in the strain of Cornish Indian Games used in these experiments, this excess production factor L_2 is entirely absent (cf. in this connection tables 1, 2 and 3, supra).

We may next consider the theoretical results which would be expected to follow the mating in all possible combinations of birds of the constitutions set forth above. In doing this account will be taken of female progeny *only*, for the sake of simplicity, saving of space, and because we are here concerned only with actual fecundity as expressed in the female. Anyone who desires can easily work out the ♂ constitutions for himself. Tables 9 and 10 give the expected numbers of female progeny from each mating, on the assumption of uniform fertility throughout. It will be seen that some odd ratios should appear.

It should be pointed out that while, for the sake of completeness, the result of every possible mating is carried out in table 9 on an assumption of equal fertility for all matings, this by no means accords with actual fact. Certain of the matings would not in practice get any offspring at all. This applies also to table 10. This point will be made clear in connection with the application of the theoretical frequencies to the observed data.

It will not be necessary in the table for Cornish Indian Games to present the theoretical frequencies in such detail. Only totals and ratios will be given.

From table 10 it will be seen that no high layers are to be expected from pure Cornish Game matings and that further the proportion of zero layers is relatively high.

Analysis of the Experimental Data

In this section the actual results in respect to fecundity will be compared with the theoretical expectations. There will be presented first the data respecting the matings of Barred Rock males and females (pure B.P.R. matings); second the data respecting matings of Cornish Indian Game males and females (pure C.I.G. matings); and finally the F_1 and F_2 matings of Barred Plymouth Rocks and Cornish Indian Games crossed reciprocally.

TABLE 9

Showing the theoretical expectation in respect to the fecundity of the daughters from all possible matings of Barred Plymouth Rocks inter se

MATINGS.		EXPECTED DISTRIBUTION OF FECUNDITY AMONG ♀ PROGENY OF THE DESIGNATED MATING.		
B. P. R. ♂ of class	B. P. R. ♀ of class	Daughters with a winter production *over 30 eggs*	Daughters with a winter production of *under 30 eggs*	Daughters with a winter production of *zero eggs*
1	1 to 6 inclusive	32		
1	All classes	Ratio = 1	0	0
2	1	4	4	
2	2	2	2	
2	3	4	4	
2	4	2	2	
2	5	2	2	
2	6	2	2	
2	All classes	Totals = 16	16	
2	All classes	Ratio = 1	1	0
3	1	6	2	
3	2	4		
3	3	6	2	
3	4	4		
3	5	2	2	
3	6	2	2	
3	All classes	Totals = 24	8	
3	All classes	Ratio = 3	1	0
4	1	3	4	1
4	2	2	2	
4	3	3	4	1
4	4	2	2	
4	5	1	2	1
4	6	1	2	1
4	All classes	Totals = 12	16	4
4	All classes	Ratio = 3	4	1
5	1 to 6 inclusive		32	
5	All classes	Ratio = 0	1	0
6	1		6	2
6	2		4	
6	3		6	2
6	4		4	
6	5		2	2
6	6		2	2
6	All classes	Totals =	24	8
6	All classes	Ratio = 0	3	1
6	1		6	2
7	1	4	4	
7	2	4		
7	3	4	4	
7	4	4		
7	5		4	
7	6		4	
7	All classes	Totals = 16	16	
7	All classes	Ratio = 1	1	0
8	1	2	4	2
8	2	2	2	
8	3	2	4	2
8	4	2	2	
8	5		2	2
8	6		2	2
8	All classes	Totals = 8	16	8
8	All classes	Ratio = 1	2	1

TABLE 9—Continued

Matings.		Expected Distribution of Fecundity Among ♀ Progeny of the Designated Mating.		
B. P. R. ♂ of class	B. P. R. ♀ of class	Daughters with a winter production *over 30 eggs*	Daughters with a winter production of *under 30 eggs*	Daughters with a winter production of *zero eggs*
9	1		4	4
9	2		4	
9	3		4	4
9	4		4	
9	5			4
9	6			4
9	All classes	Totals =	16	16
9	All classes	Ratio = 0	1	1
All classes	All classes	Grand Total = 120	160	40
All classes	All classes	Ratio = 3	4	1

Since the actual breeding operations were carried out in advance of any understanding of the mechanism of the inheritance of fecundity the matings were substantially at random so far as concerns fecundity factors. As a consequence not all possible gametic pairings have been made, while for certain combinations a relatively large number of offspring are available. Enough of the possible gametic combinations have, however, been made with Barred Rocks to show clearly how fecundity is inherited.

A word should be said in regard to the number of offspring

TABLE 10

Showing the theoretical expectation in respect to the fecundity of the daughters from all possible matings of Cornish Indian Games inter se

Mating		Expected Distribution of Fecundity Among ♀ Progeny of the Designated Mating		
C. I. G. ♂ of class	C. I. G. ♀ of class	Daughters with a winter record of *over 30 eggs*	Daughters with a winter record of *under 30 eggs*	Daughters with a winter record of *zero eggs*
1	1 to 4 inclusive		12	
1	All classes	Ratio = 0	1	0
2	1 to 4 inclusive	Totals	9	3
2	All classes	Ratio = 0	3	1
3	1 to 4 inclusive	Totals	6	6
3	All classes	Ratio = 0	1	1
All classes	All classes	Grand totals	27	9
		Ratio = 0	3	1

from the different matings. The writer would, of course, be glad if records were at hand for a large number of progeny for every mating made. There are, however, practical difficulties in the matter. The Maine Agricultural Experiment Station poultry plant has accommodations for only about 600 adult pullets per annum in spite of the fact that it is one of the largest purely experimental poultry plants in the country.[9] Now taking all the experiments together there are made about 300 separate matings each year. It is simple arithmetic to show that under the circumstances, if all matings were equally represented, only two pullets from each mating could be tested as to fecundity. As a matter of fact all matings are not equally represented. Some yield either no chickens, or too few to insure the development of adult daughters. The aim has always been in this work to put into the laying house for trap-nest records of fecundity as many daughters from each one of as many matings as possible. Of course, only healthy, normal well developed pullets can be used in the work, since any other sort could not be depended upon to give reliable normal results as to fecundity. This means that, under the prevailing climatic conditions here, only pullets hatched between a rather narrow range of dates (April 1 to June 1) can be used in the fecundity. Those hatched at other seasons will not give normal results.

Altogether it will be seen that the character fecundity in fowls is not one which lends itself readily to treatment in large masses of figures, desirable as such might theoretically be. The case is very different from the study of the inheritance of plumage colors in poultry, for example, where both sexes are available for record and the records may be made while the chicks are relatively young (or in some cases even unhatched) and before they have time to die. If all students of the inheritance of pigmentation in poultry had been obliged to keep, house, and feed every bird which was to furnish any record whatever, until approximately one and a half years after hatching, and could have got records even then only from one sex (both of which conditions obtain in the study of fecundity), it is plain that their

[9] There are *hatched* annually on this plant from 3500 to 4000 chicks, and facilities for handling adult stock make it possible to accommodate over winter about 1000 birds of all sorts, including adult pullets, hens and male birds.

recorded numbers would have fallen very far below those which they have actually, and most fortunately for the good of biology, been able to obtain.

The foregoing remarks are not in any sense intended as an *apologia* for the statistical portion of this paper, because in the opinion of the writer, who is thoroughly acquainted with the practical difficulties which beset the study of inheritance of fecundity, no apology is needed. The data here presented are about as extensive as it is practically possible to obtain in an interval of time and with an experimental equipment equal to what has been available in the present investigation. It is hoped, however, that what has been said may help the reader, who may not be practically familiar with the rearing and trap-nesting of large numbers of fowls, to understand the reason why more extensive data are not forthcoming in this paper. In every case where the number of birds to a family was too small to warrant any conclusion this fact is particularly noted. The data for these small families are not suppressed, however, but are in most instances separately tabulated.

One convention which is used throughout in the tabulation of the material should be explained. In case a bird has a winter egg record of exactly 30 eggs, she evidently falls on the boundary line between the two fecundity classes already discussed and defined (p. 302). The number of such cases is not large, but in order to be perfectly impartial in their treatment it was decided to split such a bird in two, in a metaphorical sense, and credit one-half of her to the 'Over 30' winter fecundity class, and the other half to the 'Under 30' class. This explains the fractional records which occasionally appear among the frequencies in what follows, and which might otherwise puzzle one used to thinking of a hen as an individual unit, at least during the fecund portion of her existence. In calculating the mean winter production (in eggs) of the several classes these few birds with records of exactly 30 eggs have been omitted altogether. There are obviously two equally fair ways of dealing with them in getting these averages. One is to include each one in *both* 'over' and 'under' classes; the other is to include each one in *neither* class. The latter alternative is adopted because simpler.

Barred Plymouth Rock Matings

The data will be presented for each gametic constitution separately. The analysis indicates that out of the 9 theoretically possible types of male Barred Rocks shown in table 5 only six have actually ever been used in the breeding pens. These six classes of males represented in the data are classes 1, 2, 3, 4, 7 and 8.

In any particular case it is practicable to determine the gametic constitution of a male bird in respect to fecundity only through an examination of the records of his daughters. To distinguish different gametic types of males through analysis of the male progeny, while theoretically simply, is practically not feasible while any other investigations are going on. In order to determine the gametic constitution in regard to fecundity of the cockerels from a particular mating it would be necessary to rear to maturity a reasonable number (5 to 10) of these males, and then a year from the time they were hatched to mate each of them with a number of females, and rear to maturity and trap-nest for a year a number (3 to 10 for example) of pullets grown from each of the matings of each of the cockerels. Then from the trap-nest records of these pullets it would be possible to conclude as to what was their grandfather's gametic constitution respecting fecundity. It is evident that relatively enormous experimental resources would be required to carry this out on even a very modest scale. Further the end would scarcely justify the means from either a practical or theoretical standpoint, since the theoretically expected gametic types of males can be readily obtained and their pedigrees will enable one to analyze fully the gametic factors and reactions involved in their production.

Throughout the paper, then, conclusions will be drawn as to gametic constitution of parents from an analysis of the female progeny only.

The reason why the other three classes of males (5, 6 and 9) are not represented in the matings is to be found in the method of selective breeding practised during the time in which the statistics here analyzed were collected. The chance of using in a breeding pen males of any of these types was small when the selection was carried on in the way that it was. This point will be more fully discussed farther on in the paper.

Matings of Barred Plymouth Rock males of class[10] *7*

Males of class 7, having a gametic constitution $fl_1L_2.\ fl_1L_2$, were used more often than any other sort in the pure Barred Rock matings. They are homozygous with reference to the absence of the first production factor L_1, and the presence of the second or excess production factor L_2. A reference to table 9 shows that there should be no zero winter producers among their progeny. The proportions of high and poor layers in the progeny depend upon the nature of the female with which the male is bred. For convenience the matings of each individual male will be discussed separately.

B.P.R. ♂ *553*. Indicated gametic constitution $= fl_1L_2.\ fl_1L_2$.

This male was hatched in the spring of 1908 and used as a breeder in the season of 1909. His successful 'pure' matings (i. e., those with B.P.R. females which produced adult female progeny) were as follows:

Matings: A. With 6 ♀ ♀ indicated to be of class $2 = fL_1L_2.\ FL_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	15	0	0
Expected	*15*	*0*	*0*
Mean winter production of ♀ ♀ in indicated class	51.33 eggs		

B. With 3 ♀ ♀ indicated to be of class $1 = fL_1L_2.\ Fl_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	6	9	0
Expected	*7.5*	*7.5*	*0*
Mean winter production of ♀ ♀ in indicated class	55.50 eggs	13.56 eggs	

C. With 2 ♀ ♀ indicated to be of class $4 = fL_1l_2.\ FL_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	4	0	0
Expected	*4*	*0*	*0*
Mean winter production of ♀ ♀ in indicated class	39.75 eggs		

[10] The 'class' numbers throughout refer to the arbitrary designations given in tables 5 to 10 inclusive.

All ♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	25	9	0
Expected	*26.5*	*7.5*	*0*
Mean winter production	50.48 eggs	13.56 eggs	

The agreement between observation and expectation here is as close as could be expected considering the numbers involved. Further it is evident from the mean production of the daughters falling in the several classes that the 'Over 30' and 'Under 30' classes are perfectly distinct in respect to degree of fecundity. The 'Over 30' birds produced on the average, nearly four times as many eggs in the winter period as the 'Under 30' birds.

B.P.R. ♂ *567*. Indicated gametic constitution = $fl_1L_2.\ fl_1L_2$.

This male was used in the breeding season of 1910 and sired a fairly large number of chicks of which the adult daughters appear below. He was hatched in the spring of 1909.

Matings: A. With 5 ♀ ♀ indicated to be of class 1 = $fL_1L_2.\ Fl_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	7½	9½	0
Expected	*8.5*	*8.5*	*0*
Mean winter production of ♀ ♀ in indicated class	57.28 eggs	14.78 eggs	

B. With 3 ♀ ♀ indicated to be of class 2 = $fL_1L_2.\ Fl_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	12	2	0
Expected	*14*	*0*	*0*
Mean winter production of ♀ ♀ in indicated class	55.83 eggs	22.00 eggs	

C. With 2 ♀ ♀ indicated to be of class 6 = $fl_1L_2.\ Fl_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	1½	3½	0
Expected	*0*	*5*	*0*
Mean winter production of ♀ ♀ in indicated class	48.00 eggs	14.00 eggs	

All ♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	21	15	0
Expected	*22.5*	*13.5*	*0*
Mean winter production	55.95 eggs	15.64 eggs	

It will be noted that there are two exceptions in these matings. A class 7 ♂ × class 2 ♀ should give only daughters in the 'Over 30' class. Two out of the 14 adult progeny from matings of this type laid fewer than 30 eggs in the winter period. The record of one of these two was 28 eggs. There is no doubt that this bird was a somatic variation belonging gametically to the 'Over 30' class (cf. p. 302). In general it is obvious that the agreement between observation and expectation here is very satisfactory. Further the difference in average winter production of the birds in the 'Over 30' and 'Under 30' classes is so great as to leave no doubt of the real distinctness of these classes in respect to fecundity.

B.P.R. ♂ *562.* Indicated gametic constitution $= fl_1L_2 . fl_1L_2$.

This male got comparatively few adult daughters. He was used during only one breeding season (that of 1910), having been hatched in the spring of 1909.

Matings: A. With 4 ♀ ♀ indicated to be of class 1 $= fL_1L_2 . Fl_1l_2$.

♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	5	6	0
Expected	*5.5*	*5.5*	*0*
Mean winter production of ♀ ♀ of indicated class	42.40 eggs	11.67 eggs	

B. With 2 ♀ ♀ indicated to be of class 2 $= fL_1L_2 . Fl_1l_2$.

♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	8	0	0
Expected	*8*	*0*	*0*
Mean winter production of ♀ ♀ of indicated class	70.00 eggs		

All ♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	13	6	0
Expected	*13.5*	*5.5*	*0*
Mean winter production	59.38 eggs	11.67 eggs	

In spite of the comparatively small number of individuals here, the evidence of segregation of high and low fecundity in accordance with gametic expectation is clear and indubitable.

B.P.R. ♂ *552.* Indicated gametic constitution = $fl_1L_2.\ fl_1L_2.$

This male was used as a breeder during two seasons (1909 and 1910). He was hatched in the spring of 1908. His sisters were very poor winter layers, as shown by the following table.

Sisters of ♂ *552*	*Winter production as pullets* *Eggs*
E 184	16
E 229	6
E 272	7
Mean winter production of family	9.67

The mother of ♂ 552 (♀ D725) was a good layer with a winter record of 61 eggs. From her he evidently got an L_2 factor which his sisters could not acquire in this way. The father was heterozygous relative to L_2 (belonging to class 4) and the only one of his adult progeny from the mating with ♀ D725 to bear L_2 happened to be the ♂ 552 here under discussion. In the following account of ♂ 552's breeding history the progeny in both of the years in which he was used in the pens are taken together. There is no reason why the two years should be dealt with separately.

Matings: A. With 4 ♀ ♀ indicated to be of class 2 = $fL_1L_2.\ FL_1l_2.$

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	11½	½	0
Expected	*12*	*0*	*0*
Mean winter production of ♀ ♀ in indicated class	48.27 eggs		

B. With 10 ♀ ♀ indicated to be of class 1 = $fL_1L_2.\ Fl_1l_2.$

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	17	15	2
Expected	*17*	*17*	*0*
Mean winter production of ♀ ♀ in indicated class	54.71 eggs	12.47 eggs	0 eggs

C. With 3 ♀♀ indicated to be of class 3 = $fL_1l_2 . Fl_1l_2$.

♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	2	1	0
Expected	*1.5*	*1.5*	*0*
Mean winter production of ♀♀ in indicated class	35.50 eggs	22.00 eggs	

All ♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	30½	16½	2
Expected	*30.5*	*18.5*	*0*
Mean winter production	51.07 eggs	13.06 eggs	0 eggs

In this case the two zero birds are without much question to be reckoned as somatic rather than genetic zeros. Unfortunately neither of these birds were bred, so that precise information on the point is lacking. Assuming this to be the case the agreement between observation and expectation in the large progeny is perfect. The matings under C got so few ♀ progeny as to be without significance one way or the other.

The mean winter productions again show the distinctness of the separation between the 'Over 30' and 'Under 30' fecundity classes.

B.P.R. ♂ *554.* Indicated constitution = $fl_1L_2 . fl_1L_2$.

This bird, like ♂ 552 was used in the breeding pens two years. He was hatched in 1908 and bred in each of the two following years. His breeding history was as follows:

Matings: A. With 8 ♀♀ indicated to be of class 1 = $fL_1L_2 . Fl_1l_2$.

♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	12	12	1
Expected	*12.5*	*12.5*	*0*
Mean winter production of ♀♀ in indicated class	47.67 eggs	15.58 eggs	0 eggs

B. With 3 ♀♀ indicated to be of class 2 = $fl_1L_2. Fl_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	8	0	0
Expected	*8*	*0*	*0*
Mean winter production of ♀♀ in indicated class	59.00 eggs		

C. With 2 ♀♀ indicated to be of class 6 = $fl_1L_2. Fl_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	0	3	0
Expected	*0*	*3*	*0*
Mean winter production of ♀♀ in indicated class		20.33 eggs	

All ♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	20	15	1
Expected	*20.5*	*15.5*	*0*
Mean winter poduction	52.20 eggs	16.53 eggs	0 eggs

Barring the single bird with a zero record the agreement between observation and expectation here is perfect. This exception was a late[11] hatched bird (June 2, 1910). It laid an egg on May 1, 1911, of its pullet year, and died from a combination of pulmonary and intestinal difficulties on May 22. Under these circumstances it obviously carries little weight as an exception to expectation on a gametic basis.

B.P.R. ♂ *564.* Indicated constitution = $fl_1L_2. fl_1L_2$.

This bird was hatched in 1909 and used in the breeding season of 1910, with the following results:

[11] It must always be remembered that 'late' is relative. Under our conditions of climate, etc., at Orono, June 2 represents very late hatching for birds which are to be used in fecundity work. The cold weather comes on so early in the fall and is so severe that any bird not fully developed by the middle of October or the first of November at the latest is likely to remain permanently stunted. The first of June represents about the latest possible limit of hatching for fecundity work under these conditions.

Matings: A. With 6 ♀ ♀ indicated to be of class 1 = fL_1L_2. Fl_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	9	10	2
Expected	*10.5*	*10.5*	*0*
Mean winter production of ♀ ♀ in indicated class	64.44 eggs	19.80 eggs	0 eggs

B. With 3 ♀ ♀ indicated to be of class 3 = fL_1l_2. Fl_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	2	2	0
Expected	*2*	*2*	*0*
Mean winter production of ♀ ♀ in indicated class	54.50 eggs	26.50 eggs	

C. With 1 ♀ indicated to be of class 6 = fl_1L_2. Fl_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	0	2	0
Expected	*0*	*2*	*0*
Mean winter production of ♀ ♀ in indicated class		4.00 eggs	

All ♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	11	14	2
Expected	*12.5*	*14.5*	*0*
Mean winter poduction	62.64 eggs	18.85 eggs	0 eggs

The families are small in this case. From both these pure Barred Rock and the cross matings in which ♀ 564 entered, however, there can be no doubt that he is a class 7 male. The two zero birds are to be reckoned as 'somatic zeros' rather than gametic. Both began laying at the very beginning of the spring period, and made records which indicated to one familiar with this sort of material that they belonged genetically in the 'Under 30' class and only by accident failed to lay some eggs during the winter period.

B.PR. ♂ *D58.* Indicated constitution = $fl_1L_2.\ fl_1L_2.$

This bird was purchased in January, 1908, from Gardner & Dunning, a then well-known firm of Barred Rock breeders of Auburn, N. Y. Nothing was known of this bird's previous history or pedigree. The bird was hatched in the spring of 1907, and used in our breeding pens in 1908 and 1909. In 1908 he failed to get any adult daughters. This, however, was not the fault of the bird, but of the conditions under which the breeding had to be done that year (cf. Pearl and Surface 35). From the records of the daughters of ♂ 58 obtained in 1909 and exhibited below it appears clear that he was a class 7 male. The breeding history is as follows:

Matings: A. With 9 ♀ ♀ indicated to be of class 1 = $fL_1L_2.\ Fl_1l_2.$

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	10	13	1
Expected	*12*	*12*	*0*
Mean winter egg production of ♀ ♀ in indicated class	52.22 eggs	17.25 eggs	0 eggs

B. With 4 ♀ ♀ indicated to be of class 6 = $fl_1L_2.\ Fl_1l_2.$

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	0	5	0
Expected	*0*	*5*	*0*
Mean winter egg production of ♀ ♀ in indicated class		15.80 eggs	

All ♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	10	18	1
Expected	*12*	*17*	*0*
Mean winter production	52.22 eggs	16.82 eggs	0 eggs

The single zero bird here (♀ F158) cannot fairly be regarded as a non-conformable case because of the following history. She was hatched March 30, 1909. She never laid an egg and died May 23, 1910. Autopsy showed the ovary and oviduct to be in an infantile condition. The ovary weighed 1 gram and the oviduct 2 grams. The ovary showed no oöcytes enlarged by yolk deposition or enlarging. There was no evidence that the ovary had ever shown the slightest trace of functional activity. But a *normal* bird hatched in March will exhibit signs of ovarian activity before May of the following year, even though she belongs genetically to the 'Zero' class in respect to winter production and does not lay. While the autopsy showed no obvious lesion of ovary or oviduct, this by no means proves that there may not have been present some deep-seated functional derangement.

B.P.R. ♂ *573*. Indicated constitution = $fl_1L_2.fl_1L_2$.

This bird was used in the breeding season of 1910, having been hatched in 1909. He proved not to be all that might be desired as a breeder, being somewhat lacking in vigor of constitution. Partly on this account, he got comparatively few adult daughters, as indicated in the following breeding history.

Matings: A. With 5 ♀♀ indicated to be of class 1 = $fL_1L_2.\ Fl_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	4½	6½	0
Expected	*5.5*	*5.5*	*0*
Mean winter production of ♀♀ in indicated class	47.50 eggs	15.67 eggs	

B. With 2 ♀♀ indicated to be of class 2 = $fL_1L_2.\ FL_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	4	0	0
Expected	*4*	*0*	*0*
Mean winter production of ♀♀ in indicated class	49.25 eggs		

C. With 1 ♀ indicated to be of class 3 = $fL_1l_2.\ Fl_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	2	1	1
Expected	*2*	*2*	*0*
Mean winter production of ♀♀ in indicated class	55.50 eggs	16.00 eggs	0 eggs

All ♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	10½	7½	1
Expected	*11.5*	*7.5*	*0*
Mean winter production	49.80 eggs	15.71 eggs	0 eggs

The zero bird here is an exception for which no apparent explanation is forthcoming. She was not pathological. She was however a June hatched bird. Unfortunately she was not bred, and therefore it is not possible to be sure of her gametic constitution. In spite of the fact that the total number of progeny here is small, there is little doubt of the correctness of the classification.

The mean productions for birds in the 'Over 30' class in the several matings are comparatively a little lower than those of the progeny of other class 7 males. It is interesting to speculate as to whether this may be connected with the lack of great vigor on the part of the sire. No data are available from which to get critical evidence on this point.

B.P.R. ♂ *56.* Indicated constitution $= fhL_2 . fhL_2$.

This bird was purchased in January, 1908, from Mr. C. H. Welles of Stratford, Conn. It came from a strain of Barred Rocks well known in the show-room, but not specially bred for egg production. This fact is of interest in connection with the breeding history of the bird, which indicates clearly that he was homozygous with respect to L_2. The result shows, in other words, that a male Barred Rock from a strain bred purely for the fancy may still carry in pure form the factor for high egg production.

This male bird (56) was bred two seasons (1908 and 1909). The first year he got but very few adult daughters, owing to the unfavorable conditions under which all the breeding had to be done in 1908 (cf. Pearl and Surface 35.) In 1909 the results were better. The adult daughters from both seasons are taken together in the following breeding history.

Matings: A. With 5 ♀♀ indicated to be of class 2 = fL_1L_2. FL_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	7	0	0
Expected	*7*	*0*	*0*
Mean winter production of ♀♀ in indicated class	54.57 eggs		

B. With 4 ♀♀ indicated to be of class 3 = fL_1l_2. Fl_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	9	4	0
Expected	*6.5*	*6.5*	0
Mean winter production of ♀♀ in indicated class	56.89 eggs	19.50 eggs	

C. With 2 ♀♀ indicated to be of class 6 = fl_1L_2 Fl_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	0	3	0
Expected	*0*	*3*	*0*
Mean winter production of ♀♀ in indicated class		13.67 eggs	

All ♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	16	7	0
Expected	*13.5*	*9.5*	*0*
Mean winter production	55.87 eggs	17.00 eggs	0 eggs

The agreement between observation and expectation here is satisfactory, excepting the case of the class 3 females. There the deviation from the expected half is wide, but the numbers involvel are small. The behavior of ♂ 56 with class 2 and class 6 females gives clear indication of his gametic constitution.

B.P.R. ♂ *563.* Indicated constitution = fl_1L_2. fl_1L_2.

This bird was hatched in 1909 and used as a breeder in 1910. He was an exceptionally fine, vigorous bird. The breeding history is as follows:

Matings: A. With 6 ♀♀ indicated to be of class 1 = fL_1L_2. Fl_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	11	11	1
Expected	*11.5*	*11.5*	*0*
Mean winter production of ♀♀ in indicated class	64.09 eggs	17.91 eggs	0 eggs

B. With 5 ♀♀ indicated to be of class 2 = fL_1L_2 FL_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	18	1	0
Expected	*19*	*0*	*0*
Mean winter production of ♀♀ in indicated class	63.56 eggs	1.00 eggs	

All ♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	29	12	1
Expected	*30.5*	*11.5*	*0*
Mean winter production	63.76 eggs	16.50 eggs	0 eggs

Aside from the two outstanding exceptions the agreement between observation and expectation is excellent. From the records available there is no evident explanation for the two exceptions (the 'Zero' bird in the A matings, and the 'Under 30' bird in the B matings). Neither of the birds were bred, and hence no help is to be had from the progeny in explaining them. It is reasonable to suppose that the observed records for these birds are somatic fluctuations, but this cannot be demonstrated now. This case illustrates an unavoidable difficulty which attends that method of work which first collects data at random and without any theoretical guide, and then later undertakes their analysis. If one had been carrying on the breeding in the present case under the guidance of the hypothesis as to the mechanism of the inheritance of fecundity now under discussion, obviously many matings which actually were not carried out would have been made to test out somatically exceptional individuals and so learn their gametic constitution.

B.P.R. ♂ *D31*. Indicated constitution = $fl_1L_2.\ fl_1L_2$.

This rather remarkable bird was used as a breeder for three successive years, and then retired merely because no more of his progeny were needed, and not for any evident diminution of vigor on his part. This bird was first bred as a cockerel in the spring of 1908 (hatched in 1907). All that was known of his ancestry was that he was the son of a hen that had laid 200 or more eggs in her pullet year. Some notion of the vigor of ♂ D31 as a breeder may be gained from the fact that, taking all three seasons together and including all parts of the breeding season in each year, 89.4 per cent of all the eggs laid by hens mated with him were fertile. This is an extraordinarily high record considering all the circumstances, and particularly the seasonal and housing conditions. So far as concerns adult daughters the breeding history of this bird is as follows:

Matings: A. With 9 ♀♀ indicated to be of class 1 = $fL_1L_2.\ Fl_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	10½	11½	0
Expected	*11*	*11*	*0*
Mean winter production of ♀♀ in indicated class	48.40 eggs	15.73 eggs	

B. With 8 ♀♀ indicated to be of class 2 = $fL_1L_2\ FL_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	27½	2½	0
Expected	*30*	*0*	*0*
Mean winter production of ♀♀ in indicated class	54.96 eggs	17.00 eggs	

C. With 8 ♀♀ indicated to be of class 3 = $fL_1l_2\ Fl_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	14	15	1
Expected	*15*	*15*	*0*
Mean winter production of ♀♀ in indicated class	41.93 eggs	12.20 eggs	0 eggs

D. With 1 ♀ indicated to be of class 4 = $fL_1l_2 . FL_1l_2$.

♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	5	0	1
Expected	*6*	*0*	*0*
Mean winter production of ♀ ♀ in indicated class	39.40 eggs		0 eggs

All ♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	57	29	2
Expected	*62*	*26*	*0*
Mean winter production	48.16 eggs	13.81 eggs	0 eggs

Besides the families noted above ♂ D31 got one adult daughter by each of two other females. Both these daughters had a winter record of zero eggs and were apparently pathological. In any event it was impossible to form any judgment as to their gametic constitution or that of their dams.

The general agreement between observation and expectation in this large progeny group is clear. The apparent exceptions to gametic expectation need some discussion. In the B matings (class 2 ♀ ♀) the record shows 2 1-2 in the 'Under 30' class where none is expected. Actually out of the 30 individuals from these matings only *one* daughter laid fewer than 30 eggs in the winter period. There were, however, 3 individuals which laid exactly 30 eggs in this period. So, in accordance with the convention adopted at the beginning, the record of 2 1-2 is made up as follows: 1 + 1-2 + 1-2 + 1-2 = 2 1-2. The one bird under 30 with a record of 17 eggs was late hatched and probably represented a somatic fluctuation. This bird was bred, but unfortunately got no offspring. Her eggs were nearly all fertile but the embryos died during incubation.

Of the two birds with a zero winter record it may be said that one (E96) was pathological, and on that account failed to lay. The autopsy on this bird, which died April 13, 1909, showed that it must have been functionally deranged for a long time preceding death. Yet there was clear evidence of functional activation of ovary and oviduct at some time before death. In this case the bird without question carried either L_1 or L_2 (or possibly both) and the reproductive system started to function in the normal way and bring to somatic expression these gametic factors. But before this could be done the diseased condition of the organs brought the bird as a whole into such a condition of reduced vitality that egg production was impossible.

The other bird's zero record is probably a somatic fluctuation from an 'Under 30' hereditary constitution. She began laying very shortly after the end of the winter period.

It is of interest to note that the mean winter productions are relatively rather low for the 'Over 30' classes in all matings. The contrast between ♂ D31 progeny and that of ♂ 563 (vide supra) in this respect is striking. This matter will be discussed in detail later.

Summary and discussion of matings of class 7 Barred Plymouth Rock males. Having now presented in detail the evidence respecting the matings of class 7 males with various types of females it is desirable to collect and summarize this material. In tables 11 to 16 inclusive are given the assembled results of all matings of certain particular types. It will be understood that these are all pure Barred Rock matings and represent the summation of the data previously given. These tables give the total numbers of different males and females from which data were obtained in each class of matings, as well as the classification of the adult female progeny in respect to fecundity.

TABLE 11

Showing the results of all matings of class 7 ♂♂ × class 1 ♀♀
$fl_1L_2 \cdot fl_1L_2 \times fL_1L_2 \cdot Fl_1l_2$

Number of Individuals Involved in Matings of This Type		Winter Egg Production of Adult Daughters.				
♂♂	♀♀	Class	Over 30	Under 30	Zero	Total adult ♀ offspring
10	75	Observed	92½	103½	7	203
		Expected	*101.5*	*101.5*	*0*	
Mean winter egg production of all daughters in designated class....			54.19 eggs	15.52 eggs	0 eggs	

TABLE 12

Showing the results of all matings of class 7 ♂♂ × class 2 ♀♀

$fl_1L_2 \, . \, fl_1L_2 \times fL_1L_2 \, . \, FL_1l_2$

Number of Individuals Involved in Matings of This Type		Winter Egg Production of Adult Daughters				
♂♂	♀♀	Class	Over 30	Under 30	Zero	Total adult ♀ offspring
9	38	Observed	111	6	0	117
		Expected	*117*	*0*	*0*	
Mean winter egg production of all daughters in designated class....			56.47 eggs	20.33 eggs		

TABLE 13

Showing the results of all matings of class 7 ♂♂ × class 3 ♀♀

$fl_1L_2 \, . \, fl_1L_2 \times fL_1l_2 \, . \, Fl_1l_2$

Number of Individuals Involved in Matings of This Type		Winter Egg Production of Adult Daughters				
♂♂	♀♀	Class	Over 30	Under 30	Zero	Total adult ♀ offspring
5	19	Observed	29	23	2	54
		Expected	*27*	*27*	*0*	
Mean winter production of all daughters in designated class......			47.93 eggs	15.30 eggs	0 eggs	

TABLE 14

Showing the results of all matings of class 7 ♂♂ × class 4 ♀

$fl_1L_2 \, . \, fl_1L_2 \times fL_1l_2 \, . \, FL_1l_2$

Number of Individuals Involved in Matings of This Type		Winter Egg Production of Adult Daughters				
♂♂	♀♀	Class	Over 30	Under 30	Zero	Total adult ♀ offspring
2	3	Observed	9	0	1	10
		Expected	*10*	*0*	*0*	
Mean winter egg production of all daughters in designated class....			39.56 eggs		0 eggs	

TABLE 15

Showing the results of all matings of class 7 ♂ ♂ × class 6 ♀ ♀

$fl_1L_2 \cdot fl_1L_2 \times fl_1L_2 \cdot Fl_1l_2$

Number of Individuals Involved in Matings of This Type		Winter Egg Production of Adult Daughters				
♂♂	♀♀	Class	Over 30	Under 30	Zero	Total adult ♀ offspring
5	11	Observed	1½	16½	0	18
		Expected	*0*	*18*	*0*	
Mean winter egg production of all daughters in designated class....			48.00 eggs[1]	14.44 eggs		

[1] The record of the single "Over 30" bird.

TABLE 16

Showing the results of all matings of class 7 ♂ ♂ with all classes of ♀ ♀

General Summary

Number of Individuals Involved in Matings of This Type		Winter Egg Production of Adult Daughters				
♂♂	♀♀	Class	Over 30	Under 30	Zero	Total adult ♀ offspring
11	146	Observed	243.0	149.0	10	402
		Expected	*255.5*	*146.5*	*0*	
Mean winter egg production of all daughters in designated class....			53.67 eggs	15.37 eggs	0 eggs	

From these tables the following points would appear to be definitely established:

1. The numbers of different individuals used as parents in these matings and also the numbers of adult daughters obtained from them are great enough to give an adequate test of the hypothesis under discussion. In other words, we are not dealing here with the results of a few matings, and a small offspring series. One hundred and forty-six separate and distinct matings to test out males of one gametic constitution must be regarded as an adequate number.

2. *The evidence for a definite and clean-cut segregation of high fecundity and low fecundity in gametogenesis is clear and indubitable.* The expected proportions of high producers and low producers are closely realized in all the different types of matings.

3. Furthermore, the mean egg productions of the birds in the several gametic classes are widely separated, showing that the segregation is of perfectly distinct physiological entities. Refined biometric tests are not necessary to show that the birds carrying high fecundity hereditarily lay more than those with low fecundity hereditary factors. The birds in the 'Over 30' class have average winter productions *from three to five times* greater than those of birds belonging to the 'Under 30' class.

4. The agreement between observation and expectation for the several types of mating is as close as could be expected considering the nature of the material. The only discrepancy of note is caused by the 10 birds with zero records, where none are expected. In the detailed discussions in connection with each mating it has been shown, however, that nearly all of these 10 cases, when studied individually, have a physiological explanation, which makes it impossible to regard them as real exceptions to the gametic expectations. A determination might be made of the 'goodness of fit' of theory to observation by Pearson's (42) method, were it not for the fact that that method cannot be applied to cases like the present.[12]

[12] The difficulty lies in the fact that Pearson's test depends upon a variable

$$X_2 = S\left\{\frac{(m_r - m'_r)^2}{m_r}\right\}$$

where m_r is the theoretical frequency and m'_r the observed. Now obviously in any distribution where one m_r is zero, the value of X_2 must be infinity, whatever may be the values of the other m_r's or m'_r's. That is, if the theoretically expected frequency on any base element is numerically zero the probability against the whole curve becomes infinite. Thus, for example, suppose a system of frequencies like the following, a type which is continually arising in Mendelian work.

Class	1	2	3	4	5
Theoretically expected frequency...	595	827	68	0	96
Actually observed frequency	594	828	67	1	96

Now, it does not need a mathematical measure of any kind to tell one that in this case the theoretical and actual distributions are in very close agreement. Yet, because the *theoretical* frequency on class 4 is zero, the probability by Pearson's test is literally infinite *against* the observed distribution being regarded as a random sample of a population distributed in accordance with the theoretical frequencies. Pearson

Further discussion of various points brought out by these tables is deferred to a later section of the paper.

Matings of Barred Plymouth Rock males of class 4.

Males of class 4 have a gametic constitution fL_1L_2. fl_1l_2. That is, they are heterozygous with respect to both fecundity factors. Among the progeny are to be expected high, low and zero winter layers. Four male birds of this genotypic constitution have been used in the breeding experiments. Their records follow.

B.P.R. ♂ *569.* Indicated constitution = fL_1L_2. fl_1l_2.

This male was hatched in 1909, and bred the following year. His breeding history was as follows:

Matings: A. With 1 ♀ indicated to be of class 2 = fL_1L_2. FL_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	2	0	0
Expected	*1*	*1*	*0*
Mean winter egg production of ♀♀ indicated class	67.00 eggs		

B. With 4 ♀♀ indicated to be of class 6 = fl_1L_2. Fl_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	2	6	3
Expected	*2.75*	*5.5*	*2.75*
Mean winter production of ♀♀ in indicated class	75.00 eggs	7.33 eggs	0 eggs

---

(loc. cit., p. 164, footnote) had indeed himself noted what is essentially this same difficulty in using the test on ordinary frequency distributions.

The point noted obviously limits greatly the applicability of Pearson's test, and in a most unfortunate direction. Tests of goodness of fit are much needed in Mendelian work. But it is just here that classes where the theoretical frequency is zero often occur. To determine the probable error of the individual frequency in measuring the goodness of fit of Mendelian observation and theory, as was first practised by Weldon (52) and later by Johannsen (21) and by Mendelian workers generally, does not appear to the writer to be an altogether sound procedure. It fails to take account of the *correlations* in errors amongst the several frequencies. Yet these are just as important and just as certainly existent in a Mendelian 'category' type of distribution as in the ordinary variation polygon of a continuously variable character. This point I have alluded to elsewhere recently (Pearl, 32). Pearson's test covers this point, and were it not for the other difficulty noted above would be be much more widely useful in Mendelian work than is actually the case.

C. With 4 ♀ ♀ indicated to be of class I = fL_1L_2. Fl_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	5½	6½	1
Expected	*4.9*	*6.5*	*1.6*
Mean winter production of ♀ ♀ in indicated class	44.60 eggs	8.00 eggs	0 eggs

D. With 3 ♀ ♀ indicated to be of class 4 = fL_1l_2. FL_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	3	3	0
Expected	*3*	*3*	*0*
Mean winter egg production of ♀ ♀ in indicated class	45.33 eggs	7.33 eggs	0 eggs

All ♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	12½	15½	4
Expected	*11.65*	*16*	*4.35*
Mean winter production	53.58 eggs	7.60 eggs	0 eggs

The agreement between observation and expectation is plainly very close here. The three fecundity classes are represented and in proportions as near to those indicated by hypothesis as could be expected, considering the numbers involved.

B.P.R. ♂ *566.* Indicated constitution = fL_1L_2. fl_1l_2.

This bird was used in the breeding pen in the season of 1910, having been hatched in the spring of the previous year. His sire was ♂ D556, a class 4 male to be taken up later, and his dam a class 2 female. His breeding history was as follows:

Matings: A. With 5 ♀ ♀ indicated to be of class I = fL_1L_2. Fl_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	4	8	2
Expected	*5.2*	*7*	*1.8*
Mean winter egg production of ♀ ♀ in indicated class	35.00 eggs	20.50 eggs	0 eggs

B. With 6 ♀ ♀ indicated to be of class 2 = fL_1L_2. FL_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	9	6	0
Expected	*7.5*	*7.5*	*0*
Mean winter eggs production of ♀ ♀ in indicated class	50.44 eggs	11.83 eggs	0 eggs

All ♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	13	14	2
Expected	*12.7*	*14.5*	*1.8*
Mean winter production	45.69 eggs	16.79 eggs	0 eggs

Here again the agreement between observation and expectation is very close, quite as close as could be expected with the numbers involved. The mean production of the 4 birds in the 'Over 30' class in the A matings is low.

B.P.R. ♂ *D35*. Indicated constitution = fL_1L_2. fl_1l_2.

This bird was one of the original males with which the present breeding experiments were started in 1908. The only thing known about his ancestry is that he was the son of a hen laying 200 or more eggs in the year. He got only a small adult female progeny, and was used as a breeder only one year. His breeding record follows.

Matings: A. With 4 ♀ ♀ indicated to be of class 1 = fL_1L_2. Fl_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	3	5	1
Expected	*3.4*	*4.5*	*1.1*
Mean winter production of ♀ ♀ in indicated class	58.67 eggs	15.20 eggs	0 eggs

B. With 2 ♀ ♀ indicated to be of class 3 = fL_1l_2. Fl_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	2	5	0
Expected	*2.6*	*3.5*	*0.9*
Mean winter production of ♀ ♀ in indicated class	37.50 eggs	14.60 eggs	

C. With 1 ♀ indicated to be of class 4 = fL_1l_2. FL_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	2	2	0
Expected	*2*	*2*	*0*
Mean winter production of ♀ ♀ in indicated class	40.50 eggs	23.00 eggs	

All ♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	7	12	1
Expected	*8*	*10*	*2*
Mean winter production	47.43 eggs	16.25 eggs	0 eggs

While the families in this case are small, the evidence of segregation in about the expected proportions is clear.

B.P.R. ♂ *556.* Indicated constitution = fL_1L_2. fl_1l_2.

This male was hatched in 1908 and used in the breeding pens in 1909. He proved a good breeder and got a fairly large number of adult daughters which were tested in respect to fecundity in the laying year 1909-10. As noted above he was the sire of class 4 ♂ 566. The breeding history of ♂ 556 follows.

Matings: A. With 4 ♀ ♀ indicated to be of class 1 = fL_1L_2. Fl_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	8½	10½	4
Expected	*8.6*	*11.5*	*2.9*
Mean winter egg production of all daughters in indicated class	43.75 eggs	19.60 eggs	0 eggs

V. With 9 ♀ ♀ indicated to be of class 2 = fL_1L_2. FL_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	10½	10½	0
Expected	*10.5*	*10.5*	*0*
Mean winter egg production of all daughters in indicated class	47.00 eggs	19.60 eggs	

All ♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	19	21	4
Expected	*19.1*	*22*	*2.9*
Mean winter production	46.00 eggs	19.60 eggs	0 eggs

The agreement here between observation and expectation is indeed remarkably close, and with a fairly large progeny.

Summary of results of all matings of class 4 males. Proceeding as before we may bring together here the results for each particular gametic combination taking all individuals together. While class 4 males were not used as often in these experiments as those of class 7, still the numbers involved are sufficiently large to give quite definite evidence regarding the segregation of fecundity factors.

TABLE 17

Showing the results of all matings of class 4 ♂ ♂ × class 1 ♀ ♀
$fL_1L_2 \cdot fl_1l_2 \times fL_1L_2 \cdot Fl_1l_2$

Number of Individuals Involved in Matings of This Type		Winter Egg Production of Daughters				
♂♂	♀♀	Class	Over 30	Under 30	Zero	Total adult ♀ progeny
4	17	Observed	21	30	8	59
		Expected	*22.1*	*29.5*	*7.4*	
Mean winter egg production of all ♀ ♀ in indicated class..........			48.85 eggs	16.34 eggs	0 eggs	

TABLE 18

Showing the results of all matings of class 4 ♂ ♂ × class 2 ♀ ♀
$fL_1L_2 \cdot fl_1l_2 \times fL_1L_2 \cdot FL_1l_2$

Number of Individuals Involved in Matings of This Type		Winter Egg Production of Daughters				
♂♂	♀♀	Class	Over 30	Under 30	Zero	Total adult ♀ progeny
3	16	Observed	21	16.5	0	38
		Expected	*19*	*19*	*0*	
Mean winter production of all ♀ ♀ in indicated class...............			50.38 eggs	16.69 eggs		

TABLE 19

Showing the results of all matings of class 4 ♂ ♂ × class 4 ♀ ♀
$fL_1L_2 \,.\, fl_1l_2 \times fL_1l_2 \,.\, FL_1l_2$

Number of Individuals Involved in Matings of This Type		Winter Egg Production of Daughters				
♂♂	♀♀	Class	Over 30	Under 30	Zero	Total adult ♀ progeny
2	4	Observed	5	5	0	10
		Expected	*5*	*5*	*0*	
Mean winter production of all ♀ ♀ in indicated class...............			43.40 eggs	13.60 eggs		

TABLE 20

Showing the results of all matings of class 4 ♂ ♂ × all classes of ♀ ♀
General Summary

Number of Individuals Involved in Matings of This Type		Winter Egg Production of Daughters				
♂♂	♀♀	Class	Over 30	Under 30	Zero	Total adult ♀ progeny
4	43	Observed	51½	62½	11	125
		Expected	*51.45*	*62.5*	*11.05*	
Mean winter production of all ♀ ♀ in indicated class...............			47.94 eggs	15.34 eggs	0 eggs	

No closer agreement between observation and expectation than is here shown could be expected. The results of the matings discussed in this section confirm completely the general conclusions reached above from an examination of the matings of class 7 males.

Matings of Barred Plymouth Rock males of class 3.

Males of this class have a gametic constitution $fL_1L_2.\ fl_1L_2$. That is, they are homozygous with respect to the second, or excess, production factor, and heterozygous with respect to the first. Two males of this type were used in the experiments.

B.P.R. ♂ 65. Indicated constitution $= fL_1L_2.\ fl_1L_2$

This male was purchased in 1908 from Mr. Wesley B. Barton, Dalton, Mass. Nothing is known of his breeding so far as concerns fecundity, but in all probability no particular effort towards breeding for high egg productiveness had ever been made in the stock from which he came. He was bred as a cockerel in the season of 1908 with the results set forth below.

Matings: A. With 1 ♀ indicated to be of class 1 = fL_1L_2. Fl_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	7	1	1
Expected	*6.75*	*2.25*	*0*
Mean winter production of all ♀ ♀ in indicated class	53.00 eggs	19.00 eggs	0 eggs

B. With 1 ♀ indicated to be of class 6 = fl_1L_2. Fl_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	2	3	0
Expected	*2.5*	*2.5*	*0*
Mean winter production of all ♀ ♀ in indicated class	37.00 eggs	18.67 eggs	

All ♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	9	4	1
Expected	*9.25*	*4.75*	*0*
Mean winter production	49.44 eggs	18.75 eggs	0 eggs

In this case, while the number of successful matings was small, the families were relatively large. In the case of ♀ 366, set down here as probably of class 6, it should be said that this conclusion as to her gametic constitution is reached from a study of her daughters' and granddaughters' behavior. Her own winter egg record was 33, which on this view is regarded as a somatic fluctuation from the L_1 (Under 30) class.

B.P.R. ♂ *68.* Indicated constitution = fL_1L_2. fl_1L_2.

As in the case of ♂ 65 nothing is known regarding the breeding of this bird, it having been purchased from Mr. Geo. W. Hillson, of Amenia, N. Y., early in 1908. It was bred as a cockerel the same season. The only matings to get adult daughters were those with class 1 females. The breeding history is as follows:

Matings: A. With 4 ♀ ♀ indicated to be of class 1 = fL_1L_2. Fl_1l_2.

All ♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	13	5	2
Expected	*15*	*5*	*0*
Mean winter production of all ♀ ♀ in indicated classes	59.00 eggs	25.20 eggs	0 eggs

The facts regarding the two zero birds here are of interest. According to theory no bird of this class should appear from any of these matings. One of these zero birds, E192, laid her first egg March 4, 1909, and proved thereafter, during the reproductive period (March 1 to June 1) to be a fairly good layer, with a total production for the period of 51 eggs.

Her laying during this and the subsequent summer period both in respect to its amount and its distribution, impresses one as like that of a bird carrying L_1. rather than like that of a 'genetic' zero winter layer lacking this factor. I am of the opinion that this was the case. This bird, on such a view, would represent an extreme physiological variant in respect to the beginning of laying. While apparently bearing L_1 this factor did not come to expression until much later than under normal circumstances.

The other zero bird was pathological in respect to her reproductive organs. She never laid an egg and died July 16, 1909. The autopsy record is as follows, plainly showing that the zero record of this bird cannot be taken as any indication whatever of her gametic constitution in respect to fecundity.

Autopsy of E 318, July 16, 1909. Body weight, 1730 grams. Hatched March 31, 1908. Oviduct small: parts of it contained masses of hardened secretion. Ovary with no large oöcytes. One small yolk resorbing. Body cavity filled with masses of hard yolk enclosed in peritoneal sacs. Some of these masses were small and attached to mesentery. Some were large. A large mass filled the dorsal part of body cavity on left side pushing over by a neck and connected by this with a similar mass on right side. This was partly hollow and in the cavity the surface was covered with a fruiting fungus resembling Penicillium. The peritoneum covering the masses of hard yolk formed adhesions with the viscera so that the intestine and oviduct were a bundle of adhesions clinging to these yolk masses.

It is only possible to summarize separately class 3 ♂ matings for class 1 females. This is done in table 21.

TABLE 21

Showing the results of all matings of class 3 ♂ ♂ × class 1 ♀ ♀
$fL_1L_2 \,.\, fl_1L_2 \times fL_1L_2 \,.\, Fl_1l_2$

Number of Individuals Involved in Matings of This Type		Winter Egg Production of Daughters				
♂♂	♀♀	Class	Over 30	Under 30	Zero	Total adult ♀ progeny
2	5	Observed	20	6	3	29
		Expected	*21.75*	*7.25*	*0*	
Mean winter production of all ♀ ♀ in indicated class..............			56.90 eggs	24.17 eggs	0 eggs	

TABLE 22

Showing the results of all matings of class 3 ♂ ♂ with ♀ ♀ of all classes

Number of Individuals Involved in Matings of This Type		Winter Egg Production of Daughters				
♂♂	♀♀	Class	Over 30	Under 30	Zero	Total adult ♀ offspring
2	6	Observed	22	9	3	34
		Expected	*24.25*	*9.75*	*0*	
Mean winter production of all ♀ ♀ in indicated class..............			55.09 eggs	22.33 eggs	0 eggs	

All matings of class 3 males are summarized in table 22.

The evidence for the segregation of high and low fecundity, as measured by winter egg production is quite as clear from the matings of class 3 ♂ ♂ as from those of class 7 or class 4 ♂ ♂ previously considered.

Matings of Barred Plymouth Rock males of class 2. Four males of this class were used in the experiments. None of them got a large number of adult daughters. It will be noted from table 9 that males of this class (gametic formula $fL_1L_2 .\, fL_1l_2$) should produce daughters with winter records 'Over 30' and 'Under 30' in equal numbers regardless of the type of females with which the mating is made. The only basis for classifying the females in such matings is then the breeding behavior of their progeny, and particularly their daughters.

B.P.R. ♂ *32.* Indicated constitution $= fL_1L_2.\ fL_1l_2.$

This male was hatched from Station stock in the spring of 1907 and bred in 1908. Nothing is known of his ancestry except that his mother was a '200-egg' hen. His breeding history follows:

Matings: A. With 2 ♀ ♀ indicated to be of class 1 $= fL_1L_2.\ Fl_1l_2.$

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	4	3	0
Expected	*3.5*	*3.5*	*0*
Mean winter production of all ♀ ♀ in indicated class	52.50 eggs	14.33 eggs	

B.P.R. ♂ *57.* Indicated constituion $= fL_1L_2\ fL_1l_2.$

This male was purchased from Pine Top Poultry Farm, Hartwood, N. Y. in 1908 and bred as a cockerel that year.

Matings: A. With 2 ♀ ♀ indicated to be of class 2 $= fL_1L_2.\ FL_1l_2.$

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	2	1	0
Expected	*1.5*	*1.5*	*0*
Mean winter production of all ♀ ♀ in indicated class	38.00 eggs	24.00 eggs	

B. With 2 ♀ ♀ indicated to be of class 3 $= fL_1l_2.\ Fl_1l_2.$

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	4	3	0
Expected	*3.5*	*3.5*	*0*
Mean winter production of all ♀ ♀ in indicated class	62.75 eggs	23.00 eggs	

All ♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	6	4	0
Expected	*5*	*5*	*0*
Mean winter production of all ♀ ♀ in indicated class	54.50 eggs	23.25 eggs	

B.P.R. ♂ *17*. Indicated constitution = $fL_1L_2.\ fL_1l_2$.

This cockerel was hatched in 1907 from a '200-egg' mother and was bred in the spring of 1908.

Matings: A. With 2 ♀♀ indicated to be of class 3 = $fL_1l_2.\ Fl_1l_2$.

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	3	3	0
Expected	*3*	*3*	*0*
Mean winter production of all ♀♀ in indicated class	47.00 eggs	12.33 eggs	

B.P.R. ♂ *70*. This cockerel was purchased from Mr. M. L. Chapman, Farmington, Conn., and used in the breeding season of 1908. Nothing is known of his previous history.

Matings: A. With 3 ♀♀ indicated to be of class 2 = $fL_1L_2.\ FL_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	4	5	0
Expected	*4.5*	*4.5*	*0*
Mean winter production of all ♀♀ in indicated class	68.25 eggs	19.00 eggs	

B. With 2 ♀♀ indicated to be of class 3 = $fL_1l_2.\ Fl_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	2	1	0
Expected	*1.5*	*1.5*	*0*
Mean winter production of all ♀♀ in indicated class	51.50 eggs	25.00 eggs	

All ♀ *Progeny.*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	6	6	0
Expected	*6*	*6*	*0*
Mean winter production	62.67 eggs	20.00 eggs	

Summary of results of all matings of class 2 males. The summarized results of the above matings are set forth in table 23.

TABLE 23

Showing the results of all matings of class 2 ♂ ♂ × class 2 ♀ ♀

$fL_1L_2 \,.\, fL_1l_2 \times fL_1L_2 \,.\, FL_1l_2$

Number of Individuals Involved in Matings of This Type		Winter Egg Production of Daughters				
♂♂	♀♀	Class	Over 30	Under 30	Zero	Total adult ♀ progeny
2	5	Observed	6	6	0	12
		Expected	*6*	*6*	*0*	
Mean winter egg production of all ♀ ♀ in indicated class..........			58.17 eggs	19.83 eggs		

TABLE 24

Showing the results of all matings of class 2 ♂ ♂ × class 3 ♀ ♀

$fL_1L_2 \,.\, fL_1l_2 \times fL_1l_2 \,.\, Fl_1l_2$

Number of Individuals Involved in Matings of This Type		Winter Egg Production of Daughters				
♂♂	♀♀	Class	Over 30	Under 30	Zero	Total adult ♀ progeny
3	6	Observed	9	7	0	16
		Expected	*8*	*8*	*0*	
Mean winter production of all ♀ ♀ in indicated class...............			55.00 eggs	18.71 eggs		

TABLE 25

Showing the results of all matings of class 2 ♂ ♂ × all classes of ♀ ♀

Number of Individuals Involved in Matings of This Type		Winter Egg Production of Daughters				
♂♂	♀♀	Class	Over 30	Under 30	Zero	Total adult ♀ progeny
4	13	Observed	19	16	0	35
		Expected	*17.5*	*17.5*	*0*	
Mean winter production of all ♀ ♀ in indicated class...............			55.47 eggs	18.31 eggs		

It is clear that the four class 2 males produced a progeny generation, which, though relatively small in absolute numbers, agrees very closely in respect to its gametic distribution with the expected results.

Matings of a Barred Plymouth Rock male of class 8. Males of class 8 are homozygous with respect to the absence of the first production factor, and heterozygous for the second, their gametic formula being fl_1L_2. fl_1l_2. But one bird of this type was used in the experiments.

B.P.R. ♂ *26.* Indicated constitution = fl_1L_2 fl_1l_2.

This was one of the original stock in 1908. Nothing further is known of his breeding than that he was the son of a bird that had laid 200 or more eggs in her pullet year. His dam must have been of class 1, since a class 2 ♀ could not produce a class 8 ♂. Male 26 was bred as a cockerel in 1908 with the following results:

Matings: A. With 2 ♀♀ indicated to be of class 1 = fL_1L_2 fl_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	2½	9½	5
Expected	*4.25*	*8.5*	*4.25*
Mean winter production of all ♀♀ in indicated class	35.00	9.89 eggs	0 eggs

B. With 5 ♀♀ indicated to be of class 4 = fL_1l_2. FL_1l_2.

♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	6	6	0
Expected	*6*	*6*	*0*
Mean winter productions of all ♀♀ in indicated class	69.00 eggs	15.83 eggs	

All ♀ *Progeny.*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	8½	15½	5
Expected	*10.25*	*14.5*	*4.25*
Mean winter production	60.50 eggs	12.26 eggs	0 eggs

One of the five females (♀ 397) of class 4 actually laid 31 eggs in her winter period and hence was literally an 'Over 30' bird. There can be no doubt, however, that this record is merely a fluctuation, and that ♀ 397 is really a class 4 bird of the constitution indicated. This is shown by her progeny.

Matings of a Barred Plymouth Rock male of class 1. Males of class 1 are extremely interesting both from the theoretical and the practical standpoint, since they are homozygous with respect to the presence of both fecundity factors. In consequence, *all* the daughters of any male of this class, regardless of the females with which he is mated, should be high producers. In the course of the experiments here under discussion only one male of this type has been used in the breeding pens, and owing to an unfortunate accident he was available for breeding only during a single season. This ♂ no. 550 was a remarkably fine and vigorous bird. He was easily the best bird, in respect to all fancy and utility points, out of the hundreds of cockerels raised the same year. He produced by the mating of a class 3 ♂ (♂ 68, p. 000, supra) and a class 1 ♀. That is,

$$(♂68)\quad fL_1L_2.\ fl_1L_2 \times fL_1L_2\ Fl_1l_2 \quad (♀C161)$$
$$\downarrow$$
$$♂550$$
$$fL_1L_2.\ fL_1L_2$$

This is a particularly interesting pedigree to anyone acquainted with the practical breeding and breeders of Barred Plymouth Rocks in this country, because, as already pointed out, ♂ 68 was purchased from Mr. G. W. Hillson, of Amenia, N. Y. Now it is generally supposed. and indeed has been stated by Mr. Hillson in his advertising, that his stock was founded from Mr. E. B. Thompson's 'Ringlet' strain, a stock very well known for quality in color and barring, but not commonly believed to be of any particular value for utility purposes. Yet here we have produced from this strain a male bird of the highest possible utility value, namely one that gets high-producing daughters regularly and without fail, regardless of the females to which he may be mated.

The breeding history of ♂ 550 is as follows:

Matings: A. With 5½ ♀ ♀ indicated to be classes 1 or 2 $= fL_1L_2\ Fl_1l_2$ or $fL_1L_2.\ FL_1l_2$.

B. With $4\frac{1}{2}$ ♀♀ indicated to be of classes 3, 4, or 6 = fL_1l_2. Fl_1l_2 or fL_1l_2. FL_1l_2 or fl_1L_2. Fl_1l_2.

All ♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	$16\frac{1}{2}$	$\frac{1}{2}$	1
Expected	*18*	*0*	*0*
Mean winter production of all ♀♀ in indicated class	51.25 eggs	1	0 eggs

[1]See p. 312 for explanation of the convention of dividing the birds which lay exactly 30 eggs in the winter period.

The one daughter (F379) with the zero record was evidently abnormal in respect to her reproductive organs. During the last days of September and early October she began and kept up for a period of over a week daily visits to the nest (cf. section on "Matings of Barred Plymouth Rock males with Barred F_1 females") This is *normally* a *sure* indication of approaching laying. Further, birds which begin in this way not only are precocious in laying but make high winter records. This bird, however, stopped at once, and neither visited a nest, nor laid until late the next spring and then laid only a few eggs. There is little doubt that in this case the hereditary basis for high production was present (L_1L_2) but failed of expression for purely physiological reasons. Unfortunately no post-mortem examination of this bird was made, the fact of her abnormality not having been recognized until too late to make such an examination possible.

It was unfortunate that ♂ 550 could not have been used during several breeding seasons. Even with the limited progeny actually available, however, the contrast between this bird and the others which have been discussed above is sufficiently striking.

Doubtful cases. In 1908 a Barred Plymouth Rock ♂ no. 61 was successfully mated with 3 ♀♀. The winter production records were as follows:

Mothers' winter production		*Daughters' winter production*		
♀ D157	Under 30	1 over 30	0 under 30	0 zero
♀ D168	Over 30	2 over 30	10 under 30	1 zero
♀ D90	Under 30	2 over 30	5 under 30	0 zero

The case is a difficult one, because of the behavior of certain of the daughters in subsequent matings. The most probable interpretation of the facts is that ♂ 61 belonged to class 4, and that D168 is a ♀ of class 1, but that in certain of her daughters bearing L_2, this character did not come to full expression, giving a winter record of under 30. Three of the 10 daughters of ♀ D168 recorded as 'Under 30' laid 25 or more eggs in the winter period. If we suppose these to be really L_2 birds, we should then have the following *gametic* distribution of 168's daughters.

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	5	7	1
Expected	*4.5*	*6.5*	*2*

This is as close as could be expected.

Female D90 may be of either class 3 or 4. The data at hand do not enable one to determine with certainty between these possibilities. Female D157's only daughter left no adult ♀ offspring, and therefore it is not possible to make any conjecture as to her constitution, beyond the fact that she was probably not of class 1 or 2.

In the case of a number of males the families of adult daughters obtained were so small in size as to make impossible any accurate determination of the gametic constitution of the mothers used. All of these cases are here grouped together in one table.

TABLE 26

Showing the results in respect to fecundity of daughters from pure Barred Rock matings in which the families were too small in size or number to permit classification as to gametic constitution

♂	No. of ♀ ♀ Mated	Daughters' Winter Production		
		Over 30	Under 30	Zero
60	5	6	4	1
16	2	4	1	0
5	2	3	1	0
11	14	14	11	1
527	5	4	4	0
555	8	5	8	0
551	11	9	8	1
Totals	47	45	37	3

It will be seen from this table that these families had on the average fewer than two adult daughters each, too small a number with which to work. This makes clear again the difficulty with which one has always to contend in practice in work with fecundity, namely that of getting even reasonably large families of normal *adult* daughters. One hatches a large number of chicks in order to supply thieves, crows, rats, hawks, etc., and finally get a small number of adult females available for the study of fecundity. Fecundity in fowls is not, as has been pointed out before, in all respects an ideal character for the investigation of the laws of inheritance.

Summary of results of all pure Barred Rock matings

The data presented in detail in this section of the paper, which deals with the matings of Barred Plymouth Rock males and females inter se, would appear to demonstrate the following points.

1. That there is a definite and clean-cut segregation (in the Mendelian sense) of high fecundity and low fecundity, the character 'fecundity' being here measured by winter egg production. The mode of inheritance is such as to indicate that winter egg production depends upon two separately inherited physiological factors. The presence of both of these factors (L_1 and L_2) is essential to a *high* fecundity record. The second factor L_2, without which high fecundity never appears is inherited in a sex-correlated manner, such that it is never borne in the same gamete that carries the female sex-factor F.

2. That the things segregated are perfectly definite and distinct. This is shown by the mean or average production records of the birds falling into the several fecundity classes. The birds bearing the factors for high fecundity have mean winter production records ranging from *two to five or six times as great* as the mean production records of birds lacking these high fecundity factors. Such differences as these do not depend upon refined statistical analysis for their detection and appreciation.

While by no means all the possible gametic combinations in respect to fecundity within the Barred Rock breed have yet been made, still the range covered by the data given above is fairly wide. All classes of females except the zero producers (class

5) have been repeatedly tested in the breeding pens in various different combinations. The zero winter producing females have been fairly often bred, but the difficulties of getting chickens hatched within the necessary time limits and in sufficient number to get adult daughters for fecundity work have been too great for the available resources. Of the nine possible types of males six have been tested in various combinations.

It may fairly be said, I think, that in its range, its quality and its amount, the evidence from the pure Barred Rock matings, as set forth in the preceding sections, is sufficient alone to demonstrate the Mendelian inheritance of fecundity in the breed of fowls. If, however, the principles set forth above for Plymouth Rocks are true, they ought to apply, in general at least, to other breeds of fowls and to crosses, with, of course, possible limitations and modifications in particular instances. It is desirable, therefore, to examine the results regarding the inheritance of fecundity in other breeds and crosses. This we may proceed to do.

Cornish Indian Game matings

The strain of Cornish Indian Game fowls used in these experiments is characterized, as has already been pointed out, by very poor egg production. There is no evidence that any of the individuals, either male or female, ever carry the second fecundity factor L_2. These birds therefore represent the extreme condition in the way of low fecundity as compared with the Barred Plymouth Rocks.

The Cornish Indian Game is an old breed and if one may judge from poultrymen's accounts, there certainly have existed in the past, and probably exist now strains of birds belonging to this breed which are fairly good layers. Such strains, which are in marked contrast to the one here used, undoubtedly carry in some combination, the second fecundity factor L_2. There is nothing extraordinary, or contradictory to the results of the present paper, in such a fact (if it be a fact). Indeed it will be shown, in a later section of this paper, how it has been possible experimentally to form synthetically high laying Game hens, i.e., to put the factor L_2 into their hereditary constitution (cf. section on F_2 matings).

Owing to limitation of space and for other reasons it has not been possible to carry on the fecundity studies with this breed on anything like the same scale as with the Barred Rocks. Therefore the numbers here dealt with will be smaller than in the previous section. They will be sufficient, however, to indicate clearly the hereditary constitution of the material. Of the possible types of C.I.G. ♂ ♂ in respect to fecundity as set forth in table 7, two (class 2 and class 3) have actually been used in pure Cornish matings (i.e., C.I.G. ♂ × C.I.G. ♀).

Matings of a Cornish Indian Game male of class 2 (table 7). This ♂, no. 558, was hatched in the spring of 1908 and used to head a pure Cornish pen in 1909. His breeding record indicated that he was of class 2, with a constitution $fL_1l_2.\ fl_1l_2$. His breeding history was as follows:

Matings: A. With 5 ♀ ♀ indicated to be of class 1 (Table 8) $= fL_1l_2.\ FL_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	1	9	0
Expected	*0*	*10*	*0*
Mean winter production of all ♀ ♀ in indicated class	37.00 eggs	8.56 eggs	

B. With 2 ♀ ♀ indicated to be of classes 2 or 3 $= fl_1l_2.\ FL_1l_2$ or $fL_1l_2.\ Fl_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	0	5	3
Expected	*0*	*6*	*2*
Mean winter production of all ♀ ♀ in indicated class		8.00 eggs	0 eggs

All ♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	1	14	3
Expected	*0*	*16*	2
Mean winter production	37.00	8.36 eggs	0 eggs

The one bird recorded here as 'Over 30' laid but 37 eggs. Her progeny show clearly and unmistakably that she did not bear L_2. That is to say, her record is a somatic fluctuation above the 30 limit, and has no gametic foundation. The agreement between observation and expectation on a gametic basis is really perfect for mating A. Taken as a whole the facts speak for themselves. The contrast with the results of Barred Rock matings is striking.

Matings of a Cornish Indian Game male of class 3 (table 7). Male no. 578 was hatched in 1909 and used in the breeding pens the following year. His breeding record shows that he was homozygous with respect to the absence of both fecundity factors, having the constitution $fl_1l_2 . fl_1l_2$. He then belongs to class 3 of table 7. His breeding record is as follows:

Matings: A. With 4 ♀♀ indicated to be of classes 2 or 3 = $fl_1l_2 . FL_1l_2$ or $fL_1l_2\ Fl_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	1	9	8
Expected	*0*	*9*	*9*
Mean winter production of all ♀♀ in indicated classes	39.00 eggs	13.11 eggs	0 eggs

B. With 1 ♀ indicated to be of class 4 = $fl_1l_2\ Fl_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	0	0	4
Expected	*0*	*0*	*4*
Mean winter egg production of all ♀♀ in indicated class			0 eggs

All ♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	1	9	12
Expected	*0*	*9*	*13*
Mean winter production	39.00 eggs	13.11 eggs	0 eggs

Here again as in the previous case the single 'Over 30' record is a somatic fluctuation, without gametic significance. Leaving this out of account, or rather putting it in the 'Under 30' class where it belongs, the agreement between observation and expectation is very close.

Summary of results of Cornish Indian Game matings

Summarizing all pure Cornish matings which involved 2 ♂♂ and 20 ♀♀ (C.I.G. ♂ × C.I.G. ♀) we have the following results:

All ♀ Progeny.

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	2	23	15
Expected	*0*	*25*	*15*
Mean winter production	38.00 eggs	10.22 eggs	0 eggs

Counting the two 'Over 30' records as somatic fluctuations belonging gametically to the 'Under 30' class the agreement between observation and theory is perfect. This it is seen that the same hypothesis which has been shown to account for the inheritance of fecundity in the Barred Plymouth Rock breed characterized in general by relatively high egg production, also accounts perfectly for the inheritance of this character in the entirely unrelated Cornish Indian Game breed, which is characterized by relatively poor egg production.

Reciprocal crosses of Barred Plymouth Rocks and Cornish Indian Games. F_1 generation

In connection with studies of the inheritance of plumage patterns and colors extensive experiments in crossing these two breeds have been carried out (cf. 40, 41). The results of these experiments in respect to fecundity form a crucial test of the validity of the Mendelian interpretation of the data from pure races set forth in the preceding pages. If the interpretation which has been given is correct it should account for the observed results in the F_1, F_2 and subsequent cross-bred generations. Should it fail when subjected to this test, it would necessitate its acceptance with great reservation, if at all, for the pure races. On the other hand, agreement of the results from these cross-bred matings with those obtained from the pure-bred would afford the strongest confirmation which it is possible experimentally to obtain of the essential soundness of the general conclusions reached.

Matings of Barred Plymouth Rock males and Cornish Indian Game females. Two different males were used successfully[13] in matings of this sort. Both of these birds were of class 7, having the gametic constitution fl_1L_2. fl_1L_2. One of them (♂ 554) was used in a number of pure B.P.R. matings with results already discussed in a previous section.

Matings of B. P. R. ♂ 559. Indicated constitution = fl_1L_2. fl_1L_2.

Matings: A. With 9 Cornish ♀♀ indicated to be of classes 2 or 3 = fl_1l_2. FL_1l_2 or fL_1l_2. Fl_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	18	17	2
Expected	*18.5*	*18.5*	*0*
Mean winter egg production of all ♀♀ of indicated class ...	46.38 eggs	15.00 eggs	0 eggs

If we suppose the two zero birds to represent somatic fluctuations the agreement between observation and expectation is very close. Both these zero birds were late hatched and all the facts regarding them indicate that they carried L_2, but for physiological reasons did not bring it to expression.

B. With 1 Cornish ♀ indicated to be of class 1 = fL_1l_2 . FL_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	5	1	0
Expected	*6*	*0*	*0*
Mean winter egg production of all ♀♀ of indicated class	42.75 eggs	20 eggs	

There is little doubt about this mating being of the type indicated, in spite of the one bird laying 'Under 30.' Her winter record was 20 eggs and she was a late (June) hatched bird. She probably carried L_2, but this cannot be positively asserted because no male bird from her was mated. Only in this way could the point be settled.

[13] i.e., got adult daughters.

All ♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	23	18	2
Expected	*24.5*	*18.5*	*0*
Mean winter production	46.09 eggs	15.22 eggs	0 eggs

Matings of B.P.R. ♂ *554.* This male has been shown above from his mating with Barred Rock females, to be of class 7 with the gametic constitution fl_1L_2. fl_1L_2. He was successfully mated with one Cornish Indian Game ♀ of class 2. From this mating we have

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	1	3	0
Expected	*2*	*2*	*0*
Mean winter production	49	19.33 eggs	0 eggs

Putting all the results together we have for *all matings of B.P.R.* ♂ ♂ × *C.I.G.* ♀ ♀

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	24	21	2
Expected	*26.5*	*20.5*	*0*
Mean winter production	46.22 eggs	15.86 eggs	0 eggs

We see here the same agreement between observation and expectation which has appeared in the previous cases with pure matings.

Attention may next be turned to the reciprocal cross.

Matings of Cornish Indian Game males and Barred Plymouth Rock females. Four different Cornish males were used in these matings and got adult daughters. Their breeding histories follow.

Matings of C.I.G. ♂ *558.* This bird was used in pure Cornish matings and there shown to be of class 2 (C.I.G.) with constitution fL_1l_2. fl_1l_2. His breeding history in producing F_1 females was as follows:

Matings: A. With 2 B. P. R. ♀♀ indicated to be of class 1 = $fL_1L_2. Fl_1l_2$.

♀ *Progeny*

Winter Production:	Over 30	Under 30	Zero
Observed	4	14	2
Expected	*0*	*15*	*5*
Mean winter production of all ♀♀ in indicated class	51.75 eggs	15.79 eggs	0 eggs

The four birds with 'Over 30' records are apparently outstanding exceptions. It should be noted that these birds came from mothers whose gametic constitution was of the general type L_1. L_2. This would seem to suggest that in this case the presence of L_2 in the mother, even though it did not pass to tny of the F-bearing gametes, nevertheless in some manner or other modified the L_1 in these gametes so that a higher production in the progeny resulted. In other words, these cases suggest 'intra-zygotic influence' of the gametic factors upon one another, such as is frequently suggested by the conditions observed in heterozygotes, and lately has been discussed by Davenport (6, 7) and Laughlin (23). The winter records of these four birds are to be regarded as wide fluctuations, since when bred they gave no indications of carrying F_2.

B. With 1 B. P. R. ♀ indicated to be of class 3 = $fL_1l_2. Fl_1l_2$.

♀ *Progeny*

Winter Production:	Over 30	Under 30	Zero
Observed	0	3	1
Expected	*0*	*3*	*1*
Mean winter production of ♀♀ in indicated class		6.00 eggs	0 eggs

All ♀ Progeny.

Winter Production:	Over 30	Under 30	Zero
Observed	4	17	3
Expected	*0*	*18*	*6*
Mean winter production	51.75 eggs	14.06 eggs	0 eggs

Matings of C.I.G. ♂ *557.* Indicated constitution: class 3 (C.I.G.) ♂ = $fl_1l_2. fl_1l_2$.

Matings: A. With 6 B.P.R. ♀♀ indicated to be of class 2 = fL_1L_2. FL_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	0	17	0
Expected	*0*	*17*	*0*
Mean winter production of ♀♀ in indicated class		12.88 eggs	

B. With 1 B.P.R. ♀ indicated to be of class 4 = fL_1l_2. FL_1l_2.

♀ Progeny

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	0	1	0
Expected	*0*	*1*	*0*
Observed winter production ...		10 eggs	

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	0	18	0
Expected	*0*	*18*	*0*
Mean winter production ...		12.72 eggs	

The accordance between observations and expectation here is perfect.

Mating of C.I.G. ♂ 529. Indicated constitution: class 2 (C.I.G. ♂) = fL_1l_2. fl_1l_2.

Matings: A. With 1 ♀ indicated to be of class 1 = fL_1L_2. Fl_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	1	1	1
Expected	*0*	*2.25*	*0.75*
Observed winter production ...	46 eggs	13 eggs	0 eggs

This mating by itself is, of course, without any particular significance.

B. With 6 ♀♀ indicated to be of class 2 = fL_1L_2. FL_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	5	12	0
Expected	*0*	*17*	*0*
Mean winter productions of all ♀♀ in indicated class	41.60 eggs	11.67 eggs	

Here, again, as in the case of ♂ 558 there are seen to be several birds with winter records of over 30 eggs, when none is expected.

C. With 3 ♀♀ indicated to be of class 7 = $fl_1L_2. Fl_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	1	3	2
Expected	*0*	*3*	*3*
Mean winter production of all ♀♀ in indicated class	45 eggs	13.00 eggs	0 eggs

All ♀ Progeny.

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	7	16	3
Expected	*0*	*22.25*	*3.75*
Mean winter production	42.71 eggs	12.00 eggs	0 eggs

The seven birds with records 'Over 30' belong gametically to the 'Under 30' class, and their records are somatic fluctuations. This is shown both by their history and by their behavior in F_2, all having been bred.

Matings of C.I.G. ♂ *578.* This male has been shown from his matings with pure Cornish females to belong to class 3 of C.I.G. ♂♂ (= $fl_1l_2. fl_1l_2$). His matings with Barred Rock females are as follows:

Matings: A. With 2 B.P.R. ♀♀ indicated to be of class 2 = $fL_1L_2. FL_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	0	3	0
Expected	*0*	*3*	*0*
Mean winter production of daughters		6.33 eggs	

B. With 1 ♀ indicated to be of class 4 = $fL_1l_2. FL_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	1	4	0
Expected	*0*	*5*	*0*
Mean winter production of daughters in indicated class	42 eggs	11.00 eggs	0 eggs

All ♀ Progeny.

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	1	7	0
Expected	0	8	0
Mean winter production	42 eggs	9.00 eggs	

There are no data from which to make sure whether the one bird with an 'Over 30' record represented a fluctuation from the 'Under 30' class. It probably did, but this cannot be positively asserted.

Summary of all F_1 matings

Putting together the results of the matings of all Cornish Indian Game males with Barred Rock females, we have for the actual observations:

♀ Progeny—Raw Data

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	12	58	6
Expected	0	66.25	9.75
Mean winter production	45.67 eggs	12.46 eggs	0 eggs

In view of the fact that the 11 of the 12 birds with 'Over 30' records represent somatic fluctuations from the 'Under 30' class it is desirable to present another summary table in which the progeny are distributed in accordance with their gametic constitution.

♀ Progeny on Gametic Basis

Winter Production:	*Over 30*	*Under 30*	*Zero*
	(L_1L_2)	(L_1l_2)	(l_1l_2)
Observed	1	69	6
Expected	0	66.25	9.75

The contrast between these distributions and those of the reciprocal cross discussed before is very striking. Taken together these reciprocal crosses support strongly the general hypothesis of fecundity inheritance here being tested.

Matings of the second cross-bred (F_2) generation

The F_1 birds discussed in the preceding sections were mated in all possible ways *inter se* and with the parent forms. The results of these matings will be discussed in the present section.

At the outstart it should be noted that in spite of the fact that as many F_2 birds were hatched and reared as the available facilities would permit, nevertheless, the number of adult daughters available for fecundity study is small in case of some of the matings. There are several reasons for this. Besides the obvious one such as mortality, depredations of thieves, hawks, crows, rats and the like, there is another important but not so obvious one. This is the failure or great difficulty experienced in getting certain of the F_2 cross breds to grow into normal, full-sized, healthy adult birds. After rather wide experience in handling cross-bred chicks, I am convinced that certain gametic combinations which are to be expected on Mendelian theory, and can be produced in the expected numbers in the breeding pen, are nevertheless physiologically abnormal or unsound. Such birds do not make a normal growth, but in spite of the best care and attention grow up into stunted weaklings, which always show, both in their structure and their physiological economy, the effect of this retarded, abnormal development. I am further convinced that this result is primarily due to the hereditary constitution of the individuals in question. Certain combinations of hereditary factors do not produce physiological sound and vigorous zygotes.

Of course, there is nothing novel in such a result. It is of a piece, for example, with the parts respecting the relation between hereditary constitution and physiological vigor in maize, which have been so clearly set forth and analyzed by Shull (45, 46, 47) and East (9). Other examples of the same phenomenon might be cited. The whole phenomenon is precisely what would be expected from Johannsen's general conception of inheritance and ontogeny (22).

This relationship between hereditary constitution and physiological constitution or normality takes on particular significance when one is dealing with fecundity. As has been pointed out earlier in this paper one cannot expect to get a normal somatic expression of the hereditary constitution in respect to fecundity unless the bird is a physiologically normal, well-developed individual. Stunted, under-developed, or physiologically unsound birds will lay but very few if any eggs, regardless of what fecundity factors it may carry. A marked difference is here apparent between structural and physiological characters so far as the study of inheritance is concerned. A definite structure either is or is not present in the zygote, however weak physiologically the individual may be. But if the general capability of an organism with respect to the transformation of matter and energy is markedly reduced, then all physiological characters will be affected, and fail to reach complete normal expression.

In the study of cross-bred poultry I have found pure extracted whites from crosses involving originally two heavily pigmented parent races to be conspicuously good examples of the phenomenon under discussion. It is only very exceptionally, in my experience, that such white birds are physiologically normal. Indeed because of this fact it is only with the greatest difficulty, and after many failures, that I have been able to get such extracted whites to breed, and thus form a pure white race. If the hens lay eggs, which some do not do, they are usually either infertile, or else all the embryos die at an early stage. These facts have some bearing on the popular belief of animal breeders that whites in general are delicate in constitution and hard to rear. This belief is so well known that it is not necessary to cite in detail references regarding it in the literature.

As a consequence of the above considerations, I have felt justified in leaving out of account, or rather in considering apart from the others, a few of the F_2 individuals, in all some 7 out of over 200 F_2 birds all told. In each case these birds were physiologically abnormal, and obviously so to the most casual observer. The fact that they did not lay was no criterion whatsoever of their hereditary constitution. In order that there might be no possibility of unfairly influencing ratios by leaving these birds out, the whole families (usually of two or three individuals only) to which they belonged have been rejected. As a matter of fact whenever one individual in a family is physiologically abnormal in this way all the other members will usually show the same condition in greater or less degrees.

In the F_2 generation following the reciprocal crossing of Barred Rocks and Cornish Indian Games there are a number of possible matings. The nature of these matings and the results as to color and pattern have been discussed in another place (41). That paper may be referred to in case one is not clear as to the nature of the matings. The different matings will be discussed in the following order.

1. F_1 ♂ (out of B.P.R. ♂ × C.I.G. ♀) × F_1 ♀ ♀, barred and non-barred.

2. F_1 ♂ (out of C.I.G. ♂ × B.P.R. ♀) × F_1 ♀ ♀, barred and non-barred.

3. F_1 ♂ (out of B.P.R. ♂ × C.I.G. ♀) × B.P.R. ♀ ♀

4. F ♂ (out of B.P.R. ♂ × C.I.G. ♀) × C.I.G. ♀ ♀

5. F_1 ♂ (out of C.I.G. ♂ × B.P.R ♀) × B.P.R. ♀ ♀

6. F_1 ♂ (out of C.I.G. ♂ × B.P.R. ♀) × C.I.G. ♀ ♀

7. B.P.R. ♂ ♂ × F_1 Barred ♀ ♀

8. B.P.R. ♂ ♂ × F_1 non-barred ♀ ♀

9. C.I.G. ♂ × F_1 ♀ ♀ Barred and non-barred

It will be recalled that the *barred* F_1 females come from the mating B.P.R. ♂ × C.I.G. ♀ $_1$ and that the *non-barred* (*black*) F_1 females comes from the reciprocal mating C.I.G. ♂ × B.P.R. ♀.

Matings of F_1 ♂ 576 with F_1 females. The pedigree of F_1 ♂ 576 was as follows:

B.P.R. ♂ 559 (fl_1L_2. fl_1L_2) × C.I.G. ♀ 456 (fL_1l_2. Fl_1l_2)

↓

F_1 ♂ 576

The hereditary constitutions of both ♂ 559 and ♀ 456 were known, both from their pedigrees and their progeny in other matings. From this pedigree it is evident that the gametic formula for ♂ 576 must be either fl_1L_2. fL_1l_2 or $fl_1L_2.fl_1l_2$. A study of his progeny in all matings shows clearly that it is actually the former. In other words he produced gametes of four kinds, viz., fl_1L_2, fL_1L_2, fL_1l_2, fl_1l_2.

This bird was mated with barred F_1 ♀ ♀ which had been produced by the following mating.

B.P.R. ♂ 559 ($fl_1L_2 . fl_1L_2$) × C.I.G. ♀ ♀ of type $fL_1l_2 . Fl_1l_2$

↓

A. $fl_1L_2 . FL_1l_2$-Winter record over 30

and

B. $fl_1L_2 . Fl_1l_2$-Winter record under 30

Male 576 was mated only with ♀ ♀ of the A class,[14] namely those having a gametic constitution $fl_1L_2 . FL_1l_2$, and producing two sorts of F-bearing gametes, Fl_1l_2 and FL_1l_2.

This same ♂ 576 was mated with non-barred (black) F_1 females which had been produced in the following way.

C.I.G. ♂ 558 or 529 ($fL_1l_2 . fl_1l_2$) × B.P.R. ♀ ♀ some of which were of type $fL_1L_2 . Fl_1l_2$, and some $fl_1l_2 . FL_1l_2$ (both producing F-bearing gametes of two kinds FL_1l_2 and Fl_1l_2.

↓

A. $fL_1l_2 . FL_1l_2$, Winter record under 30
B. $fl_1l_2 . FL_1l_2$, Winter record under 30
C. $fL_1l_2 . Fl_1l_2$, Winter record under 30
D. $fl_1l_2 \ Fl_1l_2$, Winter record zero.

The three non-barred ♀ ♀ with which ♂ 576 was bred were of the B-C type, producing two kinds of F-bearing gametes, FL_1l_2 and Fl_1l_2. They were thus identical, so far as concerns F-bearing gametes with the barred F_1 birds with which ♂ 576 was mated. All the progeny may then be treated together since all did, as a matter of fact, lead to the same result, having regard to the errors of sampling in such statistically small lots.

---

[14] It would of course be desirable to have data from the other mating, ♂ 576 × B ♀ ♀. If one could have foreseen what the mechanism of the inheritance of fecundity was going to turn out to be, such matings would have been made. Actually these cross bred birds were being studied primarily with reference to color characters, and the matings were made relative to that line of investigation. Naturally highly fecund females would be chosen as breeders whenever possible, in order to get more chickens for the color studies. Actually, however, all of the possible gametic combinations in respect to fecundity were tested in F_2 either from one mating or another.

TABLE 27

Showing the results of mating F_1 ♂ 576 with F_1 ♀ ♀
Type of mating: $fl_1L_2 \cdot fL_1l_2 \times fl_1L_2 \cdot FL_1l_2$ and (or) $fL_1l_2 \cdot Fl_1l_2$

Individuals Used in These Matings		Winter Record of Daughters			
♂	♀	Over 30	Under 30	Zero	Total adult ♀ progeny
576	F68	4	2	0	6
576	F89	0	3	0	3
576	F41	1	3	0	4
576	F79	1	3	1	5
576	F416	0	0	2[1]	2
576	F421	0	2	2	4
576	F33	5	3	2	10
576	F415	0	4	1	5
Total observed		11	20	8	39
Total Expected		14.6	19.5	4.9	
Mean winter production of ♀ ♀ in indicated class		42.81 eggs	12.05 eggs	0 eggs	

[1] These two individuals ought really to be excluded on the ground of physiological abnormality of the sort discussed at the beginning of this section. Neither of them made a normal growth. No poultrymen would have regarded these birds as reliable material for the study of egg production. Leaving these two birds out the totals stand as follows:

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	11	20	6
Expected	*13.9*	*18.5*	*4.6*

The same kind of evidence for the segregation of different degrees of fecundity which has been seen in all the previous matings appears again in these F_2 birds.

Matings of F_1 ♂ 577 with F_1 females. This F_1 ♂ 577 was produced in the following way:

C.I.G. ♂ 558 ($fL_1l_2 \cdot fl_1l_2$) × B.P.R. ♀ 234 ($fL_1l_2 \cdot Fl_1l_2$)

↓

F_1 ♂ 577

Such a mating as this would be expected to produce males of four (really three *different*) kinds as follows:

A. $fL_1l_2 \cdot fL_1L_2$ C. $fl_1l_2 \cdot fL_1L_2$
B. $fL_1l_2 \cdot fl_1L_2$ D. $fl_1l_2 \cdot fl_1L_2$

The results indicate that ♂ 577 was of the last (D) type, producing two kinds of gametes, fl_1l_2 and fl_1L_2. He was mated with 4 barred F_1 ♀ ♀ and 4 black F_1 ♀ ♀. All of these females, as in the preceding case, produced F-bearing gametes of two kinds in equal numbers; Fl_1l_2 and FL_1l_2. Of these matings three produced small families in which all of the individuals were so far from being normal physiologically that they cannot fairly be included in the tabulation. The details regarding them are as follows. From one barred F_1 ♀ was produced two adult daughters, both of which were undersized and stunted in development, and failed to lay. One of these daughters died early in the year. From one of the matings with black F_1 ♀ ♀ only one adult daughter was obtained, which again failed to develop normally and was only put into the adult house because of its interest from the standpoint of color inheritance. Another of the matings with a black F_1 ♀ produced four adult daughters. Two of these were extracted whites and very small, poor specimens. The whole family was saved because of these birds. Neither of them laid. Of the other sisters one died early in the laying year, never having laid. It, like the other members of the family, was from the start a weakling. Finally the fourth sister made a winter record of 8 eggs. It presented the same evidence of abnormality as the other sisters, and its egg record could by no means be taken as a just indication of its gametic constitution in respect to fecundity. No one of the seven birds under discussion would ever by any chance whatever have been put in the laying house as normal individuals for the study of fecundity. The only reason they ever were put in was simply, as already explained, because the primary object of the F_2 birds as a whole was the study of color and pattern inheritance. Even though a bird is an undeveloped weakling physiologically one may make a record of its plumage color and pattern, and see whether these change with advancing age. However, since these birds really were in the adult house, and in order to forestall the possibility of a suggestion that any records were suppresed in this study of fecundity, it has seemed advisable to take the space for the above detailed discussion of the matter.

The records for the other matings of F_1 ♂ 577 are given in table 28.

Matings of F_1 576 with Barred Plymouth Rock females. This F_1 ♂ was mated with three pure Barred Rock ♀ ♀ of class 2 (table 6). The results of these matings are shown in table 29.

TABLE 28

Showing the results of mating F_1 ♂ 577 with F_1 ♀ ♀
Type of mating: $fl_1l_2 \cdot fl_1L_2 \times fl_1L_2 \cdot FL_1l_2$ and $fL_1l_2 \cdot Fl_1l_2$
Gametes: fl_1l_2 and fl_1L_2. F-bearing gametes: FL_1l_2 and Fl_1l_2

Individuals Used in These Matings		Winter Record of Daughters			
♂	♀	Over 30	Under 30	Zero	Total adult ♀ progeny
577	F401	0	3	0	3
577	F18	0	2	1	3
577	F44	2	4	1	7
577	F99	2	2	0	4
577	F418	1	5	5	11
Total observed		5	16	7	28
Total Expected		*7*	*14*	*7*	
Mean winter production of ♀ ♀ in indicated class		36.33 eggs	11.25 eggs	0 eggs	

TABLE 29

Showing the results of mating F_1 ♂ 576 with Barred Rock ♀ ♀
Type of mating: $fl_1L_2 \cdot fL_1l_2 \times fL_1L_2 \cdot FL_1l_2$

Individuals Used in These Matings		Winter Record of Daughters			
♂	♀	Over 30	Under 30	Zero	Total adult ♀ progeny
576	1107	1	1	0	2
576	F115	1	2	0	3
576	F111	7½	3½	0	11
Total observed		9½	6½	0	16
Total Expected		*8*	*8*	*0*	
Mean winter production of ♀ ♀ in indicated class		46.78 eggs	22.83 eggs		

These results are suggestive in connection with the problem of the absolute fecundity value of the same genes from different sources, a matter which will be fully discussed later. The figures give clear evidence of Mendelian segregation of high and low fecundity.

Matings of F_1 ♂ 576 with Cornish Indian Game females. There were but two matings of ♂ 576 with pure Cornish Indian Game ♀ ♀ which produced adult female offsprings. Other matings were made but got no adult progeny. The successful matings were with C.I.G. ♀♀ of constitution fl_1l_2. Fl_1l_2. The results were as follows:

♂ 576 fl_1L_2. fL_1l_2 × fl_1l_2. Fl_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	0	3	1
	0	2	0
Total observed	0	5	1
Total expected	*1.5*	*3*	*1.5*
Mean winter production of ♀♀ in indicated class		11.80 eggs	0 eggs

The numbers here are too small to give definite results, but there is nothing incompatible in the observations, having regard to the smallness of the numbers, with what would be expected.

Matings of ♂ F_1 557 with Barred Plymouth Rock females. There were three matings of this sort, but the families were all small. The females used were of class 2 (table 6). The results were as follows:

♂ 577 fl_1l_2. fl_1L_2 × fL_1L_2. FL_1l_2.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
(♀ 1118)	0	1	0
(♀ F350)	1½	1½	0
(♀ F235)	1	2	0
Total observed	2½	4½	0
Total expected	*3.5*	*3.5*	*0*
Mean winter production of ♀♀ in indicated class	35.00 eggs	11.25 eggs	

Again the numbers involved are too small to be of any particular significance when taken by themselves. They are in conformity, however, with all the other data and therefore have cumulative value.

Matings of F_1 ♂ 577 with Cornish Indian Game females. Two matings only of this sort got adult female progeny. The families are small. The pure Cornish females used were of constitution $fL_1l_2. Fl_1l_2$ The results follow.

♂ 577 $fl_1l_2. fl_1L_2 \times fL_1l_2. Fl_1l_2.$

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
(♀ F7)	0	1	1
(♀ F11)	0	2	1
Total observed	0	3	2
Total expected	*1.25*	*2.5*	*1.25*
Mean winter production of ♀ ♀ in indicated class		7.33 eggs	0 eggs

Matings of Barred Plymouth Rock males with Barred F_1 females. While several matings were made here they all fell into one or the other of two gametic types. The Barred Rock males males used in these matings have, of course, already had their gametic constitutions determined through their matings with pure Barred Rock females.

A. Type of mating: $fl_1L_2. fl_1L_2 \times fl_1L_2. FL_1l_2.$ The results of this type of mating are shown in table 30.

There are several points which need to be noted about this table. While in general it is apparent that the observed result falls out in fair accord with expectation, the three zero birds are outstanding exceptions. No zero birds should occur in any of these matings. A careful study of the individual cases, however, indicates that only one of these apparent exceptions is really such. Two of these zero birds were very late hatched and began laying immediately after March 1, i.e., just after the arbitrary point of ending the winter period. Their records during the spring period were such as to indicate that they bore the factor L_1, and not that they lacked it. The third zero bird (no. 558) was an extremely interesting case. Something was at fault physiologically with her reproductive organs, as a result of which she never laid an egg. However, she gave clear evidence that she bore the factor L_1 (or L_2—not both) gametically. This she did through her nesting records. For some years past records have been kept in this work not only of when a hen

TABLE 30

Showing the results of mating class 2 B.P.R. ♂ ♂ with high laying Barred F_1 ♀ ♀

Mating		Observed Winter Production of Daughters		
B. P. R. ♂	Barred F1 ♀	Over 30	Under 30	Zero
552	424	3	5	0
554	87	0	4	0
563	412	7	1	0
564	405	7	2	0
567	425	2	1	3
562	404	½	½	0
Total observed		19½	13½	3
Total Expected		*18*	*18*	*0*
Mean winter production		57.16 eggs	12.69 eggs	

visited a nest and laid, but also when she visited a nest and did not lay. A large number of records have been accumulated of birds which go through the whole process of nesting and laying except that they do not discharge any eggs from the body. It was hoped to publish a paper on this subject, which throws light on the problem of the physiology of egg production, before the present paper appeared. This has not been possible owing to pressure of other work, so it will be necessary to take a little space here to discuss certain phases of this subject. It has been shown experimentally in the laboratory that if the oviduct of a normal healthy hen, with a normal ovary, is ligated, transected or removed entirely, without injury to the ovary, such a bird goes regularly through the entire process of laying, save for the extrusion of an egg, which is physically impossible. The '*n*' (nesting) record of such a bird is precisely like a normal egg record, showing the same phenomena of rhythm and cycles. Each day's '*n*' in the record of such a bird represents an egg[15] which she would have laid, had she been physically capable of so doing.

Birds in which the oviduct is occluded through some diseased condition often behave in this manner. It may result from other abnormal conditions also. With this explanation, the following

[15] Of course this does not mean that when a bird visits a nest twice in the same day she would have laid two eggs that day had she been normal. Many laying birds have the habit of visiting the nest once or twice in the same day before actually laying.

record of ♀ 558, will be clear, it being understood that '*n*' denotes a visit to a nest and the performance of those acts characteristically associated with the laying of an egg, but without the extrusion of an actual egg.

From this record taken in connection with other similar cases studied in his laboratory, there can be no doubt that ♀ 558 belongs gametically in the class 'Under 30.'

Another point is with reference to the mating ♂ 564 × ♀ 405. The excess of 'Over 30' birds here is in part due to the fact that two birds, which have winter records respectively of 32 and 34 eggs and are almost certainly to be regarded as somatic fluctuations above the division point at 30 are included in the 'Over 30' class.

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
Nov.																															
Dec.																															
Jan.											n							n	n	n		n	n		n	n	n^2	n^2			n^2
Feb.			n	n		n^2	n	n			n	n^2		n	n				n			n				n		n			
Mar.	n		n	n			n	n	n				n	n^2	n	n	n			n	n^2		n	n	n	n	n^2	n		n	n
Apr.	n	n		n^2	n	n	n	n	n	n		n	n	n		n	n			n	n			n	n	n			n	n	
May	n	n	n		n	n	n	n		n	n	n	n			n	n	n	n^2		n		n		n			n	n	n	
Jun.	n	n^2			n	n^2		n	n					n	n		n	n	n		n^2	n					n	n			
Jul	n	n	n		n^2	n	n			n	n	n		B							O		n			n				n^2	n
Aug.	n			n	n		n	n		n^2	n	n		n	n	n	n		n											n	n

Fig. 452. Nesting record of ♀ 558. '*n*' denotes a visit to the trap-nest. n^2 indicates that the bird visited the nest twice on the same day. *B* indicates that the bird became broody, and *O* that she ceased manifestations of broodiness.

If the totals are modified in accordance with the above suggestion we get

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed: (modified)	17½	17½	1
Expected	*18*	*18*	*0*
Mean winter production	60.00 eggs	15.40 eggs	0 eggs

B. Type of mating: $\left.\begin{array}{c} fL_1L_2.\ fl_1l_2 \\ \text{or} \\ fL_1l_2.\ fl_1L_2 \end{array}\right\} \times fl_1L_2.\ FL_1l_2$

♀ *Progeny*

Mating		Observed Winter Production of Daughters		
B. P. R. ♂	Barred F_1♀	Over 30	Under 30	Zero
566	419	2	3	1
Expected Mean winter production		*2.25* 46.50 eggs	*3* 13.67 eggs	*0.75* 0 eggs

While this single family is small the three classes expected are represented and in as near the right proportion as could be expected.

Putting together all the results for B.P.R. ♂ ♂ × Barred F_1 ♀ ♀ we get:

♀ *Progeny*

Unmodified Data

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	21½	16½	4
Expected	*20.25*	*21*	*0.75*

Data modified in accordance with physiological facts regarding individual birds

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	19½	20½	2
Expected	*20.25*	*21*	*0.75*

Matings of Barred Plymouth Rock males and F_1 Black females. A number of matings of this type were made, representing several different gametic combinations. The following B.P.R. males were used in these matings. The class and gametic constitution given are those which have been brought out by the pure B.P.R. matings.

Bird No.	Class (Table 5)	Gametic Constitution
552	7	$f l_1 L_2 . f l_1 L_2$
554	7	
562	7	
573	7	
564	7	
567	7	
569	4	$f L_1 L_2 . f l_1 l_2$

Of these males four, namely 552, 554, 573 and 564, were mated with females whose sire was C.I.G. ♂ 557. These birds all had the gametic constitution fl_1l_2. FL_1l_2, as shown in the section on the F_1 birds. The results of these matings are shown in table 31.

The observed figures are a rather bad, though not an impossible, approximation to the expected Mendelian half. The means indicate, however, that there is a definite segregation of the two classes. It is possible that the discrepancy in the ratio finds its explanation in a difference in the potency or absolute fecundity value of the Cornish Indian Game L_1 factor and the same factor in the Barred Plymouth Rock.

TABLE 31

Showing the results of matings of the type B.R.P. ♂ fl_1L_2 . fl_1L_2 × Black F_1 ♀ fl_1l_2 . FL_1l_2

Number of Individuals Involved in Matings of This Type		Winter Egg Production of Daughters F_2				
♂♂	♀♀	Class	Over 30	Under 30	Zero	Total adult ♀ progeny
4	4	Observed	5	14	0	19
		Expected	*9.5*	*9.5*	*0*	
Mean winter egg production of all ♀♀ in indicated class..........			37.00 eggs	11.14 eggs		

Two of the class 7 B.P.R. males (562 and 567) were mated with two F_1 blacks whose sire was C.I.G. ♂ 558. It has already been shown from the pure Cornish and F_1 matings that this Cornish ♂ 558 had the gametic constitution fL_1l_2. fl_1l_2. In respect to fecundity his F_1 daughters in the 'Under 30' class were gametically of two types: viz., fL_1l_2. Fl_1l_2 and fL_1l_2. FL_1l_2. None of the second type were used in these matings. Only a small progeny resulted from the mating of the two females of the first type. The actual results were as follows:

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	2	4	0
Expected	*3*	*3*	*0*
Mean winter egg production of all ♀♀ in indicated class ..	38.00 eggs	8.5 eggs	

B.P.R. ♂ 569 was mated with a black F_1 ♀ sired by C.I.G. ♂ 529. Only two daughters were obtained. Both made winter records under 30 eggs. The number of daughters is too small ot have any significance, or to make classification possible.

Putting all the results together (with the exception of the two individuals just noted as not capable of classification) we have:

F_1 ♀ Progeny from matings of B.P.R. ♂ ♂ × Black F_1 ♀ ♀

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	7	18	0
Expected	*12.5*	*12.5*	*0*
Mean winter production	37.29 eggs	10.55 eggs	

There is clear evidence of segregation here but there is a defect in the observed numbers in the 'Over 30' class. After careful study of all the facts a possible explanation of this appears to me that the absolute degree of fecundity manifested somatically when L_1 is present in the gametes may be less if the L_1 comes from a Cornish Indian Game than if it comes from a Barred Plymouth Rock. In other words it appears to be the case that what may be called the absolute fecundity value or worth of L_1 is different in these two breeds. An indication that this is the case is found in the following figures. In the case of pure C.I.G. matings the factor L_2 is not present. All females in the 'Under 30' class are therefore either L_1l_1 or L_1L_1 in type. The mean winter production of all pure C.I.G. ♀ ♀ in the 'Under 30' class is 10.22 eggs. The mean winter production of all pure B.P.R. ♀ ♀ in the 'Under 30' class is 15.61 eggs. The probable errors in both cases are less than 1. Of course the 'Under 30' class in the case of B.P.R. ♀ ♀ includes the following gametic types: L_1l_1, L_1L_1, l_1l_1, and L_2l_2. The last two do not occur in the pure C.I.G.'s. Granting the greatest conceivable influence to this, it is still evident that the L_1 factor of a Barred Rock probably means a higher winter production than the L_1 of a Cornish Game. But if this is true then plainly the division or upper limiting point for the low fecundity class should not be at 30 eggs but at some lower point in the case of females bearing L_1 from a Cornish Indian Game source. If it be kept at 30 eggs for all birds, and there is a difference in the absolute fecundity value of the factors, then plainly some birds will be put in the low fecundity class, because of an 'Under 30' record, although they really carry L_2 and belong in the high fecundity class. Such a state of affairs would account for just such discrepancies as those observed in the matings under discussion.

Matings of Cornish Indian Game males with Black and Barred F_1 females. Only one C.I.G. male was used in these F_2 back-cross matings. This was C.I.G. ♂ 578. As will presently appear, it is to be regretted that other Game males were not used, because of certain peculiarities arising in the results of some of these matings. From pure Cornish and F_1 matings ♂ 578 has been shown to have the gametic constitution fl_1l_2. fl_1l_2.

Male 578 was mated with 3 black F_1 females indicated to be of the type fL_1l_2 FL_1l_2, with the following results:

Matings: C.I.G. ♂ $f\ l_1l_2\ f\ l_1l_2 \times F_1$ ♀ $fL_1l_2\ FL_1l_2$.

♀ *Progeny*

Winter Production:	*Over 30*	*Under 30*	*Zero*
Observed	1	9	1
Expected	*0*	*11*	*0*
Mean winter production	41 eggs	9.67 eggs	0 eggs

It will be noted that the one 'Over 30' bird laid but 41 eggs. The record probably represents a fluctuation from the 'Under 30' class. In general the agreement between observation and expectation is satisfactory.

Turning to the matings of ♂ 678 with barred F_1 females we meet the only case in the whole investigation which is apparently unconformable. It will therefore be well to discuss it in detail. The facts are these: ♂ 578 was mated with four barred F_1 females, of which three were in the 'Over 30' class and one was a poor layer. When mated with any of these three high laying birds one half of 578's daughters should have been in the 'Over 30' and one-half in the 'Under 30' class. Mated with the poor layer only zero birds should have resulted. Nothing like this actually happened. The observed outcome was that shown in the following table:

Mating 699 (♂578 × ♀411) gave 13 adult daughters, with winter records as follows: 62, 60, 56, 32, | 30, | 28, 27, 26, 26, 7, 5, 5, 2.

Mating 700 (♂578 × ♀422) gave 7 adult daughters with winter records as follows: 47, 47, 33, | 26, 19, 15, 9.

Mating 701 (♂578 × ♀414) gave 5 adult daughters with winter records as follows: | 23, 16, 5, 0, 0.

Mating 702 (♂ 578 × ♀ 423) gave 11 adult daughters with winter records as follows: 40, 34, | 28, 26, 21, 20, 20, 17, 15, 13, 10, 4.

These records are characterized by four striking facts: (*a*) the large number of 'Over 30' records when none is expected, (*b*) the large number of high 'Under 30' records, (*c*) the absence except in one mating of zero records, and (*d*) the sharp break within the 'Under 30' class, especially to be noted in mating 699, but also clear in each of the others.

Now these four matings were remarkable in other respects than the egg records of the progeny. They gave an extraordinarily high hatching record. This is shown in table 32.

Considering that these figures include all eggs set during the whole hatching season it is evident that the record is relatively very high. In a former paper (30) I have shown (loc. cit., table B, p. 131) that for the high laying Barred Rock matings the mean percentage of fertile eggs was 80.7 per cent., while 55.1 per cent of the fertile eggs were hatched. Even those

TABLE 32

Showing the hatching records of ♂ 578's F_2 matings

MATING	Eggs Set	Eggs Infertile	Eggs Fertile	Chicks Hatched
699	58	0	58	46
700	57	0	57	37
701	37	1	36	27
702	49	5	44	37
Totals......	201	6	195	147

Per cent. of eggs fertile = 97.01.
Per cent. of fertile eggs hatched = 75.38.

results could only be considered very good taking all the facts into consideration. These back-cross matings of ♂ 578 far surpass those records.

One can only conclude that for some reason not apparent the matings 699 to 702 were physiologically extremely favorable. There seems to have been a what the breeders call a 'nick' here of unusual character. These matings were noticeable throughout the hatching season not only for the large number of the chicks produced, but also for their extra fine, vigorous character. The chick mortality from these matings was low.

As has been pointed out at the beginning of this section of the paper, there undoubtedly exist differences in what might be called physiological compatibility between fowls of different genotypic constitutions. Some concrete data regarding this have been published in a previous paper (39). More will be presented later. While some gametic combinations (at least at their first synthesis) lead to physiologically weak and abnormal individuals, others produce individuals which in vigor, rate of growth, etc., surpass the normal. This phenomenon is perhaps more clearly and strikingly shown in pre-natal mortality (embryos dead in shell) than by any other character in fowls which can readily be measured. I hope shortly to publish a paper on this subject, and will only anticipate that paper here to the extent of saying that all the experience in this laboratory with cross-bred poultry agrees in showing that while there may be differences in the ease or success with which fertilization of the egg occurs in breed crosses, these are relatively unimportant as compared with the differential embryonic mortality. The proportion of embryos which start to develop, but lack the power to complete development is uniformly much greater for some hereditary combinations than for others, regardless of the particular individuals used as parents, and under uniform conditions of incubation and of housing and feeding the parent stock.

It is in this direction that I am inclined to look for the explanation of the discordant results of ♂ 578's matings with barred F_1 females. The records give one the impression that the potency or absolute fecundity value of the several gametic factors had, because of the super-normal physiological condition, been bodily raised considerably above the normal for the strains used in these experiments. One cannot escape the feeling that all these birds were making higher records than individuals of the same gametic constitution but of more ordinary physiological character in general would have done. The scale of fecundity values has apparently shifted in an upward direction; in other words something similar to what occurs when two inbred strains of maize are crossed happened here.

Along this line is the only explanation for the outcome of these four matings that I am able to suggest. It is quite possible that it may have no bearing, and that the results are due to some peculiarity of gamete formation which can be suggested by some one. Personally, however, I am more inclined to keep to the solid ground of the observed physiological peculiarities of these matings rather than to 'juggle the genes.' Even in the hands of an adept in this direction, which the writer cannot claim to be, the latter procedure runs some risk of taking one a great way from any solid ground of fact whatever.

Regarding these four matings 699-702 the following facts are definitely known:

1. High fertility of eggs.

2. Smallest embryonic (pre-natal) mortality of any *particular* gametic combination yet experienced in the work of this laboratory.

3. Great vigor and vitality of chicks at hatching and during growth.

4. Very low chick and adult mortality.

5. A higher egg production in practically all adult daughters than would be expected from the gametic constitutions *per se* of the parent forms, the latter being definitely known from their pedigrees and from their behavior (♂ 578), or that of their full sisters in other types of matings.

I cannot escape the conviction that in some way the first four of these facts are connected with the explanation of the fifth. There the matter must be left for the present.

This case points to the importance of the physiological study of individuals in genetic work involving crossing. Only the most superficial aspects of this subject have ever been touched. The 'increased vegetative vigor' of first crosses is clear in some instances, but very far from being so in others, and nobody has ever shown by a clean-cut physiological investigation why or how the phenomenon occurs. Every breeder of experience knows that this is but one of many interesting and fundamentally significant physiological matters in connection with hybridizing and cross-breeding which need investigation. The animal breeder knows further that there are real objective phenomena, and not mere idle superstitions of the fancier at the basis of those things which the latter calls 'nicking' and 'prepotency,' for example. No doubt these things depend on simple genetic laws, but the point is that we do not now know scarcely anything definite (i.e., scientifically exact) about the phenomena, to say nothing of their underlying laws. The richness of the field which still remains quite unworked on the purely physiological side of genetics is, I think, only appreciated by the experienced breeder.

Summary and Discussion of Results

THE FACTS AND THEIR INTERPRETATION

In this paper is presented a detailed analysis and interpretation of a rather extensive series of data regarding the inheritance of fecundity in the domestic fowl. The basic data are derived from trap-nest records extending over a period of years. They include records from (*a*) pure Barred Plymouth Rocks; (*b*) Cornish Indian Games; (*c*) the F_1 individuals obtained by reciprocally crossing these two breeds; and (*d*) the F_2 individuals obtained by mating the F_1's *inter se* and back upon the parent forms in all possible combinations. The fully-pedigreed material made use of in this present paper includes something over a thousand adult females, each of which was trap-nested for at least one year, and many for a longer period. This material covers four generations. The birds of the fifth generation have just completed their winter records at the time of writing. Besides this fully pedigreed material, the collection and study of which has occupied five years there was available as a foundation, without which the results discussed in this page could not have been reached, nine years of continuous trap-nest records for Barred Plymouth Rocks, involving thousands of birds, which had been subjected during this long period to mass selection for increased egg production.

Altogether it may fairly be said that the material on which this paper is based is (*a*) large in amount, (*b*) extensive in character, and (*c*) in quality as accurate as it is humanly possible to get records of the egg production of fowls (Pearl 31). On these accounts the facts presented are worthy of careful consideration, and have a permanent value quite apart from any interpretation which may be put upon them.

The essential facts brought out in this study of fecundity appear to me to be the following:

1. The record of fecundity of a hen, taken by and of itself alone, gives no definite, reliable indication from which the probable egg production of her daughters may be predicted. Furthermore mass selection on the basis of the fecundity records of females alone, even though long continued and stringent in character, failed completely to produce any steady change in type in the direction of selection.

2. Fecundity must, however, be inherited since (*a*) there are widely distinct and permanent (under ordinary breeding) differences in respect of degree of fecundity between different standard breeds of fowls commonly kept by poultrymen, and (*b*) a study of pedigree records of poultry at once discovers pedigree lines (in some measure inbred of course) in each of which a definite, particular degree of fecundity constantly reappears generation after generation, the 'line' thus 'breeding true' in this particular. With all birds (in which such a phenomenon as that noted under *b* occurs) kept under the same general environmental conditions such a result can only mean that the character is in some manner inherited.

The facts set forth in paragraphs 1 and 2 have been presented, and, I believe, fully substantiated by clean-cut and extensive evidence, in previous papers from this laboratory. In the present paper it is further shown that:

3. The basis for observed variations in fecundity is not anatomical. The number of visible oöcytes on the ovary bears no definite or constant relation to the actually realized egg production.

4. This can only mean that observed differences (variations) in actual egg productions depend up on differences in the complex physiological mechanism concerned with the maturation of oöcytes and ovulation.

5. A study of winter egg production (taken for practical purposes as that from the beginning of the laying year in the early fall to March 1) proves that this is the best available measure of innate capacity in respect to fecundity, primarily because it represents the laying cycle in which the widest difference

exists between birds of high fecundity and those of low fecundity.

6. It is found to be the case that birds fall into three well-defined classes in respect to winter egg production. These include (*a*) birds with high winter records, (*b*) birds with *low* winter records, and (*c*) birds which do not lay at all in the winter period (as defined above). The division point between *a* and *b* for the Barred Plymouth Rock stock used in these experiments falls at a production of about 30 eggs.

7. There is a definite segregation in the Mendelian sense of the female offspring in respect to these three fecundity divisions.

8. High fecundity may be inherited by daughters from their sire, independent of the dam. This is proved by the numerous cases presented in the body of this paper where the same proportion of daughters of high fecundity are produced by the same sire, whether he is mated with dams of low or of high fecundity.

9. High fecundity is not inherited by daughters from their dam. This is proved by a number of distinct and independent lines of evidence, of which the most important are: (*a*) continued selection of highly fecund dams does not alter in any way the mean egg production of the daughters (26, 27, 28, 30, 34, 35, 36, 37); (*b*) the proportion of highly fecund daughters is the same whether the dam is of high or of low fecundity, provided both are mated to the same male;[16] (*c*) the daughters of a highly fecund dam may show either high fecundity or low fecundity, depending upon their sire; (*d*) the proportion of daughters of *low* fecundity is the same whether the dam is of high or of low fecundity provided both are mated to the same male.

10. A low degree of fecundity may be inherited by the daughters from either sire or dam or both.

11. The results respecting fecundity and its inheritance stated in paragraphs 3 to 10 inclusive are equally true for

[16] This is true, of course, only for certain gametic types of low fecundity females, as will be clear to anyone who has studied the detailed evidence. This limitation, however, in nowise diminishes the force of this particular evidence in favor of the conclusion standing at the beginning of paragraph 9.

Barred Plymouth Rocks, Cornish Indian Games, and all cross-bred combinations of these breeds in F_1 and F_2.[17]

The above statements are of definite facts, supported by a mass of evidence. Their truth is objective and depends in no way upon any theory of inheritance whatsoever. With this clearly in mind we may undertake their interpretation.

It is believed that these general facts, and the detailed results on which they are based, are completely accounted for and find their correct interpretation in the simple Mendelian hypothesis respecting the inheritance of fecundity in the fowl, which was outlined at the beginning of this paper and has been checked against the detailed data from each mating. This hypothesis involves the following points, each of which is supported by direct and pertinent evidence derived either from physiological and statistical studies of fecundity, or from the detailed data respecting the mode of inheritance of this character.

It is assumed in this hypothesis that:

1. There are three distinct and separately inherited factors upon which fecundity in the female fowl depends.

2. The first of these factors (which may be called the anatomical) determines the presence of an ovary, the primary organ of the female sex. The letter F is used throughout to denote the presence of this factor.

3. There are two physiological factors. The first of these (denoted by L_1) is the basic physiological factor, which when present alone in a zygote with F brings about a low degree of fecundity (winter record under 30 eggs). This factor is under no limitations in gametogenesis but may be carried in any gamete, regardless of what other factors may be also present.

4. The second physiological factor (denoted by L_2) when present in a zygote together with F and L_1 leads to a *high* degree of fecundity (winter record over 30 eggs). When L_1 is absent, however, and L_2 is present the zygote exhibits the same general degree of fecundity (under 30) which it would if L_1 were present alone. These two independent factors L_1 and L_2

[17] And F_3. It has not been thought wise to delay publication of this paper any longer in order to include the data for F_3. It may be said however that they are in full accord with those which have been obtained from earlier cross-bird generations and the parent forms.

must be present together to cause high fecundity, either of them alone, whether present in one or two 'doses,' causing the same degree of low fecundity.

5. The second physiological factor L_2 behaves as a sex-limited (sex-correlated or sex-linked) character, in gametogenesis, according to the following rule: the factor L_2 is never borne in any gamete which also carries F. That is to say, all females which bear L_2 are heterozygous with reference to it. Any female may be either homozygous or heterozygous with respect to L_1. Any male may be either homozygous or heterozygous with reference to either L_1, L_2 or both.

How well this hypothesis agrees with the facts has been shown in detail in the preceding sections. By way of summary the following table shows the accord between observation and expectation for all matings of each general type taken together. For reasons set forth below, the lumped figures do not give an

TABLE 33

Showing the observed and expected distributions of winter egg production for all matings taken together

Mating	Winter Production of Daughters			
	Class	Over 30	Under 30	Zero
All B. P. R. × B. P. R.	Observed	365½	259½	31
	Expected	*381.45*	*257.25*	*17.30*
All C. I. G. × C. I. G.	Observed	2	23	15
	Expected	*0*	*25*	*15*
All F_1	Observed	36	79	8
	Expected	*26.5*	*88.75*	*9.75*
All F_2 and back-crosses[1]	Observed	57½	98½	23
	Expected	*68.60*	*95.00*	*15.40*

[1] With exception of the matings of C. I. G. ♂ 578 m Barred F_1 ♀ ♀. Cf. p. 246.

altogether fair estimate of the matter, but some sort of a summary is necessary.

Considering the nature of the material and the character dealt with it can only be concluded that the agreement between observation and hypothesis is as close as could reasonably be expected. The chief point in regard to which there is a discrepancy is in the tendency, particularly noticeable in the B.P.R. × B.P.R. and the F_2 matings, for the observations to be in defect in the 'Over 30' class and in excess in the 'Zero' class. The explanation of this is undoubtedly, as has been pointed out in the body of the paper, to be found in disturbing physiological factors. The high producing hen, somewhat like the race horse, is a rather finely strung, delicate mechanism, which can be easily upset, and prevented from giving full normal expression to its inherited capacity in respect to fecundity.

In order to forestall any possible change of manipulation of the data to support a particular hypothesis all of the figures (with the exception of 7 birds discussed on p. 360 and the F_2 mating of ♂ 578) have been entered throughout exactly as they stood on the original books of record. That is to say, some birds known to be physiologically abnormal or pathological have not been rejected, but have been entered in the tables and then discussed in the accompanying text. Whether this is accounted a justifiable procedure or not will depend upon one's point of view in some degree. The investigator is usually expected to reject abnormal material. But in view of the rather hysterical attacks upon geneticists and their method of work now becoming so fashionable in this country, if for no other reason, it seems best to follow the plan of publishing all the data. The opponents to the views which underlie the Mendelian interpretation here advanced are quite welcome to make as much capital as they are able to out of the discrepancies between observation and theory in the several tables. It seems only fair, however, to ask that a judgment of the adequacy of the hypothesis be not formed from this summary table 33, but instead from the detailed data in the body of the paper.

Possible criticisms

In consideration of the fact that this paper constitutes one of the first attempts to apply a Mendelian interpretation to the facts regarding the inheritance of an economically productive character of an animal, and in view of the possible application of the results or the methods of this paper to other productive characters of other organisms it is important to examine carefully and critically the nature of the evidence and the objections which may be brought against the conclusions. In the first place it is important to note once more that the data and their interpretation are kept separate throughout, and that the value of the former is not lessened if the latter is later found to be completely invalid, or in need of modification. It is carcely necessary to say that the Mendelian hypothesis here presented is the only simple one which the writer has been able to discover, after over two years of study directed (whenever the time was available) towards this particular end, which is capable of accounting satisfactorily for all the facts. Very many other Mendelian schemes for the inheritance of fecundity have been tested against the facts in the course of the work and discarded, one by one, because inadequate. Of course, it still remains quite possible, though perhaps not very probable, that there may be an even simpler hypothesis which will equally well or better account for the facts. If so, by all means let us have it. But in the meantime, it may be fairly be said, that the hypothesis here presented brings together under a few, symbolically simple, general statements a wide range of very diverse and complex facts of inheritance.

The strongest general evidence that the Mendelian hypothesis here presented is at least a close approximation to the truth in respect to the inheritance of a fecundity in the fowl is found in the fact that it accounts equally well for so wide a range of diverse phenomena. In the two 'pure' parent races, one of generally high and the other of generally low fecundity; the two reciprocal crosses; and the twelve different kinds of matings in F_2, we have a series of really independent measures of the validity of the hypothesis. It accords with the facts in all but one (the matings of C.I.G. ♂ 578 with Barred F_1 ♀ ♀) of all of the different types of matings tested. The one exception probably has a physiological explanation (pp 373-377). In view of these facts the cumulative probability that the hypothesis applied represents at least a reasonable approximation to the true interpretation of the results becomes very great.

A possible criticism of the whole method of this investigation might be found in reference to the measure of fecundity which has been used throughout, namely, the winter egg production. Regarding this matter it should be said that the very reason why winter egg production was adopted as the unit of measure in all of the fecundity work of this laboratory was because a thorough biometrical and physiological study of egg production in fowls howed beyond question that winter production was the best practicable index or measure of a fowl's innate or constitutional capacity in respect of fecundity. The reasons for this conclusion have been set forth in this and former papers from the laboratory and need not be repeated *in extenso* here. The most significant of them is that the differences in observed production between individuals of different innate fecundity capacities are relatively greater in respect of winter productions than of any other time unit that can practically be employed in the measuring of this character. To suppose, however, that the results set forth in this paper depend for their existence upon the use of this particular time period of production as a measure of fecundity has no warrant in fact. Precisely the same results (in principle) would be obtained if yearly production records were used in the analysis. During the whole of this work complete yearly records have been kept and have been studied. They show in every essential particular the same kind of results as those of this paper. There are objections to the use of the year as a unit of measure, however, which may not be obvious to one inexperienced in these matters. In the first place, it is very much more difficult to keep large flocks of hens in normal, and healthy physiological condition over a whole year period than over a shorter period. Again the risk of an accident (say the use of bad feed or something of the kind) occurring and upsetting the birds physiologically, and coincidently rendering their fecundity records abnormal and in greater or less degree useless, is increased just in proportion as the time unit is increased. Further the year period includes as a too dominant feature, the spring egg production. The production during the months of March, April and May is practically worthless (and has long been so recognized by experienced poultrymen) as an index or measure of the true, innate or constitutional fecundity capacity of the individual. During these months (in northern latitudes) all hens which are not diseased, malformed, infantile or senile, lay anywhere from 'well' to 'very well.' There is relatively little difference between the most and the least fecund at this season. This period is therefore worthless as a measure of fecundity, and its inclusion in any longer period makes that by so much the less valuable as a measure.

In view of all these considerations it seems certain that the results obtained are not open to criticism on the ground of the time unit used as a measure of fecundity.

Another matter which needs careful consideration is as to the possibility of unconscious bias having influenced the results themselves. In other words, to what extent does the personal equation factor enter into this fecundity work? It can be fairly said, I think, that there is less opportunity for unconscious bias to affect the results here than in genetic work on most other characters. The reason is because of the impersonal and objective character of the original records in the case of fecundity. The original trap-nest records on which this whole study is based were made by Mr. F. Walter Anderson. He had neither knowledge of, nor interest in, the use of which any particular record or set of records were to be put. He was solely concerned to make as accurate record as possible of the laying of each individual hen. The system of record taking used is such that it was impossible for him to have any notion of what the total production of any given bird up to a particular date had been. The chance for bias or personal equation influencing results is excluded when, as in the present case, one person makes the basic records, and has nothing whatever to do with their analysis, while another person analyzes the data but has nothing directly to do with their collection.

Another safeguard on the results in this same direction, and also in another, is found in the fact that birds belonging to the same family (full sisters) were not given identifying numbers which would make it possible to be certain or even to surmise that they were sisters, without consultation of the pedigree records. The numbering of the birds for identification each year was purely at random and without any regard whatsoever to relationship. Furthermore members of the same family were distributed at random through the different pens and houses. No attempt is ever made, from the day the chicks hatch, to keep the birds from one family together. Indeed it is important that they be scattered at random through the flock in order to insure uniformity of *average* environmental conditions.

The writer has no desire to generalize more widely from the facts set forth in this paper than the actual material experimentally studied warrants. It must be recognized as possible, if not indeed probable, that other races or breeds of poultry than those used in the present experiments may show a somewhat different scheme of inheritance of fecundity. The directions in which deviations from the plan here found to obtain may, at least *a priori,* most probably be expected are two. These are: (*a*) differences in different breeds in respect to the absolute fecundity value or worth of the factors which determine the expression of this character, and (*b*) gametic schemes which differ from those here found either in the direction of more or fewer distinct factors being concerned in the determination of fecundity, or in following a totally different type of germinal reactions.

Regarding the first point it will be recalled that in several places in the body of the paper it has been suggested that the absolute fecundity value (i.e., the degree of actual fecundity determined by the presence of the gametic factor) may differ for the factor L_1 in the case of the Barred Rock as compared with the Cornish Indian Game breed. It is hoped later to take up a detailed study of this point, on the basis of the material here presented, and additional data now in process of collection. Wherever there is a difference in the absolute fecundity value of the L_1 factor, it means that the division point for the classification of winter productions should be taken at a point to correspond with the physiological facts. In this first study the division at 30 eggs has been found to accord sufficiently well for practical purposes with the actual facts. Similarly the absolute fecundity value of the excess production factor L_2 may be different in different breeds. In applying the results of this paper to the production statistics of other breeds of poultry the possibility of differences of the kind here suggested must always be kept in mind.

The second point (the possibility of gametic schemes for fecundity differing qualitatively from that found in the present study) is one on which it is idle to speculate in advance of definite investigations. I wish only to emphasize that nothing is further from my desire or intention than to assert before such investigations have been made that the results of the present study apply unmodified to all races of domestic poultry.

It cannot justly be urged against the conclusions of this study that the Mendelian hypothesis advanced to account for the results is so complicated, and involves the assumption of so many factors or such complex interactions and limitations of factors, a to lose all significance. As a matter of fact the whole Mendelian interpretation here set forth is an extremely simple one, involving essentially but two factors. This surely does not indicate excessive complication. To speak in mathematical terms, by way of illustration merely, it may fairly be said, that the formula here used to 'fit' the data, has essentially the character of a true graduation formula, rather than that of an interpolation formula. The number of constants (here factors) in the formula is certainly much less than the number of ordinates to be graduated.

There is no assumption made in the present Mendelian interpretation which has not been fully demonstrated by experimental work to hold in other cases. That the expression of a character may be caused by the coincident presence of two (or more) separate factors, either of which alone is unable to bring it about, has been shown for both plants[18] and animals by a whole series of studies in this field of biology during the last decade. To find examples one has only to turn to the standard hand-books summarizing Mendelian work, as for example those of Bateson and Baur. Again sex-linkage or correlation of characters in inheritance has been conclusively demonstrated for several characters in fowls by the careful and thorough experiments of a number of independent investigators. Finally it is to be noted that Bateson and Punnett (4) have recently shown that the inheritance of the peculiar pigmentation characterictic of the silky fowl follows a scheme which in its essentials is very similar to that here worked out for fecundity.

The selection problem

The results of the present investigation have an interesting and significant bearing on the earlier selection experiments on fecundity at this Station. It is now quite plain that continued selection of highly fecund females alone could not even be ex-

[18] Particularly important here are the brilliant researches of Nilsson-Ehle (24, 25) on cereals, and of Baur (2) on *Antirrhinum*.

pected to produce a definite and steady increase in average flock production. The gametic constitution of the male (in respect especially to the L_2 factor) plays so inmortant a part in determining the fecundity of the daughters that any scheme of selection which left this out of account was really not 'systematic' at all but rather almost altogether haphazard. It has been repeatedly shown in the body of the paper that the same proportion of daughters of high fecundity may be obtained from certain mothers of low fecundity as can from those of high fecundity, provided both sets of mothers are mated to males of the same gametic constitution. What gain is to be expected to accrue from selecting high laying mothers under such circumstances, at least so far as concerns the daughters?

'Selection' to the breeder means really a system of breeding 'Like produces like,' and 'breed the best to get the best;' these epitomize the selection doctrine of breeding. It is the simplest system conceivable. But its success as a system depends upon the existence of an equal simplicity of the phenomena of inheritance. If the mating of two animals somatically a little larger than the average always got offspring somatically a little larger than the average, breeding would certainly offer the royal road to riches. But if, as a matter of fact, as in the present case, a character is not inherited in accordance with this beautiful and childishly simple scheme, but instead is inherited in accordance with an absolutely different plan, which is of such a nature that the application of the simple selection system of breeding could not possibly have any direct effect, it would seem idle to continue to insist that the prolonged application of that system is bound to result in improvement.

It seems to me that it must be recognized frankly that whether or not continued selection of somatic variations can be expected to produce an effect on the race depends entirely on the mode of inheritance of the character selected. In other words, any systematic plan for the improvement of a race by breeding must be based and operated on a knowledge of the gametic condition and behavior of the character in which improvement is sought rather than the somatic. Continued mass selection of somatic variations as a system of breeding, in contrast to an intelligent plan based on a knowledge of the gametic basis of a character and how it is inherited, seems to me to be very much in the same case as a man who, finding himself imprisoned in a dungeon with a securely locked and very heavy and strong door with the key on the inside, proceeded to attempt to get out by beating and kicking against the door in blind fury, rather than take the trouble to find the location of the key and unlock the door. There is just a possibility that he could finally get out in a very few instances by the first method, but even in those cases he would be regarded by sensible men as rather a fool for his pains.

Of course what has been said is not meant to imply that selection on the basis of somatic conditions may not have a part in a well considered system of breeding for a particular end. In many cases it certainly will have. Thus in the case of fecundity in the fowls, selection of mothers on the basis of fecundity records is essential in getting male birds homozygous with respect to L_1 and L_2. But the point which seems particularly clear in the light of the present results is that blind mass selection, on the basis of somatic characters only is essentially a haphazard system of breeding which may or may not be successful in changing the type in a particular case. There is nothing in the method *per se* which insures such success, though that there is inherent potency in the method *per se* is precisely the burden of a very great proportion of the teaching of breeding (in whatever form that teaching is done) at the present time.

It seems to me that it has never been demonstrated, up to the present time, that continued selection can do anything more than:

1. Isolate pure biotypes from a mixed population, which contains individuals of different hereditary constitution in respect to the character or characters considered.

2. Bring about, as a part of a logical system of breeding for a particular end, certain combinations of hereditary factors which would never (or very rarely) have occurred in the absence of such systematic selection; which combinations give rise to somatic types which may be quite different from the original types. In this way a real evolutionary change (i.e., the formation of a race of qualitatively different hereditary constitution from anything existing before) may be brought about. This can unquestionably be done for fecundity in the domestic fowl.

But here 'selection' is simply one part of a system of breeding, which to be successful must be based on a definite knowledge of gametic as well as somatic conditions. It is very, very far removed from a blind 'breeding of the best to the best to get the best.' The latter plan alone may, as in the case of fecundity, fail absolutely to bring about any progressive change whatever.

It has never yet been demonstrated, so far as I know, that the absolute somatic value of a particular hereditary factor or determinant (i.e., its power to cause a quantitatively definite degree of somatic development of a character) can be changed by selection on a somatic basis, however long continued. To determine, by critical experiments which shall exclude beyond doubt or question such effects of selection as those noted under 1 and 2 above, whether the absolute somatic value of factors may be changed by selection, or in any other way, is one of the fundamental problems of genetics.

Prepotency

One of the least understood phenomena in genetics is that which the practical breeder calls 'prepotency.' When the scientific student of genetics deals with the matter at all he is rather apt either to throw it over entirely as a 'breeder's superstition,' or to take it as something 'given' to help him out of a difficulty in the interpretation of results which fail to conform to expectation. Some time a more searching investigation of this phenomenon must be made than is implied in either of these lines of procedure.

In a former paper (27, p. 324), it was suggested that the evidence indicated, for certain productive characters at least, that hereditary high performance tended to behave as a Mendelian dominant to hereditary low performance. The following statement was then made:

"If this suggestion is true it gives at once, I think, a possible clue to the explanation of a part at least of the known facts regarding what is called prepotency in the practical breeding of domestic animals for performance. It is customary in practice to regard an animal as prepotent in breeding for performance when the progeny of that individual uniformily tend to resemble it closely in respect to the character bred for, regardless of the other parent in each mating. Let it now only be considered that the great sire, say, of speed or of milk production belongs to a line having a high genotype with regard to those characters; then it is to be expected, on the hypothesis under consideration, that his progeny will tend on the average to be like himself in performance regardless of what he is mated with, because any female to which he is mated will be either of a high genotype like himself or of a lower one. But if genotypic high performance is dominant over genotypic lower performance, than all the offspring in the first generation must approximate to the high condition exemplified in the sire. But this is the very essence of what is called prepotency in actual breeding practice."

It seems to me that certain of the facts set forth in this paper give strong support to this view. A class I B.P.R. ♂ ($= fL_1L_2 . fL_1L_2$) will get all high producing daughters (barring physiological defects of development) regardless of the females to which he is mated. He will show all the objective phenomena of 'prepotency.' B.P.R. ♂ 550 is an example of this. A class 7 B.P.R. male would, in breeders' parlance, be regarded as less prepotent then a class I male, but, even so, more prepotent than the general run of the flock.

The essential point here should not be misunderstood. It is not, of course, contended that simple Mendelian 'dominance' in general, and prepotency are the same thing. More than that is demanded. It is only suggested that a homozygous dominant individual, when high performance is dominant over low, has all the objective characteristics of a prepotent individual in the breeder's sense.

That this suggestion explains all the facts regarding prepotence is by no means asserted. It seems to me, however, that it does furnish the explanation for a part of the phenomena at least, and by so much helps towards a final solution, since it brings us nearer to the kernel of the problem.

The practical bearing of these results

To the practical poultryman the data and conclusions of this paper would appear to have some significance. They make it possible to outline a scheme of breeding for increased egg production which shall be intelligently directed towards the attainment of that end. This, however, is not the place to discuss such a scheme. That will be undertaken later in another place.

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BULLETIN No. 206.

THE HISTOLOGY OF THE OVIDUCT OF THE DOMESTIC HEN.*

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INTRODUCTION.

More than half the weight of a normal hen's egg is elaborated by the oviduct. At least three very distinct substances are formed by it. These are the albumen, the shell membrane and the calcareous shell. The albumen may be further subdivided into the thick and the thin albumen, while the chalazæ are usually regarded as modifications of this same substance. The shell membrane consists of two layers, an inner rather delicate layer and an outer thicker layer. These layers are separated at the large end of the egg, forming between them the so-called

* Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 40.

air chamber. The shell consists of several layers of which at least three may be distinguished; (1) the inner or mamillary layer, consisting of minute conical deposits of calcareous material; (2) the middle spongy layer which is composed of a comparatively thick meshwork of fibers; (3) a delicate outer shell cuticle. In many eggs there is further deposited in the various shell layers, one or more coats of pigment.

This brief statement of the more important substances formed by the oviduct serves to show the complexity of the physiological processes which occur within this organ. For some time past, this laboratory has been engaged, among other things, in a study of these physiological processes. To form a basis for further experimental work it has seemed necessary to gain a more thorough knowledge of the histological structure of the organ with which we are dealing. The present study is thus chiefly morphological. Some discussion of the probable physiological significance of the elements described will be given in the latter part of the paper. In the main, however, these deductions must be supplemented and possibly corrected by later physiological experiments.

The hen's egg has been a classical object for the study of vertebrate embryology for the past century and a half. One would naturally expect that the formation of the egg itself would have attracted some attention during this long period. It is surprising, therefore, to find so few observations, either on the physiology of the process or on the morphology of the organs concerned. A few of the more important papers on these subjects are mentioned in the following paragraphs.

The extensive work of Coste ('47 and '49) is one of the earliest studies of these processes. He gives quite accurate and detailed observations on the physiology of the oviduct. He gave us our most complete account of the processes attending ovulation. He also records the observation of an egg in the upper part of the isthmus of which the lower end was covered with membrane while the upper end was naked. He also observed the formation of the shell. The articles of Merkel v. Hemsbach ('51) and Landois ('65) are chiefly interesting on account of the uniqueness of their views regarding shell formation. They believed that the shell membrane was a direct transformation of the muscular layers of the isthmus. One of the principal reasons for this view was the fact that the fibers of the membrane swell up and expand when treated with alkali and contract when immersed in acetic acid. In this action they appeared to them to resemble smooth muscle fibers. Nasse ('62) and Blasius ('67) pointed out the incorrectness of this view.

Landois ('65) further believed that the mamillary layer of the shell consisted of the uterine glands which were cast off with each egg and then regenerated. He says (p. 4) "Nach meinen Untersuchung der Entwickelungsgeschichte der Schale im Eileiter kann hierüber kein Zweifel mehr obwalten. Es sind die Drüsen der Uterinschleimhaut, welche sich auf der Faserschichte der Eischale angesetzt haben." This theory was an attempt to bring the avian uterus into agreement with the known action of the mammalian uterus. Blasius ('67) among others brought forward considerable evidence to refute this theory and to show that all the shell layers were secreted by the oviduct.

Nathusius ('68) believed that the egg membranes were organic tissues and that the shell and its membranes were derived from an elaboration of the yolk membranes in which the calcareous matter was deposited. Agassiz, Milne-Edwards, Blasius and others recorded observations which disproved this theory.

The most important of the older works on the histology of the avian oviduct is that of Sacchi ('87). She studied in considerable detail the histology of the oviduct in both the active and inactive states. Many of the results of the present study are not in accord with Sacchi's findings. These will be discussed at the proper places in the following paper. Loos ('81) has also contributed a most excellent paper on the structure of the avian and amphibian oviduct. He was the first to point out the tubular nature of the albumen glands in certain birds (crow) and showed there that these had definite openings into the lumen of the duct.

Giacomini ('93) has studied the histology of the oviduct in various birds, including the domestic hen. In certain respects this work is more thorough than any which precedes it. Quite recently Sturm ('10) has given an account of some of the more important features of the histology of the hen's oviduct and reviews some of the literature. Weidenfeld ('05) has also studied the histology of the hen's oviduct. Reference to these and other papers will be made at the appropriate places in the text.

After the major portion of the present paper had been written, the writer received the recent paper by Béla ('10) relating to the structure and function of the oviduct in the domestic pigeon. Unfortunately this paper is published in Hungarian which the writer is unable to read. With the aid of a few German notes kindly supplied by Dr. Béla and a careful study of the figures the writer has been able to make out some of the more important conclusions of this excellent paper. References to these points have been included in the following paper.

Material and Methods.

The material used in the present investigation consisted of the oviducts of Barred Plymouth Rock hens. All oviducts were taken from freshly killed healthy birds. The birds were selected so as to obtain oviducts in various stages, from that of actively laying birds to that of birds which had not laid for several weeks. Since the oviduct of a laying hen is a rather large organ, it was necessary in most cases, to fix only small pieces of the regions desired. In doing this the oviduct was removed from the hen, cut open along one side and spread out on a dissecting board. A rough outline drawing (actual size) was then made showing the characteristic regions and their limits. Small pieces 5 to 10 mm. square were cut out at the points desired and their position accurately charted on the diagram. These small pieces were fixed, imbedded in paraffin and sectioned in the usual manner.

For fixation a variety of fluids were used, among which were Flemming's chromo-aceto-osmic mixtures, Gilson's mercuro-nitric solution, osmo-sublimate, sublimate-acetic and Zenker's fluid. The Flemming and Gilson mixtures gave uniformly the best results.

Sections were cut from 5 to 7 mikrons thick. All staining was done on the slide. The most useful stains employed were the following: Heidenhain's iron-alum-haematoxylin, Delafield's haematoxylin, Kresylichtviolett, Ehrlich-Biondi, safranin and gentian violet. Of these Heidenhain's haematoxylin was by far the most useful.

It is a pleasure to acknowledge my indebtedness to Miss Maynie R. Curtis, assistant in this department, for attending to the details of fixing, cutting and staining the sections used in this work.

General Account of the Structure of the Oviduct.

The oviduct of a hen consists of five more or less clearly delimited regions. Beginning at the anterior end of the duct, these are ordinarily designated as (1) the funnel, (2) the albumen secreting portion, (3) the isthmus, (4) the uterus or shell gland and (5) the vagina. The funnel, known in anatomical terms as the *ostium tubae abdominale,* is a delicate thin walled portion lying immediately ventral to the ovary. Its anterior end is expanded into long lip like processes (fig. 453). The lips quickly converge to form a rather narrow, thin walled tube. In the functional oviduct the length of this tubular portion (funnel neck) is from 2 to 4 cms. The epithelium on the wall of the funnel is folded into rather low longitudinal spiral ridges.

These ridges, with more or less interruption are continuous throughout the oviduct (fig. 453). They are greatly increased in height in the lower portions of the duct. Besides these primary ridges the epithelium also forms smaller secondary folds. These secondary folds are best developed in the posterior portion of the funnel (cf. fig. 458). Their presence in other portions of the oviduct is somewhat obscured by the enormous development of the glands. As will be pointed out farther on these secondary folds bear important relations to the large glands.

The funnel region grades rather gradually into the albumen secreting portion. Figure 453 shows the region where this changes takes place. There is no difficulty in distinguishing between the two regions. In the albumen portion the walls are much thicker and the longitudinal ridges are very much higher (fig. 454). This albumen portion is the longest of the five divisions. Its average length is about 42 centimeters in the functional oviduct. The division between the albumen portion and the isthmus is very sharply marked. As clearly shown in figure 455, the real limit of the two regions appears as a narrow line extending around the oviduct. However, for some distance on either side of this the character of the longitudinal ridges is quite different.

In general appearance the isthmus resembles the albumen portion except that the ridges are not quite so high and the walls are more contracted forming a narrower portion of the duct. The isthmus in the laying hen measures on the average, about 12 cms. in length. The distinctive function of the isthmus is to secrete the shell membrane.

The isthmus is continued without any clear line of demarcation into the expanded portion known as the uterus or shell gland. (fig. 456) As may be seen from figure 456, the character of the ridges is quite different in the uterus. They are more numerous and are greatly broken up by transverse and diagonal folding. The walls of the uterus are not so thick as those of the two last mentioned regions. The length of this organ is also about 12 cms. The lower end is bounded by the large sphincter muscle.

The vagina extends from this sphincter muscle to the cloacal wall. The walls of the vagina are very muscular. The epithelial folds are much smaller than in the preceding section. The length of the vagina is between 12 and 13 centimeters.

In a typical section of the oviduct wall, as for example the albumen secreting portion, we can distinguish the following seven layers of tissue (cf. fig. 462): (1) covering the outside of the duct there is a thin, serous, peritoneal membrane; (2) immediately inside of this is a layer of longitudinal muscle fibers. As was recently pointed out by Miss Curtis ('10) these muscle fibers arise from and are continuous with the musculature of the dorsal and ventral ligaments of the oviduct. (3) Inside of these muscles is a layer of connective tissue in which the larger blood vessels are found. (4) Next there is a layer of circular muscle fibers, and (5) inside of this an inner layer of connective tissue. (6) In all parts of the oviduct except the funnel and vagina there is next a thick layer of convoluted tubular glands, and (7) finally inside of this glandular layer is the epithelium of the duct.

With this brief survey of the general anatomy of the oviduct we may next turn to the details of its histology. In doing this it will be advantageous to deal separately with the different regions of the oviduct.

Histology of the Funnel Region.

The extreme anterior portion of the oviduct is expanded into a long slit like opening. The walls of this opening are known as the lips of the funnel. They are continuous with the mesenteries of the dorsal and ventral ligaments of the oviduct. From these expanded lips the oviduct quickly converges to a comparatively narrow tube (fig. 453). This latter tubular portion is known as the funnel neck. In the laying hen it varies from 2 to 4 cms. in length. The entire funnel portion is characterized by its very thin walls and its very low longitudinal ridges. On the outer edge of the funnel lips the ridges are only slightly raised. They gradually increase in height throughout the length of the funnel. At the transition from funnel to albumen portion they increase in height very rapidly. (Cf. fig. 453) The reason for this will be discussed in a later paragraph.

Figure 457 shows under low magnification a transverse section of the wall of the funnel lips. It is thus from the extreme anterior part of the oviduct. To show the thinness of the walls in this region as compared with other portions of the oviduct, it is interesting to compare this figure with figures 462, 468 and 469. These figures are all reproduced with the same magnification (i. e. x 30). From figure 457 we note the presence of the very low longitudinal ridges. The epithelium is further thrown into a number of secondary folds. The significance of these folds will be discussed shortly. From this same figure we may also note the presence of the outer layer of peritoneum and immediately above this a more or less definite layer of longitudinal muscles. Inside of this layer is the connective tissue with scattered bundles of muscle fibers. In this region of the oviduct the bundles of muscle fibers are scattered through the connective tissue and are not sharply separated into definite layers. Even here, however, the distinction between the outer longitudinal and the inner circular layer is fairly clear and can be traced in the figure. The inner layer at this point runs somewhat diagonally with respect to the long axis of the oviduct. A little farther down the duct the fibers in this layer run around the oviduct at right angles to its long axis, i. e., become circular muscles.*

The innermost layer of the oviduct is the epithelium. From it arise all the glands which have to do with the secretion of the various egg substances.

In its embryological development, this epithelial layer has an origin very different from the other layers of the oviduct. The *Anlage* of the oviduct, known as the Müllerian duct, arises as a thickening along the Wolffian body just ventral to the gonad. This Müllerian duct is at first a solid cord of cells. It later acquires a lumen and grows posteriorly until it connects with the cloaca. At the time of this posterior growth mesenchyme cells migrate in from the surrounding tissue and form a layer about the duct. From this layer of mesenchyme cells are developed all the outer layers of the oviduct i. e. the muscles and connective tissue. On the other hand the epithelium and its derivatives, i. e., all glandular structures, are formed from the walls of the old Müllerian duct. Corresponding to this difference in origin, the functions of the two sets of tissue are entirely different. The epithelium is entirely concerned with secretion and ciliary movement while, as would be expected, the derivatives of the mesenchyme are concerned with supporting and muscular functions.

We will defer the description of the minute anatomy of the epithelium until we have examined the general relation of the layers in other parts of the funnel region.

Figure 458 shows under low magnification a section from near the middle of the funnel. (Cf. fig. 453). The wall of the oviduct is of about the same thickness here as near the funnel mouth. (Fig. 457) The same layers of tissue are present as in figure 457, but the muscles are arranged in more definite layers. The most marked difference in the two sections is in the height and arrangement of the longitudinal ridges. It is clear that these ridges are very much better developed in the middle of the funnel than nearer the mouth. These longitudinal

* It is of importance to mention here that Sacchi says that the outer layer of muscles is circular and the inner layer longitudinal. This is certainly an error. The point will be discussed more thoroughly in a later section of this paper.

ridges gradually increase in height from the almost flat condition near the funnel mouth until they reach their greatest development in the albumen secreting region. (Cf. fig. 462). At the point of transition from funnel to albumen portion the increase in the height of the ridges is more sudden. (Fig. 453). The reason for this is seen if we compare figure 459 with figures 457 and 458. Figure 459 represents under medium magnification a section of the inner layer of the oviduct wall at the place where the funnel region passes into the albumen portion. In figures 457 and 458 we note that the cores of the longitudinal ridges are composed of connective tissue alone. In figure 459, however, new structures appear in this connective tissue core. These are sections of the tubular glands which will be described later. From this point the tubular glands increase rapidly in number and size towards the posterior region of the oviduct. Figure 459 shows only the inner layers of the oviduct. The outer muscular and connective tissue layers here do not differ materially from those shown in figure 458.

We may now return to an examination of the epithelium in the funnel region. Near the funnel mouth and over the upper portion of the funnel neck the epithelium consists of only a single layer of cells. These cells however, are of two distinct kinds: (1) ciliated cells and (2) non-ciliated gland cells. As shown in figures 457 and 458, the epithelium in this region is thrown into a large number of small secondary folds. Over the tops and sides of these folds there is a single layer of ciliated cells. At the bottom of the grooves thus formed occur groups of gland cells. Figure 460 shows one of these small glands together with the character of the epithelium over the folds. Figure 461 shows a larger and more typical gland from the same region. Both figures are from the same oviduct. As shown in the figures the ciliated cells are long and columnar in shape. The slightly oval nucleus lies well toward the outer distal end of the cell. Each cell bears a number of large, strong cilia.

The non-ciliated gland cells are shorter, and as shown in figure 461 are usually more irregular in shape. These gland cells in the active oviduct stain much deeper than the ciliated cells. Especially is this true of the nuclei, many of which take a very dark haematoxylin stain. Figures 460 and 461 are both drawn from an oviduct which was actively secreting albumen at the time the bird was killed. At that time there was an egg in the albumen secreting portion about 8 cm. from the funnel mouth. Consequently we may suppose that these gland cells had been emptied of their contents very recently. In birds which have not laid for a day or two these cells take a much fainter stain.

It will further be noted from figure 460 and 461 that the nuclei of these gland cells lie well towards the inner or proximal end of the cells. On the average these nuclei are considerably larger than those of the ciliated cells. This is perhaps partly accounted for by the larger volume of many of the gland cells.

The shape of these invaginated glands varies considerably. Probably the chief factor in determining their shape is the mechanical one connected with the growth and the folding of the epithelium. However, the type of gland shown in figure 461 is much more common than any other. On the lateral sides of the gland the cells are much shorter while over the central portion they are larger, forming a kind of hump in the center of the gland pouch. The cells in this central region are nearly the same length as the ciliated cells in the adjoining ridges. These central cells also have much larger nuclei than the cells nearer the sides of the pouch. As noted above this is probably due to their larger volume. It also frequently happens in this type of gland that one or the other side the gland grows out into a rather long pouch or tube. This point is of interest in connection with the development of the tubular glands which will be described in the next section.

Glands with other shapes also occur. One of these is shown in figure 460. No evidence is at hand to show that these latter glands differ from the ordinary type (fig. 461) in their histological structure.

So far as I know all previous students of avian oviduct histology have stated that there are no glands in the funnel. Thus Sacchi says in describing the funnel (p. 297) "mancano affatto nelle pieghe le cellule di secrezione." Sturm ('10) apparently on the authority of Weidenfeld ('05) says "Der Trichter sezerniert nicht." With this conclusion I must, most emphatically, disagree. The cells described in the preceding paragraph have every appearance of being gland cells. Further they are found well out on the lips of the funnel. Figures 460 and 461 are both from sections of the funnel lips. The fact that there is no mass of glandular tissue beneath the epithelium such as occurs in other parts of the oviduct has probably led to the conclusion that there were no glandular structures present. However, as will be shown farther on in this paper, the glands found in the funnel region are very probably homologous with the larger glands occurring in other portions of the oviduct.

Béla ('10) evidently did not find any gland cells in the funnel region in the pigeon. His figures 1 and 2 fail to show any evidence of gland cells, although the character of the folds shown in his figure 1 is very similar to the condition found in the hen, (cf. my figure 457).

As we pass posteriorly along the funnel from the mouth the character of the epithelium changes in many respects. We may next examine a section from near the middle of the funnel, i. e., corresponding to figure 458. Figure 463 shows a portion of this epithelium under medium magnification. As stated before, the longitudinal ridges of the oviduct are much better developed here than nearer the mouth. The secondary folds of the epithelium are present as before. Collections of gland cells very similar to those found nearer the mouth of the funnel occur at the bottom of the grooves. The chief difference here is in the character of the epithelium which covers the top and sides of the secondary folds. Figure 463 shows a section through the middle of one of these folds with a glandular groove on either side. Portions of the adjoining folds show at the edges of the figure. The similarity of the glands to those described for the funnel mouth (fig. 461) is at once evident. As before short cells are arranged along the lateral edges of the groove, while longer cells form a hump in the center of the gland pouch. One difference is to be noted here, however. In the region of the longer gland cells, there is often a double row of nuclei. The row of nuclei nearer the outer or proximal end of the cells correspond in position and appearance to the gland cells on either side of the groove. The second row of nuclei lie much nearer the periphery of the cells. Further examination shows that the cells in which these latter nuclei occur, i. e., those nearer the periphery, are ciliated. Between these ciliated cells occur the non-ciliated gland cells in which nuclei lie well towards the inner end of the cell.

Turning now to a consideration of the cells covering the tops and sides of these folds, a condition quite different from that near the mouth of the funnel is found. In the first place the shape of the folds, while often very irregular, (Cf. fig. 458) are in general roughly triangular. (Fig. 463) This makes rather deep pouches at the sides of the glandular grooves. It will be remembered that near the mouth, the epithelium over these folds consisted of a single layer of rather long ciliated cells. Only a single row of nuclei was present (Cf. figs. 460 and 461). Here, however, the condition is more complicated. Figure 463 shows that the nuclei are arranged more or less irregularly but that several rows are present. Careful examination shows that not all of these cells are ciliated. In none of the preparation of this region which I have been able to obtain, do the cell boundaries come out distinctly. It is thus difficult to tell which cells are ciliated and which are not. By the examination of occasional sections in which some of the cell outlines are clear, it seems practically certain that the cells in which the nuclei lie well towards the periphery are ciliated. The cells with deeper lying nuclei on the other hand are non-ciliated gland cells. Except at the time these latter cells are actively discharging secretion their peripheral portion is very much compressed between the broader ciliated cells. This makes it very difficult to obtain good views of entire gland cells. Details regarding these epithelial gland cells will be discussed later in connection with other regions of the oviduct, which are more favorable for their observation.

When sections from this region of an active oviduct are stained with gentian violet or safranin the openings of the single celled glands described in the last paragraph take a much deeper stain than any other part of section. By this means it is possible to study the distribution of these gland cells over the folds of the epithelium. Examination of such sections shows that the opening of the glands are in general much more numerous along the sides of the folds than over the middle. This is also borne out by a study of the distribution of the deeper lying nuclei.

Béla ('10) (figure 4, plate 1.) shows these unicellular epithelial glands in the funnel neck of the pigeon. So far as the writer is aware this is the first time that such glands have been noted in the funnel neck of an avian oviduct.

We may pass now to a brief consideration of the epithelium in the region of the transition from funnel to albumen portion. Figure 459 shows under rather low magnification, a portion of the inner layers of the oviduct at this point. The most characteristic thing here is the appearance of sections of tubules lying in the connective tissue below the epithelium. This is the first appearance of what we may call the *tubular glands.* From this point posteriorly to the vagina they form the most important organ of secretion in the entire oviduct. At this point in the oviduct there are only a few tubules present. It thus presents an excellent place for the study of the origin of these structures, and of their relation to other glandular elements of the oviduct. Figure 464 shows a small portion of the epithelium from this region of the oviduct. This figure shows the region between two of the secondary folds of the epithelium and thus corresponds exactly to the glandular grooves found farther forward in the funnel. If we compare figure 464 with figures 460 and 461, the resemblance can be traced very easily. In the middle of figure 464 there is a group of ciliated cells with gland cells between (the lower row of gland cell nuclei can be seen here.) On either side of this ciliated area occur groups of shorter gland cells. No ciliated cells are present in these latter areas. On the left side in figure 464 this glandular area is greatly extended forming a long branched pouch of which only a portion is shown in the section represented. Now the central group of long cells corresponds to the group of long ciliated and glandular cells which form the raised portion in the center of the glandular groove in figure 462. The non-ciliated glandular areas on either side of this ciliated tuft correspond to the corners of the glandular groove in figure 461. In figure 464 it is seen that one of these corners is greatly extended and enlarged to form a long pouch or tube. If the series of sections, from which this figure has been drawn, is followed through, it is seen that the other corner of the groove is also extended into a tubular structure. These tubular structures are the beginnings of long convoluted tubular glands. These tubular glands form the most conspicuous part of the oviduct in the region between the funnel and vagina. They reach their greatest development in the albumen portion where they are very much more numerous and very much longer than in the region under discussion. (Cf. fig. 462.)

From the above description, it is clear that the tubular glands are homologous, anatomically at least, with the glandular grooves in the funnel region. These collections of gland cells are present even in the region of the funnel mouth. (Cf. fig. 461) As we pass back through the funnel they are still present but become somewhat better developed, larger and more numerous. The tendency to pouch out at the corners becomes more marked the farther one gets from the mouth. Finally at the beginning of the albumen secreting region the pouching is greatly increased and the first of the so-called tubular glands are found. These glands will be discussed more in detail in connection with the albumen secreting portion. Also the discussion of their possible function is deferred until all the anatomical facts are in hand.

The character of the epithelium other than that of the tubular glands does not differ greatly from the epithelium in the middle of the funnel. The longitudinal ridges here are broader than farther forward in the funnel. This can be seen from figure 453 also by comparing figure 459 with figure 458, although these latter figures are drawn with different magnifications.

The chief cause of this increase in width is found in the greater space taken up by the tubular glands. For this reason the secondary folds of the epithelium are forced farther apart and hence do not appear so numerous. Further, the development of the tubular glands give relief to growth forces in a downward direction, rather than a lateral one, hence the secondary folds are not so clearly cut as in the earlier sections of the funnel (Cf. figs. 459 and 458).

Now, as seen from figure 453 almost as much of the epithelial surface in the middle of the funnel is taken up by the glandular grooves as by the ciliated folds. With the broadening of the ridges at the beginning of the albumen portion, the glandular pouches are pushed farther apart, and hence more surface is devoted to the ciliated epithelium. Considering the increased glandular surface formed by the tubules it seems probable that this latter increases much more rapidly than the space devoted to the ciliated epithelium.

Just as in the section from the middle of the funnel the so-called ciliated epithelium here also contains unicellular glands. The arrangement of these is similar to that of those previously described. In figure 464 the ciliated epithelium contains two or more rows of nuclei. As before the outer smaller nuclei belong to the ciliated cells. Between these latter occur the gland cells with deeper lying and usually larger nuclei. The special histological description of these cells will be given in connection with the albumen portion, where they also occur.

SUMMARY OF SECTION ON HISTOLOGY OF THE FUNNEL.

Six tissue layers are distinguished in the funnel walls. Two of these are muscular layers, an outer longitudinal and an inner circular layer. In the funnel region these layers consist for the most part, of scattered bundles of fibers. On either side of the inner layer of muscles is a layer of connective tissue. The lumen of the funnel is lined with ciliated, glandular epithelium. The outside of the oviduct is covered by a thin peritoneal layer.

The inner surface of the oviduct is thrown into a large number of primary longitudinal ridges. The epithelium over these ridges still further forms secondary folds. Three types of glands are described. These are (1) the unicellular glands occurring between the ciliated cells in the epithelium. These glands are not found in the anterior half of the funnel. (2) The glandular grooves. These are accumulations of gland cells at the bottom of the grooves between the secondary folds of the epithelium. These are found in all portions of the funnel region except in the extreme posterior part. Here they are replaced by (3) the tubular glands. These latter glands are undoubtedly homologous with the glandular grooves found farther forward.

HISTOLOGY OF THE ALBUMEN SECRETING REGION.

That part of the oviduct lying between the funnel and the isthmus is ordinarily designated as the "albumen secreting portion." While there is good reason to believe that the secretion of albumen is not confined to this region alone, nevertheless it is here that the major portion of this substance is formed.

In the active oviduct of a Barred Plymouth Rock hen the albumen portion measures, on the average, nearly 42 cm. in length, or more than half the total length of the oviduct.

As shown in figure 454, the longitudinal ridges are very high and broad in this part of the oviduct. A better idea of the development of these ridges can be obtained from figure 462. This figure is drawn with the same magnification as figures 457, 458, 468 and 469. It is seen at once that these ridges are much higher and broader here than in any other part of the oviduct. The major portion of this increase in the size of the ridges is due to the greater development of the tubular glands. These glands form a distinct tissue layer between the inner layer of connective tissue and the epithelium.

The muscular layers in the albumen region are somewhat thicker and the bundles are much better segregated into definite layers than in the funnel region. However, the musculature of this region is much less developed than in the parts of the oviduct posterior to it. This point is clearly seen by comparing figure 462 with figures 468, 469 and 473. The slow movement of the egg through this part of the duct is evidently associated with its weak musculature.

As shown in transverse section (figure 462) the fibers in the outer layers of muscles, run in general in a longitudinal direction through the oviduct, but at the same time they take a slightly spiral course. That the inner muscular layer runs in a circular direction is evident from figure 462. These sections have been cut very nearly transverse to the long axis of the oviduct. Consequently the long fibers seen in the inner muscular layer certainly run in a transverse or circular direction. The spiral course of the fibers in the outer muscular layer rather obscures the fact as to their essentially longitudinal nature. These same facts have been brought out by Miss Curtis ('10) in connection with the study of the ligaments of the oviduct. She has shown by means of very careful dissections that the outer muscular layer, which is continuous with the musculature of the ligaments, is longitudinal and that the inner layer consists of circular fibers. These facts are opposed to Sacchi's statement that the internal muscular layer is longitudinal and the outer circular. Sacchi says (p. 297) in regard to the funnel region, "L'epithelio che le ricopere è pure cylindrico e munito di ciglia; il connessivo è attraversato da vasi, e verso l 'esterno vi sono frammisti fasci muscolari longitudinali isolati, circondati da muscoli circolari e poi dal connessivo esterno." A similar statement regarding the musculature of the uterus is made on pages 299-300. There is no doubt but that Sacchi is wrong as to the essential nature of these muscular layers.

Since it is in this region of the oviduct that the tubular glands reach their greatest development, it is thus a proper place to enter into a detailed description of their form and histology. The method of origin of these glands and their homology with certain epithelial structures of the funnel has already been pointed out (pp. 407-408). It has also been noted that the invaginated tubules follow very tortuous courses and often branch and rebranch so that it is very difficult to follow the course of a single tubule. In point of fact it is much easier to follow a tubule at the beginning of the albumen portion than at any other place in the oviduct. In the region of the oviduct represented by figure 462, it is very difficult to follow individual tubules. For the purpose of learning something about the length and form of the tubules, several individual glands have been traced for some distance by making camera drawings from a series of sections. The only adequate method of representing these tubules would be by wax plate reconstructions. The point in question, however, has not been deemed worth the time and labor required to make such a model. Figure 462 shows that there is a very large mass of tubules present. Examination of the sections shows that there are relatively few openings of these tubules into the lumen of the duct. From this evidence alone, we might conclude that each tubule must be of considerable length and consequently convoluted.

The openings of the tubules are more numerous along the sides and near the bottom of the large ridges. The positions of these openings are marked by small indentations of the epithelium. Several of these indentations can be seen in figure 462. These invaginations of the epithelium are of the nature of short ducts which connect with the lumen of the tubule. Figure 465 shows the opening of one of these tubules in the albumen region. In many cases several tubules open through the same duct. Such a case is shown in figure 470 from the isthmus region.

The tubular nature of these albumen secreting glands, and especially the presence of openings into the lumen of the oviduct, seems never to have been clearly recognized in the case of the domestic fowl. Loos ('81) describes this condition very clearly for the oviduct of the crow (*Corvus corone*). He states that at the beginning of the breeding season the epithelium of the oviduct invaginates at many places. These invaginations grow deeper into the connective tissue and form a tube. After this tube has reached the connective tissue septum it bends and grows in the opposite direction. These tubes often branch or follow a winding course. With regard to the fowl's oviduct, Loos is not so clear. Other writers and particularly Sacchi ('88) fail to recognize the openings of the tubules into the oviduct. Gadow ('91) in Bronn's "Tierreichs," who follows Sacchi chiefly, makes the following statement (p. 845) "In jede Falte (of the mucosa) erstreckt sich ein centraler Stamm von Bindegewebe der Submucosa, welches sich dann peripherisch verästelt. Der Raum zwischen diesen Verästelungen ist mit zahlreichen, unregelmässig gelagerten, polyhedrischen Zellen erfüllt welche zwischen sich kleine Massen von Eiweiss absondern. Die Oberfläche der Falten trägt überall hohe sehr regelmässige Cylinderzellen, durch welche dann die in der Tiefe secernirten Eiweissklümpchen austreten und um die Eikugel abgelagert werden."

This statement which Sacchi also makes, viz., that the secretion from the deeper lying gland cells passes out through the epithelial cells, is most certainly in error. Further the gland cells beneath the epithelium are not "unregelmässig gelagert," but are arranged very definitely into tubules as shown in figures 465, 471 and 472. Sacchi very probably saw the unicellular glands in the epithelium and believed that these were ducts passing the secretion from the deeper cells rather than being themselves secretory.

Going back to the description of the tubules, we note from figure 465, that the lumen of the tubules are filled with a finely granular secretion. Further, the cells which form the walls of the tubules are also distended with a granular substance. Within the cell the granules vary in size from those barely visible, and perhaps smaller, up to a few rather large granules. This represents the condition in that portion of an oviduct which is just beginning to pour out its secretion. Figure 465 is drawn from a section of the albumen region taken a few centimeters in front of an advancing yolk. The small, very dark staining nuclei in these sections should be noted.

If we examine a section of the oviduct which has just passed the active period of secretion we find the protoplasm still very finely granular. It now has an alveolar appearance. This is shown in figure 471 which is taken from the isthmus. Similar appearances may also be found in the albumen region.

If sections are cut from a region of the oviduct which would not normally secrete for several hours, the appearance of the cells is somewhat different. Here, as shown in figure 466, each cell contains several very large granules which take an intense haematoxylin stain. Around each of these granules is a light area which gives the appearance of a solution zone. The remainder of the cell cytoplasm is finely granular and often presents an alveolar appearance. (cf. fig. 466). It should be said that I have never been able to obtain sections which show the condition just described (fig. 466) throughout the section. In all cases the first three or four cell layers beneath the epithelium present this appearance in great detail. Beyond this the granules begin to fade out until those cells towards the center of the ridges show no evidence of granules. I have attributed this condition to the action of the fixing fluids used.

No attempt has been made to study in detail the origin and growth of the gland granules. The observations reported in the above paragraphs have been made in the course of the study of the grosser histology. In general I think the changes undergone by the granules in these glands can be said to resemble in many ways the changes described by Langley, E. Müller and others for the granules of the salivary and digestive glands.

As shown in figure 462, there is a layer of connective tissue between the inner layer of muscles and the layer of tubular glands. This connective tissue extends into the center of each ridge forming a core. At the same time the connective tissue cells are found along the walls of the tubules and often form a thin layer between the epithelium and the tubules beneath it. In figure 465 the gland cells are so distended with secretion that very few connective tissue cells can be seen. In figures 470 and 471, from the isthmus these cells are very evident. The same conditions are found in the albumen region. The connective tissue carries with it of course the smaller blood vessels. Examination of the sections show small capillaries running everywhere between the tubules.

We may next turn to a discussion of the epithelium. As stated on page 401, the epithelium of the funnel region consists of simple, ciliated, columnar cells. In all other portions of the oviduct however, there are two kinds of cells present in the epithelium. These are the ciliated cells and alternating with these are non-ciliated unicellular glands. So far as I know no one has hitherto pointed out the presence of these latter gland cells in the fowl's oviduct. However, with good preparations there cannot be the slightest doubt of their presence. Béla ('10) describes and figures these goblet cells in the oviduct of *Columba,* and Giacomini ('93) also described such mucine glands in the oviduct of certain birds. Figures 465 and 467 show the epithelial portion of an actively secreting oviduct. The distribution of these two kinds of cells is fairly even over the entire inner surface of the oviduct. In general the ciliated cells and the gland cells appear to alternate. At the point of invagination of the epithelium to form the short ducts to the tubules the unicellular glands appear larger and perhaps more numerous. This is shown somewhat indistinctly in figure 465. Many sections show this point more clearly.

The ciliated cells are of the usual columnar type. Their general appearance can be seen in figure 467. They consist of finely granular protoplasm with a rather large, usually oval nucleus. The nucleus nearly always lies about the middle of the cell or slightly towards its distal end. The distal end of the cell is armed with a large number of strong cilia. As shown in figure 465 and 467, these cells are much crowded out of shape by the great development of the gland cells. In figures 470 and 471 the gland cells are less distended and the ciliated cells present a more normal appearance.

The epithelial gland cells are of the goblet (Becherzellen) type. As stated above, they alternate with the ciliated cells. The proximal portion of the cell in the actively secreting oviduct is finely granular while the more distal portion presents an alveolar structure. Whether the alveoli represent the gland granules or an intergranular network, I cannot say. These cells as shown in figures 465 and 467 have all the appearance of being distended with secretion. In most cases they have crowded the ciliated cells to one side and have extended distally beyond the former limit of the epithelium. This is the stage immediately preceding secretion. In sections taken from an oviduct at the point where a yolk was descending, the secretion from these glands can often be seen pouring out in little streams from each cell. The nuclei of the gland cells are as a rule more nearly circular in outline than the nuclei of the ciliated cells. Further a very characteristic difference between the two kinds of cells is found in the position of the nucleus. The nuclei of the gland cells lie well towards the proximal ends of the cells, while, as stated above, the ciliated cells have their nuclei towards the distal ends. (Cf. fig. 465, 467, 470, and 471).

One point should be mentioned in regard to technique in studying these epithelial glands. While it is possible to demonstrate the presence of these glands in the sections of every active oviduct which I have examined, they do not show with the same distinctness in all cases. When these glands are not filled with secretion they are crowded back by the then larger ciliated cells. In such cases casual examination of the epithelium shows an almost completely ciliated surface. However the double row of nuclei are present and more careful study of the section has never failed to show the glands themselves. Further it is possible to demonstrate their presence by methods of differential staining as given in a later paragraph. If, however, sections are taken from a region where these glands are filled with secretion, they form the most conspicuous part of the epithelium. The sections which show these glands best have been obtained from oviducts in which the yolks had just passed the funnel region. In such an oviduct the albumen region is just on the point of extruding its secretion (cf. figs. 465 and 467).

The question now arises as to whether the tubular glands, which are derivatives of the epithelium, differ in the character of their secretion from the goblet glands in the epithelium itself. It is conceivable of course, that the two sets of glands are really concerned in the secretion of the same substance, the only difference being that the invaginated portions have lost the ciliated cells. On the other hand it is conceivable that the two sets of glands secrete entirely different substances, and that a proper mixture of the two are necessary to form the albumen as we know it.

While the final proof as to the identity on non-identity of the products of these glands must come from physiological experiments yet some evidence as to its nature can be gained from the morphology of the glands themselves. In the first place the appearance of the cytoplasm in the two sets of glands is different in all the sections which I have examined. In the tubular glands the protoplasm always consists of much coarser granules than are ever found in the epithelial cells. The most important difference, however, is in their micro-chemical reactions to various stains. Very few of the stains which I have used stain the contents of these two sets of glands with the same intensity. In the case of Heidenhain's iron-alum-haematoxylin alone, the cells of the tubular glands always take a much darker stain. The epithelial gland cells show a very slight haematoxylin stain, unless the whole section is very deeply colored.. Instead the epithelial cells have a yellow appearance with only the very small granules dark colored. If Bordeaux red is used as a counter stain this colors the cytoplasm of the tubular glands but unless very deeply stained it does not affect the epithelial glands at all. In Ehrlich-Biondi stain the granules of the tubules take a dark brownish red color while the granules of the epithelium are a yellowish red. In Kresylichtviolett the unicellular glands stain very dark purple and stand out plainly between the ciliated cells. On the other hand the tubular glands stain a very light violet. Likewise with safranin the unicellular glands take a very much deeper stain. The evidence at hand thus points to a difference in the function of these two sets of glands. The possible significance of these facts will be discussed in another place. (Cf. pp. 424-425).

SUMMARY OF SECTION ON ALBUMEN REGION.

The bundles of muscular fibers are more sharply segregated into definite layers than in the funnel. Compared with more posterior regions of the oviduct the musculature of this portion is very poorly developed. Evidence is given to show that contrary to the statement of Sacchi and others, the outer muscular layer consists of longitudinal fibers while the inner layer contains circular fibers.

The walls of the albumen region are much thicker than those of other parts of the oviduct. This increase in thickness is due to the great development of the tubular glands. These glands are formed by invagination from the epithelium. Each gland is a long, convoluted and branched tubule which opens to the lumen of the oviduct by means of a short duct. The cells of these tubular glands are characterized by small very dark staining nuclei which lie close to the basal walls of the cells. The protoplasm is very granular especially before secretion. After being emptied of its secretion, the cell has a more alveolar appearance.

The epithelium consists of two kinds of cells; (a) Ciliated cells and alternating with these (b) unicellular glands. Difference in the appearance and staining reactions indicate that these unicellular glands secrete a different substance from that produced by the cells of the tubular glands.

Histology of the Isthmus.

As stated on page 400 there is a very sharp line of demarcation between the albumen region and the isthmus. Towards the posterior end of the albumen region the longitudinal ridges become much lower. (Fig. 455). On the isthmus side the ridges are also quite low for two or three centimeters. After that the ridges in the isthmus gradually become higher although they never reach the height or breadth found in the albumen portion. The real division between these parts of the oviduct is a narrow line extending entirely around the duct. It is plainly visible in the fresh oviduct as a line of translucent tissue. (Fig. 455.)

If we cut sections in such a way as to go through this division line, we find the reason for its appearance. Figure 469, represents such a section. The albumen region is represented at the left of the figure and the isthmus at the right. It is seen at once that between these two regions the tubular glands are either entirely or partially lacking. It is this feature which causes the appearance of the line on the oviduct. The large mass of tubular glands in the ridges is replaced by connective tissue. The epithelium presents the same appearance as in the albumen portion. Both the ciliated cells and the epithelial glands are present.

It should be said that the section represented in figure 469 is cut very obliquely to the long axis of the oviduct. It thus happens that the muscular layers appear very much as in the transverse sections.

The histological structure of the isthmus proper is practically the same as that of the albumen region. Both sets of glands are present and have practically the same microscopic appearance as in the albumen portion. Figure 470 is drawn from a section in the middle of the isthmus. It will be noted that in the epithelium both the ciliated cells and the unicellular glands are present. These have the same appearance as in the albumen region in a similar stage of physiological activity.

The tubular glands do not form so thick a tissue layer here as in the albumen portion but in their microscopic appearance they are very similar in the two regions. From figure 470 we note the presence of the dark irregular nuclei lying near the basal walls of the cells. The cytoplasm in this section presents a somewhat more alveolar appearance than is shown in the figures from the albumen region. This is not a constant difference. Either the granular or alveolar appearance may be found in either region depending perhaps on the state of physiological activity and also possibly upon the method of fixation.

Although not shown in the figures it may be stated that the muscular layers, particularly the circular muscles, are somewhat thicker and better developed in the isthmus than in the albumen region. Corresponding to this the walls are firmer and more constricted than in the albumen region. This is no doubt associated with the shorter length of time required for the egg to traverse the isthmus.

It will be remembered that the distinctive function of the isthmus is to secrete the shell membrane (*Membrana testacea*). We have seen, however, that this region presents no visible differentiation which does not also occur in the albumen secreting portion of the duct. This similarity in structure does not necessarily imply a similarity in physiological activity. It is quite conceivable that the glands in the isthmus secrete different substances from the similar glands in the upper portion of the oviduct. This question will be discussed more in detail after we have examined the structure of the uterus and vagina.

Histology of the Uterus.

There is no clear dividing line between the isthmus and the uterus such as was described between the albumen portion and the isthmus (p. 400). Instead the isthmus passes gradually into the expanded uterus without any distinct break in the tissue layers. As is clearly shown in figure 456 the character of the longitudinal ridges in the uterus is quite different from that of the homologous structures in any other portion of the duct—in fact the ridges, as such, are lost and instead we find small leaf like folds of the epithelium. The immediate cause of this change in the character of the folds is probably a mechanical one connected with the greater amount of surface to be covered. If the same number (20 to 30) of ridges which are found in the albumen portion and the isthmus were continued over the expanded uterus they would lie rather far apart in this latter region. The branching of the ridges and the refolding of the intervening surface would account in some measure for the change in the character of the folds. There may also be some physiological reasons for this change since as we shall see the character of some of the glands in the uterus differ from what has been found in the other portions of the duct.

As shown in figure 468 the same muscle layers are present in the uterus as in the more anterior regions. These layers, particularly the outer, longitudinal muscles, are somewhat thicker and better developed than in the regions previously discussed. However, there is but little difference in this respect between the isthmus and the uterus. The connective tissue layers present no change of any importance from the conditions found in the anterior regions. Under low magnification the cross section of the epithelial folds in the uterus do not differ essentially in appearance from those found in the isthmus. The folds, however, are not so high and perhaps on the average contain a thicker layer of glandular tissue (tubular glands). The epithelium covering these ridges presents the same general appearance as that found in the isthmus and albumen portion. There is then no striking morphological differentiation in the appearance of the tissue layers of the uterus which would indicate its specific function of shell formation. The same layer of tubular glands and as we shall see, the same ciliated, glandular epithelium occurs here as elsewhere. If any morphological differentiation is to be found it must be looked for in the minute histology of the glands.

Under higher magnification it is clearly seen that the layer of gland tissue is composed of tubules very similar in shape and size to those seen in the earlier sections. Further search reveals the openings of these gland tubules through the epithelium (fig. 472). The openings of these glands appear to differ somewhat from those found in the anterior regions, e. g. in the albumen portion (cf. fig. 465). In the albumen region it appears as if the epithelium were invaginated to meet the gland tubules while in the uterus the gland cells appear to force their way through the epithelium with only a slight indentation of the latter. In the one case a short epithelial duct is formed, while in the other, the duct, if it may be so called, is composed of gland cells. I am not at all certain that any significance should be attached to this point but I have observed this difference very constantly in my sections.

The chief difference in the appearance of the uterine glands is in the appearance of the gland cells themselves. A comparison of figures 465 and 472 will make clear this difference between the albumen and uterine regions. Both figures are taken from active oviducts. In the active gland from the albumen region the nucleus is small, dark staining and lies well towards the proximal end of the cell. In the uterus the cell nucleus is larger, more regular in shape and usually lies towards the center of the cell. The chromatin granules and nucleoli take on a comparatively deep haematoxylin stain but the nucleus as a whole does not show the intense stain found in the albumen and isthmus regions.

The cytoplasm in cells of the uterine tubular glands does not present the heavy granular appearance described for the albumen portion. Instead these cells are diffusely granular in appearance. The granules are all of small size and take a rather weak stain with haematoxylin. In some cells there is evidence of the clumping of these granules, especially towards the periphery of the cell. I am not sure that this is not an artifact due to the fixation.

In actively secreting glands (fig. 472) this granular material can be seen lying outside the gland cells in the ducts and even in the lumen of the oviduct itself.

Turning now to the epithelium in the uterine region we find, as in the anterior parts of the oviduct, both the ciliated cells and the unicellular glands. These present practically the same arrangement and appearance as in the previous sections. Except at their distal ends the cell boundaries of these epithelial cells are very difficult if not impossible to see. The basal portion of the epithelium appears as a syncytium. This appearance may be due to the technique employed.

From the above description and figures it is clear that in the uterus the cells of the tubular glands have a somewhat different structure from the cells found in these glands in other regions of the duct. This difference in structure is undoubtedly associated with the particular function of shell secretion which is confined to the uterus.

HISTOLOGY OF THE VAGINA.

The posterior end of the uterus is marked by the strong sphincter muscle. The contracted portion of the oviduct extending from this sphincter muscle to the cloacal wall is known as the vagina. As shown in figure 456 its walls are much contracted. The inner surface is thrown into rather low longitudinal ridges which appear in general to be continuous with the folds in the uterus (fig. 456). The length of the vagina is, on the average, about 12 cm. in the laying hen.

Figure 473 represents a cross section of the wall of the vagina under low magnification. The most striking character in this figure is the great development of the inner (circular) muscular layer. In the vagina this layer is several times thicker than in any other region of the oviduct. The great development of this muscular layer is naturally associated with the need of expelling the egg which has acquired its full size and is now a firm object upon which the muscles can act. The outer longitudinal muscular layer consists of bundles of fibers scattered through the connective tissue. Compared with the circular layer the longitudinal muscles are but poorly developed. The connective tissue layers are similar to those in other parts of the duct.

As shown in figure 473, the longitudinal ridges in the vagina region are low and rather narrow. The cores of these ridges are filled with connective tissue and no layer of tubular glands is present. The epithelium covering these ridges is thrown into a large number of secondary folds.

In figure 474, two of the secondary folds from the epithelium of the vagina are shown under higher magnification. From this figure we note:

1. The entire absence of any structures resembling the tubular glands. The space beneath the epithelium is occupied by connective tissue (cf. fig. 473).

2. As in other parts of the oviduct, excepting the funnel, two kinds of cells occur in the epithelium, viz: the ciliated cells and the unicellular glands.

3. Both kinds of cells are very much narrower and especially over the crests of the folds they are longer than in many other regions of the oviduct.

4. In the depressions between the folds the cells are shorter than elsewhere. At the bottom of these depressions there frequently appears to be an accumulation of gland cells. No evidence is at hand to show that these differ physiologically from the other gland cells in this region.

The appearance of the unicellular glands in this region, especially the narrowness of the cells, indicates that possibly they serve a different function than the similar cells in other parts of the oviduct.

The function usually ascribed to the vagina is the production of the outer shell cuticle and a portion, at least, of the coloring matter of the shell. If this assumption is correct these substances must be formed by the unicellular glands described above.

It should also be stated that the walls of the cloaca contain glands. Whether these are concerned with the production of any egg substance or not has not been ascertained.

Discussion.

It may not be out of place to discuss very briefly the possible significance of certain structures which have been described in the fowl's oviduct. It must be remembered, however, that any deduction drawn from the morphology of these structures must be checked and possibly corrected by physiological studies.

As noted on page 404 previous students of oviduct histology have failed to find evidence of glandular structures in the funnel region. Consequently the funnel has been regarded as an organ for grasping the yolk at the time of ovulation but without any secretory function. In the present study we have been able to show that groups of gland cells occur at the base of the epithelial folds throughout the funnel region. We have further shown that structurally these glands of the funnel are homologous with the tubular glands found in other parts of the oviduct. On the other hand the unicellular glands found in the epithelium of other parts of the duct do *not* occur in the anterior part of the funnel.

The presence of glands in the funnel leads, of course, to the presumption that this region secretes a portion of the substance enveloping the yolk. In the normal hen's egg there is next to yolk a very thin layer of dense albuminous substance. This is known as the *chalaziferous layer* and is continued at the poles of the egg into the familiar structures known as the *chalazae.* It thus appears not unlikely that the chalazae and their corresponding albuminous layer may be secreted in the funnel. I know of no instance in the literature where an egg has been observed in the funnel region before it has entered the albumen secreting portion.

In the albumen secreting portion of the oviduct there are two sets of glands present, viz.: the tubular glands and the unicellular glands of the epithelium. As Pearl and Curtis ('12) have shown, the albumen portion secretes only the *dense* albumen. The outer layer of fluid albumen is not secreted in this region. Apparently both sets of glands take part in the formation of this dense albumen.

The distinctive function of the isthmus is to secrete the shell membrane. A very beautiful demonstration of this act was first described by Coste ('47). Coste described an egg, one end of which had just entered the isthmus. This end of the egg was covered with a thin layer of membrane, while the end still in the albumen portion was naked. This account of membrane formation has several times been confirmed in this laboratory, (Pearl and Curtis, '12). A further very interesting observation is reported by Pearl and Curtis, viz.: that in the so-called albumen portion of the oviduct only about 40 per cent, by weight, of the total albumen is formed. During the passage of the egg through the isthmus it receives in addition to the shell membrane, 10 to 20 per cent more of the total albumen. It is thus clear that in addition to the shell membranes the glands of the isthmus must also secrete albumen.

The present investigation has not revealed any visible histological difference between the glands of the albumen portion and those of the isthmus. The only differences to be noted are in the smaller volume of the tubular glands and the better development of the muscular layers in the isthmus. So far as the present investigation is concerned, no morphological difference between either set of glands in this region and the corresponding structures in the albumen region have been observed. The one fact of considerable interest, as pointed out below, is the distinct break in the layer of tubular glands between these two regions. The unicellular glands on the other hand are continuous from one region to the other.

Until the work of Pearl and Curtis it was believed that the only substance formed by the uterus was the calcareous shell. These authors have shown that in addition to this, from 30 to 40 per cent, by weight, of the albumen is added to the egg during its sojourn in the uterus. This thin albumen must pass through the shell and the membrane by osmosis.

In the present paper it has been shown (p. 420) that the cells of the tubular glands of the uterus differ in appearance from the corresponding cells in other parts of the oviduct. It seems very probable then that the tubular glands are wholly concerned in the secretion of the shell and that the fluid albumen is secreted by the unicellular glands. The evidence for such an assertion is not complete but it accords with the facts so far observed.

We have then in the uterus an observed differentiation of the cells of the tubular glands which corresponds to the distinct differentiation in function, viz.: shell formation. On the other hand there is no visible differentiation of the unicellular epithelial glands in any portion of the oviduct with the possible exception of the vagina. We further know that two distinct substances are formed in the uterus, viz.: the calcareous shell and a large portion of the fluid albumen. On this basis of fact it is possible to offer the suggestion that throughout the oviduct, with the exception of the vagina, the unicellular glands are concerned in the production of a fluid or thin albumen. On this view the characteristic difference of each region of the oviduct anterior to the vagina, is due the activity of the tubular glands.

If we extend this idea to the isthmus we may suppose that the membrane is secreted by the tubular glands while the albumen is secreted by the unicellular glands. This is again in accord with the fact that there is an abrupt break in the tubular glands between the albumen portion and the isthmus while the unicellular glands are continuous. The abruptness of the break in the tissue layer at this point corresponds very well with the abruptness in the change of function. Just as soon as the egg crosses the line between the albumen region and the isthmus the formation of membrane begins.

In the albumen region it may be assumed that the tubular glands secrete a very dense albumen while the unicellular glands secrete a more fluid substance which perhaps serves to dilute the former to some extent. There are no observations to support this view but it is not at variance with the facts so far observed.

In the anterior part of the funnel region only the homologues of the tubular glands are present and here we have a dense membranous substance in the chalazae and their accompanying layer.

In the vagina only unicellular epithelial glands are found. These differ somewhat in the form of cell and general appearance from unicellular glands in other parts of the oviduct. These are perhaps concerned in secreting the delicate outer shell cuticle and the coloring matter of the shell.

In conclusion it must again be urged that the deductions in the above paragraphs are offered only as suggestions and that sufficient facts either to prove or disprove them are not at hand

Summary.

1. Two muscular layers, an outer longitudinal and an inner circular layer can be distinguished in all parts of the oviduct.

2. The inner surface of the oviduct is thrown into a number of primary longitudinal ridges. The epithelium over these ridges forms secondary folds. In the uterus the ridges as such are lost and instead there are a number of leaf like folds of the inner surface.

3. Three types of glands are described: (1) Unicellular epithelial glands occurring between the ciliated cells in all parts

of the oviduct except the anterior portion of the funnel. (2) Glandular grooves. These are accumulations of gland cells at the bottom of the grooves between the secondary folds of the epithelium. These are found only in the funnel region. But there they occur well towards the anterior end. The presence of glandular structures in the funnel region has not hitherto been recognized. (3) In all parts of the oviduct between the funnel and the vagina there is a thick layer of glands beneath the epithelium. I have called these *tubular glands.* They consist of long convoluted and branched tubules which open to the lumen of the oviduct by short epithelial ducts. These tubular glands are homologous, structurally at least, with the glandular grooves of the funnel. The tubular glands reach their greatest development in the albumen secreting region. Histologically the unicellular epithelial glands present a similar appearance in all parts of the oviduct except the vagina. In this latter region the cells are longer and much narrower and have a slightly different arrangement than in other parts of the oviduct.

4. The walls of the tubular glands consist of large gland cells which in the albumen portion and the isthmus of a laying hen have small, irregularly shaped, dark staining nuclei which lie well towards the basal ends of the cells. In these two regions the protoplasm of the cells consist of rather coarse granules which vary greatly in size.

5. The line of demarcation between the albumen region and the isthmus is characterized by the absence of these tubular glands in that region. The cells of the tubular glands in the albumen region and in the isthmus present the same histological appearan e.

6. In the uterus the cells which form the tubular glands have a somewhat different appearance. The nuclei of these cells are large with regular outlines and are situated near the center of the cells. The protoplasm is very finely granular and is quite different from the coarsely granular condition found in other parts of the oviduct.

7. The tubular glands or any homologous structures are entirely absent from the vagina. Only the unicellular epithelial glands occur here.

8. In the last section of the paper some suggestions are offered as to the probable function of the various glandular structures in the different parts of the oviduct.

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Description of Figures.

Figures 457 to 474 were drawn with the aid of a camera lucida. All figures have been reduced one-half in reproduction. The approximate magnification of each figure, as reduced, is given below.

The following characters have the same meaning in all the figures:

O—Outer muscular layer.

I—Inner muscular layer.

T—Tubular glands.

E—Unicellular epithelial glands.

G—Glandular groove.

First Plate.

Figure 453. Photograph of the funnel region of a functional oviduct showing the expanded lips, the thin walls with their small longitudinal spiral folds and the region of transition to the albumen region. x½.

Figure 454. Photograph of a portion of the albumen secreting region showing the thick longitudinal folds. From the same oviduct as figure 453. x½.

Figure 455. Photograph from the same oviduct showing albumen portion above and isthmus below and also the line of demarcation between these two regions. x½.

Figure 456. Photograph from the same oviduct showing the expanded uterus and the narrow vagina. x½.

Second Plate.

Figure 457. Transverse section of the oviduct wall in the region of the funnel lips. x30.

Figure 458. Transverse section of the oviduct wall in the region of the funnel neck showing primary and secondary folding of the epithelium. x 30.

Figure 459. Transverse section from the region of transition from funnel to albumen portion. Note the presence of a few tubular glands which are entirely absent in the region anterior to this. Muscular layers are not shown. x60.

Figure 460. Section of an epithelial gland from the funnel region. (Cf. figure 462.) x600.

Figure 461. Section of a typical gland from the funnel region. x600.

Figure 462. Transverse section of the oviduct wall from the albumen secreting region. Note the very thick layer of tubular glands. x30.

Third Plate.

Figure 463. Transverse section of the epithelium from the middle of the funnel region. Note pouch like glands from which the ciliated cells are absent except at the center. The epithelium over the ridges has several rows of nuclei. x300.

Figure 464. Section of the epithelium from the region of transition from funnel to albumen portion. This section shows the formation of the tubular glands. x300.

Figure 465. Section from the albumen portion showing the opening of a tubular gland, also the character of the gland cells and of the epithelium. From an actively secreting oviduct. x600.

Figure 466. Gland cells from the tubular glands in the albumen region showing large dark staining granules. x1000.

Figure 467. Section of epithelium from the albumen region showing ciliated cells and unicellular glands. x1000.

Figure 468. Transverse section of the wall of the uterus. x30.

Fourth Plate.

Figure 469. Oblique section through the line of transition from albumen portion to isthmus. Note the absence of all tubular glands along this line. At the left of the figure a portion of the albumen secreting region is shown and at the right a portion of the isthmus. x30.

Fifth Plate.

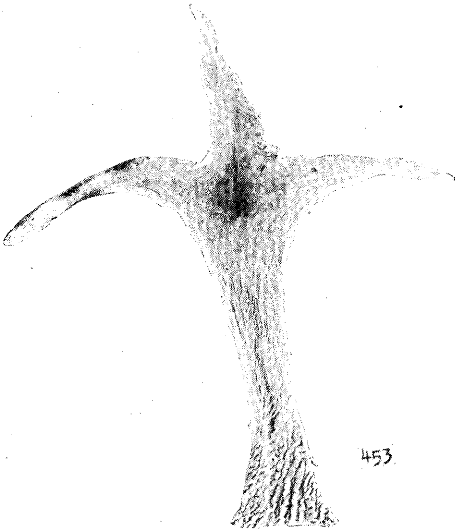
Figure 470. Section from actively secreting isthmus showing opening of tubules. x600.

Figure 471. Section from isthmus showing gland cells and epithelium after the period of active secretion. x600.

Figure 472. Section of the epithelium and opening of tubular gland from the uterus. x800.

Figure 473. Transverse section through the wall of the vagina. x50.

Figure 474. Section of the epithelium from the vagina showing the unicellular glands. x600.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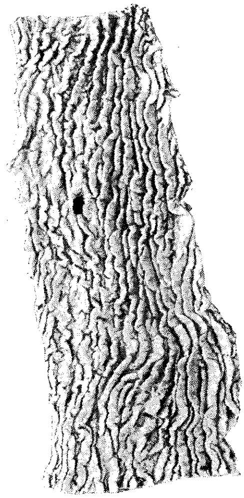
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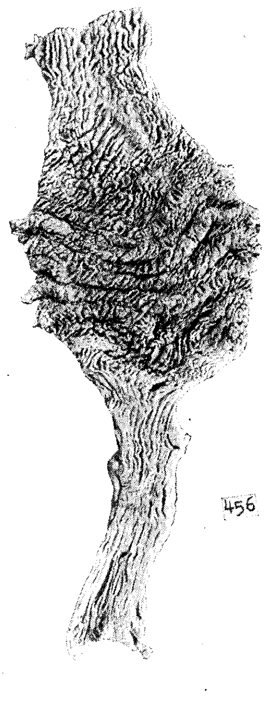
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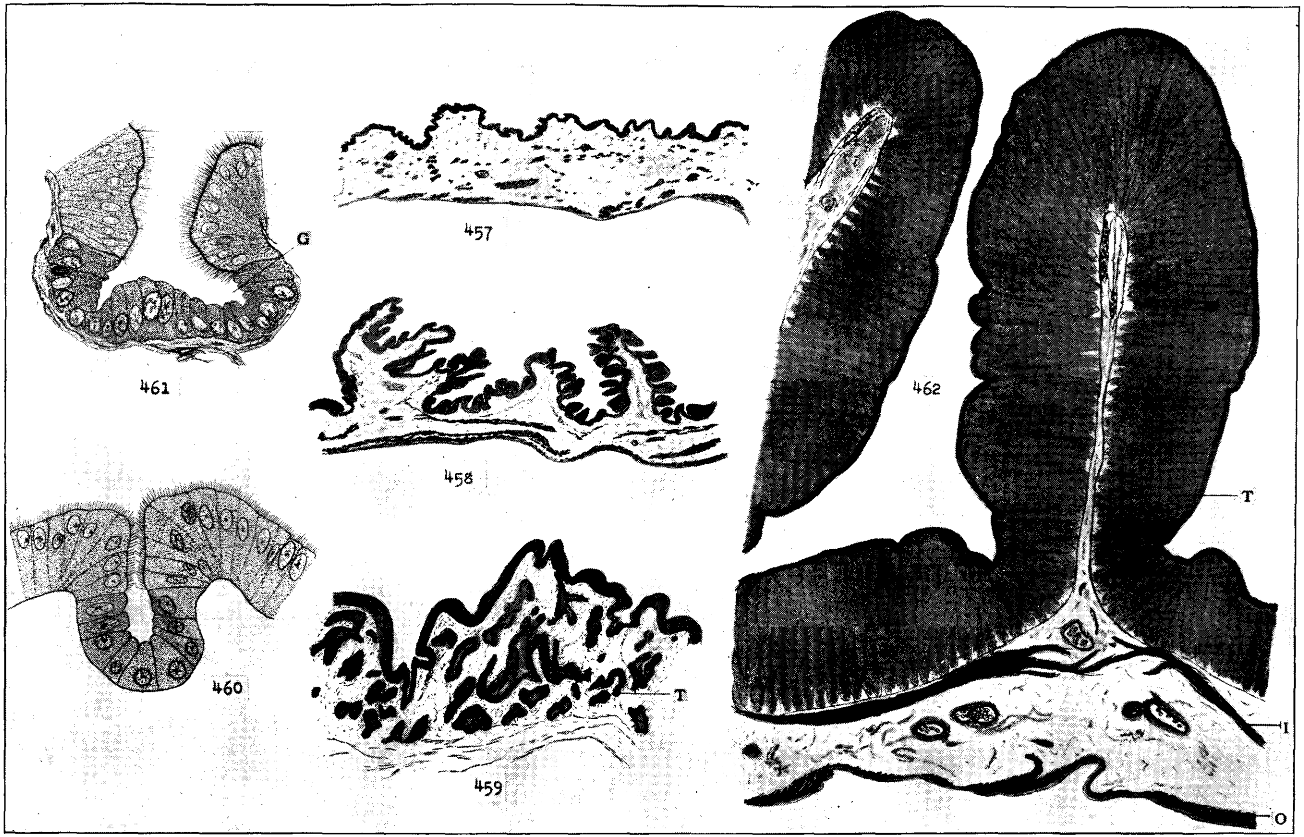

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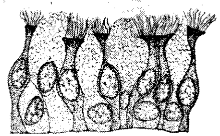

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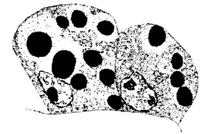

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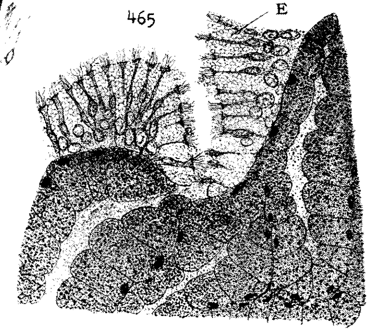

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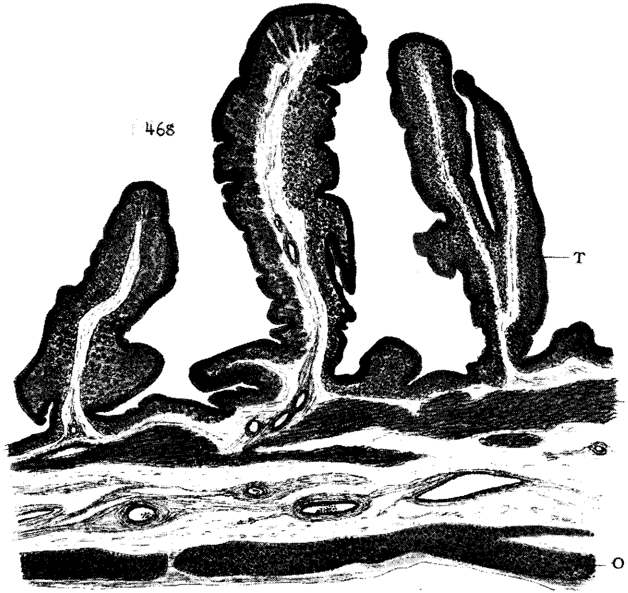

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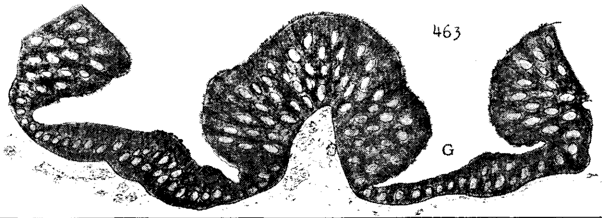

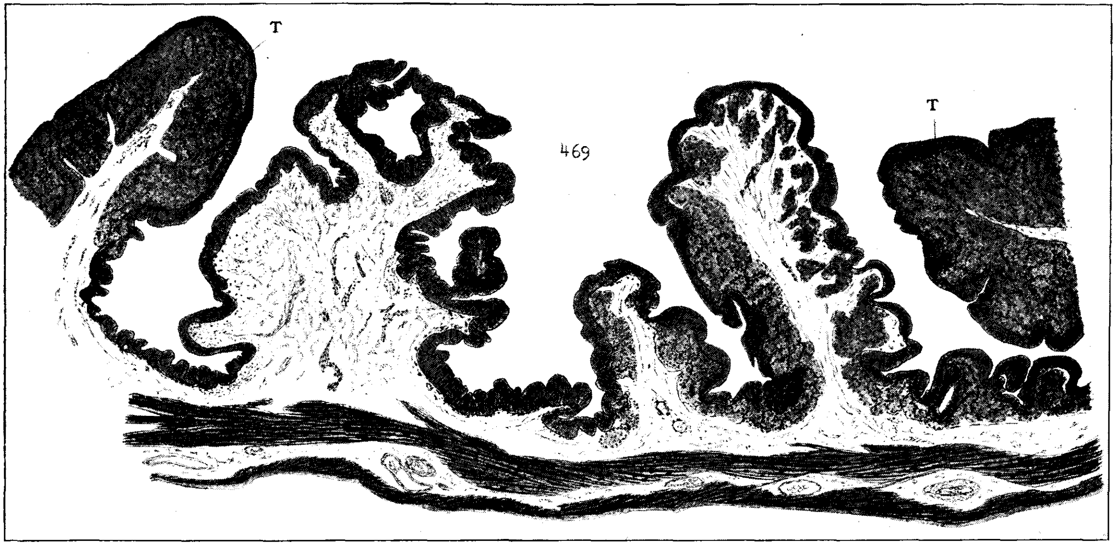

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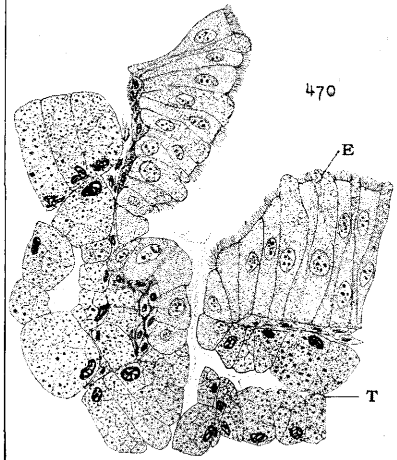

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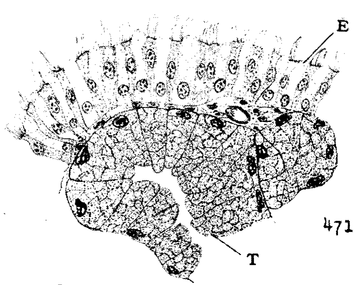

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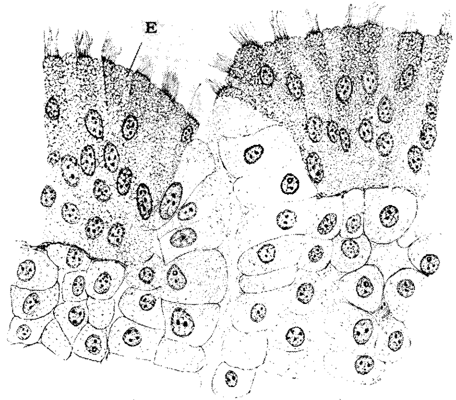

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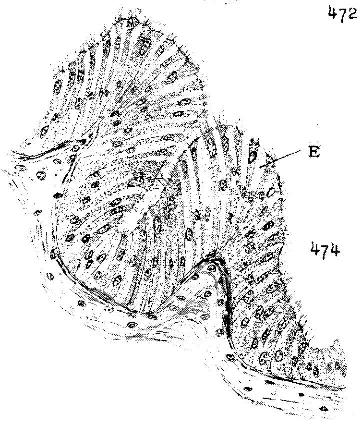

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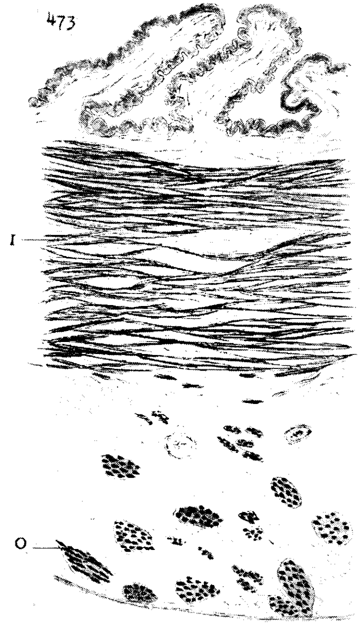

BULLETIN No. 207.

INSECT NOTES FOR 1912.*

O. A. Johannsen.

These notes are abstracts from our Station records for the present year. Though most of them deal with well known insects they are here presented because of their significance with reference to our local conditions. It is hoped that they may also contain sufficient new data upon habits and distribution to be of interest to other entomologists. In some cases descriptions, figures, and remedial measures are given so that these notes may be of service to the general reader.

The season just past has been in some ways of unusual entomological interest. The ravages of the spruce bud moth, the abundance of a spruce leaf miner and the occurrence of other spruce insects has turned much of the attention toward the conifers both native and those introduced for ornamental purposes. The increase of the gypsy moth area and the continued spread of the browntail moth have given the emphasis of one more year's experience with these two pests of paramount importance. The season has been so favorable to the development of scale insects that even those species ordinarily little noticed have been conspicuous in many parts of the State. Fortunately correlated with the abundance of injurious species the insects of 1912 have included beneficial species in great numbers. The syrphus maggots and other predaceous insects, for instance, have practically exterminated many species of plantlice over large areas, and parasites have been actively engaged in their natural welfare against the injurious caterpillars and other insects.

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* Papers from the Maine Agricultural Experiment Station: Entomology No. 61.

HOMOPTERA.

SCALE INSECTS, PLANT LICE AND OTHER BUGS.

Among the many insects which trouble the agriculturist, there is perhaps no one group which is more injurious than are the Coccidae or scale insects. In Maine there are a number of species but owing to their small size, and sombre coloring they are often passed unnoticed. The increasing practice of spraying of orchard trees by our fruit growers will tend to check the spread of species already established and prevent new ones gaining a foot hold. As the insect has sucking mouth parts and lives upon the juices of the host plants, they must be fought by means of contact sprays, such as oil emulsions, whale oil soap, or lime-sulphur. The last mentioned remedy used late in the winter as a dormant spray,* is especially recommended, for most of the species of scales mentioned in the following account.

In the preparation of these insects for examination to determine the species it is often necessary to remove them from the plant, treat them for a brief period in caustic potash, and after rinsing them in water, transfer them through several grades of alcohol, clearing in turpentine, or xylol, or other clearing fluid, and finally mounting on a glass slide in Canada balsam. Many of the scale insects are protected by a scale from which they must be removed before mounting them for examination. The scales which cover the insects in some species resemble each other so closely that the most experienced student of scale insects will not identify them without first making balsam mounts. It is therefore essential in the case of some of these species, as for example the San Jose scale, that judgment be suspended as to its identity until a thorough examination can be made.

Aspidiotus ostreaeformis.

EUROPEAN FRUIT SCALE.

Curtis, Gardiner's Chronicle III, p. 895, 1843.
Newstead, Monogr. British Coccidae. I, p. 99.
Marlatt, U. S. Dept. Agr., Div. Ent., Bul. 20, p. 81.

* See "Apple Tree Insects of Maine," or "Apple Tree Disease," for method of preparing these sprays. These bulletins may be obtained free of charge by residents of the State upon application to the Director, Maine Agricultural Experiment Station, Orono, Maine. Both have been republished in the Report Agricultural Commissioner for 1910 under the title "Apple Tree Enemies of Maine."

Scale of female. It is circular or broadly oval in outline, dark ashy gray in color with paler margin; sometimes the scale is nearly white. The exuvia is central or nearly so, dark brown, usually naked and glossy. Diameter 1-8 of an inch.

"Adult female short ovate, almost circular, old specimens becoming chitinized; yellow or ochreous yellow. Parasitised examples broadly pyriform, inflated, usually bright orange brown, and highly chitinized. Rudimentary antennæ a mere stump with a long stiff spine at the base. Rostral filaments scarcely longer than mentum. Free abdominal segments, and margin in front with a few long hairs. Pygidium always with five groups of circumgenital glands, the anterior group consisting of from 5 to 8, the anterior laterals from 7 to 12, the posterior laterals from 5 to 16. The formula of twelve examples from a single colony on plum are given below:

5	7	5	6	5	6
8—10	9—10	8—7	7—8	9—9	6—7
8—10	9—8	5—6	10—11	11—9	12—11
6	5	5	8	6	5
11—7	9—10	7—11	8—8	12—12	9—9
8—8	8—11	16—13	12—11	11—14	11—9

"The subdorsal groups of tubular spinnerets, rather short, are connected with a double series of glands or pores. Extending from near the last marginal spine to the base of the pygidium on the dorsum is a series of, usually four, large circular pores. Vaginal opening central. Anal opening about midway between the former and the apex of the pygidium. Margin of pygidium with two pairs of lobes; median pair well developed, rounded, and notched at the sides; second pair broader than the former, but only about half the length, with the hind margin emarginate, or irregularly notched, forming a wavy outline; third pair obsolete. The first pair of plates are simple and spinelike; the second finely serrate; the first two beyond the second lobe simple or bifurcate; the third, usually, deeply and widely serrate. There are usually five long spines on either side—the first at the base of the anterior margin of the median lobes; the second and third, opposite, are attached to the base of the second lobe; the fourth and fifth considerably beyond, equidistant from the second, and somewhat longer. The body-wall is considerably thickened and chitinized at the base of the plates.

"The second-stage female possesses no ventral circumgenital glands; these organs are not developed until after the final moult.

"Perfect male varying from ochreous to pale orange yellow. Apodema black, shining. Legs dusky with long sparse hairs. Eyes and ocelli black. Abdomen gradually becoming paler towards the extremity. Antennæ of the same colour as the legs, having eight long clubbed hairs on the apical joint." *

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* Newstead, Mongr. British Coccidae I, pp. 100-102.

Life history. The winter is passed by partly grown individuals which become mature early in the summer. The insect gives birth to living young which begin to appear soon after the maturity of the female. In this State they are apparently but one brooded.

This scale has been recorded from a number of different plants, among them, the apple, pear, plum, peach, cherry, birch, poplar, horse chestnut, basswood, alder, haw, maple, aspen, oak,

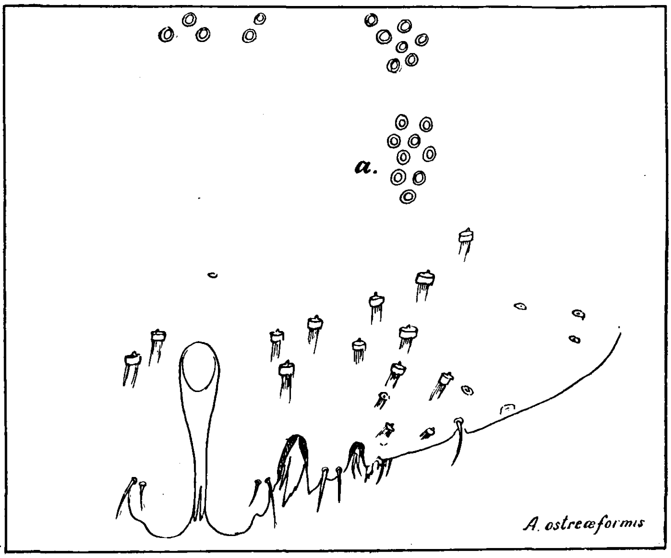

FIG. 475.

etc. It has been reported in this country from Maine, New York, New Jersey, Michigan, Ohio, Iowa, Idaho, California and several other states. In Maine it is most frequently found on large trees in old and neglected orchards, though we have records also of its occurrence on currant bushes. Specimens the past season were received from Brunswick, Millvale, Buckfield and W. Auburn.

Remedies. Spraying with lime-sulphur late in the winter or early spring before the appearance of the leaves will control it.

Aspidiotus perniciosus.

SAN JOSE SCALE.

Comstock, U. S. Dept. Agr., Div. Ent. 1880, p. 304.
Herrick. Technical Bul. 2, Miss. Agr. Exp. Sta., 1911.

Scale of female. It is circular in outline, flat, with exuviae in the center surrounded by conspicuous concentric rings. Scale gray, except central part which varies from pale yellow to reddish yellow, or sometimes even black. Diameter about 1-16 of an inch.

"Female. The body is nearly circular in outline and yellowish in color. There are two pairs of lobes with the median well developed. These appear to converge, are notched once on the lateral edges, rounded at the apices, and the thickened mesal margins extend cephalad and encircle the anal opening in a conspicuous manner. The second lobes are smaller, converge toward the median, and are notched on the lateral

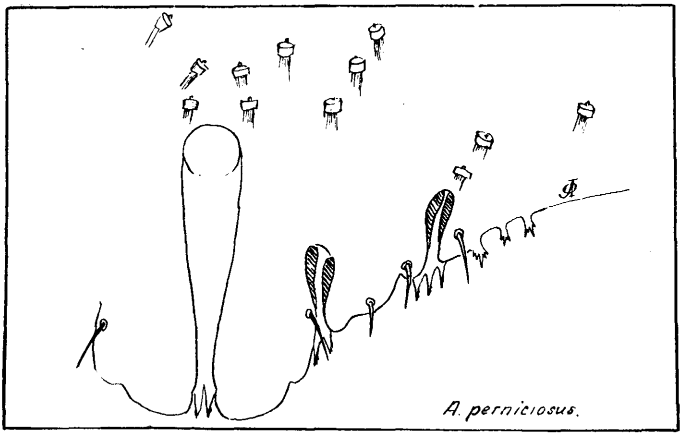

FIG. 476.

margins. There are two thickened processes between the median lobes and two surrounding each incision, the inner the larger. There are two pectinæ between the median lobes, very inconspicuous, two pectinæ in the first incision, three pectinæ in the second incision, and three or more wide, fringed extensions of the pygidial margin laterad of the second incision. These extensions are very characteristic, in fact, are a *diagnostic character.* There is a spine on the lateral base of each lobe, one laterad of the second incision and one, one-half the distance to the penultimate segment. There are, at least, three rows of dorsal pores although they are not prominent." (Herrick).

Life history. The winter is passed by this insect in a partly grown, dormant condition. On the approach of warm weather winged males and early in the summer the young appear, which are brought forth alive. In the latitude of Washington there are 4 or 5 generations, but farther north there are fewer. In parts of New York there are 3 generations. Owing to the few localities from which it has been recorded and the limited number of observations made upon this species in Maine nothing can be said in regard to the number of generations occurring during a single season. This insect occurs upon a large number of trees and shrubs in nearly every state in the Union. Specimens have been seen by the Entomologists of this Station from Limerick, West Baldwin, Wells, and Millvale.

Remedies. Spraying with lime-sulphur late in the winter or early in the spring before the appearance of the leaves will control the pest, provided the work be thoroughly done. Oil emulsions when applied by experienced men are also effective.

Aulacaspis rosae.

THE ROSE SCALE.

Bouche, Naturg. Ins. p. 14, 1834.

Herrick Tech. Bul. No. 2, Miss. Agr. Expt. Sta., 1911.

"*Scale of female.* White, often with a yellowish tinge and circular or irregular when crowded. The light yellow exuviæ are to one side of the center, in fact, quite near the edge. Diameter, 2 mm. to 3 mm.

"*Scale of male.* It is long, white, and tricarinated. Length 1.25 mm. to 1.4 mm.

"*Female.* The body is long with the anterior end, consisting of head and thorax, large and wide. The abdomen is plainly segmented with the ends of the segments projecting and those of the two preceding the last bearing 8 to 10 gland spines. There are three pairs of lobes. The median lobes are large, approximate at base but diverge laterally. They are attached to the pygidium the whole length of their lateral margins and are serrate on the inner margins. The second and third lobes are lobulated, the inner lobule always the larger. Beyond the third lobes is a double lobe-like projection marking the projection of the second pair of projecting pores. There are three pairs of conspicuous projecting pores with a single one between the median and second pairs of lobes. The plates are long and stout and situated as follows: one on the lateral base of each of the three pairs of lobes, one beyond the third pair of pores, and two usually, sometimes more, beyond the third pair of pores. There is a small seta on the median, second, and third lobes, and one just beyond the second and third pairs of pores. The dorsal pores are in three rows. The circumgenital pores were as follows in eight specimens:

15	18	12	8	16	15	17	14
24—24	21—23	23—?	31—28	27—26	25—24	24—27	22—24
20—19	24—20	27—22	25—26	21—22	23—25	26—29	21—22

"The lateral groups are often practically continuous." (Herrick 1911).

Life history. In the south this species hibernates as an immature insect but in the latitude of New Jersey and northward it winters in the egg, which hatches on the approach of spring. The species is not limited to the rose but thrives on pear, strawberry, raspberry, blackberry, etc. In this State both raspberries and blackberries are the principal sufferers. The insect has a wide distribution extending from Canada to Florida and westward to California.

Remedies. If the old raspberry or blackberry canes are regularly cleared out in the fall or spring but little trouble will be experienced from this scale.

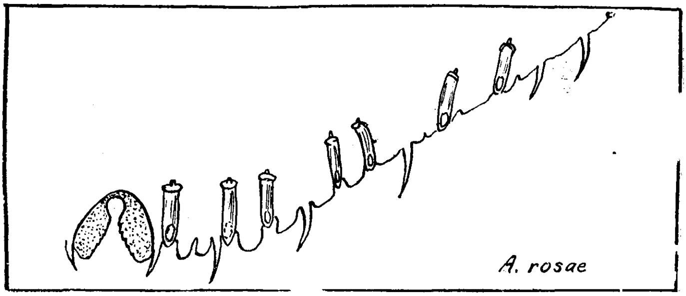

FIG. 477

Lepidosaphes ulmi.

OYSTER SHELL SCALE.

Linnaeus. Syst. Nat. Ed. X. I, p. 455, 1758.

Herrick. Tech. Bul. No. 2, Miss. Agr. Exp. Sta., 1911.

"*Scale of female.* The scale is dark colored, long, slender, often curved and usually widest at the posterior end. It is tough, composed of concentric layers and thus resembles an oyster shell. The exuviæ are yellowish or yellowish-brown and quite prominent. 2.5 mm. to 3 mm. in length.

"*Scale of male.* It is like that of the female except smaller and the posterior part lifts up like a flap for the exit of the male when full grown.

"*Female.* The body is long and slender with the abdominal segments prominent. The median lobes are wide and prominent, stand far apart and have their edges straight and parallel. The distal ends are round and prominently notched on each side. The mesal lobules of second lobes larger. The third lobes are rudimentary. The plates are long and pointed. There are two between each pair of lobes and two pairs beyond the third lobes. There is a prominent marginal pore between median and second lobes, two laterad of the third pair of plates, two laterad of the fourth pair of plates and one laterad of the fifth pair of plates. There is a seta on each basal margin of the median lobes, one between the lobules of the second lobes, one just byond the first and second pairs of marginal pores, and one between the plates of the fifth pair. The dorsal pores are as shown in figure 478. There are five groups of circumgenital pores as follows:

9	9	11	12	
16—21	18—21	15—16	17—15	
15—13	9—11	14—15	13—12"	(Herrick 1911)

Life history. This insect has long been known in this country, though believed to be a native of Europe. In June the eggs,

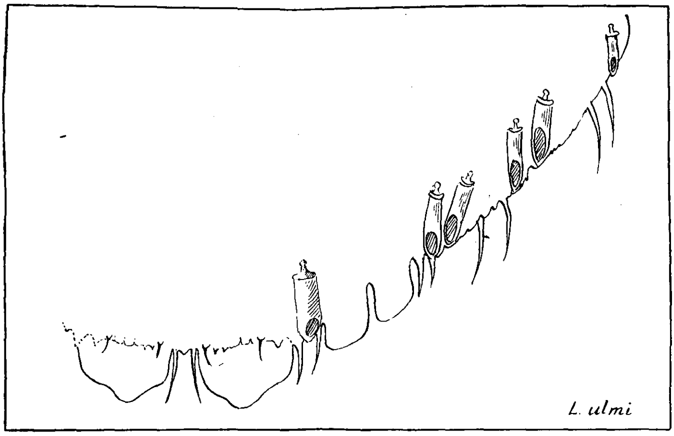

FIG. 478.

which are found under the scale of the old female, hatch, the active young appearing as small specks which soon attach themselves to new shoots by their beaks. The scale then begins to form gradually increasing in size. As with the San Jose scale the adult male is provided with both wings and legs.

The scale occurs nearly everywhere in the United States as well as in other parts of the world, and may be found on a variety of plants. The apple, pear, plum, cherry, currant, willow, elm, birch, butternut, dogwood, ash, oak, linden, poplar, and rose being particularly affected.

It is the most common scale on the apple in Maine.

Remedies. As the insect winters in the egg stage it is quite resistant to sprays, yet experience has shown that when lime-sulphur is used in early spring for several successive seasons the scales gradually decrease in number. Oil emulsions and soap solutions are both to be recommended, when applied just after the eggs hatch, but precautions must be taken in spraying young trees with an oil emulsion to make the application in sunshiny weather lest the trees be injured.

Chionaspis furfura Fitch.

THE SCURFY SCALE.

Fitch, 3rd Report, Ins. N. Y. p. 352, 1856.
Cooley, Spec. Bul. Mass. Exp. Sta. p. 23, 1899.
Herrick. Tech. Bul. No. 2. Miss. Agr. Exp. Sta., 1911.

"*Scale of female.* Usually grayish, often snow-white, and rather irregular in shape. Apt to enlarge just beyond second exuvium and bend to right or left. It is delicate in texture, flat and thin, and broad posteriorly. Length 2.6 mm. to 3.2 mm.

"*Scale of male.* It is small, snowy-white, narrow, tricarinated, and usually straight. Length .7 mm. to 1 mm.

"*Female.* There are three pairs of lobes, all of which are striated, especially the median ones. The median lobes are large, rounded, and entire. There is an oblique bar at the base of each and often an elliptical, chitinous ring is seen at their inner mesal bases. The second lobes are divided, with the inner lobule the larger, and usually with its mesal margin more or less chitinized.

"The third lobes are also divided but are always small and often obsolete. The inner lobule, at least, is usually serrate. There is a seta on the lateral margins of the median lobes at their bases, one on the outer lobules of the second and third lobes, and one just beyond the second pair of marginal pores. The plates are as follows: 1, 1, 1, 1, 4-9. The first plate is small and may be wanting, or at least is often missing. The circumgenital pores are as follows:

12	8	8	10	9	
27—33	27—27	20—22	30—25	23—22	
25—22	25—25	16—15	23—27	17—18"	(Herrick 1911).

"*Remarks.* This species was found on apple in Mississippi and on Crataegus in Texas." (Herrick 1911).

Life history. The winter is passed in the egg underneath the scale of the female. As with the Oyster shell scale the young hatch in June and soon fix themselves by their beaks either upon the bark of the tree or upon the fruit. In the south it is stated to have 2 or 3 generations per season, but in the north there is but one generation. The species is said to occur in

Maine although no specimens have been seen by the Station Entomologists from any locality within the State. It occurs in many states in the Union as well as in New Brunswick, Ontario, Nova Scotia and Prince Edward Island, so its presence in Maine would not be surprising.

Its food plants are apple, pear, cherry, quince, crab, peach, black walnut, mountain ash, elm, currant, hawthorn, etc.

Remedies. Same as for the Oyster shell scale.

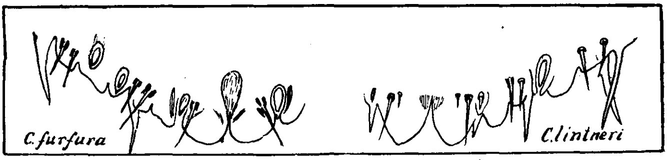

FIG. 479. FIG. 480.

Chionaspis lintneri Comstock.

LINTNER'S SCALE. (FIGS. 480 AND 486.)

Comstock. Cornell Exp. Sta. II, p. 103, 1883.

Cooley. Special Bul. Mass. Agr. College, p. 22, 1899.

"*Scale of female.* Length 2.5-3.2 mm. (⅛ inch). Decidedly broadened posteriorly, somewhat flattened, usually thin and flexible; dull dirty white or snow-white in color. Exuviæ 1 mm. long, yellowish-brown. * * * * The second exuvia is .8 mm. long.

"*Female.* Median *lobes* obscurely pointed and faintly serrate. Second and third pairs with the inner lobule larger than the outer; faintly serrate. The *gland-spines* are long and slender and are arranged as follows: 1, 1-2, 2, 1-3, 6-9. Second row of *dorsal gland-orifices* represented by the anterior group consisting of 3-6 orifices. Third row with 4-6 orifices in the anterior and 5-7 in the posterior group. Fourth row with 6-8 orifices in the anterior and 8-10 in the posterior group. Median group of *circumgenital gland-orifices,* 11-19; anterior laterals, 25-42; posterior laterals, 19-28.

"*Scale of male.* Length .8-1 mm. Parallel-sided, distinctly tri-carinate. Exuvia yellow or almost colorless, occupying about two-fifths of the length of the scale." (Cooley 1899).

This scale has been recorded from alder, willow, birch, dogwood, shadbush. It occurs in eastern United States and Canada, having been recorded from New York, Massachusetts, Maine, Prince Edward Island, and Quebec. The species was found on the gray birch at Orono, Me., in August 1910.

Gossyparia spuria Modeer.

THE ELM SCALE. (FIG. 500.)

Modeer, Act. Goth. I, p. 43, 1778.

Felt. Ins. Affecting Park and Woodland Trees. I, 203, 1905.

Doten. Bul. No. 65. Agr. Expt. Sta. Univ. of Nevada, 1908.

This scale is frequently mentioned in literature under the name of *Gossyparia ulmi.*

"Description. The adult females are by far the most conspicuous form of this insect. They may be seen clustered along the under side of the smaller limbs, usually beside a crack or crevice in the bark, and presenting a general resemblance to a growth of lichens. The full grown, viviparous females are about 1-10 inch long just before giving birth to their young, oval in outline and with slightly pointed extremities. Each is surrounded with a white, wooly secretion, which also extends partly over the insect and thus renders its segmentation more apparent.

"The young are yellowish specks and may easily be recognized as they move over the younger limbs and leaves. They have an elongated, oval form, rounded anteriorly and tapering posteriorly to a pair of pointed processes, each bearing a long and a short seta. The body segments are marked by lateral spines and there is a row of six around the anterior border of the head and an irregular row down the middle of the back. The young soon become darker and finally assume a yellowish red color. The dorsum becomes covered with a spiny, wax secreting processes, and the general form of the young larva is retained. The antenna of the female before impregnation is composed like that of the young, of 6 subequal segments, the second and third being the longest and the fourth and fifth shortest. The antenna of the immature male has 6 nearly equal segments and a longer seventh. * * * The presence of the perfect insect within may be known by the two long, protruding anal filaments. The male is not seen without special search. It is a delicate, two winged, reddish insect with rather large antennæ, and a pair of white anal filaments nearly twice the length of its body. It moves slowly over the limbs in a clumsy way, is not easily disturbed and rarely takes wing. A most interesting feature is the occurrence of two forms. The normal one has already been described, but 10 days earlier than its occurrence there may be found large numbers of males which are characterized by the possession of wing pads but no wings. These are known as pseudimagos. The reason for the existence of two forms of males is unknown." (Felt 1905).

Life history. The winter is passed as partly grown insects which are well protected by the waxy secretions. In the spring they become active and do the most damage. The young, which are brought forth alive, make their appearance in midsummer, settling on the leaves from which they migrate at the approach of fall, to the twigs and trunk where they spend the winter. This insect has a wide distribution in the United States occurring both east and west of the Mississippi. They were very abundant in the vicinity of Orono, Maine, last year (1912) being especially conspicuous during early summer upon the trunks around the pruning wounds of the American elms.

Remedies. As for the Oyster shell scale.

Phenacoccus acericola.

MAPLE PHENACOCCUS. (FIG. 481.)

King. Canadian Entomologist. XXXIV, p. 211, 1902.

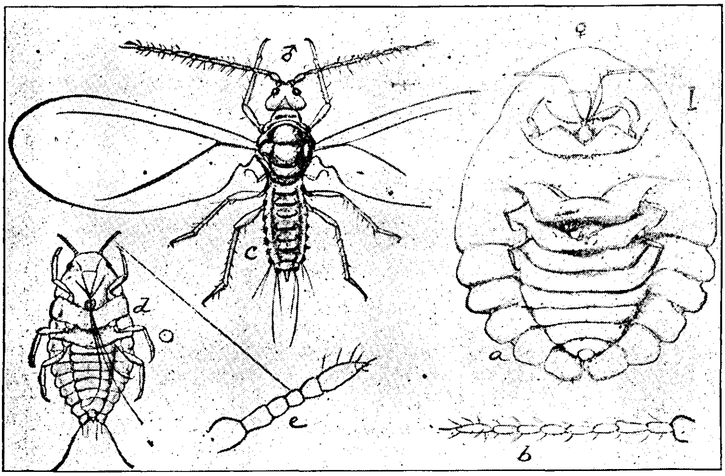

FIG. 481. *Phenacoccus acericola:*. *a*=adult female, greatly enlarged; *b*=antenna of same still more enlarged; *c*=adult male, greatly enlarged; *d*=young larva, greaty enlarged; *e*=antenna of same still more enlarged. (After Howard. Insect Life. 1894. 7 : 237).

Comstock. U. S. Dept. Agr. Rept. '80, p. 345, 1881. (*P. aceris*).
Felt. Insects Affecting Park and Woodland Trees, 182, 1905.

"Our American species when seen on the leaves appear as an irregular oval cottony mass which adheres to anything touching it and resembles very much the cottony ovisac of a *Pulvinaria.*. The cottony material is about 6 mm. in diameter and covers the insect and her eggs.

"Length of ♀ about 5 mm. long, 3 broad, plump, light yellow. Boiled in caustic potash, they turn orange red. The internal juice pressed out, the skin is colourless. The upper surface of the body is more or less covered with spinnerets and these are more dense at the posterior extremity. The margin of the body has several groups of short spines. Antennæ 9 jointed, measuring in microns.

"Joints	1.	2.	3.	4.	5.	6.	7.	8.	9.
	44.	44.	44.	30.	40.	32.	32.	28.	64.
	44.	44.	44.	32.	44.	32.	28.	28.	64.

Joint 9 is longest, 3 and 5 equal, 6 and 8 usually equal, 1 and 2 and 3 are equal and longer than any of the next five joints. The last sending in the fall, when the leaves were found on the ground, had well advanced females with their abdomen well filled with eggs, and when cleared with potash they showed only an 8 jointed antenna as follows:

"Joints (1) 40. (2) 60. (3) 48. (4) 72. (5) 40. (6) 40. (7) 28. (8) 60. Middle leg, coxa 120, femur and trochanter 240, tibia 200, tarsus 80. The legs are somewhat slender, and the claws are thin, sharp, thickened at the back, but not toothed as described by Prof. Comstock." (King 1902).

Life history. The adult females occur on the leaves in summer, and are about 1-4 inch in length. The adults are concealed by an oval mass of powdery wax within which is the yellowish female and her eggs. The young usually remain on the leaf to feed. The males form oval cocoons under the bark of the tree. The adult females leave the leaves and wander about upon limbs or trunk and after pairing settle on the underside of the leaf, seldom crowding each other. The waxy secretion soon becomes very dense and eggs, which are very numerous, are pushed into it. In some states there may be 3 generations each year. The last generation passes the winter on the trunk.

During the early summer of 1912 a number of the maples on the Campus of the University of Maine were found to have on the trunks under the rough bark large numbers of the wax covered gravid females, the young later appearing on the leaves.

This insect has a wide distribution having been recorded in many of the northern states east of the Mississippi river. Its host plants are maple, hornbeam, lime, and horse chestnut.

Remedies. Controlled by the same methods as the Oyster shell scale.

Phenacoccus dearnessi.

King, Canadian Entomologist, XXXIII, p. 180, 1901.

"Sac white, the sac wholly covering the body. ♀ dark red-brown. Boiled in caustic potash the derm is colourless. Legs and mouth-parts ochreous. Antennæ pale yellow, 9-jointed; 3 longest, although 2 + 3 are sometimes equal, 9 next and a little longer than 1, 5 + 8 next and equal, 6 + 7 are shortest and equal. The joints are quite variable in length, as will be seen from the following measurements:

Joint	1	2	3	4	5	6	7	8	9	
	40	56	60	28	44	36	36	32	60.	Formula (39) 215 (67) 84.
	40	60	60	32	26	28	28	32	52	" (23) 915 (48) (67)
	40	52	52	40	40	28	38	32	52	" (239) (145) 8 (67)
	44	56	52	24	36	32	56	60		an 8-jointed form, hardly adult.

Legs short, stout.

Middle leg: coxa, 80; fem. with troch., 180; tibia, 116; tarsus, 72; claw, 24.

Hind leg: coxa, 88; fem. with troch., 200; tibia, 148; tarsus, 84; claw 24.

Scattered over the body are several long thin hairs and short thick spines. The gland-pits are not numerous, and are very small. Caudal tubercles, large, round, with two long setæ, and several long thin hairs; the tubercles are well covered with short, stout, spear-shaped spines. Young larva: Antennæ 6-jointed, measuring as follows: Joint—(1) 24. (2) 32. (3) 40. (4) 24. (5) 24. (6) 68." (King 1901).

Life history. The life history of this species resembles that of the foregoing. The immature insects of both sexes hibernate under the rough bark of the host plant. In the early summer the eggs are laid, the young soon migrating to the under surface of the leaves. This species has been recorded from the haw and the apple. On April 29, 1912, some twigs of the gooseberry infested with this species were received from Brunswick, Maine. The twigs were covered with the puparia of males which are small elongate, and felted, as well as a few females. On May 4 to 6 the winged male adults appeared. On the 8th of May a few females were transferred from the drying gooseberry twig to the stem of a young currant bush growing indoors. One of the females (Fig. 490) laid eggs on June 11, numerous young soon appearing and settling on the underside of the leaves. Eggs from one of the other females were later also obtained some of which were transferred to young plants of apple, elm and maple, greenhouse grown. The eggs soon hatched, the young settling upon the underside of the leaves and thriving as well as upon the original host. As the experiment was discontinued in September nothing can be said of the subsequent development. This insect has been found in a few northern states as well as in Canada.

Remedies. Same methods as for preceding species.

Eulecanium corni.

THE EUROPEAN FRUIT LECANIUM.

Bouche. Stett. Ent. Zeit. V, p. 298, 1844.
Sanders. Journal Ec. Ent. pp. 428-447, II, 1909.

The following names are all synonyms, according to Sanders: Adenostomae, armeniacum, assimile, aurantiacum, canadense, caryarum, cerasifex, coryli, corylifex, crawii, cyosbati, fitchii, fraxini, guinardi, juglandifex, kansasense, kingii, lintneri, maclurarum, mori, obtusum, pyri, rehi, ribis, robiniae, rosae, rugosum, tarsale, tibiae, vini, websteri.

"This common species which occurs on so many of our economic and wild trees and shrubs, is quite convex in form with irregular, varying rugosities and pits in the hard brown derm of the adult, or dead female. Various fuscous transverse and longitudinal markings are evident on the young adult female scale before oviposition in early summer. These markings rapidly disappear at her death and darker brown suffuses the derm, leaving sometimes a trace of fuscous on the dorsum.

"The cleared derm appears brownish, antennæ 6 or 7-segmented, usually the latter; legs well developed, ordinary; anal plates heavily chitinized, together forming nearly a square; 6 large and 2 small hairs on the anal ring; marginal spines rather short and stout 18-24 mmm. in length; spiracular spines variable, rather slender, the shorter ones 30-40mmm. and the middle one 50-60 mmm. in length. The cleared derm shows extra heavy chitinization of the regions along the anterior margin extending inward toward the antennæ, and also of the posterior lobes near the cleft. The characteristic general arrangement of the many derm pores in very irregular, broken and interrupted radiating rows, is especially noticeable near the margin. In some specimens this character is not so marked." (Sanders 1909).

This insect, if the above list of synonyms be accepted, occurs in many states on a very large number of shrubs, fruit and shade trees including the apple, plum, peach, apricot, pear, currant, blackberry, mulberry, sage, orange, elm, ash, locust, linden, maple, dogwood, etc. In Maine we have found it on elm, ash, maple, honey locust, apple, rose, and bitter sweet. Fig. 488 shows specimens of Lecanium collected on red ash, Orono, July 12.

Remedies. Thorough spraying with a crude oil or a distillate oil emulsion applied as a winter treatment. The crude oil emulsion is prepared according to the following formula. (See Bul. 80, Pt. VIII. Bur. of Ent. U. S. Dept. Agr.)

"Water	gallons	86
Fish-oil soap	pounds	10
Lye	do	2
Crude oil (16° to 22° Baume)	gallons	12

About 20 gallons of the water were heated, and when this began to boil the dissolved soap and then the lye were added. This mixture was then removed to the tank, and the rest of the water (66 gallons) added, making 86 gallons in all. The spray pump engine was then started and the crude oil slowly poured into the tank, the mixture being violently agitated by the tank agitator. A perfect emulsion resulted."

Pulvinaria vitis. (Fig. 489).

Linnaeus, Syst. Nat. I, 741, 16, 1735.

Newstead, Monog. Brit. Coccidae, II, p. 51, 1903.

Pulvinaria innumerabilis of American authors is a synonym.

"Female at period of parturition more or less cordate, narrowest in front, posterior extremity emarginate, anal cleft deep; transversely wrinkled and punctate; dorsum slightly ridged, and where the transverse wrinkles are deepest they often form conspicuous projections. Colour pale to dark chestnut-brown, with a median line of pale ochreous or brownish red. At the completion of the ovisac the extremities of the body curve upwards and inwards, the cephalic area only remaining attached to the food-plant. So much is the body wrinkled at this stage that the dermis has often the appearance of being deeply folded. After parturition the colour changes to a uniform pale or dark chestnut-brown, and the dermis is slightly shining. Antennæ normally of eight joints, but there are sometimes only seven. Formula 3, 4, 5, 2, 8, 1 (6, 7), or (3, 5), (2, 4), (6, 7), 8, 1. In all the specimens the second joint possesses a very long hair, and there is a slightly shorter one on the fifth joint, and on the terminal one are five or six. Legs ordinary; digitules to tarsus simple, those of the claw rather strongly dilated. Loop of rostrum scarcely reaching insertion of intermediate legs; mentum uniarticulate and small. Dermis with numerous ovate or approximately circular pores, and fine pentagonal tesselations, which usually disappear in boiling caustic potash. Marginal hairs small, slender, and generally curved. Stigmatic channel with minute circular spinnerets; marginal spines in a group of three, of which the centre one is much the longest and very slightly curved. Anal ring of eight hairs, enveloped, as in the genus *Lecanium,* in a thin and finely striate tube, which partly obscures the hairs of the anal ring within. Anal lobes with several fine hairs at the apex.

"The young adult female exactly resembles a *Lecanium.* Colour, under a lens, ochreous or dark yellow, rendered almost obscure by more or less confluent black spots; dorsum with a median ochreous or dull crimson band; to the naked eye the females appear dark smoky-brown in colour, with a faint olivaceous tinge, but the dorsal band is usually distinct.

"Larva with the antennæ of six joints; formula (3, 6), 2 (1, 4, 5). Legs ordinary. Anal ring with six hairs." (Newstead 1903).

Life history. The smaller twigs of maples or other trees are often covered on the underside with cottony masses which protrude from under a brownish scale. The female lays her eggs about midsummer, the young emerging from the cottony egg mass, establishing themselves along the veins on the underside of the leaves, or more rarely on the more tender twigs. In the autumn the insects migrate to the twigs before the leaves fall. The males die soon after mating; the females pass the winter on the underside of the twigs, and in the spring increase in size, secrete a large amount of honey dew which smears the leaves and everything beneath the infested trees. Later in the spring the insects begin to secrete the cottony matter in which the eggs are deposited.

The insects are found in many parts of the United States and Canada. On June 27, 1912, specimens of females with the cottony egg mases were received on maple twigs from Mr. J. W. Burke, Lee, Maine.

The host plants are maple, linden, sycamore, locust, sumac, beech, elm, oak, apple, pear, box elder, alder, hawthorn, grape, willow, and others.

Remedies. As for the Oyster shell scale.

Table Giving the Differential Characters of the Scale Insects Described in the Foregoing Account.

a. Posterior margin of the abdomen of the female with lobed or serrate pygidium (figs. 475-480); legs wanting in the adult.
  b. Cover scale of female circular.
    c. Exuviae nearly central.
      d. With circumgenital pores (fig 475). *Aspidiotus ostreaeformis.*
      dd. Without circumgenital pores (fig 476). *Aspidiotus perniciosus.*
    cc. Exuviae nearly marginal (fig. 477). *Aulacaspis rosae.*
  bb. Female scale elongate or oval.
    c. Female scale rather narrow, often curved (fig. 478). *Lepidosaphes ulmi.*
    cc. Female scale oval, scarcely twice as long as wide.
      d. Median lobes of pygidium very broadly rounded at the extremities and set close together. (fig. 479). *Chionaspis furfura.*
      dd. Median lobes more spreading and indistinctly pointed. (Fig. 480). *Chionaspis lintneri.*

aa. Abdomen of adult female without a pygidium.
- b. No anal cleft nor triangular plates at posterior end of abdomen of female; antennæ and legs present in adult.
  - c. Newly hatched nymphs with rows of dorsal spines, adult surrounded by cotton but dorsally naked. *Gossyparia spuria.*
  - cc. Newly hatched nymphs without dorsal spines; antennæ 9 jointed, 6 setæ in anal ring. *Phenacoccus.*
    - d. "Tibia nearly 3 times as long as the tarsi." *P. acericola.*
    - dd. "Tibia less than twice as long as the tarsi." *P. dearnessi.*
- bb. Adult female with an anal cleft and triangular plates at posterior end of abdomen.
  - c. Adult female is naked, more or less convex and hemispherical, scale-like, hard when mature. *Eulecanium corni.*
  - cc. Secretion of female more or less cottony, ovisac posterior and adherent to twig and leaf. *Pulvinaria vitis.*

PLANT LICE.

*Aphidae.**

Among the most troublesome of the Aphides of the season were rather conspicuously those upon plum trees, currant bushes, apple trees, and elms. More detailed records of these either have been or will be given in other publications, but a few items seem to fall naturally into this bulletin.

Especial preparations had been made for migration tests with *Prociphilus venafuscus* but only a few colonies on *Fraxinus* were found this season and those were too well attended by predaceous enemies to be profitable for experimental purposes. A few colonies of this species were also found upon *Forsythia* bushes on the campus. Spring migrants were placed upon Balsam Fir seedlings in pots and in one instance a few of the progeny stationed themselves upon exposed roots and fed, normally secreting honeydew and white wax for a few days. These soon died and no conclusive data was obtained. Late in the season apterous aphides which I believe to be this species were abundant upon roots of young Balsam Firs near Orono but no pupæ were found and no developing winged forms so that again the conclusive link was lacking.

Aphis bakeri was taken on *Crataegus* in the spring and the progeny of the spring migrants responded properly to clover tests, maturing and producing there quite content. A colony of this species was brought into the Station on sweet peas.

* Notes by Edith M. Patch.

This colony was on the stem near the ground and was only a few rods from *Crataegus* from which I had collected *bakeri* in the spring.

* * * * * * * * *

It may not be out of place at this time to add an ecological note on *Schizoneura lanigera* in the form of a problem needing further study. That is what is the fate of such winter eggs of *lanigera* as are sometimes deposited on the bark of apple? That this question is of more biological than economic interest is shown by the significant wholesale flight of the sexuparae (fall migrants) *away* from *Pyrus* which provides for the normal deposition of the true sexes and winter eggs on the true winter host with *lanigera* as is the case with other migratory aphides.

But where woolly aphid colonies are very thick, sexes and the winter eggs are sometimes found upon the apple. That such occurrences are accidental * seems not improbable but whether the emerging stem mothers of *lanigera* can develop on apple or other *Pyrus* and if so whether she is a bark feeder or whether she curls an apple leaf (as she would an elm leaf in her ordinary situation) and what the characters of her progeny are, seem to be few of the points which it would be of no slight biological interest to know.

Although I have no observations to offer on the deposition of *S. lanigera* eggs on *Pyrus,* I have been more than a little interested in accounts of such occurrences which have recently been sent me and also in the published records, the earliest of which, for this country at least, seems to be that in the Report of the Entomologist of the United States Department of Agriculture for the year 1879 by J. Henry Comstock. On page 259 of this Report Dr. L. O. Howard recorded his observations made in a little orchard of Russian apple trees then on the grounds of the

* I have seen *Prociphilus venafuscus* fall migrants collect on both *Ulmus* and *Pyrus* sometimes in great numbers where they gave birth to true sexes and where winter eggs were deposited but so far as my observations have gone the spring stem mother develops only on *Fraxinus* and relatives (as *Lilac* and *Forsythia*) so that a deposition of the winter egg in any other situation than on the true winter host is apparently an accidental "error" on the part of the fall migrants which are responsible for the safe disposal of the true sexes on the appropriate winter host.

Department of Agriculture at Washington, his statement concerning the winter egg being as follows:—

"The winter egg was found on several occasions during the winter in crevices of the bark over which a colony had been stationed during the summer. It was a rather long ovoid, measuring .322 mm. (.125 inch) in length and was very similar to the winter egg of *Colopha ulmicola* (Fitch), as described by Riley in Bulletin No. 1, Vol. V, Hayden's Survey.

"This egg was laid, as Professor Thomas supposes, by a wingless female, differing from the ordinary agamic form to a certain extent. These females we only know from finding their skins around the winter egg, since they often die without depositing it. The males we have not seen."

An attempt was made to include in the bibliography of Bulletin 203 of the Maine Agricultural Experiment Station references to all original observations on the *Ulmus-Pyrus* Schizoneuran but other omissions besides the interesting note just quoted may have occurred in which case *addenda* from any one noticing them would be very gratefully appreciated.

LEPIDOPTERA.

BUTTERFLIES AND MOTHS.

Euvanessa antiopa.

THE YELLOW EDGE BUTTERFLY.

Specimens of the larva of this insect were perhaps more frequently received for identification by the Station this year than any other single species, as it was unusually abundant in many parts of the State. The eggs are yellow with white ridges and are attached in masses encircling the twig. Such a mass was found near the swelling leaf bud of elm, May 11 at Orono.

As a circular descriptive of this insect may be had upon application to the Station further details are here omitted.

Ctenucha virginica.

THE VIRGINIA CTENUCHA.

This beautiful little moth, with its blackish wings extending from 1 3-4 inches to 2 inches, peacock blue body and red head makes it a conspicuous object (fig. 493.) It is not uncommon in Maine, and was unusually abundant this season. The larva somewhat resembles that of the spotted tiger moth, but like other members of the family it feeds upon grasses and thus its habitat serves as a ready means of distinguishing it from the tiger caterpillars; and the characteristic hair tufts give good distinctive features if a careful examination is made. This insect hibernates in the caterpillar stage and completes its growth in the spring. On May 2 a collection of these caterpillars in their last instar was received at the Station (fig. 495). They were colored as follows: Body surface purplish black; no dorsal line present but subdorsal and lateral longitudinal line of yellowish white; head shining deep rich wine red with black face and jaws, prolegs reddish, matching head in color but not shining; true legs shining black; hair of 2nd and 3rd thoracic segments inclined down over head; hair of thorax and caudal 2 segments mixed black and white giving gray appearance; dorsal hair of abdominal segments, 1 to 8 inclusive, yellow with a row of 8 black tufts.

In confinement these caterpillars ate grass greedily, the first of them spinning a cocoon and pupating May 4-6, and the others following within a week. The cocoon is a loose oval case, composed almost entirely of the caterpillar hairs (fig. 494). The first moth emerged May 31 and the others emerged on and before June 3. Lot 1455. Hymenopterous parasites (Lot 1474) emerged from part of this lot on June 3.

Euproctis chrysorrhoea.

BROWNTAIL MOTH.

As in former seasons many nests containing larvæ of this species were received for identification by the Station during the winter of 1911-12, but unlike those received in former years, many nests contained only or chiefly dead caterpillars. What caused the death of the insects has not been satisfactorily traced to any single cause which would explain all cases and it is possible that fungous disease, insect parasites, and climatic conditions each were responsible for part of the mortality. Nests from neighboring places would in one case contain dead caterpillars and in the next a fair percentage of live ones. All of the nests from one Orono orchard were examined and found to contain practically only dead caterpillars. Parasites emerged from part of these nests.

Considering the fact that a single winter nest should contain from 150 to 350 or more hibernating larvæ the following record is of interest though it is incidental, as no attempt to canvas the State was made. Curiously the most northern nest received (Monson) contained only living caterpillars.

Partial Record of Winter Nests Received Spring 1912.

Monson, Piscataquis County. 6 nests, 700 larvæ alive.

Cooper, Washington County. 1 nest, 10 larvæ alive.

Bangor, Penobscot County. 8 nests. Most larvæ dead.

Orono, Penobscot County. Many nests (all from 1 orchard). All larvæ dead except a few and those were not vigorous.

Walpole, Lincoln County (1st sending). Many nests. Most larvæ dead.

Walpole, Lincoln County (2nd sending). Many nests. Most larvæ alive.

Auburn, Androscoggin County. 9 nests. Most larvæ dead.

Wales, Androscoggin County. 10 nests. All larvæ dead.

Oxford, Oxford County. 1 nest. 8 larvæ alive.

Freeport, Cumberland County. 4 nests. Most larvæ dead.

Brunswick, Cumberland County. Many nests. All larvæ alive.

Berwick, York County. Many nests. All larvæ alive.

Porthetria dispar.

GYPSY MOTH.

This dreaded insect pest is making its way northward in the State and the egg masses are numerous this fall in the vicinity of Portland.

TENT CATERPILLARS.

Malacosoma americana and *disstria.*

Both the Orchard Tent and Forest Tent caterpillars were unusually numerous in many parts of the State this year. Both species did much damage to the foliage of apple trees, in neglected orchards, both not infrequently being found upon the same tree. The former species constructs large tent-like web nests to which they retire when not feeding. The latter species do not make a tent but instead spin upon the trunk and larger branches of the tree they inhabit a delicate, and inconspicuous sheet of silk upon which they travel up and down. Both species deposit their eggs in the summer in a varnished mass in the form of a ring or belt about a twig. In this State they remain until they hatch the following spring. They are exceedingly abundant the present season, on one small wild cherry tree at Orono several dozen of these egg masses were seen upon a single twig.

Parasitic flies, *Tachina mella*, were bred from a number of the larvæ of both species taken in the vicinity of Orono this summer. Descriptive circulars giving remedial measures for these two species are issued by the Maine Agricultural Experiment Station.

Dioryctria abietella and *Enarmonia youngana*.

In Insect Notes for 1911 (p. 233) mention was made of injury to red spruce cones by insects. Among the insects found in the cones were the larvæ of 2 species of Tineid moths which were later reared and proved to be the above mentioned species. Lots 1303, 1386 Sub. 6.

Peronia ferrugana.

BIRCH LEAF ROLLER.

Schiffermueller, Syst. Verg. Wien. 128, 1776.
Clemens. Proc. Ent. Soc. Phil. III, 576, 1864. (P. gallicolana).

"Fore wings dull ochreous or whitish tinted with ochreous. Near the middle of the costa is a semi-oval blackish-brown spot containing blackish dots, and sometimes a whitish spot on the costa. Along the interior edge of this costal spot are a few tufts, and near the base of the fold of the wing is a single black one. The costa near the base is slightly marked with blackish and the apical portion of the wing is clouded with reddish-ochreous-reddish. Hind wings shining, rather dark gray." (Clemens).

This common European species which is also found in eastern United States, has been rather abundant in the vicinity of Orono for several seasons. The larva constructs a loose tube of silk within the rolled up edge of a gray birch leaf similar to that shown in figure 180 of Packard's Forest Insects (p. 507). In the leaf axils of the tree upon which the larvæ were found, occurred curious little tubular nests each containing a larva very similar if not identical with the above mentioned species. These tubes are constructed of silk and debris and extend down into the twig which is somewhat swelled at this point (fig. 482). Rübsaamen in the Berliner Entomologische Zeitschrift (p. 63, Vol. 33, 1889) states that this tubular nest on the Birch is the work of *P. ferrugana*. If there is no error in the identification it is probable that the larva spends its earlier life thus, and later becomes a leaf roller. As we failed to rear adults from this leaf axil inhabitant and did not observe whether the larva later left the tubes to become leaf rollers we cannot prove the identity of the two forms. Our identification of the moth was confirmed by Mr. August Busck of the National Museum. Lot. Nos. 1289, 1411, 1453.

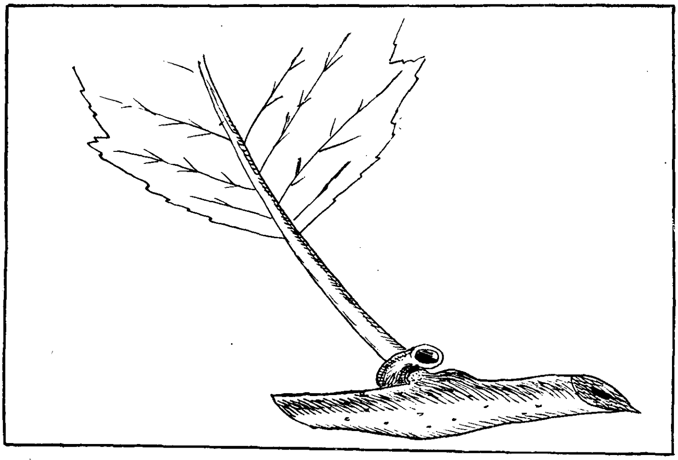

FIG. 482. *Peronia ferrugana.*

A larva forming on the alder a similar axil tube is also not uncommon at Orono, Maine. The twig is less swollen than in the case of the birch, though the projecting tube does not differ.

Olethreutes albeolana.

This species as well as an undetermined *Eucosoma* also construct tubes within the curled edge of gray birch leaves at Orono, Maine. Specimens determined by Mr. A. Busck of the National Museum. Lot 1411a.

Eulia quadrifasciana.

This species was bred from a larva found under the bark of an apple tree at Orono, Maine. Lot 1252.

Apatela funeralis.

The red headed sooty black caterpillars, each segment with transversely elliptical pale yellow mark margined with orange, were found on the Campus at Orono, Aug. 1, feeding on *Cornus stolonifera.* Lot 1553.

Tortrix fumiferana (Spruce bud moth).

Epinotia piceafoliana and *Recurvaria piceaella.*

These Tortricids were bred from larvæ found feeding upon the leaves of red and white spruces, in the spring of 1912 at Orono and elsewhere. An account of their life history will be given in a later bulletin.

HYMENOPTERA.

A PARASITE OF THE BROWNTAIL MOTH.

Monodontomerus aereus. (*Chalcidae*)

Walker, Ent. Mag. II, 158, 1834.

Mayr, Verh. Zool. bot. Ges. Wien. XXIV, p. 71, 1874.

L. O. Howard and W. F. Fiske Bul. 91, Bureau of Entomology, U. S. Dept. Agr. p. 245, 250, 1911.

"Female. Bronze, somewhat shining, quasi squamose, pubescent. Mandibles reddish fuscous; eyes and ocelli reddish; antennæ black, pubescent, first joint bronze; squamulæ reddish fuscous. Abdomen a greenish bronze, smooth, apex sparsely pubescent, not longer than the thorax, apical segment bronzy; ovipositor red, scarcely exceeding half the length of the abdomen; tegmina black, pubescent. Legs reddish fuscous, pubescent; coxæ and femora dusky greenish bronze; tarsi red, paler under the base, tip more dusky. Wings hyaline, iridescent; veins fuscous, stigma moderate in size. Length of body about 1-8 inch, wing about 3-16 inch." (Walker).

The occurrence of this parasite of the Browntail moth at Walpole, Maine, was noted in Insect Notes for 1911 (p. 243, Bul. 195, Maine Agr. Exp. Sta.). Other Maine localities from which the species has been taken either by us or by the representatives of the Bureau of Entomology, U. S. Dept. of Agriculture, are Stroudwater, Leeds Center, Bridgton, Vassalboro, Richmond, Brunswick, Freeport, Poland, Gray, Windham, Portland, Sebago, Cornish, Wells, Berwick, York, and Kittery.

This species was imported from Europe and distributed in Massachusetts about 6 years ago by the entomologists engaged in the gypsy and browntail moth investigations. Since that time the insects have gradually spread until now it has a wide distribution in northern New England. The females (figs. 483 and 499) have the habit of hibernating in the winter webs of the browntail moth, not attacking the caterpillar stage but are parasitic upon the browntail moth pupæ.

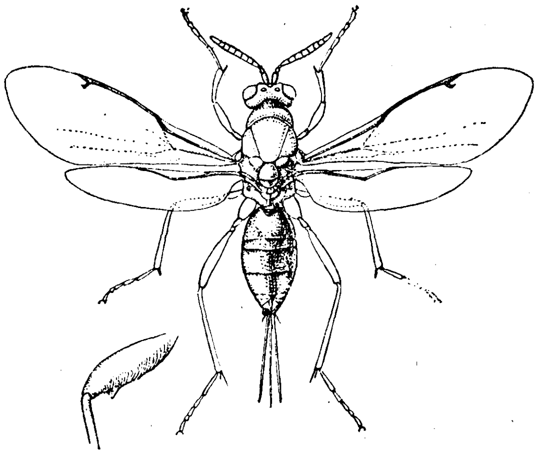

FIG. 483. *Monodontomerus aereus.* Greatly enlarged. (After Howard and Fiske, 1911).

As a period of about 2 months must elapse from the time of the escape of the parasites from the winter webs until the caterpillars of the browntail moth pupate, the little parasite must live in the open during the interval. There seems to be but one generation a year. The female deposits her eggs in the browntail moth pupæ in June, the developing young feeding internally. When mature they escape from the pupæ, the females in the fall seeking shelter in the new winter nests of the young browntail moth caterpillars.

Measures for protecting the parasite. The present method of destroying the browntail moth nests in midwinter while effective in killing the caterpillars, also destroys these parasites if present. A modification of this method could well be made by which the parasite is allowed to escape before the destruction of the nests. As heretofore the nest should be removed from the orchard or shade trees during the winter but they should be held and kept under normal outdoor conditions until the first warm days of spring when both parasites and caterpillars become active. As the parasite is the first to emerge from the nest, the nest could be destroyed as soon as the caterpillars are seen to be actively congregating on the outside. The nests as soon as cut from the tree may be placed in a barrel or other receptacle, the outside of which, at some distance from the top edge, should be smeared with a band of tree tangle foot or some similar preparation so that if the caterpillars start to creep down the side they will be checked by the sticky substance. The parasite, a small shiny black 4-winged fly, about 3-16 of an inch in length, would fly off unharmed if the tangle foot is not placed too near the upper edge. It is suggested that these barrels be placed in the vicinity of wood lots in which browntail nests are still known to exist. The parasites would thus aid in reducing the infestation in the wood lands as well as being enabled to breed and spread.

Pteromalus egregius. (*Chalcidae*)

Förster, Beitr. Monogr. Pteromal. p. 22, 1841.

L. O. Howard and W. F. Fiske. Bul. 91 Bur. Ent. U. S. Dept. Agr. 1911.

"Female. Dark green, scape at the base and the legs reddish yellow, femur dark green with yellow apex, the posterior tibiæ brown in the middle. Propodeum shining, at the base coarsely punctate, on each side with an elongate furrow; the middle transversely depressed, and with a row of deep furrows, the apex smooth, transversely aciculate. Abdomen green, with violet fasciæ. Length 1-8 inch." (Förster).

This little parasite of the browntail moth, also imported from Europe by the Entomologists of the U. S. Dept. of Agriculture about 6 years ago has been gradually spreading northward. In 1911 it was recorded by the government entomologists from Cumberland County, Maine. In March 1912, a number of specimens were obtained from winter nests which had been collected in an orchard at Orono, Maine. Fig. 484.

The females of this species also enter the web nests of the browntail moth caterpillars, but unlike the *Monodonotomerus* they oviposit upon the caterpillars after these have become dormant. The developing larvæ then feed externally upon the caterpillars, becoming full fed before cold weather sets in. Transformations are completed in the spring, the adults leaving the web nests 2 or 3 weeks after the caterpillars become active.

Protection of the parasite. The same means may be used as for *Monodonotomerus* only in this case the barrels should be left longer before destroying the webs of the browntail caterpillars.

Pteromalus puparum. (*Chalcidae*)

This little parasite was reared in large numbers from chrysalids of the yellow edge butterfly on several occasions during

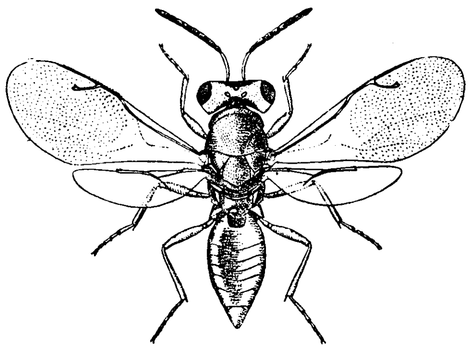

FIG. 484. *Pteromalus egregius.* Greatly enlarged. (After Howard and Fiske, 1911).

July 1912. From a single chrysalid collected on the campus of the University of Maine, 87 specimens emerged. Lot 1516.

Elachertes johannseni Crawford. (*Chalcidae*)

This species mentioned in Insect Notes for 1911 (p. 243, Bul. 195 Me. Agr. Exp. Sta.) under the title of *Elachertes* sp. has recently been described by Mr. J. C. Crawford in the Proceedings of the U. S. National Museum, Vol. 43, p. 181, 1912.

Habrobracon johannseni Viereck. (*Braconidae*)

The species noted in Insect Notes for 1911 (p. 243, Bul. 195, Me. Agr. Exp. Sta.) under the name of *Bracon* sp. has recently been described by Mr. H. L. Viereck in the Proceedings of the U. S. National Museum, Vol. 42, p. 622, 1912.

ANT SWARMS.

Some male and female winged ants were received from Squirrel Island Aug. 28 with the following account by the collector. Mr. Alex Doyle.

"They invaded this island last Sunday. They seemed to come in numerous different swarms from over the water,— from the east or northeast. Each swarm was so dense as to present the appearance at a distance of 1-2 to 3-4 mile of small clouds floating across a clear sky. They drifted by my house so floating across a clear sky. They drifted by my house so thickly that by reaching out the hand or a cap from the piazza they could be captured, yet not one entered the piazza."

COLEOPTERA.

BEETLES.

Haltica bimarginata.

ALDER FLEA-BEETLE.

Say. Journal Phil. Ac. Nat. Sci., IV, 1824.

"*Larva.* Body somewhat flattened; head scarcely two-thirds as wide as the body in the middle; black, becoming brown in front near the jaws. Body livid brown above; the tubercles black; paler beneath; with three pairs of black jointed thoracic legs; no abdominal legs; but an anal prop-leg. The abdominal segments each with a transverse, oval-rounded, ventral, rough space forming a series of creeping tubercles, and in front on each segment is a transverse, oval, crescentic chitinous area bearing two piliferous tubercles; the back of each segment divided into two ridges, each bearing a row of six sharp tubercles, bearing short hairs; a single ventral row on each side of the ventral plate. Length 7 to 10 mm.

"*Pupa.* Body rather thick, white. Antennæ passing around the bent knees (femero-tibial joints) of the first and second pair of legs, the end scarcely going beyond the middle of the body. Elytra with five or six rather deep longitudinal creases. The salient points of the body armed with piliferous warts. Abdominal tip square at the end, with a stout black spine projecting from each side. Length, 6 mm." (Packard's Forest Insects p. 631).

"*Adult.* Oblong, subparallel. Above dark blue, moderately shining; under surface and legs blue-black, antennæ piceous. Thorax wider than long, margins very narrow, the ante-basal depression deep, reaching the sides and joining the marginal depression; surface distinctly alutaceous, sparsely punctate. Elytra wider at base than thorax, with a prominent fold extending from umbone to near apex; surface finely, rather sparsely and indistinctly punctate. Length 5-6 mm." (Blatchley's Coleoptera of Indiana).

We found this species very abundant during the past season at Orono, Castine and Monmouth, and it has also been reported from other localities. The larvæ were very numerous on the leaves of the alder (Alnus incana) during July about Orono, skeletonizing the leaves. Sometimes half a dozen larvæ were found at work upon a single leaf. The insects pupate early in August, adults appearing during the first weeks of September. The description of the larva given above, which was taken from Packard's "Forest Insects," was evidently drawn up from alcoholic specimens. In life the ground color is dark brown, or sometimes almost black, with bluish black tubercles.

WIRE WORMS IN CORN.

Agriotes mancus.

Say, Jour. Phil. Ac. Nat. Sc. III, 171, 1823.

Comstock and Slingerland. Bul. 33, Ag. Exp. Sta. Cornell

Horn. Can. Ent. Vol. 4, p. 6, 1872.

Forbes, 18th Report, 1894.

"*Larva.* The newly hatched larvæ must be very small, and, according to European writers, they grow very slowly. The smallest larvæ of the wheat wireworms we have seen were about 4 mm. in length. All variations in size occur at the same time up to a full grown larva which measures from 16 mm. to 19 mm. The larvæ are quite slender cylindrical somewhat flattened on the venter, sparsely hairy, and of a waxy yellow color, lighter at the sutures. The anal segment tapers gradually to a subacute brown point, and bears on the dorsal aspect, near the cephalic border, two large conspicuous, brown eye-like depressions resembling the breathing pores. By these, the wheat wireworm of any size may be readily separated from any other species which we have found infesting fields." (Comstock and Slingerland). Fig. 496.

"*Pupa.* "The pupa resembles the imago in many of its characters, being, however, about one-fourth longer, and in the abdominal region more slender, the only differences of moment being the following:

"Thorax at each angle with a stout bristle-like appendage more slender towards the tip, about a sixteenth of an inch long. That at the anterior angle is supported on a small papilla, the posterior being prolonged from the tip of the angle. Terminal abdominal segment above subquadrate, emarginate at tip, angles acute and divergent, beneath with deep sinuous groove on each side and a median shallower groove.

"Abdomen above and beneath of nine segments, the first very narrow, distinctly visible above, beneath visible only at the sides; second slightly broader, beneath nearly entirely concealed. The remaining segments are distinctly visible both above and beneath, the distal angles being slightly prominent, giving the sides of the abdomen a dentate appearance." (Horn 1872).

"*Imago.* Robust, color piceous to brown, elytra often paler, surface moderately pubescent. Head and thorax very convex, the mouth inferior, mandibles broad and chisel-shaped at tip; surface of head and thorax densely and coarsely punctate; striæ of elytra deep, punctate, interspaces nearly flat, rugose, and punctulate, antennæ and feet rufous. "Length 7-9 mm." (Forbes, 1894). Fig. 498.

In Insect Notes for 1911 (p. 229, Bul. 195, Me. Agr. Exp. Sta.) there was published an account of experiments made at Highmoor Farm, Monmouth, Maine, upon wire worm extermination. Both poisons and repellants were used without avail in the field, and as a check several wire worms were placed in a small jar with some grains with which special pains were taken to coat them heavily with arsenate of lead. Several days later, some larvæ were seen, each half buried within the grain, the hull intact except for a small hole the diameter of the insect's body. A month later only the hulls of the grain remained. All the wire worms were still alive and apparently healthy. (Fig. 497.) Tobacco dust, lime and other repellants also proved ineffectual. The successful growth of Canada field peas in some of the infested plots gave the suggestion that crop rotation would be the solution of the wire worm problem and to that end potatoes, clover, beans, oats, corn, Canada field peas, and a mixture of peas and oats were sown in plots 200 feet in length, but of varying width, separated from each other by fallow areas 8 to 10 feet wide. A narrow strip plowed 6 times during the month of August 1911 was crossed at right angles by the 1912 plots. Owing to the very late spring and wet fields, the planting was unusually late. No fertilizer was put upon the field. About the middle of August the crops were inspected. Making allowance for the lateness of planting and lack of fertilizer, all the crops with the exception of the corn were in as good a condition as could be expected. The corn was rather poor though much better than on the same field the preceding season.

In preparing the field for planting half of each plot was plowed in June, the other half being only harrowed. Wire worms were abundant in the field especially about the roots of the corn plants, though apparently not as numerous as in 1911. The difficulty in conducting field experiments of this kind is the practical impossibility of having reliable checks which can be tested quantitatively, owing to the numerous uncontrollable factors. Whether the cultivation of the field during the 2 years was the cause of the apparent reduction of the wire worms or whether the weather conditions were most concerned we have no means of knowing.

There was nothing, however, in the experiments in 1912 to invalidate the conviction that continued cultivation and rotation of crops will in the course of several seasons materially reduce the wire worms in an infested field. Certain it is that sod land is always more heavily infested than fields long in cultivation. At Guilford, Maine, a place of worn out sod land newly planted to potatoes produced plants that looked at first glance like those affected with "black leg." Examination showed stems and tubers chewed by wire worms which were seen *in situ*.

A more satisfactory method of testing the food preferences of wire worms would probably be to introduce a sufficient number of larvæ of a known species into pots of the plants to be tested with suitable checks for comparison.

Most of the larvæ found at Highmoor in 1911 were *Agriotes mancus*. In 1912 over 99% of the larvæ examined belonged to this species. On August 7 while digging for larvæ several adults of this species, evidently recently transformed, as well as pupæ were found.

This species which in the middle west is known as the Wheat wire worm because of its depredations upon wheat is also a pest there to Indian corn. The adult insect probably lays her eggs near the roots of grasses and the young hatching therefrom are supposed to require 3 years to complete the life cycle. The larva transforms to the pupa late in July or early in August. The adults emerge from the ground in May or June. There is reason for believing that the pupæ soon transform into adults and that they hibernate underground in this form, and not as pupa.

Hylurgops (Hylesinus) opaculus.

ELM BARK BORER.

Specimens of these scolytid beetles together with a sample of their work on elm were received from Augusta, July 24, Lot 1531.

Xyleborus dispar.

APPLE TREE SHOT BORER.

Complaints of this species accompanied specimens of the beetle and examples of its work in apple bark from Rockport, Aug. 1. Lot 1551. Similar material was received Sept. 10 from Carmel. Lot 1582.

Oberea bimaculata.

CANE BORER.

Raspberries and other canes in Maine are frequently attacked by this borer which gives yearly evidence of its presence. Oviposition wounds in raspberry cane were received from East Boothbay July 17. Lot 1524. Oviposition work in blackberry and adult beetles were received from North New Portland Aug. 1. Lot 1552.

Leptura canadensis.

Specimens of this long-horned borer were received from South Paris Aug. 8, with the statement that "they have made so many holes in a piazza post of southern pine that it looks like a pepper box." Lot 1556.

Galerucella luteola.

IMPORTED ELM LEAF BEETLE.

Hibernating adult elm leaf beetles were received from Biddeford, April 20. Lot 1452. Other sendings of the adults were received from the same place May 16. Lot 1464. Larvæ were received from Eliot July 15. Lot 1515. The experience of other infested states with this imported pest seems to be in store for Maine. Much of the work on elms popularly laid to the door of *Galerucella luteola* in Maine during the past two seasons, however, was done by the larvæ of a blue *Haltica* (Bul. 195, Me. Agr. Exp. Sta. p. 233).

Saperda tridentata.

ELM-BORER.

Packard, Forest Insects, 1890, p. 224.

Forbes, Bul. 154, Univ. of Illinois Agr. Exp. Sta. 1912.

This dangerous enemy of the elm is also at work in the State and specimens were captured on the Campus July 10. Lot 1504.

Packard gives an account of this insect which reads in part: "Perforating and loosening the bark and furrowing the surface of the wood with their irregular tracks, flat white longicorn borers, changing to beetles in June and July; the beetles flat, dark brown, with a longitudinal three-toothed red stripe on the outer edge of each wing-cover.

"This is the most destructive borer of the elm in the Northern and Eastern States, often killing the trees by the wholesale. Great numbers of the larvæ of different sizes have been found boring in the inner bark and also furrowing with their irregular tracks the surface of the wood, the latter being, as it were, tattoed with sinuous grooves, and the tree completely girdled by them in some places. The elms on Boston Common have in former years been killed by this borer, and valuable trees, we have been informed, have been killed by them in Morristown, N. J. It has been found in all stages in the elm at Detroit, Mich., by Mr. H. G. Hubbard."

Dr. S. A. Forbes in the bulletin referred to gives an account of this insect associated with "a fatal affection of the elm now prevailing over a large part of southern Illinois."

SPRAY TEST FOR CONIFERS.

It seems often desirable to recommend sprays for coniferous trees infested by aphides and there is apparently not much data as to spray injury on such trees. For this reason Mr. William C. Woods applied the sprays here indicated upon young healthy conifers at Orono as follows:

(a) Whale oil soap. One pound in two gallons of water.

(b) 69-70 Bowker's Lime-sulphur (1 part of lime-sulphur to 40 parts of water). 1-70 Nikoteen (1 part of Nikoteen to 400 parts of water).

(c) Scalecide. (1 part Pratt's Scalecide to 25 parts of water.)

On August 25, 1911, Red Spruce, White Spruce, White Pine, Balsam Fir, and Larch were sprayed with (a) and (b). On September 5, 1911, the same species of trees were sprayed with (c).

About mid July, 1912, the sprayed trees were visited and careful comparison made between these and the nearest unsprayed checks.

	(a)	(b)	(c)
Larch	No injury	No injury	No injury
Red Spruce	(Trees not located).	(Trees not located).	No injury
White Spruce	No injury	No injury	No injury
White Pine	No injury	No injury	No injury
Balsam Fir	Slight injury. Tree had grown 2 ft.	A few leaves dead. No other injury.	Tree alive. 12 branches dead. 38 branches badly injured.

The experiment was not on a large enough scale to permit any sweeping generalizations, but the results certainly indicate no especial susceptibility on the part of these conifers to injury by sprays ordinarily used on other vegetation in combating scale insects and aphides. The sprays were heavily applied until the branches were dripping and a year later all the trees were in good condition except two of the Balsam Firs and as some unsprayed Balsam Firs in the vicinity selected for checks were also in an unthrifty condition the evidence that the state of these trees was due to the spray was not at all conclusive.

ENTOMOLOGICAL PAPERS FROM THE MAINE AGRICULTURAL EXPERIMENT STATION.

NOS. 41-59.*

41. *Insect Notes for 1909.* By O. A. Johannsen. Bulletin No. 177. Me Agr. Expt. Sta.
42. *The Fungus Gnats of North America.* Part II. By O. A. Johannsen. Bulletin No. 180. Me. Agr. Expt. Sta.
43. *Gall Aphides of the Elm.* By Edith M. Patch. Bulletin No. 181. Me. Agr. Expt. Sta.
44. *Four Rare Aphid Genera from Maine.* By Edith M. Patch. Bulletin No. 182. Me. Agr. Expt. Sta.
45. *Paedogenesis in Tanytarsus.* By O. A. Johannsen. Science, Vol. 32, p. 768.
46. *Insect Notes for 1910.* By O. A. Johannsen. Bulletin No. 187. Me. Agr. Expt. Sta.
47. *Macrosiphum destructor and Macrosiphum solanifolii.* By Edith M. Patch. Bulletin 190. Me. Agr. Expt. Sta.
48. *Insect Notes for 1911.* By O. A. Johannsen and Edith M. Patch. Bulletin No. 195. Me. Agr. Expt. Sta. 229-243.
49. *Pemphigus tessellata (acerifolii) on Alder and Maple.* By Edith M. Patch. Bulletin No. 195. Me. Agr. Expt. Sta., pp. 244-248.
50. *The Fungus Gnats of North America.* Part III. By O. A. Johannsen. Bulletin No. 196. Me. Agr. Expt. Sta.
51. *Notes on Psyllidae: Livia.* By Edith M. Patch. Psyche, Vol. 19, pp. 5-8.
52. *The Fungus Gnats of North America.* Part IV. (Conclusion) By O. A. Johannsen. Bulletin No. 200. Me. Agr. Expt. Sta.
53. *Aphid Pests of Maine.* Part I. By Edith M. Patch. Bulletin 202. Me. Agr. Expt. Sta., pp. 159-178.
54. *Food Plant Catalogue of the Aphidae of the World.* Part I. By Edith M. Patch. Bulletin No. 202. Me. Agr. Expt. Sta., pp. 179-214.
55. *Notes on Psyllidae.* By Edith M. Patch. Bulletin No. 202. Me. Agr. Expt. Sta., pp. 215-234.
56. *Elm Leaf Curl and Woolly Aphid of the Apple.* By Edith M. Patch. Science Vol. 36, pp. 30-31.
57. *A Teritiary Fungus Gnat.* By O. A. Johannsen. The American Journal of Science, Vol. 34, p. 140.
58. *Elm Leaf Curl and Woolly Apple Aphid.* By Edith M. Patch. Bulletin 203. Me. Agr. Expt. Sta.
59. *Woolly Aphid Migration from Elm to Mountain Ash.* By Edith M. Patch. Journal Economic Entomology, Vol. 5, p. 395.

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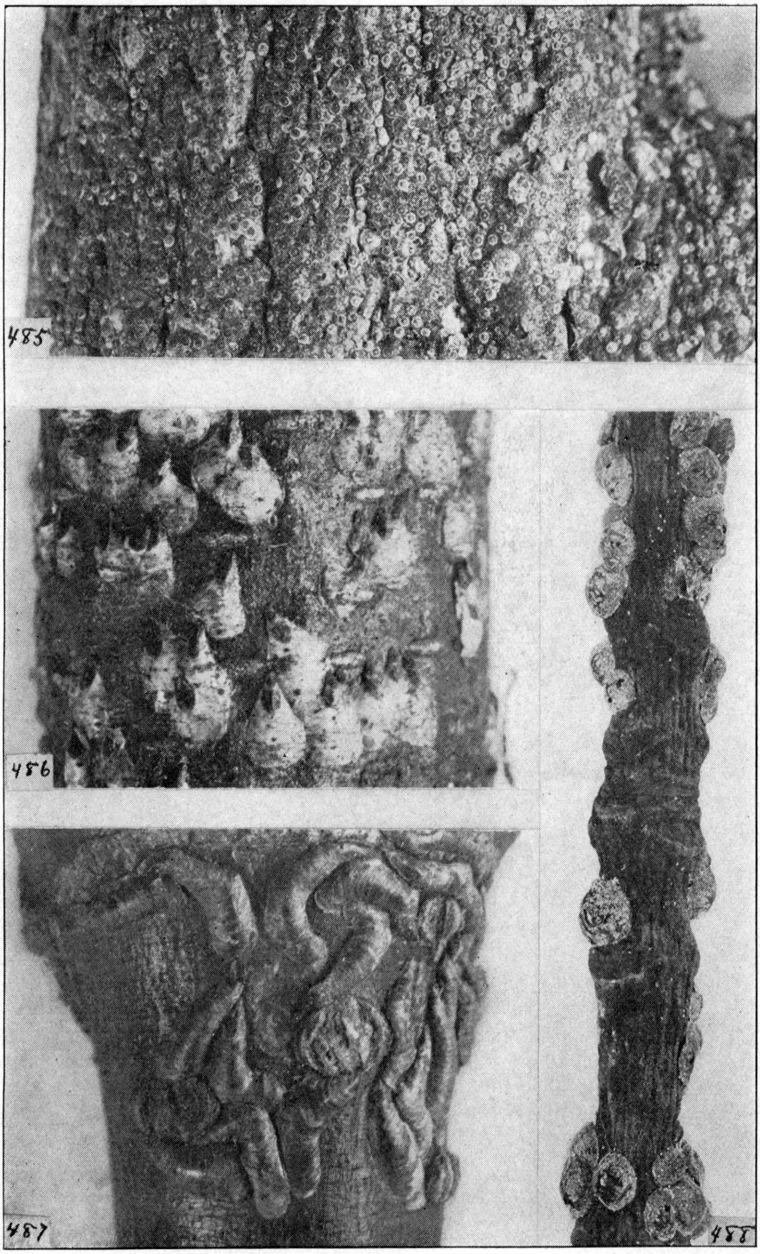
* For a detailed list of earlier publications see circular 382-5-10 of the Me. Agr. Expt. Sta.



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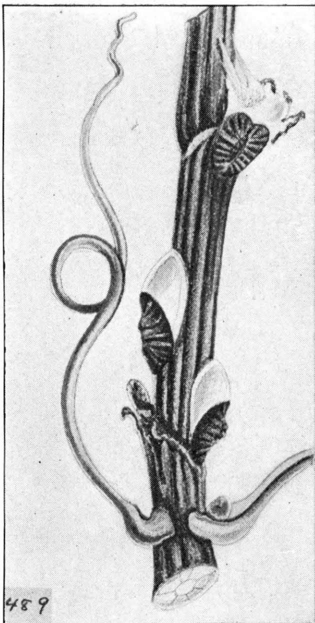

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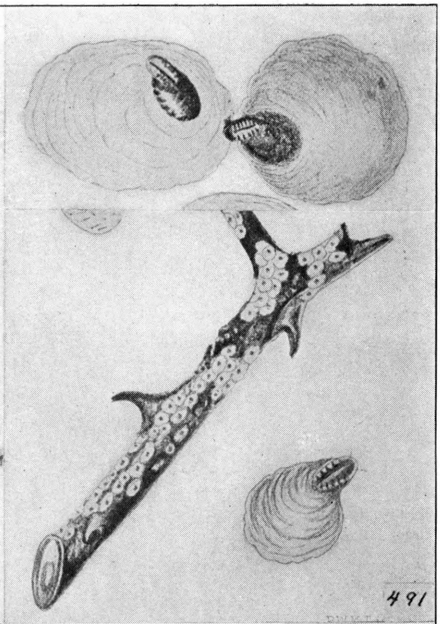

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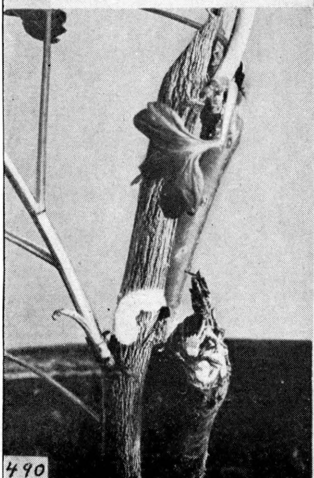

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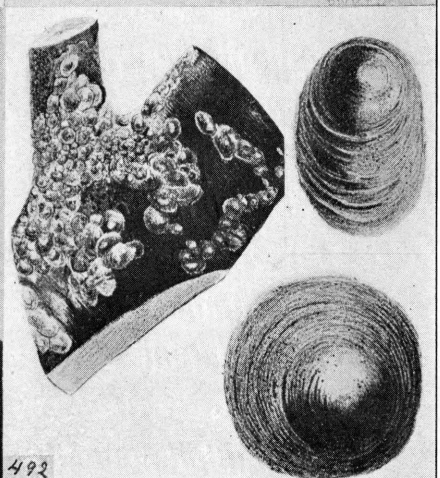

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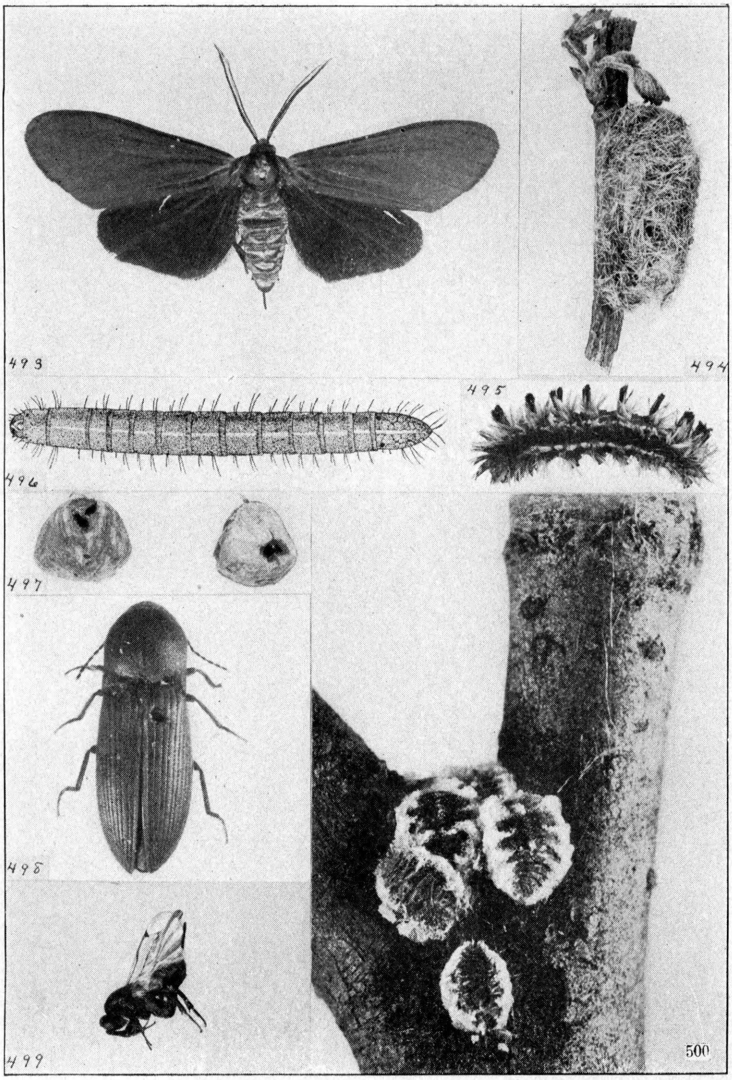
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METEOROLOGICAL OBSERVATIONS.

For many years the meteorological apparatus was located in the Experiment Station building and the observations were made by members of the Station Staff. June 1, 1911, the meteorological apparatus was removed to Wingate Hall and the observations are in charge of Mr. James S. Stevens, professor of physics in the University of Maine.

The instruments used were at Lat. 44° 54′ 2″ N. Lon. 64° 40′ 5″ W. Elevation 135 feet.

The instruments used are the same as those used in preceding years, and include: Wet and dry bulk thermometers; maximum and minimum thermometers; rain-gauge; self-recording anemometer; vane; and barometer. The observations at Orono now form an almost unbroken record of forty-four years.

METEOROLOGICAL SUMMARY FOR 1912.

OBSERVATIONS MADE AT THE UNIVERSITY OF MAINE.

1912.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Mean.	Total.
Highest temperature	46	49	51	81	89	91	95	84	80	80	62	52	......	......
Lowest temperature	-30	-31	-20	7	13	32	38	36	30	27	17	-5	......	......
Mean temperature	10.9	17.7	27.0	43.5	57.1	63.8	67.2	62.5	57.5	49.8	39.4	27.8	42.68	......
Mean temperature in 44 years	16.27	18.78	28.39	40.89	52.74	62.01	67.20	65.27	57.55	45.35	34.47	20.91	42.49	......
Total precipitation in inches	2.87	2.50	4.55	4.60	8.05	2.32	4.60	4.69	3.11	4.97	2.92	3.27	......	48.45
Mean precipitation in 44 years	4.20	3.80	4.21	2.90	3.58	34.5	3.28	3.46	3.48	3.79	3 60	3.68	......	43.42
Number of days with precipitation of .01 or more	6	3	9	9	13	8	7	13	8	13	6	7	......	102
Snow fall in inches	18	15	3	......	......	......	......	......	......	......	......	10	......	46
Mean snow fall in 44 years	22.5	21.7	15.8	5.4	0.19	......	......	......	......	0.74	7.3	16.4	......	90.0
Number of clear days	11	18	14	13	5	7	6	2	4	11	4	10	......	105
Number of fair days	14	8	9	7	19	16	14	21	16	12	16	10	......	161
Number of cloudy days	6	3	8	10	7	7	11	8	10	8	10	11	......	99
Total movement of wind in miles	4883	4769	4865	5505	4965	3984	1896	3284	2806	4317	4207	4615	4183	50096

REPORT OF TREASURER FOR FISCAL YEAR ENDING JUNE 30, 1912.

RECEIPTS.	Hatch fund.	Adams fund.	General account.	Inspections.
Balance July 1, 1911			1,364 10	
Treasurer of United States	$15,000 00	$15,000 00		
State				$9,000 00
Sales, etc			8,804 45	
Analysis fees				14,813 84
Deficit			673 88	
Total	$15,000 00	$15,000 00	$10,842 43	$23,813 84
DISBURSEMENTS.				
Salaries	$5,168 71	$13,181 92	$1,295 81	$12,186 59
Labor	2,280 37	112 94	2,753 56	
Publications	13 00			
Postage and stationery	468 37	22 22	107 63	419 31
Freight and express	331 07	73 06	204 04	126 00
Heat, light and power	393 40	134 15	107 97	328 93
Chemical supplies	52 15	30	69 63	389 10
Seeds, plants and sundry supplies	317 56	444 05	1,185 40	94 84
Fertilizers	653 10	57 77	210 60	
Feeding stuffs	2,214 76	18 70	378 61	
Library	851 88	42 80	4 00	
Tools, implements and machinery	371 21	51 13	2,869 57	
Furniture and fixtures	214 42	24 44	29 81	
Scientific apparatus	197 90	314 62		188 62
Live stock	654 80	10 90	1,506 13	
Traveling expenses	305 80	222 13	24 16	2,855 08
Contingent expenses	25 00		32 43	107 87
Buildings	486 50	288 87	62 99	
Deficit June 30, 1911				123 52
Balance June 30, 1912				*6,993 98
Total	$15,000 00	$15,000 00	$10,842 43	$23,813 84

* The large balance is due to the fact that fees are paid in advance for the whole year and the State year ends December 31.

The classified report does not include $1,000.00 paid for services and feeding stuffs in poultry investigations by the U. S. Department of Agriculture, an appropriation of $5,200 from the State for printing Station publications nor the receipts and expenditures for food packed under inspection.

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APPENDIX

Official Inspections

36 to 45

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January, 1912.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
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Official Inspections

36

SEED INSPECTION.

The first law regulating the sale of seeds was enacted by the Legislature of 1897. This was revised by the legislature of 1905. This was again revised by the legislature of 1911 so as to conform with the requirements recommended by the Association of Official Seed Analysts and agreed to by the American Seed Dealers Association. The chief requirements of the law follow. The full text of the law will be sent on request.

The Chief Requirements of the Law.

The following are the chief points of the law and the rules and regulations for carrying out the law regulating the sale of agricultural seeds which, as directed by the law, the Director of the Station, has made. They became effective June 29, 1911.

1. *Kind of seeds coming under the law.* The law applies to the sale, distribution, transportation, or the offering or exposing for sale, distribution, or transportation of the seeds of alfalfa, barley, Canadian blue grass, Kentucky blue grass, brome grass, buckwheat, alsike clover, crimson clover, red clover, medium

clover, white clover, field corn, Kaffir corn, meadow fescue, flax, hungarian, millet, oats, orchard grass, rape, redtop, rye, sorghum, timothy and wheat for seeding purposes.

2. *The brand.* Each lot or package shall be plainly marked with the name of the seed and its minimum percentage of purity.

3. *Mixtures.* Mixtures must be plainly marked with the name of the seed and the percentage of purity. In case the mixtures contain seeds not included in 1 these need not be named. (e. g., a mixture consisting of half redtop, 90 per cent pure, quarter Kentucky blue grass, 85 per cent pure and the remainder seeds not named in the law, could be marked "Redtop 45 per cent pure, Kentucky blue grass 21 per cent pure." The statement of the remaining constituents may or may not be named.)

4. *Adulteration.* A seed is adulterated if its purity falls below its guaranty or if it contains the seed of any poisonous plant.

5. *Misbranding.* A seed is misbranded if the package or label bears any statement, design or device which is false or disleading in any particular, or if it does not carry the statements named in 2.

6. *Free analysis.* Free analysis of seeds on sale in Maine will be made of samples taken in accordance with directions furnished by the Station. Samples not so taken may be refused examination. Blanks with full directions will be furnished on request.

7. *Paid analysis.* As an accommodation to residents of Maine samples of seeds not on sale in Maine will be examined at cost, and the results will not be published. The cost of the analysis of blue grass or redtop is $1.00 per sample and for other seeds 50 cents. Remittance should accompany the sample.

8. *Written guaranty.* No prosecution will lie against any person handling agricultural seeds provided he obtains at the time of purchase a written guaranty signed by the person residing in the United States, from whom the purchase was made, to the effect that the seeds are not adulterated or misbranded within the meaning of the Maine law regulating the sale of agricultural seeds. After a person has been notified by the Director of the Maine Agricultural Experiment Station that an article of

agricultural seed appears to be adulterated or misbranded the written guaranty will not protect further sales.

9. *Hearings.* The person who is believed to have violated the law regulating the sale of seeds will be granted a hearing at which he may appear in person or by attorney or by letter. The notice of the hearing will name the time and place of the hearing and a copy of the charge. Failure to appear will not prejudice the case. The hearing will be private and every opportunity will be given for explanation and establishment of innocence. If the time appointed is not a convenient one, postponement within reasonable limit will be granted.

The Maine Jobber and the Seed Trade.

At present it is usually 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. Four 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 than 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 cusutomer, 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 sepecial 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."

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 plaintain seed. If this plaintain seed is the door-yard variety which is present practically all over Maine, there would be comparatively little harm from using clover seed which contained it. On the other hand—lance leaved plaintain or rib grass is not abundant in Maine. It is an undesirable plant and using seed carrying it might introduce a weed into land which is at present free from it. It is important that the farmer should know the vitality as well as the purity of the seed that he is to use. No matter how pure a seed may be, if half of it will not sprout it has no more value than if the seed were half chaff.

While it is not easy to make an exact purity test, it is not difficult for a farmer to so acquaint himself with the seeds that he is ordinarily using that by the help of an ordinary reading or magnifying glass he will be able to tell whether the seed in question contains any considerable amount of impurities. If the seed is spread out upon a white plate, a little practice will enable a farmer to see whether a given seed is reasonably pure or not, and he will soon learn to detect the more common foreign seeds.

Vitality of Seeds.

It is much easier for the farmer to test the vitality of seed than to make a purity examination. The following simple instructions for performing germination tests at home without any special apparatus will enable the farmer to learn for himself whether the seed that he is using has good vitality or not. Germination tests may be made in two ways,—the so-called blotting paper methods, and the sand method. In making the germination test with blotting paper, blue blotting paper of common weight, cut into strips about 6 x 19 inches, should be used. This is laid folded twice so as to get a piece of three thicknesses and about six inches square, on an ordinary dinner plate or platter. The seeds if small are placed on the top of the paper and if large between the folds. The paper is kept moist (not soaked) and at a temperature of 70 to 80 degrees F.

If only a vitality test is desired the blotting paper method is preferable, but if it is desired to know how many seeds may be expected to grow, the sand method is in some ways preferable. In this method a thin layer of fine sand is sprinkled on the bottom of a flat dish and the seeds to be tested placed on it under a thin covering of sand. This must be kept moist and well shaded and at a somewhat higher temperature than in the first case.

At the end of every second day in the case of some seeds, and the third day in the case of those germinating more slowly, the sprouted seeds should be removed from the blotters or the sand and counted, the per cent being readily found by referring back to the number of seeds which were taken for the test. If 100 seeds are used, the number that sprout give the vitality per cent.

The Results of Inspection.

The inspection of grass seed sold in Maine in 1911 were made almost entirely by the seed analyst whose experience makes it possible for him to tell almost at a glance whether a seed is or is not what it is guaranteed. In all suspicious cases in which he was in doubt samples were taken. It therefore happens that the samples, the analyses of which are here reported, are the doubtful ones that were found within the State and represent a selection made from very many hundred lots.

There has been a very remarkable improvement in the quality of grass seed which is handled and there were practically no violations of the law in this State in 1911. This improved condition of Maine grass seed has been brought about chiefly by patient education. It has seldom been necessary in all the years that the law has been in effect to resort to prosecution.

DESCRIPTION OF TABLES.

The table which follows shows the number of dealers (109) visited by the inspector and the number of samples (640) examined.

The table on pages 7 to 9 summarizes the results of the examinations of samples of seeds examined by the Station in 1910.

The table on pages 9 and 10 contains a list of the different kinds of weed seeds obtained from seeds which were examined in the year 1911. 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 11 to 12 contains the analyses of official samples obtained in 1911. The inspector only drew samples from lots of which he was doubtful as to their corresponding to their guaranty.

Table showing the result of the inspection of seed in lots at dealers in 1911. These seeds were all examined at the dealers to see if they were in accord with the guaranties upon them. In doubtful cases samples were taken to the laboratory.

NAMES OF SEEDS AND NUMBER OF LOTS OF EACH INSPECTED.													
Timothy.	Red clover.	Alsike clover.	Mammoth clover.	White clover.	Redtop.	Hungarian.	Japanese millet.	German millet.	Kentucky blue grass.	Orchard grass.	Alfalfa.	Total number of lots.	Number of dealers visited.
166	125	108	22	5	96	73	38	1	3	1	2	640	109

Table showing results of examination of samples of seed in 1911.

Names of Weeds.	Kind of Seed and Number of Samples.									
	Red clover.	Alsike clover.	Mammoth clover.	Canadian blue grass.	Timothy.	Redtop.	Kentucky blue grass.	Hungarian.	Millet.	Orchard grass.
Number of samples examined	61	44	12	1	64	21	2	15	4	1
American pennyroyal	1	1	–	–	–	–	–	–	–	–
American wild mint	–	–	–	–	6	2	–	–	–	–
Barnyard grass	3	–	–	–	–	–	–	7	–	–
Bitter sweet	–	–	–	–	–	–	–	–	1	–
Black medick	6	35	–	–	–	–	–	–	–	–
Blue vervain	1	–	–	–	9	–	1	–	–	–
Bracted plantain	5	–	–	–	–	2	–	–	–	–
Canada thistle	–	5	1	1	–	–	–	–	1	–
Caraway	–	–	–	–	1	–	–	–	–	–
Catnip	1	–	–	–	–	–	–	1	–	–
Charlock	2	–	–	–	–	–	–	–	–	–
Chicory	1	1	–	–	1	–	–	–	–	–
Common mallow	4	–	–	–	–	–	–	–	–	–
Common nightshade	2	–	–	–	–	–	–	–	–	–
*Corn cockle	–	–	–	–	–	–	–	–	–	–
Corn mayweed	–	–	–	–	1	–	–	–	–	–
Crabgrass	3	1	–	–	2	2	–	4	–	–
Dandelion	–	–	–	–	2	–	1	–	–	–
Dock	39	22	9	–	8	–	1	1	–	1
Ergot	–	–	–	–	30	21	2	–	–	–
Evening primrose	1	1	–	–	40	1	–	–	–	–
False flax	–	11	–	–	1	–	–	–	–	–
Five finger	–	2	–	1	42	12	–	–	–	–
Flax dodder	6	–	–	–	–	–	–	–	–	–
Fowl-meadow grass	–	–	–	–	3	1	–	–	–	–
Goosefoot	19	8	3	–	40	1	–	7	–	–
Green foxtail	44	6	6	–	11	–	–	15	–	–

*Found in sample of vetch.

Table showing results of examination of samples of seed in 1911—Continued.

Names of Weeds.	Kind of Seed and Number of Samples.									
	Red clover.	Alsike clover.	Mammoth clover.	Canadian blue grass.	Timothy.	Redtop.	Kentucky blue grass.	Hungarian.	Millet.	Orchard grass.
Heal-all	4	1	2	–	3	–	–	–	–	–
Hedge mustard	–	3	–	1	15	–	–	–	–	–
Indian mallow	–	–	–	–	–	–	–	–	1	–
Knot grass	3	–	–	–	1	–	–	–	1	–
Lady's thumb	15	–	2	–	–	–	–	12	2	–
Marsh elder	1	–	–	–	–	–	–	–	–	–
Mayweed	3	4	–	1	11	–	–	–	–	–
Mint	–	–	–	–	2	3	–	–	–	–
Motherwort	–	–	–	–	1	–	–	–	–	–
Moth mullein	–	–	–	–	12	7	–	–	–	–
Mouse-ear chickweed	1	3	–	–	–	14	1	–	–	–
Mustard	2	–	–	–	–	–	–	–	–	–
Night-flowering catchfly	11	39	1	–	3	–	–	–	–	–
Old-witch grass	10	4	2	–	13	7	1	8	–	–
Paspalum setaceum	2	–	–	–	–	–	–	–	–	–
Pennsylvania persicaria	–	–	–	–	–	–	–	–	1	–
Peppergrass	–	5	–	–	29	6	–	–	–	–
Pigweed	2	2	–	–	2	–	–	5	–	–
Pimpernel	–	–	–	–	1	–	–	–	–	–
Plantain	–	2	–	–	2	11	–	–	–	–
Purslane	–	–	–	–	–	2	–	–	–	–
Ragweed	10	–	1	–	–	–	–	5	3	–
Raspberry	–	–	–	–	1	–	–	–	–	–
Rat's-tail fescue grass	–	–	–	–	–	3	–	–	–	–
Ribgrass	36	5	3	–	4	1	–	–	–	–
Rugel's plantain	28	6	6	1	41	4	–	1	–	–
Sedge	1	2	–	–	43	18	1	–	–	–
Sheep sorrel	21	37	5	–	18	9	2	–	–	–
Shepherd's purse	–	1	–	–	2	4	–	–	–	–

Table showing results of examination of samples of seed in 1911—Concluded.

Names of Weeds.	Kind of Seed and Number of Samples.									
	Red clover.	Alsike clover.	Mammoth clover.	Canadian blue grass.	Timothy.	Redtop.	Kentucky blue grass.	Hungarian.	Millet.	Orchard grass.
Slender crabgrass	10	1	–	–	4	–	–	5	–	–
Spiny sida	4	–	–	–	–	–	–	–	3	–
Spurge	3	–	1	–	2	–	1	–	–	–
Tumble-weed	–	1	–	–	1	–	–	–	–	–
Virginia three-seeded mercury	3	–	–	–	–	–	–	1	–	–
White vervain	–	–	–	–	1	–	–	–	–	–
Wild carrot	5	–	–	–	–	–	–	–	–	–
Wild madder	–	–	–	–	3	–	–	–	–	–
Wormseed mustard	1	–	–	–	3	–	–	1	–	–
Yarrow	–	–	–	–	1	21	–	–	–	–
Yellow daisy	–	–	–	–	20	6	–	–	–	–
Yellow foxtail	3	–	–	–	–	–	–	14	4	–
Yellow rocket	–	1	–	–	–	–	–	–	–	–
Yellow-wood sorrel	–	–	–	–	4	–	–	–	–	–

A list of weed seeds found in seeds examined in 1911.

Nomenclature, Gray's Manual, 17th Edition, 1908.

Common Name.	Scientific Name.
American pennyroyal	Hedeoma pulegioides (L.) Pers.
American wild mint	Mentha canadensis (L.) Brig.
Barnyard grass	Echinochloa crusgalli (L.) Beauv.
Bitter sweet	Solanum dulcamara L.
Black medick	Medicago lupulina L.
Blue vervain	Verbena hastata L.
Bracted plantain	Plantago aristata Michx.
Canada thistle	Cirsium arvense (L.) Scop.
Caraway	Carum carvi L.
Catnip	Nepeta cataria L.
Charlock	Brassica arvensis L.
Chicory	Cichorium intybus L.
Common mallow	Malva rotundifolia L.
Common nightshade	Solanum nigrum L.
Corn cockle	Agrostemma githago L.

A list of weed seeds found in seeds examined in 1911—Concluded.

NOMENCLATURE, GRAY'S MANUAL, 17TH EDITION, 1908.

COMMON NAME.	SCIENTIFIC NAME.
Corn mayweed	Matricaria inodora L.
Crabgrass	Digitaria sanguinalis (L.) Scop.
Dandelion	Taraxacum officinale Weber.
Dock	Rumex Sp.
Ergot	*Claviceps purpurea (Fr.) Tul.
Evening primrose	Oenothera biennis L.
False flax	Camelina microcarpa Andrz.
Five finger	Potentilla monspeliensis L.
Flax dodder	Cuscuta epilinum Weihe.
Fowl meadow grass	Glyceria nervata (wild.) Trin.
Goosefoot	Chenopodium album L.
Green foxtail	Setaria viridis (L.) Beauv.
Heal-all	Prunella vulgaris L.
Hedge mustard	Sisymbrium officinale (L.) Scop.
Indian mallow	Abutilon theophrasti Medic.
Knot grass	Polygonum aviculare L.
Lady's thumb	Polygonum persicaria L.
Marsh elder	Iva ciliata Willd.
Mayweed	Anthemis cotula L.
Mint	Mentha Sp.
Motherwort	Leonurus cardiaca L.
Moth mullein	Verbascum blattaria L.
Mouse-ear chickweed	Cerastium vulgatum L.
Mustard	Brassica nigra (L.) Koch.
Night flowering catchfly	Silene noctiflora L.
Old-witch grass	Panicum capillare L.
Pennsylvania persicaria	Polygonum pennsylvanicum L.
Peppergrass	Lepidium virginicum L.
Pigweed	Amaranthus retroflexus L.
Pimpernel	Anagallis arvensis L.
Plantain	Plantago major L.
Purslane	Portulaca oleracea L.
Ragweed	Ambrosia artemisiifolia L.
Raspberry	Rubus idaeus L.
Rat's 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 paspalum	Paspalum setaceum Michx.
Spiny sida	Sida spinosa L.
Spurge	Euphorbia preslii Guss.
Tumble-weed	Amaranthus graecizans L.
Virginia three-seeded mercury	Acalypha virginica L.
White vervain	Verbena urticaefolia L.
Wild carrot	Daucus carota L.
Wild madder	Galium mollugo L.
Wormseed mustard	Erysimum cherianthoides 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 the kind of seed, name and location of dealer, and the results of the analysis of official samples taken in 1911.

Station number.	Kind of Seed, Name and Town of Dealer. Special Marks.	Purity. Guaranteed.	Purity. Found.	Impurities. Inert matter.	Impurities. Harmless—Foreign.	Impurities. Noxious—Foreign.
	ALSIKE CLOVER.	%	%	%	%	%
	Wm. F. Chick, Bangor.					
6851	Lotus Alsyke	96.1	96.3	0.8	2.7	0.2
6852	D. B. Alsike clover	99.2	99.0	0.4	0.5	0.1
	A. H. Fogg Co., Houlton.					
6893	Ace Alsike 97 %, lot 86143	97.0	96.8	0.6	2.1	0.5
6894	Globe Alsyke, 98 %, lot 86134	98.0	98.3	0.2	1.3	0.2
	George B. Haskell Co., Lewiston.					
6827	XXX Alsike (Globe)	98.0	98.7	0.2	0.9	0.2
6828	XX Alsike (Ace) 86102	95.0	95.2	0.5	3.6	0.7
6829	X Alsike (Kaiser) 86105	92.0	91.2	0.7	6.7	1.4
	Oscar Holway Co., Auburn.					
6854	"Bell" Alsike	97.0	95.7	1.1	2.7	0.5
6872	"Bell" Alsike. Shippers' test 97%	97.0	96.9	0.9	2.0	0.2
6925	A. A. Howes & Co., Belfast. Alsike	99.0	97.8	0.5	1.2	0.5
	RED CLOVER.					
	Wm. F. Chick, Bangor.					
6850	Pansy Medium Clover	99.2	98.5	1.0	0.3	0.2
	A. H. Fogg Co., Houlton.					
6895	Globe Medium Clover, 99%, 76896	99.0	99.6	0.3	–	0.1
6900	Ace Medium Clover, 99%, 77042	99.0	98.5	0.7	0.5	0.3
	George B. Haskell Co., Lewiston.					
6824	XXX Red Clover (Globe) 76896	99.0	99.7	0.2	0.1	–
6825	XX Red Clover (Ace) C76893	99.0	99.2	0.5	0.1	0.2
6826	X Red Clover (Kaiser) 76843	96.0	97.2	1.0	0.8	1.0
	Oscar Holway Co., Auburn.					
6836	Globe R. Clover, lot 70952	99.0	99.8	0.1	0.1	–
6839	Red Clover, lot C85	99.0	99.6	0.2	0.1	0.1
6840	Red Clover, lot 55	99.0	99.2	0.6	0.1	0.1
6871	"Bell" Clover, shippers' test, 99%	99.0	97.8	0.8	1.0	0.4
	G. F. Rowe, China.					
6923	Ace Brand Red Clover, C77071	99.0	98.8	0.9	0.1	0.2
	MAMMOTH CLOVER.					
	Wm. F. Chick, Bangor.					
6848	Prime Mammoth Clover	99.6	99.3	0.5	0.1	0.1
6849	D. B. Mammoth Clover	99.8	99.4	0.4	0.1	0.1
	A. H. Fogg Co., Houlton.					
6898	Ace Mammoth Clover, 77049	99.0	99.2	0.5	0.1	0.2
6899	Globe Mammoth Clover, 76965	99.0	99.7	0.1	0.2	–

Table showing the kind of seed, name and location of dealer, and the results of the analysis of official samples taken in 1911—Concluded.

Station number.	KIND OF SEED, NAME AND TOWN OF DEALER. SPECIAL MARKS.	PURITY. Guaranteed.	PURITY. Found.	IMPURITIES. Inert matter.	IMPURITIES. Harmless—Foreign.	IMPURITIES. Noxious—Foreign.
	HUNGARIAN.					
	Wm. F. Chick, Bangor.					
6846	Hungarian	98.6	98.4	0.7	–	0.9
6847	Hungarian	98.0	97.1	0.3	–	2.6
	E. P. Ham, Lewiston.					
6866	Prime Hungarian	97.0	98.9	0.5	–	0.6
	Oscar Holway Co., Auburn.					
6837	Hungarian, lot 80908	96.0	99.3	0.1	–	0.6
	Shaw, Hammond & Carney, Portland.					
6924	Hungarian, lot 50, car 3768, O. S. No. 1	98.0	98.2	0.1	0.1	1.6
	REDTOP.					
	E. P. Ham, Lewiston.					
6869	Fancy Red Top	92.0	84.8	13.0	1.0	1.2
	George B. Haskell Co., Lewiston.					
6830	X Redtop (Massabesic) R. J. 62	90.0	89.7	5.9	2.4	2.0
	Oscar Holway Co., Auburn.					
6842	Fancy Red Top	93.0	92.8	5.8	0.1	1.3
6855	Red Top "B"	90.0	91.4	7.7	0.4	0.5
6873	"Mart" Red Top, shippers' test, 92%	92.0	91.5	6.7	0.3	1.5
	TIMOTHY.					
	A. H. Fogg Co., Houlton.					
6896	Globe Timothy, lot 69962 R	99.0	99.6	0.2	0.1	0.1
6897	Pine Tree Timothy, lot 61276	99.0	99.5	0.2	0.2	0.1
	E. P. Ham, Lewiston.					
6863	"Blue Jay", Timothy	99.0	98.9	0.7	0.3	0.1
6864	"Veribest", Timothy	97.0	97.7	0.6	1.3	0.4
6865	"Bell", Timothy	98.0	98.1	0.5	0.9	0.5
	George B. Haskell Co., Lewiston.					
6823	X Timothy (Bison), T61132	96.0	97.1	1.0	1.6	0.3
	Oscar Holway Co., Auburn.					
6834	Timothy, T142	99.0	98.9	0.4	0.5	0.2
6835	Timothy, "Globe", 69167	99.5	99.6	0.2	0.1	0.1
6836	Timothy, "Bison", 60180	97.0	98.2	0.5	1.1	0.2
6841	Timothy, "Pine Tree"	99.0	99.6	0.2	0.1	0.1
	Oscar Holway Co., Auburn.					
6936	No. 450 Timothy	98.0	98.9	0.5	0.5	0.1
	John Watson & Company, Houlton.					
6926	Rennie Timothy, T3514, T3516	99.0	99.3	0.5	0.1	0.1
	JAPANESE MILLET.					
	Johnson Bros., North Berwick.					
6929	Japanese Millet, 81177	97.0	95.2	0.1	–	4.7

February, 1912

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

ANALYSTS

James M. Bartlett **Herman H. Hanson**
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Official Inspections

37

CARBONATED BEVERAGES.

During the summer of 1910 an investigation of the carbonated beverages, or bottled sodas, sold in Maine was made and the results reported in Official Inspections 27. During the season just passed this study was continued and the findings are contained in the following pages.

A list of the bottlers of soda waters in Maine and the results of the examination of their products appears on page 20. Samples from all but four of the 51 manufacturers were analyzed and three of these exceptions are reported in Official Inspections 27. The one whose goods were not examined was not bottling at the time of our visit.

The samples were all examined for saccharin and artificial colors and special examinations were made on many of the goods which bore fancy names. Tests were made in some cases for alcohol and in others for different preservatives. In the cases of goods carrying saccharin prosecutions were commenced and in all cases the dealers have plead guilty and the cases have been settled by the payment of a fine.

A larger portion of the manufacturers than last year were found to be using only the seven permitted dyes for coloring purposes. In all of those cases where dyes not of the permitted seven were found present the goods were carefully examined for poisonous materials but none were discovered.

A sanitary inspection was made of all premises where possible.

In Publication 425 of this Station, The Requirements Under the Law Regulating the Sale of Foods, the following definition of carbonated beverages is given:

143. *Carbonated beverages.* The standards for carbonated beverages, root beer 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, either bottled or sold at fountains. Benzoate of soda may be used in bottled goods if its presence and amount are declared on the label and at fountains if conspicuous signs are used declaring its presence and amount used.

For the present cream soda, sarsaparilla, root beer, birch beer and ginger ale may be sold without statement that they are artificially colored and flavored. If benzoate of soda is present it must be declared.

In Food Inspection Decision 135 the use of saccharin has been prohibited in foods entering interstate commerce after July 1, 1911. In consideration of the fact that much of the bottled soda for this season's trade has already been put up and supplies and labels already purchased, the sale of carbonated beverages containing saccharin will be permitted in Maine until January 1, 1912, provided the presence of saccharin is plainly stated on the label.

SACCHARIN.

In Official Inspections 27 it was stated that saccharin would be allowed in bottled sodas, provided its presence and amount were stated upon the label. It will be noted that since that publication was issued there has been a decision under the National Food and Drugs Act prohibiting the use of saccharin in goods entering interstate trade. As it has always been the policy of the executive of the Maine Food Law to make the regulations under the State law conform, as far as possible, with those under the National law, saccharin cannot now be lawfully used in foods or beverages whether its presence is stated or not. This regulation went into effect January 1, 1912.

The goods examined in 1911 might lawfully contain saccharin provided its presence and amount were stated upon the label. One company was found to be using saccharin and stating that fact upon its labels. Five different companies were found to be using saccharin as an artificial sweetener and not stating that fact upon the labels. In each one of these cases the manufacturers were fined for the offence.

Misbranded Bottles.

In last year's report upon this industry the subject of bottles misbranded by having the names of different manufacturers blown in the glass and being used promiscuously by any bottler in the State was taken up at some length. It was there stated that a reasonable time would be given for the bottlers of the State to straighten out this particular matter. This notice received some attention last season and several of the bottlers made sincere attempts to use only bottles bearing their own name or plain bottles. Others paid no attention whatever to the notice and perhaps there were some who did not see it. No prosecutions were made during the present season for this kind of misbranding, but a vigorous campaign of education was carried on and it seems improbable that there is now any bottler in the State who does not understand the necessity for this ruling and the reason why it was made. As stated before, it is a great injustice to a manufacturer of high grade goods to have his bottles filled by makers of low grade, artificially sweetened and flavored sodas.

As a result of conferences held with some of the leading bottlers of the State the people engaged in the bottled soda industry have formed a bottlers' association for the purpose of mutual protection and improvement and with one of its prime objects the regulation of this kind of misbranding. It does not necessarily follow that a bottling firm cannot live up to the requirements of the food law without joining this association, but membership in it is strongly recommended, as the means adopted by the association seem to be the fairest and easiest ways to correct the misbranding which is under consideration. The following bottlers have joined this association and are evidently attempting to live up to its requirements. The list was corrected by the Secretary of the Association in January, 1912.

Copeland & Co., Bangor.
I. B. Burgoin, Fort Kent.
C. E. Odiorne Bottling Co., Portland.
Leslie Curtis, Dexter.
Milo Bottling Co., Milo.
Geo. H. Tardif, Waterville.
Gideon Mahew, Waterville.
C. E. Hevener, Rockland.
Mt. Kebo Spring Co., Bar Harbor.
John O'Reilly & Son, Skowhegan.
Bath Bottling Co., Bath.
D. Ziter & Bro., Caribou.
Rumford Bottling Co., Rumford.
Murdock & Freeman Co., Portland.
Glenwood Spring Co., Augusta.
Bangor Bottling Co., Bangor.
Pine Spring Water Co., Brunswick.
J. L. Spratt, Bangor.
Vincent Bottling Co., Auburn.
Ingalls Bros., Portland.
M. Rudman, Waterville.
Hartleb & Cheltra, Bath.
Wm. Palmer, Houlton.
W. A. Seekins, Pittsfield.
Belfast Candy Co., Belfast.
Hanscom Bottling Co., Biddeford.
Dennis Bros., Cherryfield.

The Use of Misbranded Bottles.

So far as the Maine Food Law is concerned bottles having names blown in the glass that are not those of the bottler actually putting up the goods may be used if the names and other distinguishing marks blown in the glass are fully covered by a label stating the name and address of the bottler actually putting out the goods. Since bottled beverages are frequently put on ice or in ice water for cooling before they are sold by the retailer, the labels must be so firmly attached that they will stand this treatment. The excuse that a bottle was properly labelled when it left the bottling works will not be accepted as a reason for passing goods that are in mislabeled bottles.

In this connection there is another important thing for the bottler to notice. By a provision of law (Revised Statutes Chapter 40, Sections 37-39) bottles and other containers with the names of the owners upon them can be registered. There is a punishment by fine or imprisonment or both for using commercially in any way such registered containers, by any person other than the one who has registered them.

With the double danger of an attached label soaking off or using unwittingly a registered bottle there would seem to be only one safe course for the bottler of beverages. Use only bottles bearing his own name or plain bottles. To do otherwise is dangerous.

Misbranded Soda.

One or two cases were discovered in which goods flavored with imitation flavors and colored artificially were labeled as though the goods were real and not imitation. For example, goods marked "blood orange" were found upon examination to be artificially flavored and colored with a coal tar dye. One case which seemed particularly flagrant was prosecuted and a fine of $25 imposed. The other case of this kind was connected with a saccharin case and was settled in connection with the prosecution of that case. It is possible to make an orange soda water from the real orange extract and containing the natural color and flavor, and in the labeling sharp distinction should be made between these goods and goods which imitate them by means of synthetic flavors and coal tar dyes.

Artificial Colors.

As was stated at the beginning of this discussion, a larger proportion of the manufacturers than last year were found to be using the seven permitted coal tar dyes for this work. In all cases where other than the permitted dyes were used careful examination was made of the goods in order to ascertain if any poisonous or deleterious materials were present. In the goods examined no poisons were found and no prosecutions were made in these cases. It is earnestly recommended, however, that wherever coal tar colors are used in bottled sodas only one, or a mixture, of the seven permitted dyes be used. These seven permitted dyes are made expressly for use in foods and during the process of manufacture all poisonous materials are carefully excluded. On the other hand there are hundreds of coal tar dyes on the market which are made not particularly for food work and which do contain traces of arsenic, or which have been found to be poisonous in themselves. While the certified colors may be slightly more expensive than the uncertified ones still the difference is so trifling that with the small amount necessary for the coloring of bottled sodas the difference in price is negligible. It is, perhaps, unnecessary to state that should poisonous colors be found in food products prosecution would without hesitation be made.

ALCOHOL.

A much smaller percentage of the goods examined the present year were found to contain alcohol than the goods analyzed last year. In Official Inspections 27 it was stated that "the flavor of some of these bottled soft beverages is dependent to a more or less extent upon the amount of alcohol present, and a constant use of some of these containing approximately one per cent. of alcohol would quite readily be a means for developing a taste for alcoholic beverages." It is to be regretted that any of the bottled sodas carry alcohol to the slightest extent.

CREAM SODA, SARSAPARILLA SODA, BIRCH, ETC.

No new regulations in regard to the labeling of goods known as cream soda, sarsaparilla soda, birch, root beer, ginger ale, etc., have been made in this State and for the present they may be lawfully manufactured and sold as in the past. It is understood that investigations under the National Law have been going on for some time concerning the composition of these goods and the right to the use of some of the above names upon the ordinary bottled soda waters. If new regulations are in the future promulgated under the National law it is probable that such regulations would be adopted in the enforcement of the Maine law as it has always been the policy of the executive of the State law to have Maine regulations and rulings conform, as far as possible, with those under the National law so that the dealers might have but one set of regulations by which to govern their manufacturing.

WATER USED IN BOTTLED SODAS.

In the examination of the bottled sodas thus far we have made no bacteriaiological examination as there were so many more obvious things that needed first attention. It is realized, however, that this is one of the most important phases of the work, and it is now planned to take up this important question next summer. It is hoped to find the goods as pure in this respect as it is possible to make them, but it is feared that some may be found of inferior quality because of the contamination of the water supply. It is well known that some of the manufacturers of bottled sodas in the State are using only the purest spring water and that the preparation of their goods is carried on with extreme care. Other manufacturers use local supplies of various kinds, and it is feared that some of these may not be properly safeguarded from possible pollution. It does not necessarily follow that because spring water is used the finished product is pure. Springs themselves may be contaminated in various ways. They may be situated so that they receive surface drainage, or they may receive contamination from ignorant or careless people who use them as a source of supply. And of course the purest water may be handled carelessly and the finished product rendered unfit for drinking.

It has been considered by some that the process by which the goods are charged with carbonic acid gas is a means of sterilization. Recent experiments in one of the western states do not bear out this contention. And this fact should be borne carefully in mind that whatever contamination is present in the water used will enter into the finished product for consumption. If tap water is used from the town supply and there is suspicion that it is polluted in any way its use should be discontinued. A water that may be used with comparative safety for household purposes may be unsafe for soda water. Drinking water may easily be boiled and thus rendered harmless, but such measures cannot be taken with soda waters without destroying their palatability.

Sanitation.

As was stated in Official Inspections 35, in a few of the bottling establishments visited during the last season no attempt at screening was found and during the summer months the situation with regard to the presence of flies was very bad. In some of the places the floors were dirty and the places were very much cluttered with bottles, cases and barrels, and in one case in particular the toilet facilities were not properly arranged.

It is the hope of the executive of the Maine Food Law and should be the ambition of each bottler to have the bottled sodas of Maine as pure as it is possible to make them, and to have them put up under perfectly sanitary conditions. Those of the bottlers who are also interested in this subject are invited to correspond with the Director with regard to any feature of the business which in his mind is in need of improvement.

Table showing results of analyses of samples of soda water Carbonated Beverages purchased in summer of 1911, arranged alphabetically by towns.

Name of Town; Brand, if any, and Maker.	No. of samples analyzed.	Remarks.
Auburn, Vincent Bottling Company	6	Passed.
Bangor, Bangor Bottling Works	8	Passed.
Bangor, Copeland & Co	4	Passed.
Bangor, F. E. Robinson	7	Three samples adulterated with saccharin, not declared.
Bangor, J. M. Ross	9	"Blood orange" soda misbranded. Not marked artificial color.
Bangor, J. L. Spratt	7	Passed.
Bath, Bath Bottling Co	2	Passed.
Bath, Hartleb & Cheltra	3	Passed.
Belfast, Belfast Candy Co., Mayo & White	5	Passed.
Biddeford, Hanscom Bottling Co	9	"Jersey Creme" contained trace of saccharin.
Brunswick, Pine Spring Water Co	1	Passed.
Calais, Beckett & Co	4	Passed.
Caribou, E. Ziter & Bros	1	Adulterated with saccharin, not declared.
Cherryfield, Washington County Bottling Co., Dennis Bros	8	Passed.
Danforth, Sam Ross	5	Adulterated with saccharin, not declared.
Dexter, Leslie Curtis	11	Passed.
Eastport, Eastport Bottling Co., Frank Malloch	4	Passed.
Fort Kent, I. B. Burgoin	4	Passed.
Freeport, Pinecroft Bottlery	5	Passed.
Greatworks, B. F. Piers	3	Passed.
Houlton, Wm. Palmer Bottling Co	14	Passed.
Lewiston, Maine Bottling Co	8	Passed.
Lewiston, Somoar Carbonating Co	6	Passed.
Lewiston, Windsor Mineral Spring Co	3	Passed.
Lubec, T. G. Mitchell	4	Passed.
Millinocket, Millinocket Bottling Co	7	Passed.
Milo, Milo Bottling Co	4	Passed.
Patten, Patten Bottling Co	2	Passed.
Pittsfield, Wm. Seekins	2	Passed.
Portland, Ingalls Bros	9	"Jersey Creme" contained trace of saccharin.
Portland, Murdock & Freeman	7	Passed.
Portland, C. E. Odiorne Bottling Co	6	Passed.
Portland, Portland Bottling Co	5	Passed.
Portland, Underwood Spring Corporation	7	Passed.
Presque Isle, Presque Isle Bottling Co., T. J. Michaud, Mgr	12	Adulterated with saccharin. Two bottles misbranded, not marked artificial color.
Prospect, Switzer Water Co. (P. O. Stockton Springs)	7	Passed.
Rockland, C. E. Havener	7	Passed.
Rockland, Hewitt Bottling Works	6	Passed. Contained saccharin but were properly marked.
Rockland, Knox County Bottling Works	1	Passed.
Rumford, Virginia Spring Water Co	6	Passed.
*Rumford Falls, Murdock & Freeman Co	3	Passed.
Rumford Falls, Rumford Bottling Co		Passed.
Skowhegan, John O'Reilley & Son	11	Passed.
Van Buren, Jos. J. Cyr	7	Adulterated with saccharin, not declared.
Waldoboro, B. A. Boggs	4	Passed.
Waterville, Gideon Mahew	2	Passed.
Waterville, Mineral Water Soda Co., M. Rudman	3	Passed.
Haverhill, Mass., "Granite State Spring Water Ginger Ale"	1	Passed.
"U. S. Club Ginger Ale"	1	Passed.

* Recently purchased by the Rumford Bottling Co.

Ice Cream.

During the summer of 1911 about 80 samples of ice cream were examined from the various dealers in the cities and towns of Auburn, Bangor, Fairfield, Lewiston, Oakland, Portland, and Waterville, with the results given in the table on pages 22 and 23. Two prosecutions were made. In one case the dealer was warned before the sample was obtained that the f rmula which he was using would not make a standard ice cream and he was advised to change his formula. Some time after an official sample was obtained at his place and it was found to be but slightly over half the standard in milk fat content. The other case which was prosecuted seemed also a particularly flagrant one for the following reasons:

During the previous year two samples of ice cream from this dealer both were found to be below the standard. He was warned that his goods should be of better quality. He placed the blame upon the person from whom he was obtaining his cream. He was advised to obtain a written guaranty from this person and take particular pains to get a better quality of cream for his goods. The same conditions were found in the season of 1911 and in correspondence it developed that no written guaranty had been obtained, and that apparently no change had been made in the formula or in the manner of making up the goods. The case was therefore prosecuted and a fine paid.

In another case where prosecution was commenced the goods from this same person had been analyzed the previous year and had been found below standard. Before the case came to trial, however, the dealer went out of business and moved from the State.

There have been a number of cases develop during the past two seasons' examination in which it seemed apparent that the dealers were not obtaining cream which contained the amount of butter fat which they supposed they were getting. These cases are still being investigated and this study will be continued another season and if it is found that either creameries or dairymen are supplying dealers with cream below standard and below the grade paid for such cases will be prosecuted wherever found. In these as in all other matters were the work of the Station and the Department of Agriculture touch we have the fullest cooperation of Commissioner Buckley and his assistants.

Table showing results of analyses of samples of ice cream purchased in the summer of 1911, arranged alphabetically by towns.

Station Number.	Town and Dealer.	Milk fat per cent.	Remarks.
9866	Auburn, Bumpus & Getchell.......	16.0	Passed.
9863	Auburn, E. L. Fowles............	14.5	Passed.
9864	Auburn, E. A. Pettingill..........	15.3	Passed.
9860	Auburn, R. A. Rounds............	14.2	Passed.
9865	Auburn, Fred L. Ruggles..........	16.4	Passed.
9862	Auburn, J. M. Stevens & Co.......	15.9	Passed.
9861	Auburn, L. E. Tarr...............	16.1	Passed.
9788	Bangor, J. F. Boyd...............	13.0	Dealer warned. Purchased from Geo. E. Lufkin.
9913	Bangor, Simon Belinian...........	15.0	Passed.
9786	Bangor, G. N. Brountas...........	14.5	Passed.
9782	Bangor, Buckley & Preble.........	13.6	Dealer warned. Purchased from Harry Witham.
9916	Bangor, O. Elias.................	7.8	Dealer fined.
10080	Bangor, Floros Bros..............	14.1	Passed.
9914	Bangor, C. A. Fowler.............	12.7	Dealer warned.
10077	Bangor, C. A. Fowler.............	12.5	Dealer warned.
9787	Bangor, Frawley's Pharmacy......	17.0	Passed.
9785	Bangor, G. E. Lufkin.............	13.8	Passed.
10078	Bangor,G. E. Lufkin..............	13.3	Dealer warned.
9781	Bangor, C. McKenna..............	13.9	Passed. Purchased from Harry Witham.
9912	Bangor, S. Shiro.................	17.4	Passed.
9789	Bangor, Caldwell Sweet...........	17.5	Passed.
9784	Bangor, C. S. Vafiades............	15.0	Passed.
9909	Bangor, Wyman's Drug Store......	11.5	Dealer warned.
9915	Bangor, Wyman's Drug Store......	13.4	Dealer warned.
10079	Bangor, Wyman's Drug Store......	13.5	Dealer warned.
9921	Fairfield, C. E. Holt..............	14.2	Passed.
9923	Fairfield, C. W. McClintock........	14.4	Passed.
9922	Fairfield, The Wilson Pharmacy....	14.6	Passed.
9938	Lewiston, Babcock & Sharp........	14.8	Passed.
9930	Lewiston, C. Biladeau............	14.6	Passed.
9867	Lewiston, A. L. Grant............	15.4	Passed.
9934	Lewiston, A. E. Harlow...........	14.7	Passed.
9935	Lewiston, Mrs. S. E. Holmes.......	15.6	Passed.
9868	Lewiston, Lewiston Candy Kitchen.	16.7	Passed.
9936	Lewiston, Chas. Morneau, Jr.......	15.3	Passed.
9933	Lewiston, Geo. A. Ross...........	17.5	Passed.
9937	Lewiston, P. K. Sarantos..........	16.2	Passed.
9932	Lewiston, Smith's Drug Store......	14.8	Passed.
9869	Lewiston, Samuel Stewart.........	14.8	Passed.
9931	Lewiston, H. F. Walker...........	15.9	Passed.
9917	Oakland, C. H. Martin............	12.6	Dealer warned. Inspector called second time but found no ice cream being made.
9969	Portland, Deering Ice Cream Co....	13.7	Passed.
10002	Portland, Hay's Drug Store........	13.2	Passed with warning.
10008	Portland, Hay's Drug Store........	15.2	Passed.
9972	Portland, Heseltine & Tuttle Co....	12.3	Dealer warned.
10012	Portland, Heseltine & Tuttle Co....	13.5	Passed with warning.
9976	Portland, T. E. Hilton............	12.4	Dealer warned.
10015	Portland, T. E. Hilton............	14.6	Passed.
9971	Portland, Leighton's Store.........	10.9	Dealer warned. Purchased from C. C. Pooler. (See 10011.)
10011	Portland, Leighton's Store.........	13.5	Passed with warning. Purchased from C. C. Pooler.
10000	Portland, I. F. Lord & Son........	15.4	Passed.
9975	Portland, O. S. Maxell............	12.3	Dealer warned.
10014	Portland, O. S. Maxell............	15.6	Passed.
9999	Portland, Wm. E. Murphy.........	13.8	Passed.
10001	Portland, Geo. E. Sawyer..........	16.8	Passed.
9974	Portland, J. G. Sawyer............	9.8	(See No. 10013.)
10013	Portland, J. G. Sawyer............	13.5	Passed with warning.
9997	Portland, Simmons & Hammond....	14.1	Passed.

Table showing results of analyses of samples of ice cream purchased in the summer of 1911, arranged alphabetically by towns—Concluded.

Station Number.	Town and Dealer.	Milk fat per cent.	Remarks.
9970	Portland, Smith & Broe	12.2	Dealer warned. Purchased from Pierce Ice Cream Co.
10009	Portland, Smith & Broe	11.3	Dealer warned. Purchased from Pierce Ice Cream Co.
9973	Portland, G. F. Soule	15.4	Passed.
9998	Portland, J. J. Thuss	12.8	Dealer warned.
9996	Portland, West End Dairy	12.8	Dealer warned.
10007	Portland, West End Dairy	12.6	Dealer warned.
9813	Waterville, College Ave. Pharmacy	10.1	Dealer warned. Inspector made second visit and found no ice cream being made.
9803	Waterville, Geo. A. Daviau	13.0	Dealer warned.
9807	Waterville, Pierre Fortier	15.7	Passed.
9810	Waterville, W. A. Hager	17.1	Passed.
9808	Waterville, Hawker's Drug Store	17.7	Passed.
9814	Waterville, E. W. Luques	19.9	Passed.
9802	Waterville, S. Paganucci	13.9	Passed.
9812	Waterville, S. Paganucci	14.3	Passed.
9806	Waterville, J. D. Parents	21.2	Passed.
9805	Waterville, A. J. Ponsant	14.4	Passed.
9809	Waterville, E. L. Simpson	12.8	(See 9918.)
9918	Waterville E. L. Simpson	13.3	(See text.)
9804	Waterville, Jos. Vantrosco	12.5	(See 9919.)
9919	Waterville, Jos. Vantrosco	10.5	Prosecution commenced, but dealer went out of business and moved from the State.
9811	Waterville, Verzoni Bros	16.9	Passed.

Hearings and Prosecutions.

Whatever the nature of the seeming violation of any of the provisions of the laws regulating the sale of agricultural seeds, commercial fertilizers, commercial feeding stuffs, drugs, foods, fungicides or insecticides, hearings are appointed as directed by the law. In the great majority of instances the defendant either offers satisfactory explanation or gives assurance that the public will be protected in the future. Whenever it seems that the interests of the public can be equally served the cases are passed without prosecution. In the execution of the laws far more stress is laid upon educational than upon punitive methods. No merely technical violations of law are followed by prosecutions. When cases have to be brought they are usually brought as civil instead of criminal prosecutions as in this way uncontested cases can be more readily and speedily settled. It also is often true that the case is not so serious as to justify giving the person a criminal record. By means of the hearings every violation is investigated and the parties concerned have their attention very plainly brought to the violations and the need for reform. While a law without penalties would be impossible of execution the hearing feature is proving to be an exceedingly valuable provision, helpful alike to the executive and to the trade, and hence is working to the interest of the public.

Most of the cases were settled without prosecution. The cases that were settled by prosecution during the three months ending December 31, 1911, are as follows: In each instance the accused plead guilty and settled without the case being tried.

List of Cases Settled Without Trial on Payment of Fines in the Quarter Ending December 31, 1911.

Name and Town of Defendant.	Nature of Complaint.
Bowley, J. P. & Co., Sanford	Misbranded pickles. Contained alum.
Broggi, F., Sanford	Misbranded pickles. Contained alum.
Carl, E. S., Saco	Adulterated oysters. Contained added water.
Coffin, G. W., Mechanic Falls	Adulterated oysters. Contained added water.
Cyr, J. J., Van Buren	Misbranded bottled sodas. Contained saccharin.
Doughty & Jewett, Portland	Adulterated oysters. Contained added water.
Elias, O., Bangor	Adulterated ice cream. Low in milk fat.
Levesque, Paul, Lewiston	Adulterated oysters. Contained added water.
McGary Bros., Houlton	Misbranded pickles. Contained alum.
Palmer Cash Market, Lewiston	Adulterated oysters. Contained added water.
Presque Isle Bottling Co., Presque Isle	Misbranded bottled sodas. Contained saccharin.
Robinson, F. E., Bangor	Misbranded bottled sodas. Contained saccharin.
Ross, S. B., Danforth	Misbranded bottled sodas. Contained saccharin.
Simpson, E. L., Waterville	Adulterated ice cream. Low in milk fat.
Ziter, D. & Bro., Caribou	Misbranded bottled sodas. Contained saccharin.

March, 1912

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

CHAS. D. WOODS, Director

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Official Inspections.

38

FEEDING STUFF INSPECTION.

The changes in the law which became effective July 1, 1911, were pointed out in Official Inspections 32. This was mailed to dealers and others likely to be interested.

Herewith are reported (pages 26-55) the analyses of samples examined during the year from March 1911, and (pages 56-72) a classified list of the feeding stuffs registered for sale in Maine before February 15, 1912. A few brands have been registered while the number was in the hands of the public printer.

Especial attention is called to the fact that the law calls for the maximum percentage of fiber to be stated upon the package, and in the case of compounded feeds the names of the materials of which they are composed. These are important helps in the selection of a feed and should be given careful consideration by dealers and feeders. In the table giving the list of feeding stuffs registered these facts are set forth.

Copies of the requirements of the law, certifies for registering and directions for sampling can be had on application. All correspondence relative to inspection laws and their enforcement should be addressed to Director Chas. D. Woods, Orono, Maine.

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	* Source of sample.	Station number.
COTTONSEED MEALS.		
American Cotton Oil Co., N. Y. City. Choice Cottonseed Meal	D	2952
American Cotton Oil Co., New York City. Choice Cottonseed Meal	O	2991
H. F. Bridges & Co., Memphis, Tenn. Cottonseed Meal	D	2850
	D	4039
	D	4181
	D	4233
	D	4254
	O	4265
	D	4267
F. W. Brode & Co., Memphis, Tenn. Dove Brand Cottonseed Meal	D	2863
	D	2883
	D	2892
	D	2894
	D	2895
	D	2996
	D	2941
	D	2949
	O	4037
	D	4040
	D	4043
	D	4072
	D	4113
	D	4139
	O	4162
	D	4190
	D	4191
	D	4200
	D	4218
	D	4234
	O	4237
	D	4257
	D	4258
	O	4275
	D	4279
	D	4280
	D	4288
F. W. Brode & Co., Memphis, Tenn. Owl Brand Cotton Seed Meal	D	2847
	D	2852
	D	2862
	D	2875
	D	2881
	D	2885
	D	2886
	D	2887
	D	2890
	D	2893
	D	2896
	D	2898

* Samples marked D are from dealer and those marked O were taken by the inspector.

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
2952	–	–	40.37	41.00	–	–	–	–	–	0
2991	7.63	7.43	41.68	41.00	7.39	9.00	10.72	10.50	25.15	0
2850	–	–	41.06	41.00	–	7.00	–	–	–	0
4039	–	–	41.25	41.00	–	9.00	–	–	–	0
4181	–	–	41.43	41.00	–	9.00	–	9.00	–	0
4233	–	–	41.18	41.00	–	9.00	–	9.00	–	0
4254	–	–	37.62	41.00	–	9.00	–	9.00	–	0
4265	7.16	7.33	42.25	41.00	8.88	9.00	9.74	9.00	24.64	0
4267	–	–	41.50	41.00	–	9.00	–	9.00	–	0
2863	–	–	42.50	38.62	–	–	–	–	–	0
2883	–	–	40.37	38.62	–	–	–	–	–	0
2892	–	–	39.75	38.62	–	7.00	–	–	–	0
2894	–	–	38.06	38.62	–	6.00	–	–	–	0
2895	–	–	39.68	38.62	–	6.00	–	–	–	0
2926	–	–	42.62	38.62	–	6.00	–	–	–	0
2941	–	–	39.50	38.62	–	6.00	–	–	–	0
2949	–	–	39.00	38.62	–	–	–	–	–	0
4037	7.60	6.19	39.06	38.62	7.95	6.00	11.80	10.00	27.40	0
4040	–	–	36.31	38.62	–	6.00	–	–	–	0
4043	–	–	37.50	38.62	–	6.00	–	10.00	–	0
4072	–	–	40.12	38.62	–	6.00	–	10.00	–	0
4113	–	–	40.87	38.62	–	6.00	–	–	–	0
4139	–	–	41.00	38.63	–	6.00	–	10.00	–	0
4162	–	–	39.69	38.62	–	6.00	–	10.00	–	0
4190	–	–	41.25	38.62	–	6.00	–	10.00	–	0
4191	–	–	39.50	38.62	–	6.00	–	10.00	–	0
4200	–	–	41.62	38.63	–	6.00	–	10.00	–	0
4218	–	–	41.56	–	–	–	–	–	–	0
4234	–	–	37.50	38.62	–	6.00	–	10.00	–	0
4237	–	–	40.00	38.63	–	6.00	–	10.00	–	0
4257	–	–	39.75	–	–	–	–	–	–	0
4258	–	–	39.50	38.62	–	–	–	–	–	0
4275	–	–	39.87	38.63	–	6.00	–	10.00	–	0
4279	–	–	38.31	38.62	–	–	–	–	–	0
4280	–	–	38.25	38.63	–	6.00	–	10.00	–	0
4288	–	–	38.62	38.63	–	6.00	–	10.00	–	0
2847	–	–	42.00	41.00	–	6.00	–	–	–	0
2852	–	–	41.62	41.00	–	6.00	–	–	–	0
2862	–	–	41.94	41.00	–	6.00	–	–	–	0
2875	–	–	40.12	41.00	–	6.00	–	–	–	0
2881	–	–	42.12	41.00	–	6.00	–	–	–	0
2885	–	–	42.50	41.00	–	6.00	–	–	–	0
2886	–	–	40.75	41.00	–	6.00	–	–	–	0
2887	–	–	40.87	41.00	–	6.00	–	–	–	0
2890	–	–	39.43	41.00	–	6.00	–	–	–	0
2893	–	–	40.75	41.00	–	6.00	–	–	–	0
2896	–	–	42.18	41.00	–	6.00	–	–	–	0
2898	–	–	40.62	41.00	–	6.00	–	–	–	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	* Source of sample.	Station number.
Owl Brand Cottonseed Meal—Concluded	D	2900
	D	2904
	D	2906
	D	2908
	D	2910
	D	2913
	D	2915
	D	2916
	D	2919
	D	2929
	O	4017
	O	4053
	D	4115
	D	4137
	O	4141
	O	4146
	O	4147
	D	4153
	D	4154
	D	4156
	O	4157
	O	4163
	D	4176
	D	4179
	D	4180
	D	4189
	D	4192
	O	4196
	D	4201
	D	4204
	D	4208
	O	4213
	D	4217
	D	4222
	D	4229
	O	4238
	D	4240
	D	4242
	D	4246
	D	4247
	D	4248
	O	4249
	O	4250
	D	4253
	D	4255
	O	4262
	D	4272
	D	4274
	O	4278
	D	4285
	D	4287
Buckeye Cotton Oil Co., Cincinnati, O. Buckeye Cottonseed Meal	O	2818
	M	2838
	M	2844
	D	2848
	D	2851
	O	2869
	D	2870

* Samples marked D are from dealer and those marked O were taken by the inspector.

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein		Fat.		Fiber.		Nitrogen free extract.	Weed seeds.
			Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.		
2900	–	–	42.50	41.00	–	6.00	–	–	–	0
2904	–	–	39.75	41.00	–	–	–	–	–	0
2906	–	–	41.62	41.00	–	6.00	–	–	–	0
2908	–	–	42.31	41.00	–	–	–	–	–	0
2910	–	–	41.00	41.00	–	6.00	–	–	–	0
2913	–	–	42.25	41.00	–	6.00	–	–	–	0
2915	–	–	42.94	41.00	–	6.00	–	–	–	0
2916	–	–	42.25	41.00	–	6.00	–	–	–	0
2919	–	–	40.25	41.00	–	6.00	–	–	–	0
2929	–	–	44.25	41.00	–	6.00	–	–	–	0
4017	9.18	6.50	42.25	41.00	7.95	6.00	8.05	10.00	26.07	0
4053	6.33	7.99	41.00	41.00	8.28	6.00	6.33	10.00	30.07	0
4115	–	–	40.12	41.00	–	6.00	–	10.00	–	0
4137	–	–	42.50	41.00	–	6.00	–	10.00	–	0
4141	–	–	41.75	41.00	–	6.00	–	10.00	–	0
4146	–	–	42.19	41.00	–	6.00	–	10.00	–	0
4147	–	–	39.56	41.00	–	6.00	–	10.00	–	0
4153	–	–	40.81	41.00	–	6.00	–	10.00	–	0
4154	–	–	40.50	41.00	–	–	–	–	–	0
4156	–	–	41.87	41.00	–	–	–	–	–	0
4157	–	–	39.62	41.00	–	6.00	–	10.00	–	0
4163	–	–	41.94	41.00	–	6.00	–	10.00	–	0
4176	–	–	41.50	41.00	–	–	–	–	–	0
4179	–	–	42.18	41.00	–	–	–	–	–	0
4180	–	–	41.06	41.00	–	6.00	–	10.00	–	0
4189	–	–	41.50	41.00	–	6.00	–	10.00	–	0
4192	–	–	42.87	41.00	–	6.00	–	10.00	–	0
4196	–	–	39.37	41.00	–	6.00	–	10.00	–	0
4201	–	–	42.50	–	–	–	–	–	–	0
4204	–	–	42.93	–	–	–	–	–	–	0
4208	–	–	43.00	41.00	–	6.50	–	10.00	–	0
4213	–	–	41.12	41.00	–	6.00	–	10.00	–	0
4217	–	–	41.37	–	–	–	–	–	–	0
4222	–	–	43.94	41.00	–	6.50	–	10.00	–	0
4229	–	–	43.25	41.00	–	–	–	–	–	0
4238	–	–	44.37	41.00	–	6.00	–	10.00	–	0
4240	–	–	42.32	–	–	–	–	–	–	0
4242	–	–	40.75	41.00	–	6.00	–	10.00	–	–
4246	–	–	44.25	41.00	–	6.00	–	10.00	–	0
4247	–	–	44.62	41.00	–	6.00	–	–	–	0
4248	–	–	42.36	41.00	–	6.00	–	10.00	–	0
4249	–	–	43.62	41.00	–	6.00	–	10.00	–	0
4250	–	–	43.18	41.00	–	6.00	–	10.00	–	0
4253	–	–	44.00	41.00	–	6.00	–	10.00	–	0
4255	–	–	43.37	41.00	–	6.00	–	10.00	–	0
4262	–	–	38.94	41.00	–	6.00	–	10.00	–	0
4272	–	–	42.06	41.00	–	6.00	–	10.00	–	0
4274	–	–	41.75	41.00	–	6.00	–	10.00	–	0
4278	–	–	43.62	41.00	–	6.00	–	10.00	–	0
4285	–	–	40.25	41.00	–	–	–	–	–	0
4287	–	–	43.50	41.00	–	6.00	–	10.00	–	0
2818	–	–	37.37	39.00	–	6.50	–	–	–	0
2838	–	–	40.87	39.00	–	6.50	–	–	–	0
2844	–	–	39.87	39.00	–	6.50	–	–	–	0
2848	–	–	37.18	39.00	–	–	–	–	–	0
2851	–	–	35.56	39.00	–	6.50	–	–	–	0
2869	–	–	40.12	39.00	–	–	–	–	–	0
2870	–	–	38.56	39.00	–	–	–	–	–	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Buckeye Cottonseed Meal—Concluded	O	4022
	D	4058
	O	4082
	D	4088
	D	4101
	D	4102
	D	4104
	O	4110
	D	4117
	C	4120
	D	4131
	D	4132
	O	4144
	O	4160
	D	4206
	C	4221
	D	4224
	D	4226
	D	4227
	D	4228
	D	4231
	D	4252
	D	4260
	O	4261
	O	4264
	D	4268
	O	4277
	D	4284
T. H. Bunch Commission Co., Little Rock, Ark. Old Gold Brand Cottonseed Meal	D	2878
	D	2888
	O	4283
Chapin & Co., Hammond, Ind. Green Diamond Brand Choice Cottonseed Meal	D	4103
	O	4128
S. P. Davis, Little Rock, Ark. Good Luck Brand Cottonseed Meal	D	2840
	D	2854
	D	2872
	D	2877
	O	4010
	O	4096
	D	4119
	D	4155
	O	4172
	O	4173
	D	4186
	D	4188
	D	4225
	D	4273
Humphreys-Godwin Co., Memphis, Tenn. Dixie Brand Cottonseed Meal	D	2836

* Samples marked D are from dealer and those marked O were taken by the inspector.

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4022	8.45	6.79	39.00	39.00	7.56	6.50	10.92	10.00	27.28	0
4058	–	–	38.50	38.50	–	6.50	–	–	–	0
4082	–	–	40.25	38.50	–	6.50	–	10.00	–	0
4088	–	–	42.87	38.50	–	–	–	–	–	0
4101	–	–	38.00	38.50	–	6.50	–	10.00	–	0
4102	–	–	38.25	38.50	–	6.50	–	10.00	–	0
4104	–	–	44.12	38.50	–	6.50	–	10.00	–	0
4110	–	–	37.93	38.50	–	6.50	–	10.00	–	0
4117	–	–	42.06	38.50	–	6.50	–	10.00	–	0
4120	–	–	37.50	39.00	–	6.50	–	10.00	–	0
4131	–	–	39.37	39.00	–	6.50	–	10.00	–	0
4132	–	–	38.50	38.50	–	6.50	–	10.00	–	0
4144	–	–	40.31	38.50	–	6.50	–	10.00	–	0
4160	–	–	43.81	38.50	–	6.50	–	10.00	–	0
4206	–	–	41.43	38.50	–	6.50	–	10.00	–	0
4221	–	–	40.62	38.50	–	6.50	–	10.00	–	0
4224	–	–	41.62	38.50	–	6.50	–	10.00	–	0
4226	–	–	41.37	38.50	–	6.50	–	10.00	–	0
4227	–	–	40.50	38.50	–	6.50	–	10.00	–	0
4228	–	–	41.00	38.50	–	6.50	–	10.00	–	0
4231	–	–	40.12	39.00	–	6.50	–	10.00	–	0
4252	–	–	43.12	38.50	–	6.50	–	10.00	–	0
4260	–	–	41.87	38.50	–	6.50	–	10.00	–	0
4261	–	–	39.16	38.50	–	6.50	–	10.00	–	0
4264	–	–	43.18	38.50	–	6.50	–	10.00	–	0
4268	–	–	43.12	38.50	–	6.50	–	10.00	–	0
4277	–	–	42.12	38.50	–	6.50	–	10.00	–	0
4284	–	–	42.12	38.50	–	6.50	–	10.00	–	0
2878	–	–	40.69	41.00	–	9.00	–	–	–	0
2888	–	–	39.56	41.00	–	9.00	–	–	–	0
4283	–	–	38.87	41.00	–	9.00	–	9.00	–	0
4103	–	–	44.75	41.00	–	8.00	–	10.00	–	0
4128	6.98	7.12	44.06	41.00	7.93	8.00	7.84	10.00	26.07	0
2840	–	–	38.81	41 00	–	7.00	–	–	–	0
2854	–	–	38.12	41.00	–	7.00	–	–	–	0
2872	–	–	44.12	41.00	–	7.00	–	–	–	0
2877	–	–	43.43	41.00	–	7.00	–	–	–	0
4010	7.19	7.07	40.56	41.00	7.69	9.00	10.73	10.50	26.76	0
4096	–	–	38.75	41.00	–	7.00	–	10.50	–	0
4119	–	–	40.50	41.00	–	7.00	–	10.50	–	0
4155	–	–	41.87	41.00	–	7.00	–	10.50	–	0
4177	–	–	41.94	41.00	–	7.00	–	10.50	–	0
4173	–	–	37.37	41.00	–	7.00	–	10.50	–	0
4186	–	–	41.50	41.00	–	7.00	–	10.50	–	0
4188	–	–	38.37	41.00	–	7.00	–	10.50	–	0
4225	–	–	39.37	41.00	–	7.00	–	10.50	–	0
4273	–	–	40.62	41.00	–	7.00	–	10.50	–	0
2836	–	–	41.12	41.00	–	–	–	–	–	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

MANUFACTURER OR SHIPPER AND BRAND.	* Source of sample.	Station number.
Dixie Brand Cottonseed Meal	D	2837
	D	2853
	D	2864
	D	2880
	D	2891
	D	2902
	D	2905
	D	2909
	D	2943
	D	2914
	D	2953
	D	2956
	D	2957
	O	4003
	D	4059
	D	4062
	D	4065
	D	4075
	O	4084
	O	4086
	O	4087
	D	4092
	D	4099
	O	4106
	D	4118
	D	4121
	D	4138
	O	4166
	O	4167
	D	4182
	D	4183
	O	4198
	D	4199
	D	4202
	D	4203
	D	4207
	O	4212
	O	4214
	D	4216
	D	4230
	O	4236
	D	4243
	D	4256
	D	4269
	O	4276
	D	4282
	D	4286
Keeton-Krueger Co., Atlanta, Ga. Peacock Brand Cottonseed Meal	D	4177
	D	4289
Kemper Mill & Elevator Co., Kansas City, Mo. Choice Cottonseed Meal	D	4175
	D	4178
	D	4184
	D	4187
Memphis Cottonseed Products Co., Memphis, Tenn. Selden Cottonseed Meal	D	2917

* Samples marked D are from dealer and those marked O]were taken by the inspector

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
2837	–	–	40.81	41.00	–	–	–	–	–	0
2853	–	–	41.37	38.62	–	6.00	–	–	–	0
2864	–	–	42.87	38.62	–	6.00	–	–	–	0
2880	–	–	39.18	38.62	–	6.00	–	–	–	0
2891	–	–	40.50	38.62	–	6.00	–	–	–	0
2902	–	–	42.00	38.62	–	6.00	–	–	–	0
2905	–	–	40.87	38.62	–	6.00	–	–	–	0
2909	–	–	41.31	38.62	–	6.00	–	–	–	0
2943	–	–	40.00	38.62	–	6.00	–	–	–	0
2944	–	–	43.25	38.62	–	6.00	–	–	–	0
2953	–	–	41.62	41.00	–	6.00	–	–	–	0
2956	–	–	40.69	38.62	–	6.00	–	–	–	0
2957	–	–	39.62	38.62	–	6.00	–	–	–	0
4003	6.75	6.40	42.75	38.62	9.77	6.00	7.02	12.00	27.31	0
4059	–	–	40.12	38.62	–	6.00	–	–	–	0
4062	–	–	40.00	38.62	–	6.00	–	–	–	0
4065	–	–	40.81	38.62	–	6.00	–	–	–	0
4075	–	–	39.56	41.00	–	6.00	–	–	–	0
4084	–	–	36.41	38.62	–	6.00	–	12.00	–	0
4086	–	–	39.19	38.62	–	6.00	–	12.00	–	0
4087	–	–	40.00	38.62	–	6.00	–	12.00	–	0
4092	–	–	38.69	38.62	–	6.00	–	–	–	0
4099	–	–	39.00	38.62	–	6.00	–	12.00	–	0
4106	–	–	40.68	38.62	–	6.00	–	12.00	–	0
4118	–	–	37.00	38.62	–	6.00	–	12.00	–	0
4121	–	–	38.62	38.62	–	6.00	–	12.00	–	0
4138	–	–	43.56	38.62	–	6.00	–	12.00	–	0
4166	–	–	40.19	38.62	–	6.00	–	12.00	–	0
4167	–	–	39.94	38.62	–	6.00	–	12.00	–	0
4182	–	–	42.32	38.62	–	6.00	–	12.00	–	0
4183	–	–	39.37	38.62	–	6.00	–	12.00	–	0
4198	–	–	41.62	38.62	–	6.00	–	12.00	–	0
4199	–	–	40.69	38.62	–	6.00	–	12.00	–	0
4202	–	–	41.56	38.62	–	6.00	–	12.00	–	0
4203	–	–	38.00	38.62	–	6.00	–	12.00	–	0
4207	–	–	42.56	38.62	–	6.00	–	12.00	–	0
4212	–	–	38.76	38.62	–	6.00	–	12.00	–	0
4214	–	–	43.06	38.62	–	6.00	–	12.00	–	0
4216	–	–	41.43	38.62	–	6.00	–	12.00	–	0
4230	–	–	39.56	38.62	–	–	–	–	–	0
4236	–	–	41.30	38.62	–	6.00	–	12.00	–	0
4243	–	–	40.62	38.62	–	6.00	–	12.00	–	0
4256	–	–	42.62	38.62	–	–	–	–	–	0
4269	–	–	41.44	38.62	–	6.00	–	12.00	–	0
4276	–	–	41.50	38.62	–	6.00	–	12.00	–	0
4282	–	–	41.62	38.62	–	6.00	–	12.00	–	0
4286	–	–	42.62	38.62	–	6.00	–	12.00	–	0
4177	–	–	41.25	41.00	–	6.00	–	10.00	–	0
4289	–	–	41.50	41.00	–	6.00	–	10.00	–	0
4175	–	–	41.36	41.00	–	7.50	–	10.00	–	0
4178	–	–	40.37	41.00	–	–	–	–	–	0
4184	–	–	38.87	41.00	–	7.50	–	10.00	–	0
4187	–	–	40.31	41.00	–	7.50	–	10.00	–	0
2917	–	–	43.19	41.00	–	6.00	–	–	–	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

MANUFACTURER OR SHIPPER AND BRAND	* Source of sample.	Station number.
F. E. Morse & Co., Little Rock, Ark. Golden Brand Cottonseed Meal	O	4028
W. C. Nothern, Little Rock, Ark. Bee Brand Cottonseed Meal	O	4124
	C	4223
	O	4239
	D	4241
Ozark Oil Co., Ozark, Ark. Medium Grade Cottonseed Meal	O	4129
Roney & Hicky, Memphis, Tenn. B. & J. Cottonseed Meal	D	2925
W. Newton Smith, Baltimore, Md. Choice Dirego Brand Cottonseed Meal	D	2857
	D	2859
	D	2860
	D	2861
	D	2865
	D	2866
	D	2868
J. E. Soper Co., Boston, Mass. Pioneer Cottonseed Meal	D	2845
	D	2876
	D	2899
	O	4047
J. E. Soper Co., Boston, Mass. Soper's Prime Cottonseed Meal	O	4168
Southern Cotton Oil Co., Memphis, Tenn. Standard Grade Cottonseed Meal	D	4279

COTTONSEED FEEDS.

Humphreys-Godwin Co., Memphis, Tenn. Creamo Brand Cottonseed Feed	D	4133
	O	4169
	D	4259
	D	4271

* Samples marked D are from dealer and those marked O were taken by the inspector.

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein.		Fat.		Fiber.		Nitrogen free extract.	Weed seeds.
			Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.		
4028	7.31	6.75	40.12	41.00	8.93	9.00	8.66	9.00	28.23	0
4124	7.25	6.50	40.87	41.00	7.93	7.00	11.87	10.50	25.58	0
4223	-	-	39.50	41.00	-	6.50	-	10.00	-	0
4239	-	-	40.30	41.00	-	7.00	-	10.50	-	0
4241	-	-	40.12	41.00	-	7.00	-	10.50	-	0
4129	8.10	5.96	36.50	-	6.19	-	14.82	-	28.43	0
2925	-	-	41.25	41.00	-	6,00	-	-	-	0
2857	-	-	41.75	41.00	-	7.00	-	-	-	0
2859	-	-	37.25	41.00	-	7.00	-	-	-	0
2860	-	-	38.25	41.00	-	7.00	-	-	-	0
2861	-	-	35.94	41.00	-	7.00	-	-	-	0
2865	-	-	40.25	41.00	-	7.00	-	-	-	0
2866	-	-	37.00	41.00	-	7.00	-	-	-	0
2868	-	-	40.75	41.00	-	7.00	-	-	-	0
2845	-	-	41.00	41.00	-	8.00	-	-	-	0
2876	-	-	41.87	41.00	-	8.00	-	-	-	0
2899	-	-	41.87	41.00	-	8.00	-	-	-	0
4047	7.37	11.45	42.25	41.00	8.24	8.00	7.56	10.00	23.13	0
4168	7.39	6.48	36.50	38.50	7.92	5.00	12.71	-	29.00	0
4279	-	-	38.31	38.62	-	-	-	-	-	0
4133	-	-	24.50	22.00	-	5.00	-	22.00	-	0
4169	8,02	5.61	23.94	22.00	5.60	5.00	20.48	22.00	36.35	0
4259	-	-	25.00	20.00	-	5.00	-	22.00	-	0
4271	-	-	26.00	20.00	-	5.00	-	22.00	-	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	* Source of sample.	Station number.
GLUTEN FEEDS.		
Corn Products Refining Co., New York City, N. Y. Diamond Gluten Meal	D	4245
American Maize Products Co., New York City, N. Y. Cream of Corn Gluten Feed	D	2846
	O	2986
Corn Products Refining Co., New York City, N. Y. Buffalo Gluten Feed	D	2839
	D	2841
	D	2855
	D	2858
	D	2897
	D	2903
	D	2914
	D	2923
	D	2924
	D	2927
	D	2946
	O	2978
	O	2985
	D	4112
	D	4210
Corn Products Refining Co., New York City, N. Y. Crescent Gluten Feed	O	2997
Corn Products Refining Co., New York City, N. Y. Pekin Gluten Feed	O	4057
The Dewey Bros. Co., Blanchester, O. Buckeye Gluten Feed	D	4134
Douglas & Co., Cedar Rapids, Iowa. Cedar Rapids Gluten Feed	O	2721
	O	4263
Huron Milling Co., Harbor Beach, Mich. Jenks Gluten Feed	D	2856
	O	4026
	D	4232

* Samples marked D are from dealer and those marked O were taken by the inspector.

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein.		Fat.		Fiber.		Nitrogen free extract.	Weed seeds.
			Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.		
4245	9.94	1.53	46.62	40.00	2.13	1.50	1.33	4.00	38.45	0
2846	–	–	25.50	23.00	–	–	–	–	–	0
2986	8.39	6.40	24.38	23.00	3.30	2.50	7.06	8.50	50.47	0
2839	–	–	31.56	23.00	–	2.00	–	–	–	0
2841	–	–	25.81	23.00	–	2.50	–	–	–	0
2855	–	–	26.00	23.00	–	2.50	–	–	–	0
2858	–	–	29.56	23.00	–	–	–	–	–	0
2897	–	–	26.18	23.00	–	2.50	–	–	–	0
2903	–	–	28.18	23.00	–	2.50	–	–	–	0
2914	–	–	26.25	23.00	–	2.50	–	–	–	0
2923	–	–	28.12	23.00	–	–	–	–	–	0
2924	–	–	29.37	23.00	–	–	–	–	–	0
2927	–	–	28.28	23.00	–	–	–	–	–	0
2946	–	–	27.12	23.00	–	2.50	–	–	–	0
2978	8.83	5.19	27.56	23.00	2.69	2.50	6.73	8.50	49.00	0
2985	8.80	5.08	27.00	23.00	2.82	2.50	6.49	8.50	49.81	0
4112	–	–	27.12	23.00	–	2.50	–	–	–	0
4210	–	–	28.75	23.00	–	–	–	–	–	0
2997	8.72	3.80	24.75	24.00	5.23	2.50	7.40	8.50	50.10	0
4057	9.14	3.59	27.00	24.00	1.97	2.50	8.00	8.50	50.30	0
4134	–	–	22.88	–	–	–	–	–	–	0
2721	–	–	18.63	22.00	–	4.00	–	–	–	0
4263	10.03	0.90	23.25	20.00	7.28	3.00	8.87	8.00	49.67	0
2856	–	–	23.31	23.00	–	3.00	–	–	–	0
4026	7.73	2.52	23.00	–	4.16	–	7.49	–	57.10	0
4232	–	–	25.87	22.00	–	3.00	–	8.00	–	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand	* Source of sample.	Station number.
LINSEED OIL MEAL.		
Guy G. Major Co., Toledo, O. Old Process Linseed Oil Meal	D O O D	2918 2966 2984 4185
Spencer, Kellogg & Sons, Minneapolis, Minn. Ground Oil Cake	O	4174
DISTILLERS GRAINS.		
Ajax Milling & Feed Co., New York City, N. Y. Ajax Flakes	D O O D D	2922 4020 4105 4116 4211
J. W. Biles Co., Cincinnati, O. Fourex Brand Grains	O	2994
Continental Cereal Co., Peoria, Ill. Continental Gluten Feed	O	4107
Deutsch & Sickert, Milwaukee, Wis. Climax Grains	O	4035
Dewey Bros. Co., Blanchester, O. Corn Three D Grains	O	4108
Griswold & Mackinnon, St. Johnsbury, Vt. Extra Good Distillers Grains	D	2942
WHEAT OFFALS, FEED FLOUR.		
Gwinn Milling Co., Columbus, O., Gwinn's Red Dog Flour	O O	4006 4073
Peninsular Milling Co., Flint, Mich. Utility Flour	O O	4067 4090
Pillsbury Flour Mills Co., Minneapolis, Minn. Pillsbury's XXX Daisy	O	2999

* Samples marked D are from dealer and those marked O were taken by the inspector.

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
2918	–	–	34.13	30.00	–	5.00	–	–	–	0
2966	8.62	7.16	31.75	30.00	5.50	5.00	9.83	10.00	37.14	0
2984	9.38	7.48	27.75	30.00	5.78	5.00	10.13	10.00	39.48	0
4185	–	–	34.25	30.00	–	7.00	–	10.00	–	0
4174	10.32	5.42	37.50	33.00	5.87	5.00	8.30	11.00	32.59	0

2922	–	–	30.37	30.00	–	11.00	–	–	–	0
4020	6.72	1.71	30.06	31.00	12.47	12.00	12.70	14.00	36.34	0
4105	–	–	31.30	30.00	–	11.00	–	14.00	–	0
4116	–	–	30.06	30.00	–	–	–	–	–	0
4211	–	–	32.43	30.00	–	11.00	–	14.00	–	0
2994	7.46	4.08	32.12	31.00	11.30	12.00	12.09	13.00	32.95	0
4107	5.61	4.98	31.06	31.00	12.59	13.50	8.65	8.50	37.11	0
4035	4.88	6.28	33.31	30.00	13.81	10.00	14.66	–	27.06	0
4108	7.07	1.62	31.56	26.00	13.59	9.00	11.70	13.00	34.46	0
2942	–	–	29.25	30.00	–	10.00	–	–	–	0

4006	10.95	1.59	14.63	–	2.93	–	0.92	–	68.98	0
4073	–	–	17.25	–	–	–	–	–	–	0
4067	11.39	0.89	12.94	–	2.14	–	0.63	–	72.01	0
4090	10.90	1.14	14.19	–	2.38	–	0.77	–	70.62	0
2999	11.10	2.30	19.13	15.00	5.08	4.50	1.83	4.00	60.56	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	* Source of sample.	Station number.
WHEAT OFFALS, MIDDLINGS.		
Christian Breisch & Co., N. Lansing, Mich. Winter Wheat Middlings	O	4015
Duluth-Superior Milling Co., Duluth, Minn. Wheat Middlings	O	4145
Goshen Milling Co., Goshen, Ind. Middlings	D O	2911 4032
Gwinn Milling Co., Columbus, O. Gwinn's Wheat Middlings	O	4005
Minot Flour Mills Co., Minot, N. D. Fancy Middlings	O	4070
Pillsbury Flour Mills Co., Minneapolis, Minn. Pillsbury's Middlings	O	2969
Voight Milling Co., Grand Rapids, Mich. Voight's Pure Middlings	O	4024
Washburn Mills, Minneapolis, Minn. Standard Middlings	O	2970
WHEAT OFFALS, BRAN.		
Atlas Flour Mills, Milwaukee, Wis. Atlas Bran	O	4031
Bay State Milling Co., Winona, Minn. Winona Bran, Fancy Flaky	O	4085
Commercial Milling Co., Detroit, Mich. Henkel's Bran	O	4150
Wm. A. Coombs Milling Co., Coldwater, Mich. Winter Wheat Bran	O	4054
Flour Mills Co., Ltd., Canada, Western Canada Bran	O	4045

* Samples marked D are from dealer and those marked O were taken by the inspector.

ANALYSES OF FEEDING-STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4015	10.34	4.55	15.38	15.60	4.71	4.00	5.24	4.60	59.78	0
4145	9.76	4.98	18.38	16.25	5.57	6.00	7.93	8.00	53.38	0
2911	–	–	16.63	–	–	–	–	–	–	0
4032	10.72	7.35	16.50	18.00	4.31	5.00	4.44	7.00	56.68	0
4005	10.19	3.08	16.13	17.00	4.93	4.60	3.89	6.00	61.78	0
4070	9.14	4.31	19.25	–	5.42	–	6.56	–	55.32	0
2969	9.79	5.64	16.50	15.00	5.45	4.50	9.00	8.00	53.62	0
4024	10.43	4.23	16.25	–	4.60	–	4.77	–	59.72	0
2970	9.17	7.19	18.13	15.00	5.75	4.00	7.24	8.00	52.50	0
4031	8.68	6.43	17.06	15.00	5.05	3.50	10.94	12.00	51.84	0
4085	9.85	6.63	15.38	15.00	4.73	4.07	10.94	11.00	52.47	Many.
4150	9.97	6.34	16.69	14.00	4.81	3.00	10.02	12.00	52.17	Few.
4054	9.43	6.10	15.32	14.00	4.00	3.00	8.85	–	56.30	0
4045	9.84	6.09	15.75	16.82	5.36	5.50	10.60	10.86	52.36	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	* Source of sample.	Station number.
Goshen Milling Co., Goshen, Ind. Bran	D	2912
Gwinn Milling Co., Columbus, O. Gwinn's Wheat Bran	O	4029
Kelley Milling Co., Kansas City, Mo. Pure Winter Wheat Bran	O	4140
Kemper Mill & Elevator Co., Kansas City, Mo. Diamond K. Bran	O	4056
Maple Leaf Milling Co., Canada. Canada Bran	O	2983
The New England Flour Co., Powerful Standard Bran	O	2971
New Prague Flouring Mill Co., New Prague, Minn. Seal of Minnesota Bran	O	4149
Noblesville Milling Co., Noblesville, Ind. N. M. Co's. Bran, Pure Wheat Feed	O	4148
Northwestern Consolidated Milling Co., Minneapolis, Minn. Pure Wheat Bran	O	4007
Ohio Cereal Co., Circleville, O. Winter Wheat Bran	O	4123
Pillsbury's Flour Mills Co., Minneapolis, Minn. Pillsbury's Wheat Bran	C	2889
Pillsbury's Flour Mills Co., Minneapolis, Minn. Pillsbury's Bran	O	2996
Quaker Oats Co., Chicago, Ill. Bell Cow Bran	O	2989
Sparks Milling Co., Alton, Ill. Wabash Bran	O	4030
David Stott, Detroit, Mich. Stott's Pure Winter Wheat Bran	O	4013
Geo. Tileston Milling Co., St. Cloud, Minn. Fancy Bran	O	4068

* Samples marked D are from dealer and those marked O were taken by the inspector.

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
2912	–	–	15.56	–	–	–	–	–	–	0
4029	9.25	5.72	17.00	15.00	3.95	4.00	7.90	8.00	56.18	0
4140	8.92	6.00	16.50	15.00	4.46	3.50	8.85	9.00	55.27	0
4056	8.74	6.75	15.50	14.50	4.23	3.50	9.10	9.50	55.68	0
2983	9.07	6.02	15.75	–	10.51	–	9.99	–	48.66	0
2971	8.94	7.55	16.63	14.00	4.61	3.50	10.35	9.50	51.92	0
4149	9.59	6.64	16.25	12.50	5.57	4.00	10.56	12.05	51.39	0
4148	9.71	6.60	17.00	14.50	4.18	3.70	8.50	8.00	54.01	0
4007	9.03	6.64	15.88	14.00	5.38	4.00	9.86	11.00	53.21	0
4123	10.03	7.40	16.88	14.00	4.16	4.00	9.77	9.50	51.76	Few.
2889	–	–	14.38	12.00	–	4.00	–	–	–	0
2996	10.06	9.55	15.75	14.50	5.24	4.00	11.18	11.00	42.27	Few.
2989	9.51	5.53	17.32	–	5.48	–	9.15	–	53.01	0
4030	9.00	6.17	17.00	14.00	4.57	3.50	8.19	8.00	55.07	0
4013	9.48	6.40	16.38	16.00	4.91	4.00	9.07	–	53.76	Few.
4068	9.88	6.29	15.06	14.50	5.10	4.00	10.84	11.00	52.83	Few.

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Geo. Urban Milling Co., Buffalo, N. Y. Wheat Bran	O	4019
Voight Milling Co., Grand Rapids, Mich. Voight's Pure Wheat Bran	O	4025
Voight Milling Co , Grand Rapids, Mich. Voight's Bran	O	4036
Washburn Mills, Minneapolis, Minn. Coarse Bran	O	4002

WHEAT OFFALS, MIXED FEED.

Acme-Evans Co., Indianapolis, Ind. Acme Feed	O	4000
Allen, Baker Co., St. Louis, Mo. Apex Fancy Mill Run Mixed Feed	O	4151
Amendt Milling Co., Monroe, Mich. Winter Wheat Amco Pure Feed	O	4018
Ansted & Burke Co., Springfield, O. Best Flour Wm. Tell Mixed Feed	O	2974
Blish Milling Co., Seymour, Ind. Blish's Bull's Eye Mixed Feed	O	4016
Chapin & Co., Hammond, Ind. Vermont Brand Mixed Fee	O	2972
Chas. M. Cox Co., Boston, Mass. Columbia Mixed Feed	O	4069
Wm. A. Coombs Milling Co., Coldwater, Mich. Winter Wheat Mixed Feed	O	4122
Chas. M. Cox Co., Boston, Mass. Wirthmore Wheat Feed	O	4165
Duluth-Superior Milling Co., Duluth, Minn. Boston Mixed Feed	O D	4021 4074

* Samples marked D are from dealer and those marked O were taken by the inspector

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4019	8.91	6.29	16.25	15.00	5.39	4.00	9.80	11.00	53.36	0
4025	9.85	6.33	15.82	–	3.90	–	8.64	–	55.46	0
4036	9.09	7.04	16.13	–	4.33	–	8.61	–	54.80	0
4002	8.90	6.37	15.00	14.50	5.05	4.00	11.10	11.00	53.58	Few.
4000	7.88	6.11	17.25	16.50	4.72	4.00	7.86	–	56.18	0
4151	9.98	6.18	17.19	14.00	4.39	4.00	8.14	–	54.12	0
4018	9.51	5.68	17.25	16.80	4.98	4.40	7.52	7.50	55.06	0
2974	9.08	6.56	16.88	14.50	4.87	3.50	7.51	11.50	55.10	0
4016	9.82	6.43	16.88	16.50	4.58	4.50	7.47	9.10	54.82	0
2972	9.76	5.37	16.82	14.00	5.16	4.00	7.26	–	55.63	0
4069	9.84	5.20	16.26	16.80	5.17	4.10	8.83	10.50	54.70	0
4122	10.27	5.70	15.75	15.00	4.54	3.00	7.52	–	56.22	0
4165	10.50	5.90	16.57	16.00	4.73	4.00	7.80	–	54.50	Few.
4021	10.49	5.44	16.25	16.00	5.49	4.50	8.89	8.50	53.44	0
4074	–	–	16.00	16.00	–	4.00	–	–	–	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Everett-Aughenbaugh & Co., Waseca, Minn. Eaco Winged Horse Mixed Feed	O	4027
Federal Milling Co., Lockport, N. Y. Lucky Mixed Feed	O	4012
Griswold & Mackinnon, St. Johnsbury, Vt. Xtragood Mixed Feed	O	4193
J. Hale & Sons, Lyons, Mich. Acme Mixed Feed	O	4052
H. L. Halliday Milling Co., Cairo, Ill. Soft Winter Mixed Feed	O	4050
Hannibal Milling Co., Hannibal, Mo. Red Star Mill Run Mixed Feed	O	4083
Hunter-Robinson-Wenz Co., St. Louis, Mo. Wildfire Mixed Feed	C	2867
Hunter-Robinson-Wenz Co., St. Louis, Mo Sunshine Choice Soft Winter Mixed Feed	O	2988
Huron Milling Co., Harbor Beach, Mich. Mixed Feed	D O	2882 4049
Kemper Mill & Elevator Co., Kansas City, Mo. Anchor Mixed Feed	O O	2973 4161
Lawrenceburg Roller Mills Co., Lawrenceburg, Ind. Snowflake, Mixed Feed	O	2964
A. H. McLeod Milling Co., St. Johnsbury, Vt. Brook's Fancy Mixed Feed	O	4194
Geo. Q. Moon Co., Binghampton, N. Y. Fresh Ground Home Made Mixed Feed	O	4014
Noblesville Milling Co., Noblesville, Ind. N. M. Co's. Mixed Feed	O	2998
Northwestern Consolidated Milling Co., Minneapolis, Minn. XXX Comet	O	4158

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein.		Fat.		Fiber.		Nitrogen free extract.	Weed seeds.
			Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.		
4027	9.62	6.09	16.75	15.00	5.62	3.00	8.91	12.00	53.01	Few.
4012	9.75	5.45	16.50	14.00	5.52	4.00	8.00	–	54.78	0
4193	10.05	5.27	16.88	–	4.58	–	8.07	–	55.15	0
4052	9.56	5.87	15.75	–	4.17	–	7.05	–	57.60	0
4050	9.30	7.95	15.50	14.50	4.11	4.00	8.40	8.00	54.74	Few.
4083	9.66	6.80	16.69	14.00	4.69	4.00	8.05	–	54.11	Few.
2867	–	–	18.50	–	–	–	–	–	–	0
2988	9.15	6.90	17.13	14.50	4.88	4.00	8.11	8.00	53.83	Few.
2882	–	–	14.88	–	–	–	–	–	–	0
4049	9.51	7.63	14.38	–	4.69	–	8.61	–	55.18	0
2973	9.21	6.44	16.13	16.00	4.59	4.00	8.23	5.00	55.40	Few.
4161	9.98	6.52	16.50	16.00	4.89	4.00	8.26	8.00	53.85	Few.
2964	9.56	5.51	16.13	15.20	4.40	4.30	6.81	8.00	57.59	Few.
4194	9.87	5.38	17.25	–	4.71	–	7.96	–	54.83	Few.
4014	9.61	6.05	16.13	–	5.40	–	7.58	–	55.23	Few.
2998	9.25	5.55	17.50	15.00	4.50	4.00	7.12	–	56.08	0
4158	10,76	3.14	17.88	16.00	4.97	4.00	2.34	3.00	60.91	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Red Wing Milling Co., Red Wing, Minn. Go-Far Wheat Feed	O	4164
Russell-Miller Milling Co., Minneapolis, Minn. Occident Mixed Feed	C O	2871 2977
Sparks Milling Co., Alton, Ill. Dry Mash Mixed Feed (Winter)	O	2993
Sparks Milling Co., Alton, Ill. Try Me Mixed Feed	O	4034
F. W Stock & Sons, Hillsdale, Mich. Monarch Mixed Bran & Middlings from Pure Wheat	O	2982
F. W. Stock & Sons, Hillsdale, Mich. Monarch Bran & Middlings	O	4009
F. W. Stock & Sons, Hillsdale, Mich. Superior Mixed Bran, Middlings & Flour	O	4011
Valley City Milling Co., Grand Rapids, Mich. Farmers Favorite Winter Wheaty Mixed Cow Feed	O	2980
Valley City Milling Co., Grand Rapids, Mich. Farmers Favorite Choice Wheat Cow Feed	O	4127
Wagner & Gates Milling Co., Independence, Mo. Mill Run Bran Mixed Feed	D	4114
Wiliams Bros. Co., Kent, O. Kent Mixed Feed	O	4001

ADULTERATED WHEAT OFFALS.

Indiana Milling Co., Terre Haute, Ind. Sterling Feed	O O	2975 2987
Quaker Oats Co., Chicago, Ill. Sterling Feed	O	4038

* Samples marked D are from dealer and those marked O were taken by the inspector.

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein.		Fat.		Fiber.		Nitrogen free extract.	Weed seeds.
			Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.		
4164	9.84	6.42	17.94	16.50	5.41	4.10	6.92	8.50	53.47	0
2871	–	–	20.38	15.00	–	4.00	–	–	–	0
2977	10.05	4.82	18.56	15.00	5.75	4.50	8.48	10.00	52 34	0
2993	8.96	12.49	17.00	16.00	4.56	4.45	8.05	8.00	48.94	Few.
4034	9.48	6.19	17.25	16.00	4.33	4.00	7.72	8.00	55.03	Few.
2982	9.98	6.24	17.88	–	5.59	–	8.25	–	52.06	Few.
4009	9.52	6.30	17.63	–	5.49	–	8.00	–	53.06	Few.
4011	10.48	4.23	16.88	–	4.55	–	5.59	–	58.27	Few.
2980	10.01	5.73	16.19	14.79	4.94	4.25	7.37	7.50	55.76	0
4127	9.92	5.51	16.13	14.79	4.81	4.25	7.22	7.50	56.41	0
4114	–	–	16.75	15.00	–	4.00	–	–	–	0
4001	8.72	5.28	16.75	10.00	4.79	2.00	6.99	15.00	57.47	0
2975	8.21	4.46	10.75	9.80	3.53	2.75	17.77	14.00	55.83	0
2987	8.53	4.66	10.00	9.80	3.50	2.75	16.71	14.00	57.16	0
4038	7.74	4.07	10.63	10.00	3.93	4.00	9.84	10.00	63.79	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	* Source of sample.	Station number.
MISCELLANEOUS COMPOUND FEEDS. Protein over 20 per cent.		
J. W. Biles Co., Cincinnati, O. Union Grains	C C D D O O D D	2842 2843 2921 2947 2968 2990 4079 4209
Blatchford Calf Meal Factory, Waukegan, Ill. Calf Meal	O	2963
Chapin & Co., Hammond, Ind. Unicorn Dairy Ration	O	2967
Wm. S. Hills Co., Boston, Mass. Purity Perfect Ration	M O	2920 4125
Wm. S. Hills Co., Boston, Mass. Purity Milk Maker	C	4251
Husted Milling Co., Buffalo, N. Y. Husted Molasses Feed	O O	4023 4109
Quaker Oats Co., Chicago, Ill. Blue Ribbon Dairy Feed	O	4061
MISCELLANEOUS COMPOUND FEEDS. Protein 10-20 per cent.		
American Milling Co., Chicago, Ill. Sucrene Dairy Feed	O O	2951 4215
Buffalo Cereal Co., Buffalo, N. Y. Bufceco Horse Feed	O	4143
Buffalo Cereal Co., Buffalo, N. Y. Bufceco Stock Feed	D	4281
E. A. Clark & Co., Portland, Me. Peerless Scratch Feed	O	4159

* Samples marked D are from dealer and those marked O were taken by the inspector.

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein		Fat.		Fiber.		Nitrogen free extract.	Weed seeds.
			Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.		
2842	–	–	23.75	24.00	–	–	–	–	–	0
2843	–	–	23.63	24.00	–	–	–	–	–	0
2921	–	–	24.00	24.00	–	7.00	–	–	–	0
2947	–	–	23.75	24.00	–	7.00	–	–	–	0
2968	7.43	4.57	23.57	24.00	7.52	7.00	10.38	9.00	46.53	0
2990	8.20	5.66	23.75	24.00	7.06	7.00	9.77	9.00	45.56	Few.
4079	–	–	24.25	24.00	–	7.00	–	9.00	–	0
4209	–	–	24.44	24.00	–	7.00	–	9.00	–	0
2963	8.88	5.56	25.62	25.00	7.04	5.00	6.45	–	46.45	0
2967	8.14	3.93	26.25	26.00	6.58	5.50	8.69	10.00	46.41	Few.
2920	–	–	26.62	–	9.85	–	9.87	–	–	0
4125	–	–	25.87	24.00	–	7.00	–	9.00	–	0
4251	–	–	22.38	24.00	–	7.00	–	9.00	–	0
4023	9.45	8.12	23.19	18.00	5.14	4.00	8.37	9.00	45.73	Few.
4109	–	–	23.63	18.00	–	4.00	–	9.00	–	Many.
4061	6.19	6.20	26.00	25.00	4.61	4.50	11.32	9.00	45.68	Few.
2951	10.02	8.51	16.93	16.50	4.58	3.50	10.95	12.00	49.01	0
4215	8.71	8.33	17.00	16.50	3.45	3.50	13.07	12.00	49.44	Few.
4143	8.93	2.93	12.63	10.00	4.56	4.00	8.54	8.00	62.41	0
4281	–	–	10.44	8.00	–	4.00	–	9.00	–	0
4159	11.51	1.90	11.38	11.00	3.28	3.00	3.96	5.00	67.97	Few.

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	* Source of sample.	Station number.
Albert Dickinson Co., Chicago, Ill. Alfalfa Meal	O	4051
S. E. Faithful, Boston, Mass. Rye Grains	O	4044
Husted Milling Co., Buffalo, N. Y. Husted Stock Feed	O	4033
Northwest Mills Co., Minneapolis, Minn. Sugarota Dairy Feed	O	2879
Quaker Oats Co. Chicago, Ill. Quaker Molasses Dairy Feed	D O	2928 4060
Quaker Oats Co., Chicago, Ill. Schumacher Stock Feed	O D	2995 4111
Standard Cereal Co., Chillicothe, O. Standco Hominy Feed	D	4290

MISCELLANEOUS COMPOUND FEEDS. Protein under 10 per cent.

Manufacturer or Shipper and Brand.	* Source of sample.	Station number.
Empire Mills, Olean, N. Y. Empire Feed	O	4008
D. H. Grandin Milling Co., Jamestown, N. Y. Grandin's Stock Feed	O O	4142 4235
W. H. Haskell & Co., Toledo, O. Haskell's Stock Feed	O	4004
Wm. S. Hills Co., Boston, Mass. Purity Special Stock Feed	O	4126
H-O Co., Buffalo, N. Y. New England Stock Feed	O	4197
Michigan Sugar Co., Crosswell, Mich. Dried Beet Pulp	O O	2932 2981

* Samples marked D are from dealer and those marked O were taken by the inspector.

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4051	7.06	10.43	14.13	12.00	1.63	1.00	30.38	35.00	36.37	0
4044	7.27	1.70	15.88	16.00	6.78	5.00	14.33	16.00	54.04	0
4033	8.30	4.29	10.82	8.00	6.50	4.00	6.91	–	63.18	Few.
2879	–	–	18.50	16.50	–	3.50	–	–	–	0
2928	–	–	18.00	16.00	–	3.50	–	12.00	–	0
4060	6.32	7.37	16.13	16.00	4.68	3.50	14.40	12.00	51.10	Many.
2995	10.20	3.68	10.63	10.00	3.85	2.25	9.13	10.00	62.51	0
4111	–	–	10.50	10.00	–	3.25	–	–	–	0
4290	–	–	11.19	10.00	–	7.00	–	4.00	–	0
4008	10.15	2.61	8.63	7.50	4.48	3.00	5.60	9.00	68.53	Few.
4142	–	–	9.44	10.00	3.88	4.40	5.68	8.21	–	Few.
4235	11.81	2.24	9.00	8.50	3.61	3.50	6.67	9.00	66.67	Few.
4004	8.48	3.02	9.50	8.00	7.80	4.00	7.00	8.00	64.20	0
4126	10.25	2.89	9.06	10.00	3.83	3.25	8.32	9.00	65.65	0
4197	8.76	4.49	8.82	9.00	3.50	4.00	10.49	9.00	62.86	0
2932	–	–	8.50	8.00	1.20	0.50	18.75	20.00	–	0
2981	8.20	3.52	8.63	8.00	0.76	0.40	19.63	20.00	59.26	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	* Source of sample.	Station number.
St. Louis Sugar Co., St. Louis, Mich. Dried Beet Pulp	C	4205
A. H. McLeod Milling Co., St. Johnsbury, Vt. Brook's Fancy Corn and Oat Stock Feed	O	4195
Mollett Grain & Milling Co., McClure, O. Park City Stock Feed	O	4170
Northern Illinois Cereal Co., Lockport, Ill. Peru C. & O. Feed	O	4171

POULTRY FEEDS.

Jos. Breck & Sons, Boston, Mass. Breck's Ground Beef Scraps	O	4046
Jos. Breck & Sons, Boston, Mass. Breck's Poultry & Swine Meal	O	4048
Albert Dickinson Co., Chicago, Ill. Globe Scratch Feed	O	4055
Park & Pollard Co., Boston, Mass. Dry Mash Feed	O	2979
Park & Pollard Co., Boston, Mass. Gritless Chick Feed	O	2962
Park & Pollard Co., Boston, Mass. Scratch Feed	O	2976
Portland Rendering Co., Portland, Me. Cooked Meat Scraps for Poultry	O	2965

* Samples marked D are from dealer and those marked O were taken by the inspector.

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein.		Fat.		Fiber.		Nitrogen free extract.	Weed seeds.
			Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.		
4205	–	–	10.00	8.00	–	0.5	–	20.00	–	0
4195	9.77	3.50	9.75	7.63	3.58	2.97	9.91	–	63.49	0
4170	10.82	4.38	9.88	–	6.31	–	6.61	–	62.00	Few.
4171	11.79	3.16	8.44	8.00	3.16	3.50	11.40	–	57.05	0
4046	6.33	33.20	41.18	43.00	15.23	12.00	–	–	–	0
4048	6.41	44.90	30.06	33.00	11.26	10.00	2.85	–	4.52	0
4055	10.47	10.13	10.00	10.00	2.57	2.50	2.33	5.00	64.50	Few.
2979	9.42	11.73	22.75	20.00	4.18	3.00	7.23	–	44.69	Few.
2962	11.20	5.16	13.50	10.00	2.57	2.77	2.53	–	65.04	Few.
2976	11.11	4.57	9.75	10.00	3.18	3.00	2.51	–	68.88	Few.
2965	5.59	33.02	43.31	40.00	15.50	8.00	–	–	–	0

Table showing brands, the manufacturers or shippers, the components and the guaranteed analysis of Feeding Stuffs registered in Maine before February 15, 1912.

Kind of Feed, Brand, and Maker or Shipper, and Components of Compounded Feeds.	Guaranteed Analysis. Fiber not more than—per cent.	Protein not less than—per cent.	Fat not less than—per cent.
CHOICE COTTONSEED MEAL.			
Bee Brand Cottonseed meal W. C. Northern, Little Rock, Ark.	10.5	41.0	7.0
Choice Cottonseed Meal American Cotton Oil Co., New York City, N. Y.	10.5	41.0	9.0
Choice Cottonseed Meal Kemper Mill & Elevator Co., Kansas City, Mo.	10.0	41.0	7.5
Good Luck Cottonseed Meal Cracked Screened Cake S. P. Davis, Little Rock, Ark.	10.5	41.0	7.0
Green Diamond Brand Choice Cottonseed Meal Chapin & Co., Hammond, Ind.	10.0	41.0	8.0
Old Gold Cottonseed Meal T. H. Bunch Commission Co., Little Rock, Ark.	9.0	41.0	9.0
Owl Brand High Grade Cottonseed Meal F. W. Brode & Co., Memphis, Tenn.	10.0	41.0	6.0
Peacock Brand Cottonseed Meal Keeton-Krueger Co., Atlanta, Ga.	10.0	41.0	6.0
Pioneer Cottonseed Meal J. E. Soper Co., Boston, Mass.	10.0	41.0	7.0
PRIME COTTONSEED MEAL.			
Acme Cottonseed Meal T. H. Bunch Commission Co., Little Rock, Ark.	11.0	39.0	8.0
Buckeye Cottonseed Meal Buckeye Cotton Oil Co., Cincinnati, O.	10.0	38.5	6.5
Dixie Brand Cottonseed Meal Humphreys-Godwin Co., Memphis, Tenn.	12.0	38.6	6.0
Dove Brand Cottonseed Meal F. W. Brode & Co., Memphis, Tenn.	10.0	38.6	6.0
Prime Cottonseed Meal American Cotton Oil Co., New York City, N. Y.	11.5	38.6	8.0
COTTONSEED MEAL AND COTTONSEED HULL BRAN.			
Creamo Brand Cottonseed Feed Humphreys-Godwin Co., Memphis, Tenn.	22.0	20.0	5.0

List of Registered Feeding Stuffs, 1912—Continued.

Kind of Feed, Brand, and Maker or Shipper, and Components of Compounded Feeds.	Guaranteed Analysis. Fiber not more than—per cent.	Protein not less than—per cent.	Fat not less than—per cent.
LINSEED OIL MEAL.			
Cleveland Flax Meal or Linseed Oil Meal American Linseed Co., New York City.	7.5	36.0	1.0
Old Process Oil Meal American Linseed Co., New York City, N. Y.	8.0	34.0	5.0
Old Process Oil Meal Guy G. Major Co., Toledo, Ohio.	10.0	30.0	5.0
WHEAT BRAN.			
Anchor Bran Kemper Mill & Elevator Co., Kansas City, Mo.	9.5	14.5	4.0
Bran Colton Bros. Co., Bellefontaine, Ohio.	9.5	14.5	4.0
Bran Geo. Urban Milling Co., Buffalo, N. Y.	11.0	15.0	4.0
Bran Lake of the Woods Milling Co., Ltd., Montreal, Can.	9.0	15.5	4.0
Bran Maple Leaf Flour Mills Co., Toronto, Ont.	9.0	15.5	4.0
Bran Ogilvie Flour Mills Co., Ltd., Montreal, Can.	9.0	15.5	4.0
Bran Russell-Miller Milling Co., Minneapolis, Minn.	11.0	13.0	4.0
Bran Western Canada Flour Mills Co., Ltd., Toronto, Can.	9.0	15.5	4.0
Bran Wm. A. Coombs Milling Co., Coldwater, Mich.	–	14.0	3.0
Diamond Bran Kemper Mill & Elevator Co., Kansas City, Mo.	9.5	14.5	4.0
Dudley Bran Charles M. Cox Co., Boston, Mass.	9.0	15.5	4.0
Duluth Imperial Bran Duluth-Superior Milling Co., Duluth, Minn.	11.25	14.5	4.0
Eaco Winged Horse Bran Everett Aughenbaugh Co., Waseca, Minn.	12.0	14.0	3.0
"Emco" Bran Edwardsville Milling Co., Edwardsville, Ill.	4.2	14.0	3.5
Esmeralda Bran The Ohio Cereal Co., Circleville, Ohio.	9.5	14.5	4.0
Fancy Bran Geo. Tileston Milling Co., St. Cloud, Minn.	11.0	14.5	4.0

List of Registered Feeding Stuffs, 1912—Continued.

KIND OF FEED, BRAND, AND MAKER OR SHIPPER, AND COMPONENTS OF COMPOUNDED FEEDS.	Guaranteed Analysis.		
	Fiber not more than—per cent.	Protein not less than—per cent.	Fat not less than—per cent.
Farmers' Favorite Bran Valley City Milling Co., Grand Rapids, Mich.	10.9	17.7	3.4
F. W. Stock & Sons Bran F. W. Stock & Sons, Hillsdale, Mich.	9.5	15.5	3.0
Gwinn's Wheat Bran Gwinn Milling Co., Columbus, Ohio.	8.1	15.8	4.4
Harter's Pure Wheat Bran Harter Milling Co., Toledo, Ohio.	8.0	15.0	4.0
Henkel's Bran Commercial Milling Co., Detroit, Mich.	14.0	14.0	3.0
Lucky Bran Federal Milling Co., Lockport, N. Y.	10.0	12.0	4.0
Monogram Bran Charles M. Cox Co., Boston, Mass.	9.0	15.5	4.0
Noblesville Milling Co.'s Wheat Bran Noblesville Milling Co., Noblesville, Ind.	–	14.5	3.7
Pillsbury's Bran The Pillsbury Flour Mills Co., Minneapolis, Minn.	11.0	14.5	4.0
Pure Wheat Bran Northwestern Consolidated Milling Co., Minneapolis, Minn.	11.0	14.5	4.0
Pure Winter Wheat Bran Detroit Milling Co., Detroit, Mich.	9.5	16.0	4.0
Pure Winter Wheat Bran Kelley Milling Co., Kansas City, Mo.	9.0	15.0	3.5
Pure Spring Wheat Bran Detroit Milling Co., Detroit, Mich.	11.0	16.0	4.5
Seal of Minnesota Bran New Prague Flouring Mill Co., New Prague, Minn.	11.5	15.0	4.3
Snowflake Bran Lawrenceburg Roller Mills Co., Lawrenceburg, Ind.	9.5	14.2	3.8
Star & Crescent Bran Star & Crescent Milling Co., Chicago, Ill.	10.0	15.0	4.0
Stott's Pure Spring Wheat Bran David Stott, Detroit, Mich.	11.0	16.0	4.5
Stott's Pure Winter Wheat Bran David Stott, Detroit, Mich.	9.5	16.0	4.0
Trojan Bran Allen & Wheeler Co., Troy, Ohio.	9.5	14.5	4.0
Voight's Pure Bran Voight Milling Co., Grand Rapids, Mich.	–	–	–
Wabash Bran Sparks Milling Co., Terre Haute, Ind.	8.0	14.0	3.5

List of Registered Feeding Stuffs, 1912—Continued.

Kind of Feed, Brand, and Maker or Shipper, and Components of Compounded Feeds.	Guaranteed Analysis.		
	Fiber not more than—per cent.	Protein not less than—per cent.	Fat not less than—per cent.
Washburn-Crosby Co.'s Coarse Bran Washburn-Crosby Co., Minneapolis, Minn.	11.0	14.5	4.0
Waseo Bran Lyon-Greenleaf, Wauseon, Ohio.	9.5	14.5	4.0
Wheat Bran Bay State Milling Co., Winona, Minn.	11.0	15.0	4.7
William Tell Bran Ansted & Burke Co., Springfield, Ohio	11.5	14.0	3.0
WHEAT MIDDLINGS.			
Apex Middlings Detroit Milling Co., Detroit, Mich.	18.0	18.0	5.0
Climax Middlings David Stott, Detroit, Mich.	18.0	18.0	5.0
Eaco Winged Horse Middlings Everett Aughenbaugh Co., Waseca, Minn.	10.0	15.0	3.0
Esmeralda Wheat Middlings Ohio Cereal Co., Circleville, Ohio.	5.8	15.0	4.0
Farmers' Favorite Middlings Valley City Milling Co., Grand Rapids, Mich.	6.3	16.8	4.7
Fine White Middlings David Stott, Detroit, Mich.	8.0	16.0	5.0
Flour Middlings Russell-Miller Milling Co., Minneapolis, Minn.	6.0	16.0	5.0
F. W. Stock & Sons Middlings F. W. Stock & Sons, Hillsdale, Mich.	6.0	17.0	4.4
Gwinn's Wheat Middlings Gwinn Milling Co., Columbus, Ohio.	6.0	17.0	4.6
Harter's Pure Wheat Middlings Harter Milling Co., Toledo, Ohio.	6.0	17.0	4.0
Lucky Middlings Federal Milling Co., Lockport, N. Y.	10.0	15.0	4.0
Middlings Colton Bros. Co., Bellefontaine, O.	6.0	15.0	4.0
Middlings Geo. Urban Milling Co., Buffalo, N., Y.	8.0	16.0	5.0
Middlings Wm. A. Coombs Milling Co., Coldwater, Mich.	–	15.0	3.0
No. 8 White Middlings Chapin & Co., Hammond, Ind.	8.0	14.0	3.0
Pennant Middlings David Stott, Detroit, Mich.	8.0	17.0	5.5

List of Registered Feeding Stuffs, 1912—Continued.

Kind of Feed, Brand, and Maker or Shipper, and Components of Compounded Feeds.	Guaranteed Analysis		
	Fiber not more than—per cent.	Protein not less than—per cent.	Fat not less than—per cent.
Pillsbury's A Middlings Pillsbury Flour Mills Co., Minneapolis, Minn.	6.0	15.0	4.5
Pillsbury's B Middlings Pillsbury Flour Mills Co., Minneapolis, Minn.	8.0	15.0	4.5
Pure Wheat Flour Middlings Northwestern Consolidated Milling Co., Minneapolis, Minn.	6.0	15.5	4.5
Pure Wheat Middlings Northwestern Consolidated Milling Co., Minneapolis, Minn.	10.0	15.0	4.5
Seal of Minnesota Standard Middlings New Prague Flouring Mill Co., New Prague, Minn.	6.0	18.5	6.0
Snowflake Middlings Lawrenceburg Roller Mills Co., Lawrenceburg, Ind.	6.0	16.0	5.1
Sphinx Middlings Federal Milling Co., Lockport, N. Y.	8.0	17.0	3.0
Standard Middlings Duluth-Superior Milling Co., Duluth, Minn.	8.0	16.0	5.0
Standard Middlings Russell-Miller Milling Co., Minneapolis, Minn.	9.0	15.0	4.0
Star and Crescent Middlings Star & Crescent Milling Co., Chicago, Ill.	8.0	16.0	4.0
Trojan Middlings Allen & Wheeler Co., Troy, Ohio.	6.0	15.0	4.0
Voight's Pure Middlings Voight Milling Co., Grand Rapids, Mich.	-	-	-
Washburn-Crosby Co.'s Flour Middlings Washburn-Crosby Co., Minneapolis, Minn.	6.0	17.0	5.0
Washburn-Crosby Co.'s Standard Middlings (Shorts) Washburn-Crosby Co., Minneapolis, Minn.	8.0	15.0	4.0
Waseo Middlings Lyon-Greenleaf, Wauseon, Ohio.	6.0	16.0	4.0
Wheat Middlings Bay State Milling Co., Winona, Minn.	8.0	17.0	5.0
William Tell Middlings Ansted & Burk Co., Springfield, Ohio.	7.5	14.5	4.0
Winter Wheat Middlings Christian Breisch & Co., N. Lansing, Mich.	4.1	15.0	-

WHEAT MIXED FEEDS. OFFALS FROM MILLING OF WHEAT.

Acme Feed Acme-Evans Co., Indianapolis, Ind.	9.0	16.5	4.0
Adrian Mixed Feed Detroit Milling Co., Detroit, Mich.	9.0	16.5	5.0

List of Registered Feeding Stuffs, 1912—Continued.

KIND OF FEED, BRAND, AND MAKER OR SHIPPER, AND COMPONENTS OF COMPOUNDED FEEDS.	Guaranteed Analysis.		
	Fiber not more than—per cent.	Protein not less than—per cent.	Fat not less than—per cent.
Anchor Mixed Feed Kemper Mill & Elevator Co., Kansas City, Mo.	5.0	16.0	4.0
Blish's Bull's Eye Mixed Feed Blish Milling Co., Seymour, Ind.	9.0	16.5	4.5
Boston Mixed Feed Duluth-Superior Milling Co., Duluth, Minn.	8.5	16.0	4.5
Brooks Fancy Mixed Feed A. H. McLeod Milling Co., St. Johnsbury, Vt.	9.0	16.0	4.5
Buckeye Mixed Feed Quaker Oats Co., Chicago, Ill.	8.0	13.0	4.0
Champion Mixed Feed Portland Milling Co., Portland, Mich.	9.4	15.8	-
Claro Mixed Feed Claro Milling Co., Waseca, Minn.	11.0	15.0	3.0
Columbia Mixed Feed Charles M. Cox Co., Boston, Mass.	9.0	16.0	4.0
Crescent Mixed Feed Kemper Mill & Elevator Co., Kansas City, Mo.	5.0	16.0	4.0
Eaco Winged Horse Mixed Feed Everett-Aughenbaugh Co., Waseca, Minn.	12.0	15.0	3.0
Emco Mixed Feed Edwardsville Milling Co., Edwardsville, Ill.	4.2	14.9	3.7
Erie Winter Mixed Feed Chapin & Co., Hammond, Ind.	10.0	14.0	3.5
Esmeralda Mixed Feed Ohio Cereal Co., Circleville, Ohio.	6.3	16.4	3.7
Farmers' Favorite Cow Feed Valley City Milling Co., Grand Rapids, Mich.	7.5	14.8	4.2
F. W. Stock & Sons Monarch Feed F. W. Stock & Sons, Hillsdale,Mich.	10.5	17.5	4.4
F. W. Stock & Sons Superior Feed F. W. Stock & Sons, Hillsdale, Mich.	7.0	18.0	5.0
"Gold Mine" Mixed Feed Sheffield-King Milling Co., Faribault, Minn.	8.9	15.9	4.9
Ground Wheat Feed Star & Crescent Milling Co., Chicago, Ill.	6.0	15.0	4.5
Grafton Mixed Feed Grafton Roller Mill Co., Grafton, N. D.	11.9	15.5	6.1
Gwinn's Dairy Feed Gwinn Milling Co., Columbus, Ohio.	7.0	16.4	4.5
Harter's Pure Wheat Bran & Middlings Harter Milling Co., Toledo, Ohio.	6.0	18.0	4.0

List of Registered Feeding Stuffs, 1912—Continued.

Kind of Feed, Brand, and Maker or Shipper, and Components of Compounded Feeds.	Guaranteed Analysis.		
	Fiber not more than—per cent.	Protein not less than—per cent.	Fat not less than—per cent.
Heavy Mixed Feed David Stott, Detroit, Mich.	9.0	16.5	5.0
HonestMixed Feed David Stott, Detroit, Mich.	9.0	16.5	5.0
Lucky Mixed Feed Federal Milling Co., Lockport, N. Y.	10.0	14.0	4.0
Kent Mixed Feed Williams Bros. Co., Kent, Ohio.	8.0	12.0	3.0
Mixed Feed Bay State Milling Co., Winona, Minn.	10.0	17.0	5.0
Mixed Feed Colton Bros. Co., Bellefontaine, Ohio.	6.0	14.5	4.0
Mixed Feed Geo. Urban Milling Co., Buffalo, N. Y.	10.5	16.0	4.0
Mixed Feed Northwestern Consolidated Milling Co., Minneapolis, Minn.	10.0	15.0	4.5
Mixed Feed Wm. A. Combs Milling Co., Coldwater, Mich.	–	15.0	3.0
Noblesville Mixed Feed Noblesville Milling Co., Noblesville, Ind.	–	15.0	3.7
Occident Mixed Feed Russell-Miller Milling Co., Minneapolis, Minn.	10.0	15.0	4.5
Osota Mixed Feed National Milling Co., Toledo, Ohio.	8.0	17.0	4.5
Pennant Mixed Feed National Milling Co., Toledo, Ohio.	8.5	16.0	3.7
Pillsbury's Mixed Feed Pillsbury Flour Mills Co., Minneapolis, Minn.	8.0	16.0	4.5
Planet Feed Northwestern Consolidated Milling Co., Minneapolis, Minn.	8.0	15.0	4.0
Purity Mixed Feed Wm. S. Hills Co., Boston, Mass.	10.0	15.0	4.0
Regent Mixed Feed Charles M. Cox Co., Boston, Mass.	10.0	15.0	3.0
Sioux Fancy Mixed Feed Donahue-Stratton Co., Milwaukee, Wis.	9.0	15.0	4.0
Snowflake Mixed Feed Lawrenceburg Roller Mills Co., Lawrenceburg, Ind.	8.0	15.2	4.3
Trojan Mixed Feed Allen & Wheeler Co., Troy, Ohio.	8.0	14.5	4.0
Try Me Mixed Feed Sparks Milling Co., Alton, Ill.	8.0	15.0	4.0

List of Registered Feeding Stuffs, 1912—Continued.

Kind of Feed, Brand, and Maker or Shipper, and Components of Compounded Feeds.	Guaranteed Analysis. Fiber not more than—per cent.	Protein not less than—per cent.	Fat not less than—per cent.
Vermont Brand Mixed Feed Chapin & Co., Hammond, Ind.	-	14.0	4.0
Voight's Pure Cow Feed—Mixed Feed—Offal of Mill where separation is made Voight Milling Co., Grand Rapids, Mich.	-	-	-
Wabash Mixed Feed Sparks Milling Co., Terre Haute, Ind.	8.0	14.0	3.5
Washburn-Crosby Co.'s Mixed Feed Washburn-Crosby Co., Minneapolis, Minn.	9.0	16.0	4.5
Waseo Mixed Feed Lyon-Greenleaf, Wauseon, Ohio.	8.0	15.0	4.0
William Tell Mixed Feed Ansted & Burk Co., Springfield, Ohio.	11.5	14.5	3.5
Wirthmore Mixed Feed Charles M. Cox Co., Boston, Mass.	7.0	16.0	4.0
Xtragood Mixed Feed Griswold & Mackinnon, St. Johnsbury, Vt.	7.5	16.0	4.0

WHEAT FEED FLOUR.

Gwinn's Red Dog Gwinn Milling Co., Columbus, Ohio.	-	-	-
Pillsbury's Daisy Pillsbury Flour Mills Co., Minneapolis, Minn.	4.0	16.0	4.5
Red Dog Bay State Milling Co., Winona, Minn.	3.0	18.0	5.0
Red Dog Russell-Miller Milling Co., Minneapolis, Minn.	6.0	16.0	4.5
Star Red Dog Star & Crescent Milling Co., Chicago, Ill.	3.0	16.5	4.0
Washburn-Crosby Co.'s Adrian (Red Dog Flour) Washburn-Crosby Co., Minneapolis, Minn.	4.0	17.0	5.0
XXX Comet Northwestern Consolidated Milling Co., Minneapolis, Minn.	3.0	16.5	4.0

WHEAT OFFAL, GROUND CORN AND GROUND CORN COB.

Bluegrass Feed A. Waller & Co., Henderson, Ky.	17.0	9.0	2.0
Sterling Feed Indiana Milling Co., Terre Haute, Ind.	14.0	9.8	2.7

List of Registered Feeding Stuffs, 1912—Continued.

Kind of Feed, Brand, and Maker or Shipper, and Components of Compounded Feeds.	Guaranteed Analysis		
	Fiber not more than—per cent.	Protein not less than—per cent.	Fat not less than—per cent.
WHEAT AND CORN CHOP.			
Esmeralda Special Chop Ohio Cereal Co., Circleville, Ohio.	4.0	16.0	5.0
CORN MILLING OFFALS.			
Bufceco Hominy Feed Buffalo Cereal Co., Buffalo, N. Y.	4.0	10.0	7.0
Green Diamond Hominy Meal Chapin & Co., Hammond, Ind.	5.0	10.0	7.0
Gwinn's Cracked Corn Gwinn Milling Co., Columbus, Ohio.	2.0	9.0	4.3
Henkel's Coarse Feed Corn Meal Commercial Milling Co., Detroit, Mich.	2.0	8.5	-
Homcoline American Hominy Co., Indianapolis, Ind.	7.0	17.0	5.0
"Standco" Hominy Feed Standard Cereal Co., Chillicothe, Ohio.	4.0	10.0	7.0
CORN AND OATS GROUND TOGETHER.			
Corn & Oat Chop J. B. Ham Co., Lewiston, Me.	5.0	10.0	4.0
Corn & Oat Chop Kimball Bros. Co., Bath, Me.	5.8	10.2	4.8
Corn & Oat Feed Dinsmore Grain Co., Wiscasset, Me.	4.8	10.1	3.7
Monmouth Pure Corn and Oats Feed E. M. Marks, Monmouth, Me.	8.0	10.0	5.0
Esmeralda Corn and Oats Chop Ohio Cereal Co., Circleville, Ohio.	6.0	10.0	4.0
Gwinn's Horse & Mule Feed Gwinn Milling Co., Columbus, Ohio.	6.0	10.5	5.0
Horse Feed E. Merritt & Sons, Houlton, Me.	8.0	10.0	4.0
Lucky Chop Federal Milling Co., Lockport, N. Y.	8.0	9.0	3.0
CORN AND OAT OFFALS.			
Corn and Oat Chop S. W. Thaxter & Co., Portland, Me.	8.0	8.0	4.0

List of Registered Feeding Stuffs, 1912—Continued.

KIND OF FEED, BRAND, AND MAKER OR SHIPPER, AND COMPONENTS OF COMPOUNDED FEEDS.	Guaranteed Analysis. Fiber not more than— per cent.	Protein not less than— per cent.	Fat not less than— per cent.
Star Feed Toledo Elevator Co., Indianapolis, Ind.	12.5	7.0	5.5
Winner Chop Feed David Stott, Detroit, Mich.	10.0	8.9	4.5
Wirthmore Stock Feed Charles M. Cox Co., Boston, Mass.	7.0	9.0	4.0
DRIED DISTILLERS GRAINS.			
Ajax Flakes Ajax Milling & Feed Co., New York City, N. Y.	14.0	30.0	11.0
Buckeye Gluten Feed Dewey Bros. Co., Blanchester, Ohio.	15.0	20.0	5.0
Climax Corn Distillers Grains Hermann Deutsch Co., Milwaukee, Wis.	15.0	30.0	10.0
Continental Gluten Feed Continental Cereal Co., Peoria, Ill.	10.5	29.0	12.5
Fourex (XXXX) Distillers' Dried Grains J. W. Biles Co., Cincinnati, Ohio.	13.0	31.0	12.0
Xtragood Distillers Grains Griswold & Mackinnon, St. Johnsbury, Vt.	14.0	30.0	10.0
CORN BY-PRODUCT.			
Buffalo Gluten Feed Corn Products Refining Co., New York City, N. Y.	8.5	23.0	2.0
Cedar Rapids Gluten Feed Douglas & Co., Cedar Rapids, Iowa.	8.0	20.0	2.0
Cream of Corn Gluten Feed American Maize Products Co., New York City, N. Y.	8.5	23.0	2.5
Crescent Gluten Feed Corn Products Refining Co., New York City, N. Y.	8.5	23.0	2.0
Diamond Gluten Meal Corn Products Refining Co., New York City, N. Y.	4.0	40.0	1.5
COOKED FOOD PRODUCT.			
Force Screenings The H-O Co., Buffalo, N. Y. Composed of cooked wheat and salt	9.0	11.0	3.0
GROUND ALFALFA HAY.			
Alfalfa Meal Albert Dickinson Co., Chicago, Ill.	35.0	12.0	1.0

List of Registered Feeding Stuffs, 1912—Continued.

KIND OF FEED, BRAND, AND MAKER OR SHIPPER AND COMPONENTS OF COMPOUNDED FEEDS.	Guaranteed Analysis. Fiber not more than—per cent.	Protein not less than—per cent.	Fat not less than—per cent.
Amco Alfalfa Meal. American Milling Co., Chicago, Ill.	30.0	13.0	2.0
DRIED BEET PULP.			
Dried Beet Pulp. Larrowe Milling Co., Detroit, Mich.	20.0	8.0	0.5
COMPOUNDED FEEDS ARRANGED IN ORDER OF PROTEIN AND FIBER CONTENT.			
PROTEIN ABOUT 9 PER CENT.; FIBER ABOUT 4 PER CENT.			
Husted Germaline. Husted Milling Co., Buffalo, N. Y. Corn meal, molasses.	4.0	9.0	3.0
Purity Stock Feed. Wm. S. Hills Co., Boston, Mass. By-products of corn and oats, cottonseed meal, salt.	5.0	8.5	3 0
PROTEIN 7.5 TO 9 PER CENT.; FIBER ABOUT 9 PER CENT.			
Brooks Fancy Corn and Oat Stock Feed. A. H. McLeod Milling Co., St. Johnsbury, Vt. Corn, oats, gluten.	8.5	9.0	3.0
Bufceco Chop Feed. Buffalo Cereal Co., Buffalo, N. Y. Corn, hominy feed, oat bran, oat hulls.	9.0	7.0	3.0
Bufceco Stocd Feed. Buffalo Cereal Co., Buffalo, N. Y. Corn, hominy feed, oat hulls, oat bran, gluten feed.	9.0	8.0	4.0
Empire Feed. Empire Mills, Olean, N. Y. Corn, hominy, oat hulls.	9.0	7.5	3.0
Fine Ground Eclipse Feed. Husted Milling Co., Buffalo, N. Y. Corn meal, hominy feed, oats, oat hulls, wheat middlings, salt.	9.0	9.0	4.0
Grandin's Stock Feed. D. H. Grandin Milling Co., Jamestown, N. Y. Oats, corn, barley, barley middlings, oat hulls, salt.	9.0	8.5	3.5
Haskell's Oat Feed. W. H. Haskell & Co., Toledo, Ohio. Corn, oats, oat hulls, hominy feed, oat shorts.	8.0	8.0	4.0
Haskell's Stock Feed. W. H. Haskell & Co., Toledo, Ohio. Carn, oats, hominy feed, oat hulls, oat shorts.	8.0	8.0	4.0
Henkel's Chop Feed. Commercial Milling Co., Detroit, Mich. Corn meal, wheat, oat middlings, oats, oat hulls.	8.0	8.0	5.0
Husted Stock Feed. Husted Milling Co., Buffalo, N. Y. Corn meal, hominy feed, oat hulls, wheat middlings, salt.	9.0	8.0	4.0

List of Registered Feeding Stuffs, 1912—Continued.

KIND OF FEED, BRAND, AND MAKER OR SHIPPER AND COMPONENTS OF COMPOUNDED FEEDS.	Guaranteed Analysis: Fiber not more than—per cent.	Protein not less than—per cent.	Fat not less than—per cent.
Mayflower Stock Feed. Husted Milling Co., Buffalo, N. Y. Corn meal, oats, hominy feed, oat hulls, salt.	9.0	7.5	3.5
Monarch Chop Feed. Husted Milling Co. Buffalo, N. Y. Corn meal, oats, oat hulls, hominy feed, salt.	9.0	7.5	3.5
New England Stock Feed. H-O Co., Buffalo, N. Y. Corn, hominy feed, oat hulls, oat shorts, oats, salt.	9.0	9.0	1.0
Park City Stock Feed. Mollett Grain & Milling Co., McClure, Ohio. Corn, oat hulls, oats.	9.5	7.5	3.5
White Diamond Feed. Quaker Oats Co., Chicago, Ill. Corn, oatmeal mill by-product, (oat middlings, oat hulls, oat shorts) salt.	9.0	8.0	3.2
PROTEIN ABOUT 8 PER CENT.; FIBER ABOUT 12 PER CENT.			
Justasgood Stock Feed. Griswold & Mackinnon, St. Johnsbury, Vt. Corn, oatmeal mill by-product, oat middlings, oat hulls, oat shorts, salt.	12.0	7.5	3.0
Peru C. and O. Feed. Northern Illinois Cereal Co., Lockport, Ill. Corn, oat shorts, oat middlings, oat hulls.	12.0	8.5	3.5
Regal Stock Feed. Imperial Grain & Milling Co., Toledo, Ohio. Corn, corn cobs, oat middlings, oat hulls, oat bran, cottonseed meal, salt.	12.8	8.0	3.5
Victor Feed—Boss Feed. Quaker Oats Co., Chicago, Ill. Corn, oat middlings, oat hulls, oat shorts, flax plant by-product, salt.	12.0	8.0	3.0
PROTEIN 15 PER CENT.; FIBER 3 TO 7 PER CENT.			
Henkel's Coarse Brown Feed. Commercial Milling Co., Detroit, Mich. Wheat middlings, buckwheat middlings, corn, rye middlings.	8.0	15.0	4.0
Henkel's Fine White Feed. Commercial Milling Co., Detroit, Mich. Wheat middlings, buckwheat middlings, corn, rye middlings.	4.0	15.0	3.5
PROTEIN 12-14 5 PER CENT.; FIBER 8-10 PER CENT.			
Bufceco Dairy Feed. Buffalo Cereal Co., Buffalo, N. Y. Corn, wheat middlings, hominy feed, gluten feed, oat hulls.	8.0	12.0	3.0
Bufceco Horse Feed. Buffalo Cereal Co., Buffalo, N. Y. Oats, corn, barley, gluten feed, wheat middlings, hominy feed, ground oats, oat hulls, oat bran, oat middlings.	8.0	10.0	4.0
Henkel's Feed. Commercial Milling Co., Detroit, Mich. Wheat middlings, buckwheat middlings, corn, rye middlings.	8.0	14.5	4.5

List of Registered Feeding Stuffs, 1912—Continued.

Kind of Feed, Brand, and Maker or Shipper and Components of Compounded Feeds.	Guaranteed Analysis.		
	Fiber not more than—per cent.	Protein not less than—per cent.	Fat not less than—per cent.
H. O. Co.'s Algrane Horse Feed. H-O Co., Buffalo, N. Y. Oats, oat shorts, corn, oat hulls, wheat middlings, hominy feed, gluten feed, salt.	9.0	11.0	4.0
H. O. Co.'s Algrane Milk Feed. H-O Co., Buffalo, N. Y. Oat hulls, wheat middlings, cottonseed meal, oat shorts, gluten feed, corn, oats, salt.	9.0	14.0	4.0
Husted Horse Feed. Husted Milling Co., Buffalo, N. Y. Corn meal, cracked corn, ground oats, wheat middlings, whole oats, hominy feed, gluten feed, oat hulls, oil meal, salt.	9.0	12.0	4.0
Schumacher Stock Feed—Sterling Stock Feed. Quaker Oats Co., Chicago, Ill. Corn, barley, wheat flour, cottonseed meal, oatmeal mill by-product (oat middlings, oat hulls, oat shorts), salt.	10.0	10.0	3.2
Xtragood Stock Feed. Griswold & Mackinnon, St. Johnsbury, V. Corn, barley, wheat flour, cottonseed meal, oatmeal mill by-product, (oat middlings, oat hulls, oat shorts), salt.	10.0	10.0	3.2
PROTEIN 16-17 PER CENT.; FIBER 12-16 PER CENT.			
Daisy Dairy Feed. Quaker Oats Co., Chicago, Ill. Molasses, grain screenings, meal, flax plant by-product, oatmeal mill by-product (oat middlings, oat hulls, oat shorts), cottonseed meal.	16.0	16.0	4.0
Jersey Feed. E. Merritt & Sons, Houlton, Me. Cottonseed meal, wheat, corn, oats, buckwheat.	16.0	17.0	5.0
International Dairy Feed. International Sugar Feed Co., Minneapolis, Minn. Cottonseed meal, molasses, grain screenings cleaned, oat clips, salt.	12.0	16.5	3.5
Quaker Molasses Dairy Feed. Quaker Oats Co., Chicago, Ill. Molasses, malt sprouts, cottonseed meal, grain screenings meal, flax plant by-product, oatmeal mill by-product (oat middlings, oat hulls, oat shorts).	14.0	16.0	3.5
Sucrene Dairy Feed. American Milling Co., Chicago, Ill. Cottonseed meal, gluten feed, molasses, oat clippings, ground and bolted grain screenings, salt.	12.0	16.5	3.5
PROTEIN 18-20 PER CENT.; FIBER 9 PER CENT.			
Husted Dairy Feed. Husted Milling Co., Buffalo, N. Y. Cottonseed meal, corn meal, oat clips, wheat middlings, gluten feed, oil meal, distillers' grains, malt sprouts, salt.	9.0	20.0	4.0
Husted Molasses Feed. Husted Milling Co., Buffalo, N. Y. Cottonseed meal, gluten feed, oat clips, corn meal, oil meal, wheat middlings, distillers' grains, malt sprouts, salt, molasses.	9.0	18.0	4.0
PROTEIN 24-26 PER CENT.; FIBER 9-10 PER CENT.			
Blue Ribbon Dairy Feed. Quaker Oats Co., Chicago, Ill. Molasses, wheat bran, malt sprouts, hominy feed, cottonseed meal, oatmeal mill by-product, (oat middlings, oat hulls, oat shorts).	9.0	25.0	4.0

List of Registered Feeding Stuffs, 1912—Continued.

Kind of Feed, Brand, and Maker or Shipper and Components of Compounded Feeds.	Guaranteed Analysis. Fiber not more than—per cent.	Protein not less than—per cent.	Fat not less than—per cent.
Unicorn Dairy Ration Chapin & Co., Hammond, Ind. Distillers' feed, cottonseed meal hominy, gluten feed, barley feed and sprouts, wheat bran.	10.0	26.0	5.5
Union Grains, Ubiko, Biles' Ready Dairy Ration J. W. Biles Co., Cincinnati, Ohio. Fourex distillers dried grains, cottonseed meal, Old Process linseed meal, wheat middlings, wheat bran, hominy meal, barley malt sprouts, salt.	9.0	24.0	7.0
SO-CALLED PREPARED CALF MEAL.			
Blatchford's Calf Meal J. W. Barwell, Waukegan, Ill. Locust bean meal, wheat flour, flaxseed, cottonseed meal, beans and lentils.	5.0	25.0	5.0
Schumacher Calf Meal Quaker Oats Co., Chicago, Ill. Wheat meal, oatmeal, ground flaxseed, dried milk.	3.0	19.0	8.0
MEAT SCRAPS.			
Blue Ribbon Meat Scraps Park & Pollard Co., Boston, Mass.	-	45.0	12.0
Breck's Ground Beef Scraps Jos. Breck & Sons, Boston, Mass.	-	48.0	12.0
Meat Scrap Portland Rendering Co., Portland, Me.	-	40.0	8.0
BONE.			
Bone Meal Portland Rendering Co., Portland, Me.	-	20.0	5.0
Cracked Bone Portland Rendering Co., Portland, Me.	-	10.0	5.0
SO-CALLED POULTRY SCRATCH FEEDS.			
Competition Scratch Feed Husted Milling Co., Buffalo, N. Y. Corn, wheat, barley, Kaffir corn, buckwheat.	6.0	10.0	2.0
Globe Scratch Feed—with Grit Albert Dickinson Co., Chicago, Ill. Corn, wheat, barley, oats, Kaffir corn, beckwheat, sunflower, oil cake, shells, grit.	5.0	10.0	2.5
Grandin's Scratch Grains D. H. Grandin Milling Co., Jamestown, N. Y. Corn, wheat, oats, barley, buckwheat, Kaffir corn, Milo maize, sunflower seed.	8.0	8.0	3.5
H. O. Co.'s Algrane Scratching Feed H-O Co., Buffalo, N. Y. Wheat, oats, Kaffir corn, buckwheat, corn, Milo maize, sunflower seed, oat groats.	9.0	11.0	3.5

List of Registered Feeding Stuffs, 1912—Continued.

Kind of Feed, Brand, and Maker or Shipper and Components of Compounded Feeds.	Guaranteed Analysis. Fiber not more than—per cent.	Guaranteed Analysis. Protein not less than—per cent.	Guaranteed Analysis. Fat not less than—per cent.
Husted Scratch Feed Husted Milling Co., Buffalo, N. Y. Corn, wheat, barley, Kaffir corn, peas, buckwheat, sunflower seed.	5.0	10.0	3.0
Peerless Scratch Feed E. A. Clark & Co., Portland, Me. Corn, wheat, oats, buckwheat, barley, Kaffir corn, sunflower seed.	5.0	11.0	3.0
Purity Scratch Feed Wm. S. Hills, Co., Boston, Mass. Corn, wheat, Kaffir corn, oats, sunflower seeds, buckwheat.	6.0	10.0	3.0
Schumacher Scratching Grains Quaker Oats Co., Chicago, Ill. Wheat, Kaffir corn, barley, corn, buckwheat, sunflower seed, charcoal.	5.0	10.0	2.5
Scratch Feed Park & Pollard Co., Boston, Mass. Corn, wheat, buckwheat, barley, oats, charcoal, sunflower seed.	5.0	10.0	3.5
Scratch Feed F. A. Waldron & Son, Portland, Me.	4.0	10.5	3.5
Wirthmore Scratch Feed Charles M. Cox Co., Boston, Mass. Corn, wheat, barley, buckwheat, Kaffir corn, oats.	5.0	11.0	3.0
Xtragood Scratch Feed Griswold & Mackinnon, St. Johnsbury, Vt. Corn, wheat, barley, Kaffir corn, buckwheat, sunflower seed.	5.0	10.0	3.0
Yankee Scratch Feed O. L. Clark, Freeport, Me. Corn, wheat, oats, buckwheat, Kaffir corn, hemp, sunflower seed.	4.5	10.0	3.5

SO-CALLED CHICK FEEDS.

Kind of Feed, Brand, and Maker or Shipper and Components of Compounded Feeds.	Fiber not more than—per cent.	Protein not less than—per cent.	Fat not less than—per cent.
Breck's Hygienic Chick Food Jos. Breck & Sons, Boston, Mass. Millet, Kaffir corn, cracked corn, wheat.	3.0	8.0	2.0
Crescent Chick Feed Albert Dickinson Co., Chicago, Ill. Corn, wheat, Kaffir corn, hulled oats, millet, grit.	5.0	10.0	2.5
Gritless Chick Feed Park & Pollard Co., Boston, Mass. Corn, wheat, rice, millet, canary seed, shredded fish.	5.0	10.0	2.8
H. O. Co.'s Chick Feed H-O Co., Buffalo, N. Y. Corn, cut oatmeal, cracked wheat, Kaffir corn, peas, millet.	9.0	12.0	3.0
H. O. Co.'s Steam Cooked Chick Feed H-O Co., Buffalo, N. Y. Corn, cut oat meal, wheat, Kaffir corn, peas, millet.	9.0	12.0	3.0
Husted Chick Feed Husted Milling Co., Buffalo, N. Y. Corn, wheat, Kaffir corn, split peas, millet, cut oatmeal.	5.0	11.0	2.5

List of Registered Feeding Stuffs, 1912—Concluded.

Kind of Feed, Brand, and Maker or Shipper and Components of Compounded Feeds.	Guaranteed Analysis. Fiber not more than—per cent.	Protein not less than—per cent.	Fat not less than—per cent.
Intermediate Chick Feed. Park & Pollard Co., Boston, Mass. Kaffir corn, wheat, barley, oats, millet, rice.	5.0	10.0	3.5
Peerless Baby Chick Feed. E. A. Clark & Co., Portland, Me. Wheat, hulled oats, Kaffir corn, corn and millet.	4.0	12.0	3.0
Peerless Intermediate Chick Feed. E. A. Clark & Co., Portland, Me. Corn, wheat, Kaffir corn, hulled oats, barley and millet.	4.0	12.0	3.0
Red Ribbon Chick Feed. Park & Pollard Co., Boston, Mass. Corn, wheat, rice, oats, millet, Kaffir corn.	5.0	10.0	3.5
Schumacher Little Chick Feed. Quaker Oats Co., Chicago, Ill. Wheat, Kaffir corn, millet, corn, oat groats, pigeon grass, charcoal, marble grit.	5.0	10.0	2.5
Sun Chick Starter—with Grit. Albert Dickinson Co., Chicago, Ill. Corn, wheat, Kaffir corn, cut oats, millet, peas and grit.	5.0	10.0	2.5
Wirthmore Chick Feed. Charles M. Cox Co., Boston, Mass. Wheat, Kaffir corn, corn, peas, millet, hulled oats.	3.5	11.0	3.0
Wirthmore Intermediate Chick Feed. Charles M. Cox Co., Boston, Mass. Corn, wheat, Kaffir corn, buckwheat, peas, hulled oats.	3.5	11.0	3.0
SO-CALLED POULTRY GROWING FEEDS.			
Colonial Developing Feed—with Grit. Albert Dickinson Co., Chicago, Ill. Corn, wheat, Kaffir corn, hulled oats, buckwheat, millet, grit.	5.0	10.0	2.5
Growing Feed. Park & Pollard Co., Boston, Mass. Bran, middlings, corn, wheat, barley, alfalfa, fish, meat, bone, salt.	5.0	10.0	3.5
Peerless Growing Feed. E. A. Clark & Co., Portland, Me. Oats, wheat bran, wheat meal, corn meal, bone meal, Kaffir corn meal, meat meal, granulated milk, powdered charcoal.	5.0	14.0	4.0
Wirthmore Growing Feed. Charles M. Cox Co., Boston, Mass. Barley, wheat, corn.	4.5	15.0	5.0
SO-CALLED POULTRY FEED OR POULTRY MASH.			
American Poultry Food. Quaker Oats Co., Chicago, Ill. Corn, barley, cottonseed meal wheat bran.	9.0	12.0	3.5
Breck's Complete Poultry Feed. Jos. Breck & Sons, Boston, Mass. Corn, wheat, Kaffir carn, barley, buckwheat, sunflower.	3.4	8.0	2.0

List of Registered Feeding Stuffs, 1912—Continued.

KIND OF FEED, BRAND, AND MAKER OR SHIPPER AND COMPONENTS OF COMPOUNDED FEEDS.	Guaranteed Analysis.		
	Fiber not more than—per cent.	Protein not less than—per cent.	Fat not less than—per cent.
Breck's Poultry & Swine Meal. Jos. Breck & Sons, Boston, Mass. Meat scraps, cottonseed meal, bone meal, fenugreek.	3.0	32.0	10.0
Bufceco Poultry Feed. Buffalo Cereal Co., Buffalo, N. Y. Corn, hominy, wheat bran, wheat middlings, gluten feed, rolled oats.	5.0	15.0	4.0
Dry Mash. Park & Pollard Co., Boston, Mass. Bran, middlings, corn, wheat, barley, alfalfa, fish, bone, salt.	10.0	20.0	3.0
Grandin's Poultry Mash. D. H. Grandin Milling Co., Jamestown, N. Y. Corn meal, bran, middlings, red dog flour, ground oats, barley, middlings, gluten feed, cottonseed meal, beef scraps.	8.0	15.0	4.0
H. O. Co.'s Dry Poultry Mash. H-O Co., Buffalo, N. Y. Oat middlings, gluten feed, wheat middlings, rolled oats, alfalfa meal, corn, hominy feed, cracked wheat, wheat bran.	9.0	20.0	3.5
H. O. Co.'s Poultry Feed. H-O Co., Buffalo, N. Y. Oat middlings, gluten feed, wheat middlings, rolled oats, wheat bran, hominy feed.	9.0	17.0	5.5
Husted Laying Mash. Husted Milling Co., Buffalo, N. Y. Corn meal, rolled oats, wheat bran, wheat middlings, cottonseed meal, gluten feed.	8.0	15.0	3.0
Monmouth Dry Mash. E. M. Marks, Monmouth, Me. Wheat bran, wheat middlings, ground oats, corn meal, ground alfalfa, beef scraps, gluten feed, Schumacher Stock Feed.	8.0	20.0	5.0
"Orono Brand" Dry Mash. F. T. Hathaway, Yarmouthville, Me. Corn meal, wheat bran, wheat middlings, gluten meal, linseed meal, beef scrap.	6.5	22.0	6.5
Peerless Poultry Mash. E. A Clark & Co., Portland, Me. Ground oats, fish meal, corn meal, alfalfa meal, wheat bran, wheat meal, gluten, milk albumen, powdered charcoal.	10.0	20.0	3.0
Purity Poultry Mash. Wm. S. Hills Co., Boston, Mass. Corn meal, gluten, wheat middlings, wheat bran, oil meal, Hen-e-ta Bone.	7.0	13.0	3.0
Queen Poultry Mash. Albert Dickinson Co., Chicago, Ill. Alfalfa meal, corn feed meal, wheat meal, corn bran, wheat bran, beef scraps, oil cake, salt.	10.0	11.0	2.5
Wirthmore Mash Feed. Charles M. Cox Co., Boston, Mass. Wheat bran, alfalfa meal, Buffalo Gluten Feed, oats, cracked corn, corn meal, beef scrap, fish scrap.	9.5	17.0	5.0
Yankee Dry Mash. O. L. Clark, Freeport, Me. Corn meal, bran, ground oats, cut alfalfa, fish meal, dried milk, albumen, charcoal.	6.5	16.0	4.0

March, 1912.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

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Official Inspections

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VINEGAR.

During the season of 1911 only a few samples of vinegar were collected, but the inspectors made thorough examinations at all of the several hundred stores which they visited to learn the kinds of vinegars which were on sale and what was being done in the case of imitation vinegars. The vinegar situation is very good in the State.

Imitation vinegar. The low grade, distilled, artificially colored, imitation vinegars which were so abundant a few years ago have practically disappeared from the market. Occasionally the inspectors found goods of this type of imitation vinegars similar to that which was found at the store of C. E. Withee, Benton Falls. This was bought from Fuller-Holway Co., Augusta, and it was labeled "E. E. Clifford & Co., Colored Distilled Vinegar, 3 per cent acetic acid, Portland, Me." The vinegar did not seem to be of very good flavor and hence would not be especially desirable for table purposes, and did not carry acetic acid enough to make it safe for keeping pickles. The sample analyzed 3.4 per cent acid. Other than the coloring matter, which was burnt sugar, it was like a somewhat weak, distilled vinegar. Neither in taste nor odor did it at all resemble cider vinegar.

White distilled vinegar. The white distilled vinegars which are used for pickling purposes are still sold to a considerable extent in the State and doubtless in some respects are superior to cider vinegar for the purpose of keeping pickles. The sample purchased from Pomerleau & Huard, Water St., Augusta, and which on analysis was found to carry 4.4 per cent of acetic acid is typical of this class of vinegar. We have not found these vinegars to run below the lawful strength.

Sugar vinegar. The straight sugar vinegars are still sold to some extent in the State and, as far as our inspectors' observations go, in accordance with the requirements of the law.

There was found in the wholesale house of E. T. Gallagher & Co., Bangor, a lot of vinegar labeled "Compound of Syrup and Distilled Vinegar. Fleishmann Vinegar Works," which was found to be not a mixture of syrup vinegar and distilled vinegar, but distilled vinegar to which a sugar product had been added. The case was taken up under the National law, the product seized, and the goods destroyed.

Cider vinegar. A normal, well fermented cider vinegar will frequently carry from 5.5 to 6.5 per cent acetic acid. The standard is fixed at 4 per cent. This has resulted in many of the large handlers and manufacturers of vinegar reducing, by the addition of water, the cider vinegars so that they will carry something over the 4 per cent acetic acid required by law. Dilution of vinegar naturally reduces not only the acid strength but the amount of other ingredients in proportion to the dilution, so that reduced vinegars will not comply with the analytical constants for this product, but the relations existing between these various ingredients will remain the same. When vinegar is diluted with water the label must plainly indicate the fact that it has been reduced by the addition of water. This type of goods is illustrated by the sample obtained from Dunn & Ross, Auburn, which they had from Ross Co., Auburn. This was labeled: "Reduced to standard 40 grains. Haynes-Piper Co., Ayer, Mass. Pure Cider Vinegar." It, of course, was not a pure cider vinegar, but a cider vinegar to which water had been added. This type of goods labeled to plainly show that it has been diluted will be passed in this State until further notice.

Adulterated cider vinegar. Some of the larger factories are not only diluting their vinegar to the normal strength, or a little bit more, by the addition of water but are skillfully blending apple jelly and other apple products to these diluted vinegars so that they appear even better than the straight, country made cider vinegar. Such addition is an adulteration, for the law provides that a product shall be deemed to be adulterated if it be mixed, colored, powdered, coated or stained in a manner whereby damage or inferiority is concealed. The only purpose of adding these materials to a reduced vinegar is for the purpose of concealing damage or inferiority. A vinegar thus reinforced can be lawfully sold if it is plainly labeled "Imitation Vinegar."

Branding vinegar. The retailer who handles any vinegar that is not strictly what it appears to be must label the package delivered to his customer. The law applies to a single pint just as it does to a barrel. Anything that a manufacturer needs to label in order to lawfully sell must be labeled equally plainly when it is delivered to the consumer.

CATCHUP.

According to the standards fixed in Maine 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. Benzoate of soda can be used if its presence and amount are plainly stated.

In 1911 quite a number of samples of catchup were examined. Microscopical examination was made only partially. Nearly all of the specimens showed some spores or mycelium which indicated in a way that the materials were somewhat inferior when they were used. They, however, were not at all bad and in most instances no more were found than would naturally appear in a home-made tomato catchup.

The catchups were all tested for coal tar colors and found to be free from artificial coloring.

The following brands contained no benzoate of soda.

Hatchet Brand Tomato Catchup. Twitchell-Champlin Co., Portland, Me.

Hazard's Shrewsbury's Tomato Catchup, purchased from the Geo. C. Shaw Co., Portland, Me.

Heinz Tomato Catchup. H. J. Heinz Co., Pittsburg, Pa., purchased from Trefethen & Sweet Co., Portland, Me.

Libby's Tomato Catchup. Libby, McNeil & Libby, purchased from Trefethen & Sweet Co., Portland, Me.

Newport Tomato Catchup. Jersey Packing Co., Cincinnati, O., purchased from Trefethen & Sweet Co., Portland, Me.

Snider's Catchup. T. A. Snider Preserve Co., Cincinnati, O., purchased from Patrons Coöperative Corporation, Portland, Me.

Solar Brand Catchup. Packed for C. A. Weston, Portland, Me., and obtained from them.

The following brands contained less than one-tenth of one per cent of benzoate of soda, and were so labeled.

Curtis Bros. Blue Label Catsup. D. W. True & Co., Portland, Me.

Sunnyside Catchsup. Jersey Packing Co., Cincinnati, O., purchased from D. W. True & Co., Portland, Me.

The following were misbranded in that they were labeled to contain one-tenth of one per cent benzoate of soda and contained more than one-tenth and less than two-tenths.

Columbia Catchup. Columbia Conserve Co., Indianapolis, Ind., purchased from Littlefield & Co., Portland.

Tomato Catchup. Geo. C. Shaw Co., Portland.

Montauk Point Brand Tomato Catchup. E. E. Clifford Co., Portland.

Parker House Brand Tomato Catchup. McMechen Preserving Co., Wheeling, W. Va., purchased from Twitchell-Champlin Co., Portland

Perfection Brand Catchup. Packed for Contant, Patrick Co., Portland.

Pride of Jersey Tomato Catchup. Packed by Bridgton Preserving Co., Bridgton, N. J., purchased from C. A. Weston Co., Portland.

Star Brand Tomato Catchup. Packed for Shaw, Hammond & Carney, Portland.

Waldorf Brand Tomato Catchup. Put up by the Williams Bros. Co., Detroit, Mich.

The Montauk Point Brand Tomato Catchup, E. E. Clifford Co., Portland, Me., was branded to carry two-tenths of one per cent of benzoate of soda, which it practically did.

The E. E. Clifford Co. imported from Chicago barrels of catchup that came labeled "Kinsey Brand Catchup. Huss, Edler Preserve Co., Chicago," and claimed on the label to contain one-tenth of one per cent of benzoate of soda. Before bottling these goods samples of them were submitted for examination and found to carry .336 per cent of benzoate of soda, and the bottles were labeled as containing one-third of one per cent benzoate of soda. At the time when these samples were taken the United States Department of Agriculture was not prosecuting misbranding for benzoate of soda. These cases were not reported to them although they were misbranded under the National Act.

PICKLES.

Under the law a food is misbranded if "it fails to bear a statement on the label of the quantity or proportion of each and any added coloring matter, preservative, chemical or drug contained therein." Under the food regulations benzoate of soda is at present permitted to be used in foods provided its presence and amount are plainly stated on the label. Alum may be used in limited amount in pickles provided its presence and amount are plainly stated on the label.

Pickles which contain added alum must when they are delivered to the consumer be labeled so as to plainly show the fact that they contain alum. In order to see how generally this regulation was being complied with the inspectors purchased during the winter months pickles at several establishments in different towns of the State. In each instance the inspector visited the store and purchased one or more of the different kinds the dealer carried. The character of the goods thus obtained is pointed out in the following tables. In all cases where the goods were misbranded hearings were appointed, and prosecutions instituted unless the dealer was able to prove that he had exercised such care in his purchase that pickles free from alum should have been received. Part of the cases have been settled by the payment of a fine and the others are in course of prosecution.

In a few instances where there were only small traces of alum present the goods are passed as though they were free from alum. It has sometimes happened in their manufacture that pickles have been put in the same vats as alum treated pickles and have in this way been slightly contaminated with alum.

List of dealers who sold the inspectors pickles that did not contain alum. Arranged alphabetically by towns.

E. Deering. Deering Mercantile Co.
E. Deering. W. J. Lucas.
E. Deering. Geo. H. Philbrook.
Houlton. E. A. Gillin & Co.
Houlton. Hallett, McKeen Co.
Houlton. Knox Bros.
N. Deering. Pride Bros.
N. Deering, Wallace & Frank.
Patten. Quincy & Rowe.
Presque Isle. Aroostook Coöperative Co.
Presque Isle. J. H. O'Donnell & Co.
Sanford. John P. Bowley & Co.
Sanford. Ideal Cash Market.
Sanford. Nowell & Libby.
So. Berwick. J. A. Maddox & Son.
So. Berwick. Rideout's Grocery.
Van Buren. H. A. Gagnon.
Van Buren. Van Buren Tea Store.
Van Buren. F. L. Watson.
Woodfords. Fred B. Estes.
Woodfords. Hamilton Bros.
Woodfords. L. P. Senter & Co.

Dealers who sold the inspectors pickles that contained alum but the package was labeled so as to disclose that fact.

Sherman Mills. I. E. Seavey.
South Berwick. E. J. Lauzon.
South Berwick. Rideout's Grocery.

List of dealers who sold the inspectors pickles that were misbranded in that they contained alum and were not labeled to show that fact. Hearings were appointed and all cases either have been or are in the way of being prosecuted. Arranged alphabetically by towns.

East deering. H. A. Curtis & Co.
East Deering. Deering Mercantile Co.
Houlton. Houlton Meat Supply.
Houlton. McGary Bros.
Presque Isle. Barker's Cash Grocery.
Presque Isle. Max X. Beaulieu.
Presque Isle. Coffin & McKay.
Presque Isle. D. LeVasseur.
Presque Isle. R. H. McDonald.
Presque Isle. John B. Raymond.
Sanford. John O. Bowley & Co.
Sanford. F. Broggi.
Sanford. Lizotte & Caron.
Sanford. R. Rankins.
South Berwick. Dube Bros.
South Berwick. J. A. Maddox & Son.
Van Buren, W. F. Paradis.
Woodfords, Fred B. Estes.
Woodfords. Hamilton Bros.

CHESTNUTS.

As ordinarily found in the market the American chestnuts frequently contain more or less wormy nuts. One lot found with S. Christopher of Presque Isle, Me., was so bad that a sample was purchased. Something over 25 per cent of them were obviously bad and over 15 per cent more were found to be bad on opening. Of the lot, a little more than half of them were edible. A hearing was appointed and a case was brought on the ground that they were adulterated as they consisted in whole or in part of a filthy, decomposed vegetable substance. The defendant plead guilty and paid the fine.

SALT.

The tables on the two following pages give the results of the examination of different brands of table salt purchased by the inspectors.

Standards. As defined in the regulations made by the Director table salt, dairy salt, is fine grained crystalline salt containing on a water-free basis, not more than one and four-tenths (1.4) percent. of calcium sulphate ($CaSO_4$) nor more than five-tenths (0.5) percent. of calcium and magnesium chlorides ($CaCl_2$ and $MgCl_2$), not more than one-tenth (0.1) percent. of matters insoluble in water.

The determinations made were water, sulphuric acid, calcium, magnesium, and matters insoluble in cold, distilled water. Tests for starch and carbonates were made in all cases. Carbonates were found only in the cases of the two compounds and starch was not found at all. In the calculation of results the sulphuric acid was assumed to be in combination with calcium as calcium sulphate, and any excess of calcium was calculated to the chloride. Magnesium was assumed to be present as chloride. In the cases of the compounds containing carbonates carbon dioxide was determined with Schlötter's apparatus and this was calculated with either calcium or magnesium as either was found to be present.

For the most part the samples were all well within the limits fixed by the standards. It will be noticed that additions were made to some of the brands of materials designed to prevent caking. These are in all cases declared upon the label.

Table showing brand of salt, dealer from whom it was

BRAND.	DEALER AND MAKER OR PACKER.	Station Number.
Climax	Milliken-Tomlinson Co., Portland. "Guaranteed pure."	9548
Columbia	Chas. Hayward & Co., Bangor. International Salt Co., N. Y "White, dry, pure"	9712
Crystaline	Littlefield & Co., Portland. Crystaline Salt Co., "White, dry, pure"	9577
Diamond Crystal	W. H. Shurtleff Co., Portland. "The salt that is all salt".	9537
Diamond Star	A. T. Fuller, Augusta. Dirigo Salt & Soda Co., Augusta. "Unsurpassed"	9719
Duncan	Fuller-Holway Co., Augusta. Duncan Salt Co., Silver Springs, N. Y. "Choice Table Salt"	9720
Gold Medal	T. R. Savage Co., Bangor. Put up for T. R. Savage Co., Bangor. "Fancy Table Salt"	9713
Hatchet	Twitchell-Champlin Co., Portland	9525
Ivory	Thurston & Kingsbury, Bangor. Worcester Salt Co., N. Y. "Ivory Compound Salt. 99% high grade table salt, 1% carbonate of magnesia"	9711
Keystone	C. A. Weston Co., Portland. "High Grade Granulated Salt"	9558
LeRoy	E. W. Gross Co., Auburn. LeRoy Salt Co., LeRoy, N. Y. "Finest table salt"	9723
Peerless	John Cassidy Co., Bangor. "Granulated Salt for Table and Dairy Use"	9714
Perfection	Conant, Patrick & Co., Portland. Distributed by Conant, Patrick & Co., Portland. "Prepared with a small per cent. phosphate to prevent hardening"	9541
Portland	Lord Bros. & Co., Portland. "New Process Granulated Salt"	9538
Purity	Thorndike & Hix, Rockland. International Salt Co., New York	9731
Red Cross	H. S. Melcher Co., Portland. Put up expressly for H. S. Melcher Co., Portland	9566
Royal Lily	Geo. C. Shaw Co., Portland. Manufactured in New York for Geo. C. Shaw Co., Portland. "Prepared with a small per cent. phosphate to prevent hardening"	9588
Shaker	W. H. Shurtleff & Co., Portland. Diamond Crystal Salt Co., St. Clair, Mich. "1¾% calcium carbonate"	9536
Star	W. H. Shurtleff Co., Portland. Packed for W. H. Shurtleff Co., Portland	9621
True's Imperial	D. W. True & Co., Portland. "Absolutely pure. Size 5".	9522
Winner Fancy	Shaw, Hammond & Carney, Portland. Packed for Shaw, Hammond & Carney, Portland	9559
Worcester	Patrons Co-operative Corporation, Portland. Worcester Salt Co., N. Y.	9499
Yorkshire	Thorndike & Hix, Rockland. International Salt Co., N. Y. "Pure"	9732
Yorkshire	Thorndike & Hix, Rockland. International Salt Co., N. Y. "Pure. Extra Refined"	9730

purchased, name of the maker, and results of analysis.

Station number.	Kind of package.	Weight claimed.	Weight found.	Water—per cent.	Matter insoluble in water—per cent.	Calcium sulphate —per cent.	Calcium chloride —per cent.	Magnesium chloride —per cent.	Sodium chloride —per cent.	REMARKS.
9548	bag...	.....	2.5	0.35	0.10	1.32	0.37	0.12	97.74	
9712	bag ..	.....	4.25	0.29	0.03	1.30	0.13	0.30	97.95	Trace phosphoric acid.
9577	carton	.....	2.44	0.36	0.00	1.16	0.54	trace	97.94	
9537	carton	.....	3.38	0.15	0.07	0.48	.....	0.03	99.27	
9719	bag...	.....	4.84	0.31	0.02	1.25	0.19	0.08	98.15	Trace phosphates.
9720	bag...	.....	2.15	0.32	0.06	0.74	0.31	0.09	98.48	
9713	bag...	.....	4.25	0.33	0.03	1.16	0.19	0.10	98.19	Trace phosphates.
9525	carton	.....	2.19	0.21	0.00	1.18	0.16	0.09	98.36	
9711	carton	.....	2.25	0.21	0.70	0.59	0.20	0.28	98.02	Contains carbonates.
9558	bag...	.....	2.63	0.65	0.04	1.18	0.47	trace	97.66	
9723	bag...	5.0	4.84	0.37	0.04	0.82	0.35	0.07	98.35	
9714	bag...	14.0	13.69	0.41	0.02	1.31	0.31	0.08	97.87	
9541	can...	.....	2.19	0.75	0.92	1.05	0.10	trace	95.56	1.62 per cent. calcium phosphate.
9538	bag...	.....	2.69	0.34	0.00	1.21	0.11	0.06	98.28	
9731	carton	.....	2.34	0.27	0.10	1.28	0.06	0.33	97.96	Trace phosphates.
9566	bag...	.....	2.50	0.30	0.00	1.24	0.64	trace	97.82	
9588	can...	.....	2.94	0.55	0.63	1.22	.....	0.08	96.00	1.52 per cent. calcium phosphate.
9536	carton	.....	2.88	0.10	1.49	0.21	.....	trace	98.20	Contains calcium carbonate.
9621	box...	.....	17.56	0.37	trace	1.09	0.46	trace	98.08	
9522	bag...	.....	4.75	0.41	0.00	1.09	0.15	0.07	98.28	
9559	bag...	.....	4.75	0.22	0.05	1.38	0.46	trace	97.89	
9499	bag...	5.0	5.06	0.43	0.00	1.13	0.24	0.16	98.04	
9732	bag...	.....	2.53	0.18	0.06	1.11	0.30	0.10	98.25	
9730	carton	.....	3.90	0.10	0.00	1.19	0.20	0.08	98.43	Trace phosphates.

MOLASSES.

Molasses is the product left after separating the sugar from the product obtained by evaporating the purified juices of a sugar producing plant to a solid or semi-solid consistency in which the sugar chiefly exists in the crystalline state. Molasses thus separated should contain not more than 25 per cent water and not more than 5 per cent of ash.

Before the passage of the food law there was sold in the State a large amount of compound or imitation molasses which usually consisted of glucose flavored with a low grade cheap molasses. The character of the molasses on sale has greatly improved within the last few years. There is now practically no imitation or compound molasses sold in the State. While comparatively few samples have been examined, the inspectors in their rounds have made careful observations of the kinds of molasses that were on sale.

The samples herein reported were purchased by the inspectors without making themselves known and were the kind of goods that would have been delivered to any customer who went into the store and asked for molasses. It will be noted that the majority of the samples are within the limits in ash content, and most of them are a trifle too thin. That is, they carry a little more water than the standards allow. The differences, however, have not been sufficient to seem to warrant prosecutions.

Table showing the results of analyses of samples of molasses collected by inspectors in Auburn and Lewiston.

Sta. No.	Dealer.	Price per quart.	Water.	Ash.	Sucrose.	*Total sugar.
9492	Bickford's Grocery, E. A. Bickford	10	24.0	5.0	43.0	62.6
9473	E. W. Beaumont & Co.	10	25.0	5.4	34.9	73.1
9483	A. E. Dudley	13	24.6	4.7	39.3	54.2
9489	J. F. Eaton	14	26.4	5.1	40.5	59.4
9486	Guimond & Simard	13	26.8	4.1	39.1	53.5
9491	Hilton & Co.	13	25.3	5.2	37.3	58.2
9482	Howard & Goss	10	25.0	5.1	38.4	62.6
9487	Merchant & Dillingham	13	26.0	4.3	44.8	62.7
9480	D. Morisette & Bro.	15	27.5	5.1	37.7	60.6
9477	Theo. F. Nadeau	13	25.1	4.2	45.0	73.0
9490	Perryville Cash Market, A. E. Jennings	10	....	5.1	37.9	70.5
9484	A. Roger	15	26.2	5.8	30.5	46.8
9475	Tanguay & Ouellette	13	25.4	5.4	36.8	61.0
9488	A. Walter	13	26.0	4.6	44.7	62.2
9478	Fred I. Wills	14	26.8	1.3	47.7	67.3

* Sucrose plus invert sugar as determined by polariscope method.

VICTOR PURE FOOD BRINE.

In 1908, Official Inspections 4, attention was called to two preparations designed for the packers of meat; one put up by the Preservaline Manufacturing Co. of New York under the name "F. L. P.," which was a mixture of salt petre and common salt; the other "Victor Pure Food A Savoline," Wolf, Sayer & Heller, Inc., 84-86 Pearl St., New York. This consisted of about 70 per cent of sugar, 22 per cent of salt and 6 per cent of salt petre, and sold at 27 cents a pound in New York City. This was, of course, worth about five cents a pound.

Mr. A. B. Jewett of Skowhegan gave to the inspector a package of "Victor Pure Food Brine," manufactured by Wolf, Seyer & Heller, Inc., 37 Pearl St., New York. On analysis this was found to carry 47.84 per cent common salt, 49.26 per cent of potassium nitrate, .73 per cent of material chiefly corn starch insoluble in cold water, undetermined, including water, 1.17 per cent. The directions for use are "To five gallons of water add one pound Victor Pure Food Brine, eight pounds of salt and two pounds of granulated sugar. The result will please you."

At present salt petre is allowed to be used in foods without statement of fact and the packer of meats would get into no difficulty in using this for packing and curing corn beef, shoulders, etc., or for packing and curing hams, and bacon, as the label recommends, but these goods are worth about five cents per pound and are sold at a considerable advance of that figure.

CREAM OF TARTAR.

Samples of cream of tartar have been examined which have been submitted by correspondents. We have found them to be practically pure cream of tartar. Some samples have contained a trace of tartaric acid which resulted in their being usually a little more than full strength. That is, they would neutralize a little more carbonate of soda than perfectly pure cream of tartar would. The addition, however, is probably accidental and is not considered as an adulteration.

SALERATUS, BICARBONATE OF SODA.

Several samples of bicarbonate of soda have been submitted by correspondents and have been found to be practically pure sodium bicarbonate, approximately 99.5 per cent pure. As far as our observation goes, the package goods as well as the bulk goods are of good quality.

RICE.

Because of the inspection practically all of the grocery stores situated in towns along the lines of the railroad have been visited in the last few months. Attention has been called, among other things, to the proper labeling of rice. According to the data which have been collected by the inspectors, about one-third of the rice on sale in the State is not coated, and about two-thirds of it is coated with glucose and talc. Bags in which this rice is shipped are for the most part properly labeled, although some times the stenciling is so poorly done that is can only be deciphered with difficulty. No prosecutions have been made for selling adulterated rice which was not properly labeled, but now that the trade has been thoroughly notified on this subject there is no excuse for any dealer furnishing his customer with adulterated rice unless it is correctly labeled to show the nature of the adulteration.

BRANDY DROPS, CORDIALS.

Occasionally during the past two years samples of confectionery supposed to contain intoxicants have been sent to the Station for examination. In only one instance had the sample been taken in such a way that identity could be established. They have been sent under the names of brandy drops, cordials, and chocolate cordials. In none of these has more than a trace of alcohol been found. They have contained a syrup with no appreciable alcoholic flavor.

There was found with the Holmes Confectionery Co., Milk St., Portland, Defiance Chocolate Cordials made by the Lovell & Covell Co., Boston, U. S. Serial No. 7276, of which a full five pound package was purchased. The contents were found to weigh 4.9 lbs. The liquid with which the chocolates were filled composed approximately 28 per cent of the total weight. This, however, contained by weight less than four-tenths per cent alcohol, which was no doubt from the flavoring materials.

While no standards have been fixed for "cordial" the dictionery meaning implies the presence of spirits. The goods were evidently misbranded. The sale was stopped in Maine but because of irregularities it was not practicable to prove interstate shipment and no case was brought under the United States law.

SANITARY FOOD.

In order to call the special attention of dealers to the care that the law requires them to exercise in handling food a red slip that reads as follows is enclosed in this number of Official Inspections:

"Manufacturers and Dealers should take notice that food is adulterated 'if in the manufacture, sale, distribution, transportation, it is not at all times securely protected from filth, flies, dust or other contamination, or other unclean, unhealthful or unsanitary conditions.'

This should be carefully read. The more it is studied the broader will be found its application."

Ignorance and carelessness are the chief factors that have to be reckoned with in the enforcement of this part of the food law. A dealer in meats while explaining to the executive of the law the very sanitary arrangement he had installed for the display and sale of meat actually sat upon the meat block while doing so! A certain restaurant keeper prides himself upon making an attractive window display of his food. While the writer was looking at this display a newspaperman came along and remarked "Fine. Isn't it?" It did not appear so fine to him after it was pointed out that the foods, most of them cooked, were exposed to all the dust of the room and that an attractive basket of doughnuts was so placed that every person entering the shop must pass within a few inches of it and that it was at such a height that if the person chanced to cough while passing that some of the small particles of sputum must inevitably fall upon the displayed food that would be eaten without being sterilized by further cooking! Very rarely has a report been made upon unsanitary exposure of food without it coming as a surprise to the person concerned.

While under the law the Director of the Station is empowered to make uniform rules and regulations for carrying out its provisions, he will not at present lay down specific instructions that must be followed in order to meet this section. It is his purpose, however, to see that its requirements are complied with.

Very likely dealers themselves will discover ways that are simpler and equally effective with the following suggestions. If, however, these suggestions are followed dealers will be held to have taken all needed precautions and no prosecutions will result. If it should later develop that these suggestions are not adequate they will be modified, but ample notice will be given that dealers may make any needed changes.

Package foods, wrapped foods, or foods that carry their own natural protection in the way of an inedible skin, as the orange, the lemon, the potato, the turnip, undressed poultry, unopened shell fish, etc., do not need to be handled as carefully and be as completely protected as those not having these natural protective coverings. Foods without natural or artificial coverings or those from which the protective coverings have been removed require complete protection. Foods that are eaten as sold without cooking need to be more thoroughly protected than foods that are cooked before being eaten. Bakers products handled in an unsanitary way are more likely to act as carriers of disease than meat products that are subjected to heat before being eaten. The same is true of berries which are so generally eaten raw as compared with vegetables that are usually cooked.

The Display of Food.

It is in the display of food for sale, particularly at retail, that there is the greatest liability for the dealer to violate the law relative to the protection of food from contamination.

Sidewalk, street, and cart display. Foodstuffs that are protected by complete inedible coverings, whether natural or artificial, when displayed in the open, should be at least two feet above the street or sidewalk and not surrounded by unclean, unhealthful or unsanitary conditions.

Other food stuffs (berries, breads, meats, etc.) must be protected by suitable coverings. Screens or nettings are not adequate. The only form of display furniture that suggests itself to the executive of the law as suitable are tight cases made of glass, wood or metal, and fitted with tightly fitting doors. A cart could be so constructed of glass, wood or metal, that display of food would be sanitary. Such a cart has probably yet to be made.

Display within the shop or store. The same general principles apply as in sidewalk display. Foods that have no inedible protective coverings must be protected from dust and all possible contamination. Probably cases of glass and metal or wood are the only forms of furniture that will both protect the food and permit of display.

Meats and meat products which are piled on counters and meat blocks are not properly protected. The display of meats intended for sale as now generally practiced by butchers and dealers is for the most part in violation of law. In order to sell meat under a sanitary condition and in conformity with the law of the State all meat products of every description, dressed carcasses, all cuts, hamburger steak, sausage, poultry, game, fish, fish products, etc., should be kept in a refrigerator, cold storage or ice box. For the purpose of display these may be made partly of glass. A very attractive and efficient glass and wood front to an ice room has been recently devised by a Maine man.

The Actual Sale of Food.

If the salesman has clean hands and clothing, is in good health and the shop is in good sanitary condition, there is not great danger of the food becoming contaminated while the customer is being waited upon. The food should not be exposed to the dust of the room, to the breath of the salesman, and to his touch more or longer than is necessary. In the case of goods peddled from carts (baker, butcher, etc.) there is much danger of contamination even while the sale is being made. Such carts should be frequently cleaned. Drivers should not engage in stable work before loading unless they change their clothing and wash their hands and arms after such work. Drivers who have to handle unwrapped foods should always wear gloves while driving and remove them before touching the food.

Hearings and Prosecutions.

Whatever the nature of the seeming violation of any of the provisions of the laws regulating the sale of agricultural seeds, commercial fertilizers, commercial feeding stuffs, drugs, foods, fungicides or insecticides, hearings are appointed as directed by the law. In the great majority of instances the defendant either offers satisfactory explanation or gives assurance that the public will be protected in the future. Whenever it seems that the interests of the public can be equally served the cases are passed without prosecution. In the execution of the laws far more stress is laid upon educational than upon punitive methods.

After due hearings it seemed the duty of the executive to bring prosecutions under the law in a number of cases. The following were settled by compromise as provided in the law out of court and in most cases before actual proceedings had been commenced. A few cases are pending.

List of Cases Settled Without Trial on Payment of Penalty in the Quarter Ending March 31, 1912.

Name and Town of Defendant.	Nature of Complaint.
Applin, H. G., Stockton Springs	Adulterated sweet spirits of nitre. Low in ethyl nitrite.
Barker, R. M., Presque Isle	Misbranded pickles. Contained alum.
Beaulieu, Max X., Presque Isle	Misbranded pickles. Contained alum.
Berry, R. H., Pittsfield	Adulterated black antimony. Contained no antimony.
Bosserman, W. E., Bethel	Adulterated tincture of iodine. Low in iodine.
Buckley, Leo J., Newport	Adulterated sweet spirits of nitre. Low in ethyl nitrite.
Christopher, S., Presque Isle	Adulterated chestnuts. Wormy and unfit for food.
Clark, F. O., Camden	Misbranded sausage. Contained cereal.
Coffin & McKay, Presque Isle	Misbranded pickles. Contained alum.
Cotton, P. L., Lisbon	Adulterated tincture of iodine. Low in iodine.
Curtis, A. J., Woodfords Sta	Misbranded pickles. Contained alum.
Dascombe, H. R., Wilton	Adulterated tincture of iodine. Low in iodine. Contained no potassium iodide.
Dillingham, E. L., Thomaston	Misbranded pork sausage. Contained cereal.
Dudley-Weed Drug Co., Portland	Adulterated tincture of iodine. Low in iodine.
Eells Lime Co., Rockport	Misbranded pork sausage. Contained cereal.
Estes, Fred B., Woodfords	Misbranded pickles. Contained alum.
Farley, J. H., Bridgewater	Misbranded Compound Extract of Vanilla.
Gove & Sons, J. F., Perry	Adulterated pork sausage. Short weight.
Green & Co., H. W., Camden	Adulterated pork sausage. Short weight.
Hamel, J. H., Portland	Adulterated sweet spirits of nitre. Low in ethyl nitrite.
Hammond Drug Co., Portland	Adulterated tincture of iodine. Low in iodine and alcohol.
Hannaford & Son, C. P., Winthrop	Adulterated black antimony. Contained no antimony.
Holley, Frank H., North Anson	Adulterated tincture of iodine. Low in iodine.
Houlton Meat Supply, T. V. Holdaway, Houlton	Misbranded pickles. Contained alum.
Hoyt, Andy L., South Windham	Adulterated tincture of iodine. Low in iodine and alcohol.
Jordan, V. B., Hartland	Misbranded feeding stuffs. Not labeled.
Kearns, P. E., Ellsworth	Adulterated pork sausage. Short weight.
LeVasseur, D., Presque Isle	Misbranded pickles. Contained alum.
McDonald, R. H., Presque Isle	Misbranded pickles. Contained alum.
Messier, Arthur E., Lewiston	Misbranded sweet spirits of nitre.
Page, Albert F., Bucksport	Adulterated sweet spirits of nitre. Low in ethyl nitrite and misbranded.
Parlor Drug Store, Lewiston	Misbranded and adulterated sweet spirits of nitre. Low in ethyl nitrite.
Pelosi, V., Portland	Adulterated and misbranded sweet spirits of nitre. Low in ethyl nitrite.
Pineo, S. S., Milltown	Misbranded pork sausage. Contained cereal.
Pulsifer, W. G., Mechanic Falls	Adulterated sweet spirits of nitre. Low in ethyl nitrite.
Ross, J. M., Bangor	Misbranded bottled sodas. Artificially colored.
Senter & Co., L. P., Woodfords	Misbranded pickles. Contained alum.
Starrett, A. & P. D., Warren	Adulterated pork sausage. Short weight.
Stewart & Sons, A. L., Cherryfield	Misbranded cottonseed meal. Not labeled.
Van Wart, W. A., Cherryfield	Adulterated sweet spirits of nitre. Low in ethyl nitrite.

May, 1912.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

CHAS. D. WOODS, Director

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Official Inspections

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SPIRIT OF NITROUS ETHER.

(Sweet spirit of nitre)

There is probably no preparation dispensed by druggists that is more liable to deterioration than sweet spirit of nitre. The U. S. Pharmacopoeia Eighth Revision gives a method of preparation that will in the hands of an experienced pharmacist give a uniform and satisfactory preparation. It is doubtful if any pharmacist in Maine prepares spirit of nitrous ether in this way, but makes it instead by diluting concentrated nitrous ether purchased from manufacturing druggists and chemists.

Concentrated Nitrous Ether.

Frequent examination of the concentrated nitrous ether used by Maine druggists has been made and in no instance has the resultant preparation made by the Station chemists been below the standard given in the Pharmacopoeia. The only criticism that can be made is that the concentrated nitrous ether sent out by one house made, in the two times it was tested at the Station, a preparation that was a fifth over strength. Part of the over-strength reported in the table on pages 93 and 94 was due to the use of this company's concentrated nitrous ether.

Concentrated nitrous ether usually remains in perfect condition for many months if the containers are kept hermetically sealed. As soon as the concentrated nitrous ether is opened, even in the cold, loss from evaporation commences. The manufacturers are now putting dates upon their concentrated nitrous ether packages and the length of time they are guaranteed to retain their strength.

How Long Will Spirit of Nitrous Ether Keep Standard?

In order to test this point one of the Station chemists 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 nitrate or equal to 101.5 per cent U. S. P. standard. This was 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.

Preparing and Keeping Sweet Spirit of Nitre.

If spirit of nitrous ether is prepared, kept and dispensed in accord with the following directions that were published in 1908 by the Executive of the Drug Law it will be of perfect strength.

Concentrated nitrous ether. 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.*

* Concentrated nitrous ether in small-sealed tubes or other packages may be purchased and when added to one pint of alcohol will make a trifle more than one pint of spirit of nitrous ether of U. S. P. strength.

Preparing spirit of nitrous ether. This 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, 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.

Keeping spirit of nitrous ether. Store in small, 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 advised.

Samples Collected in Winter of 1912.

Although the experiment on keeping spirit of nitrous ether given above was made in hot weather, the collecting of samples was made in cold weather when it is possible to keep preparations cold without the use of a refrigerator. As spirit of nitrous ether will not freeze at any natural temperature it may be kept in Maine far below the freezing point much of the time. When the present samples were for the most part collected the average temperature for weeks had been -1.5° below zero Fahrenheit.

The results of the examination of the samples purchased from druggists are given in the table which follows.

Table showing the results of analyses of samples of spirit of nitrous ether (sweet spirit of nitre) purchased in January 1912 from Maine druggist. Arranged alphabetically by towns:

Station number.	Town and Dealer.	Price four ounces.	Per cent. ethyl nitrite.	Per cent. U. S. P. standard.
		Cts.		
10502	Anson, F. A. Manter	20	4.02	100.5
10498	Bangor, Caldwell Sweet Co	–	3.41	85.0
10468	Belfast, R. H. Moody	25	4.17	104.3
10469	Belfast, W. O. Poor & Son	23	4.54	113.5
10500	Bingham, E. W. Moore	25	3.17	79.3
10456	Buckfield, J. A. Rawson	30	3.47	86.8
10423	Bucksport, Albert F. Page	30	9.95	248.8
10543	Cherryfield, S. S. Hutchinson	30	4.21	105.3
10544	Cherryfield, W. A. Van Wart	25	2.67	66.8
10579	Cherryfield, W. A. Van Wart	–	*4.46	*111.5
10552	Columbia Falls, Mary R. Chandler	20	3.63	90.8
10449	Dexter, E. A. Brewster & Son	35	3.84	96.0
10448	Dexter, A. L. Davis	35	4.42	110.5
10454	Dixfield, Guy Gardner	25	3.07	76.7
10562	Eastport, Byron N. Andrews	25	4.20	105.0
10563	Eastport, W. F. Capen	25	3.19	79.8
10561	Eastport, J. P. Hutchison	25	4.01	100.3
10491	Farmington, Hardy & Tarbox	30	4.29	107.3
10446	Foxcroft, Wm. Buck & Co	20	4.80	120.0
10447	Foxcroft, L. P. Evans	30	3.32	83.0
10481	Foxcroft, L. P. Evans	–	*4.08	*102.0
10422	Hampden Highlands, Frank G. Rogers	30	2.68	67.0
10464	Hartland, R. C. Hamilton	25	4.12	103.0
10465	Hartland, A. W. Miller	15	4.01	100.3
10458	Lewiston, Arthur E. Messier	40	3.60	90.0
10459	Lewiston, Parlor Drug Store	40	2.18	54.4
10460	Lewiston, South End Pharmacy	20	3.84	96.0
10550	Lisbon Falls, A. N. Beal	25	3.94	98.5
10549	Lisbon Falls, Edward H. Webber	25	4.50	112.5
10495	Livermore Falls, S. S. Locklin	20	3.25	81.3
10487	Madison, H. H. Haines	25	3.60	90.0

* Dealer's sample.

Analyses of Spirit of Nitrous Ether—Continued.

Station number.	Town and Dealer.	Price four ounces.	Per cent. ethyl nitrite.	Per cent. U. S. P. standard.
		Cts.		
10488	Madison, E. W. Wright	25	4.29	107.3
10570	Mechanic Falls, Merrill & Denning	25	3.52	88.0
10571	Mechanic Falls, W. G. Pulsifer	–	2.97	74.3
10452	Newport, G. M. Barrows	20	5.20	130.0
10525	Oakland, Samuel J. Foster	35	4.16	104.0
8753	Pittsfield, Pittsfield Drug Store	–	4.05	101.3
10529	Phillips, R. H. Preble	25	4.05	101.3
10534	Portland, Asa F. Abbott	20	4.31	107.8
10475	Portland, Frank J. Bragdon	30	3.32	83.0
10538	Portland, J. H. Hamel	25	3.16	79.0
10535	Portland, Fred D. Harvey	20	2.52	†63.0
8787	Portland, H. H. Hay's Sons	–	3.85	96.3
10437	Portland, V. Pelosi	10	1.01	25.3
10478	Portland, Washington Ave. Pharmacy	35	3.32	83.0
10531	Rangeley, Harry C. Riddle	20	4.46	111.5
10547	Sabattus, Edwin Woodside	20	3.37	84.3
10482	Skowhegan, Frank W. Bucknam	25	4.00	100.0
10485	Skowhegan, G. R. Fogg	25	5.21	130.3
10483	Skowhegan, W. G. Lord	25	4.63	115.8
10484	Skowhegan, Sampson & Avore	25	3.92	98.0
10569	So. Paris, Chas. H. Howard Co	20	3.65	91.3
10568	So. Paris, A. E. Shurtleff Co	25	4.29	107.3
10473	Unity, C. B. Mitchell	–	3.96	99.0
10527	Waterville, College Ave. Pharmacy	20	3.56	89.0
10521	Waterville, Daviau's Red Cross Pharmacy	35	3.08	77.0
10517	Waterville, Dorr Drug Store	35	5.30	132.5
10523	Waterville, Willard R. Jones	25	4.37	109.3
10516	Waterville, Larkin Drug Co	35	3.69	92.3
10432	Winterport, F. C. Atwood	25	4.26	106.5
10510	Winthrop, C. P. Hannaford & Son	25	2.68	67.0
10541	Winthrop, F. S. Jackson	–	4.06	101.5

* Dealer's sample.
† Two dealer's samples submitted afterwards were up to standard.

Discussion of Results.

In 1909 it was found that at least one wholesale druggist and manufacturing chemist within the State had adopted 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 explained "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." This very undesirable practice has, so far as the observations of the inspectors go, entirely stopped.

Preparations sold by others than druggists. In some of the smaller towns in the State spirit of nitrous ether is sold by the grocers. Where this is put up by reputable houses and in conformity with the directions these preparations were in fairly good condition. For instance Bakers (plainly marked with date and caution not to use after three months) carried 3.86 per cent ethyl nitrite or 96.5 per cent of the standard. Foss's preparation, dated Aug. 8, 1911, carried in January 3.57 per cent or almost 90 per cent of the standard. But Foss preparation dated October 5, 1910, was being sold by a retailer in January 1911 although it was plainly labeled with the date of its preparation and with the caution: "The dealer should keep his stock as fresh as possible." This carried 2.88 per cent ethyl nitrite and was 72 per cent standard. A preparation put up without date by a Portland wholesale house carried 2.89 per cent nitrous ether.

It would seem safe for the dealer and for the purchaser to use these bottled sweet spirits of nitre, provided they bear the date of preparation and are not sold or used more than three months after they are prepared.

In the case of goods sold in bulk and dispensed by people ignorant of drugs the situation is very different and would be laughable if it were not so serious. A Hampden dealer, who bought the preparation with the stock when he purchased the business, sold the inspector 4 ounces for 25 cents that did not carry even a trace of the original spirit of nitrous ether. A Stockton dealer sold the deputy 4 ounces for 20 cents and actually put it into a soda water bottle with a loose stopper! The inspector transferred it to a proper sized bottle with a tight stopper. Perhaps this precaution was unnecessary in this case for the preparation had only .3 per cent ethyl nitrite.

To the purchaser there is only one thing to be said: Never purchase bulk drugs from any one except a druggist. If you must buy medicines from the general store always buy goods put out by a reliable pharmacist, in small bottles, and properly labeled.

Samples purchased from druggists. There has been a very great improvement in the quality of the spirit of nitrous ether dispensed at the Maine drug stores. In 1908 before the directions for its preparation and storage were published even the best druggists were frequently found at fault with the strength of the spirit of nitrous ether dispensed. While there is still room for improvement the situation is encouraging. Only four of the samples collected were less than three-fourths the standard strength. With the exception of one sample none were seriously overstrength, and most of these were due to the concentrated nitrous ether used being overstrong. As the U. S. Pharmacopoeia does not fix the maximum strength the overstrong samples were passed, but the dealers notified of the findings. Where the samples were less than 85 per cent standard hearings were appointed and in most instances it was found necessary to begin prosecutions. All the cases except one were settled out of court and that is still pending.

TINCTURE OF IODINE.

Although it is not as important from the practical standpoint as it is in the case of some other drugs that tincture of iodine be of proper strength, it is an exceedingly convenient and satisfactory preparation from which to form an opinion of the care exercised by the druggist in the preparation and storage of medicines. It is a preparation that is in frequent demand and hence is likely to be fairly freshly prepared. It is made up of three different ingredients, and requires, in addition to the usual care incident to weighing and measuring, attention that the ingredients are completely dissolved. If left unstoppered the alcohol evaporates, and it becomes too strong. If the solution is imperfect it is too weak. If it is properly made and kept it will remain for months without any change in its composition.

The three constituents are readily and accurately determined in the chemical laboratory. For these numerous reasons tincture of iodine has been from time to time purchased and analyzed.

Properly prepared tincture of iodine carries 6.86 grams of iodine, 4.9 grams of potassium iodide and 86.4 grams alcohol in each 100 cubic centimeters. This weight of alcohol is equivalent to 94.9 per cent by volume.

The recent examinations are reported in the table on page 98.

This table should be studied by the druggists of Maine for it is illuminating on drug store practices. While improvement has been made there is still room for marked improvement. It will be noted that in no single instance did a sample carry as much alcohol as it should. This may have been due to the alcohol itself not being 95 per cent strength. As the other ingredients are soluble in water the weakened alcohol does not affect the amounts of iodine and potassium iodide. In every instance where the iodine or the potassium iodide used in preparation of the tincture has been tested by the Station chemists they have been found to be of good quality. There is no apparent reason other than faulty preparation or careless keeping to permit the idoine going above 7.2 grams or below 6.5 grams per 100 cubic centimeters or for the potassium iodide going above 5.2 or below 4.6 grams per cubic centimeter. Fifty per cent of the samples were within these limits as regards iodine and 18 per cent as regards potassium iodide. Eight per cent of the samples were above these limits for iodine and 40 per cent above in iodide. Forty-two per cent of the samples were lower in iodine and 18 per cent lower in iodide than the limit named.

Whenever the iodine found was less than 6.25 grams per 100 cubic centimeters a letter of warning was sent to the dealer, and if it fell below 6.1 a hearing was appointed. In a quite extended investigation made in 1908 the tinctures of iodine on sale varied enormously, ranging from 9.12 grams to as low as 1.7 grams per 100 cubic centimeters. Nearly 50 per cent of the samples varied from the normal so greatly that prosecution would follow if such goods were found today. While there has been an improvement, and with one exception no sample that was examined seemed to be wilfully adulterated, over 20 per cent deviated so far from the normal that hearings were appointed and prosecutions followed.

Table showing the results of analyses of samples of tincture of iodine purchased in winter of 1912. Arranged alphabetically by towns.

Station number.	Town and Dealer.	Paid for 4 ounces.	In 100 c. c. Iodine.	Potassium iodide.	Alcohol.
		Cts.	Gr.	Gr.	Per cent.
10472	Belfast, Edmund Wilson	40	6.19	3.70	90.9
10565	Bethel, W. E. Bosserman	25	4.99	6.15	72.7
10425	Bucksport, R. B. Stover	50	6.77	–	–
10455	Canton, Nathan Reynolds	35	6.67	4.29	88.6
9678	Caribou, Caribou Drug Store	–	5.27	–	–
10564	Eastport, Havey & Wilson	40	6.22	4.11	90.8
10545	Ellsworth, E. C. Moore	40	6.70	5.78	90.3
10546	Ellsworth, G. A. Parcher	35	6.85	5.45	90.3
10492	Farmington, Frank E. Drake	50	5.56	4.37	89.4
10533	Kingfield, L. L. Mitchell	40	7.07	5.72	82.1
10457	Lewiston, Pharmacie Nationale	50	5.77	4.69	90.4
10551	Lisbon, P. L. Cotton	35	5.64	4.49	91.4
10496	Livermore Falls, Harris Drug Store	40	6.09	4.06	90.4
10554	Machias, Crane's Pharmacy	–	7.00	5.29	90.8
10553	Machias, D. A. Curtis & Co	40	7.04	5.13	88.3
10515	Monmouth, C. W. Prescott	35	6.09	5.41	87.7
10503	No. Anson, F. H. Holley	50	4.88	4.43	86.4
10566	Norway, Noyes Drug Store	–	7.00	4.37	88.3
10575	Norway, F. P. Stone	–	*7.77	–	–
10567	Norway, F. P. Stone	45	4.23	2.49	90.8
10461	Orono, Chas. F. Nichols	–	6.80	5.91	88.1
10528	Phillips, E. H. Whitney	40	7.40	5.90	86.4
10537	Portland, Colcord & Washburn	35	6.85	4.22	86.9
10574	Portland, Dudley-Weed Drug Co	–	*7.06	–	–
10540	Portland, Dudley-Weed Drug Co	40	5.51	4.70	90.1
10539	Portland, William J. Flanigan	50	6.45	4.75	89.5
10476	Portland, Hammond Drug Co	35	3.76	3.87	70.0
8793	Portland, H. H. Hay's Sons	–	6.98	–	–
10474	Portland, W. A. Holland & Co	40	7.45	5.73	90.4
10435	Portland, Pearl St. Drug Store	35	5.82	4.27	91.6
10536	Portland, John M. Shaw	40	6.70	5.11	80.9
10508	Readfield, G. W. Manter	30	6.77	5.60	90.2
10501	Solon, Leslie W. McIntire	40	6.82	4.34	88.3
10426	Stockton Springs, John M. Ames Co	35	6.30	0.00	90.4
10530	Strong, Chas. E. Dyer	–	6.57	5.39	85.8
10524	Waterville, Pierre Fortier	40	6.47	3.64	84.0
10519	Waterville, Wm. C. Hawker & Co	35	6.67	7.23	81.5
10522	Waterville, Vose & Luques	50	6.97	6.05	85.2
10493	Wilton, H. R. Dascombe	40	4.94	0.00	90.4
10439	So. Windham, A. L. Hoyt	35	4.83	4.91	87.0

* Dealer's sample.

SWEET OIL.

Although they knew better, a few years ago some druggists in the State were selling cottonseed and other vegetable oils that did not come from the olive as sweet oil. There were a few prosecutions and the practice ceased. Maine druggists are now dispensing only olive oil under the name of sweet oil. When the inspectors were making the rounds the past summer and fall they found in the general stores two ounce bottles of sweet oil that were not always olive oil. As in each instance it developed at the hearings that these were old goods, their analyses are not here published nor the names of the people who put them up. Evidence was given that the practice of putting up cottonseed oil under the name of sweet oil had stopped long before these misbranded goods were found.

BLACK ANTIMONY.

This is a material that is used quite largely in veterinary practice and in 1908 it was found to be grossly adulterated. Every sample of black antimony purchased in the State was found to consist of ground limestone and carbon. The sale of this kind of material for veterinary purposes still continues, but it is sold under the name of "Horse Medley". It is, of course, perfectly inert so far as remedial qualities are concerned.

Quite extended purchases were made of black antimony by the inspectors throughout the State during the past winter and in all but three cases they were given practically chemically pure antimony sulphide which is true black antimony. In three instances the adulterated article was sold to the inspector. In two cases the dealers made affidavit that they purchased the goods for straight black antimony. This was further substantiated by the fact that they carried "Horse Medley" in addition to what they supposed to be the pure black antimony. Unfortunately the sales could not be traced back to the wholesaler, and the cases were dropped.

The sample of black antimony purchased at the drug store of R. H. Berry, Pittsfield, was found to consist largely of calcium carbonates and carbon and carried a small amount of copper, iron, magnesium and silica. The case was compromised without prosecution on the payment of a small penalty.

THE PUBLIC AND THE PHARMACIST.

The pharmacist differs from other business men in that he is engaged in a profession and that there is an educational requirement before he can be registered to compound medicines under the laws of the State. In many instances these men bring high ideals to their business. Unfortunately there are many more druggists in the State than are needed to supply the demand for medicines and still more unfortunately many men are engaged in selling medicines in closed packages who are not in the drug business. Also many physicians dispense medicines and thus fill their own prescriptions. This has brought it about that most, if not all, of the druggists in the State have found it necessary, in order to earn a living, to add other lines than drugs to their business.

To the writer something like the following seem to be the duty of the physician, the pharmacist and the public.

Only so far as the exigencies of the situation demand should the physician dispense medicines. He should write prescriptions and these should be filled by registered pharmacists. The pharmacist should not prescribe even in the case of simple disorders. Each profession should respect the other. In all things that he handles, sundries as well as medicines, the druggist should handle only the best. His ideal should be quality and not lowness of price. When a person purchases at the drug store he should have the right to feel certain that whatever he buys is of the highest quality. The public should purchase their medicines, even proprietory medicines, of the regular registered pharmacist. The best pharmacists will not sell remedies that do not have medical endorsement. When one has drugs or medicines to purchase quality is the essential. Price is comparatively non-essential. Some remedies deteriorate with age, and an old, weakened drug may be useless. Others actually change in composition so that a comparatively inert remedy may develop into a powerful poison. The pharmacist knows about drugs; the department or general store manager does not.

Registered pharmacists, physicians and clergymen, are essential to the well being of a community. It is a citizen's duty to the public of which he is a part, to assist in retaining these professional men against the time of need. The purchase of medicines from other than druggists is a civic blunder.

June, 1912.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

CHAS. D. WOODS, Director

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Official Inspections

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Table showing the results of examinations of jams, jellies and preserves purchased by the inspectors. Samples arranged alphabetically by States and Towns where the goods were made.

Station Number.	Price, cents.	Net weight ounces.	BRAND. MAKER AND DEALER.	RESULTS OF EXAMINATION.
9589	30	12.6	"Medallion Raspberry Jam. Bishop & Co., Los Angeles, Calif." Geo. C. Shaw Co., Portland....	Contains 2.65 per cent. cane sugar No preservative, artificial color, foreign matter or glucose found
9590	30	14.9	"Medallion Strawberry Jam. Bishop & Co. Los Angeles, Calif." Geo. C. Shaw Co, Portland....	Contains 27.78 per cent. cane sugar. No preservative, artificial color, foreign matter or glucose found.
9592	40	11.3	"Guava Jelly. Made by Lillian M. Blake, Miami, Fla." Geo. C. Shaw Co., Portland........	Contains 39.5 per cent. cane sugar, 0.55 per cent. of ash. No preservative, artificial color, foreign matter or glucose found.
9502	15	15.3	"Rex Imitation Fruit Jelly, colored with amaranth. Contains added phosphate; 80 per cent. corn syrup; 20 per cent apple juice. Corn Products Refining Co., Davenport, Iowa. Trefethen & Sweet Co., Portland.	Contains 78.8 per cent. glucose; 1.6 per cent. cane sugar. Phosphates, starch and dextrose present. Colored with amaranth Starch not declared. Misbranded.
9574	–	8.8	"Apple Jelly. Put up by W. F. Reed Co., Auburn, Me. Guaranteed pure apple and sugar." H. S. Melcher Co., Portland....	Contains 29 per cent. cane sugar; 0.22 per cent. ash. Starch present No preservative, artificial color or glucose found.
9501	10	7.7	"Pure Apple Jelly. A. M. Pollock, Cumberland Center Me." Trefethen & Sweet Co., Portland	Contains 7.2 per cent. cane sugar; 0.3 per cent. ash. No preservative, artificial color or glucose found
9547	–	8.0	"Pure Home Made Apple Jelly. C. O. Lund, Falmouth Corner, Me." Thompson-Hall Co., Portland....................	Contains 6.2 per cent. cane sugar; 0.18 per cent ash. No preservative, artificial color, foreign matter or glucose found.
9534	–	13.5	"Apple Jelly" Twitchell-Champlin Co., Portland, maker and dealer........................	Contains 51.5 per cent. cane sugar, 0.47 per cent. ash. No preservative, artificial color or glucose found. Considerable starch present.
9530	–	10.5	"Apple Jelly. Currant Flavor." Twitchell-Champlin Co., Portland, maker and dealer........	Contains 57.3 per cent. cane sugar; 0.55 per cent. ash Considerable starch. No preservative, artificial color or glucose found.
9533	–	10.1	"Apple Jelly. Grape Flavor." Twitchell-Champlin Co., Portland, Me., maker and dealer...	Contains 42.3 per cent cane sugar; 0.47 per cent. ash. Considerable starch. No preservative, artificial color or glucose found.
9532	–	10.1	"Apple Jelly. Pineapple Flavor." Twitchell-Champlin Co., Portland, Me., maker and dealer...	Contains 41.6 per cent. cane sugar; 0.53 per cent. ash. Large amount of starch. No preservative, artificial color or glucose found.

Table showing the results of examinations of jams, jellies and preserves purchased by the inspectors. Samples arranged alphabetically by States and Towns where the goods were made—Continued.

Station Number.	Price, cents	Net weight, ounces.	Brand, Maker and Dealer.	Results of Examination.
9531	–	10.6	"Apple Jelly Strawberry Flavor." Twitchell-Champlin Co., Portland, Me., maker and dealer...	Contains 46.5 per cent. cane sugar; 0.53 per cent. ash. Considerable starch. No preservative, artificial color or glucose found.
9526	–	14.2	"Family Preserves. Raspberry. Made from fresh ripe berries and pure cane sugar." Twitchell-Champlin Co., Portland, maker and dealer.	Contains 27.8 per cent. cane sugar; No preservative, artificial color, foreign matter or glucose found.
9528	–	13.1	"Our Best Family Preserves. Damson. Made from fresh ripe berries and cane sugar." Twitchell-Champlin Co., Portland, maker and dealer.	Contains 18 per cent. cane sugar. No preservative, artificial color, foreign matter or glucose found.
9527	–	14.5	"Our Best Family Preserves. Strawberry. Made from fresh ripe berries and pure cane sugar." Twitchell-Champlin Co., Portland, maker and dealer.	Contains 15.7 per cent. cane sugar. No preservative, artificial color, foreign matter or glucose found.
9557	–	8.8	"Marvel Brand Apple Jelly. Absolutely pure." Packed for C. A. Weston Co., Portland...	Contains 35.8 per cent. cane sugar, 0.37 per cent. ash. Very little starch. No preservative, artificial color or glucose found.
9593	25	11.4	"Klico Club Lemon Marmalade. Klico Club Sauce Co., Westbrook, Me." Geo. C. Shaw Co., Portland.	Contains 5.5 per cent. cane sugar. No preservative, artificial color, foreign matter or glucose found.
9504	25	11.4	"Klico Club Grape Fruit Marmalade. Klico Club Sauce Co., Westbrook, Me." Trefethen & Sweet Co., Portland.	Contains 1.8 per cent. cane sugar. No preservative, artificial color, foreign matter or glucose found.
9585	25	7.4	"Home Made Currant Jelly. Made expressly for Jas. A. Hayes & Co., Boston." W. L. Wilson & Co., Portland..............	Contains 18.8 per cent. cane sugar; 0.54 per cent. ash. No preservative, artificial color, foreign matter or glucose found.
9516	25	9.9	"Apple Jelly Currant Flavor. Apple juice, 50 per cent.; corn syrup, 25 per cent.; sugar, 25 per cent. Artificially colored. Sodium benzoate, 1–10 of 1 per cent. Logan, Johnson & Co., Boston, Mass." D. W. True & Co., Portland............	Contains 20.1 per cent. glucose; 7.5 per cent. cane sugar; considerable starch; more phosphoric acid than pure jelly carries. Colored with amaranth. Sharp acid taste probably due to phosphoric acid. No sodium benzoate found.
9515	25	9.9	"Apple Jelly. Raspberry Flavor. Apple juice, 50 per cent.; corn syrup, 25 per cent.; sugar, 25 per cent. Artificially colored. Sodium benzoate 1–10 of 1 per cent. Logan, Johnson & Co., Boston, Mass." D. W. True & Co., Portland.	Contains 19.8 per cent. glucose, 9.7 per cent. cane sugar, considerable starch: more phosphoric acid than pure jelly. Colored with amaranth. Quite sharp acid taste, probably due to phosphoric acid.

Table showing the results of examinations of jams, jellies and preserves purchased by the inspectors. Samples arranged alphabetically by States and Towns where the goods were made—Continued.

Station Number.	Price, cents.	Net weight, ounces.	Brand, Maker and Dealer.	Results of Examination.
9514	25	.97	"Apple Jelly. Strawberry Flavor. Apple juice, 50 per cent.; corn syrup, 25 per cent.; sugar, 25 per cent. Artificially colored. Sodium benzoate 1–10 of 1 per cent. Logan, Johnson Co., Boston, Mass." D. W. True & Co., Portland.	Contains 21.4 per cent. glucose, 10.9 per cent. cane sugar; considerable starch; more phosphoric acid than pure jelly. Colored with amaranth Sharp acid taste, probably due to phosphoric acid.
9518	–	13.2	"Ideal Pineapple Preserve. Pineapple, 55 per cent.; corn syrup compound, 35 per cent.; granulated sugar, 10 per cent.; sodium benzoate, 1–10 of 1 per cent. Logan, Johnson & Co., Boston, Mass." D. W. True & Co., Portland.	Contains 49.9 per cent. glucose; 25.8 per cent. cane sugar. No benzoate found.
9521	–	12.7	"Ideal Plum and Apple Preserve. Plum, 35 per cent.; apple, 20 per cent.; corn syrup, 35 per cent.; granulated sugar, 10 per cent.; sodium benzoate, 1–10 of 1 per cent. Artificially colored. Logan, Johnson & Co, Boston, Mass." D. W. True & Co., Portland.	Contains 53 per cent. glucose; 8.7 per cent. cane sugar, colored with amaranth. No benzoate of soda found.
9519	–	12.8	"Ideal Raspberry and Apple Preserve. Raspberry, 35 per cent.; apple, 20 per cent.; corn syrup, 35 per cent.: granulated sugar, 10 per cent.: sodium benzoate, 1–10 of 1 per cent. Artificially colored. Logan, Johnson & Co., Boston, Mass." D W. True & Co., Portland.	Contains 32.8 per cent. glucose, cane sugar, 9.6 per cent. Colored with amaranth. Only trace of benzoate found.
9520	–	12.8	"Ideal Strawberry and Apple Preserve. Strawberry, 35 per cent.; apple, 20 per cent.; corn syrup, 35 per cent.; granulated sugar, 10 per cent.; sodium benzoate, 1–10 of 1 per cent. Colored. Logan, Johnson & Co, Boston, Mass." D. W. True & Co., Portland.	Contains 30 per cent. glucose; 12.5 per cent. cane sugar, colored with amaranth. No benzoate of soda found.
9578	25	17.4	"Red Cloak Raspberry Preserves Fruit and sugar only. Logan, Johnson & Co., Boston, Mass." W. L. Wilson & Co., Portland..	Contains 36.5 per cent. cane sugar. No preservative, artificial color, foreign matter or glucose found.
9579	25	16.0	"Red Cloak Strawberry Preserves. Fruit and sugar only. Logan, Johnson & Co., Boston, Mass." W. L. Wilson & Co., Portland..	Contains 25.5 per cent. cane sugar. No preservative, artificial color, foreign matter or glucose found.
9562	–	8.9	"Imitation Apple Jelly. Made from apple juice, .500; glucose, .499; tartaric acid, .001. Jos. Middleby, Jr., Inc., Boston, Mass." Shaw, Hammond & Carney, Portland.	Contains 68.2 per cent. glucose, no cane sugar; 0.7 per cent ash. Considerable starch. No artificial color found.

Table showing the results of examinations of jams, jellies and preserves purchased by the inspectors. Samples arranged alphabetically by States and Towns where the goods were made—Continued.

Station Number.	Price, cents.	Net weight ounces.	Brand, Maker and Dealer.	Results of Examination.
9561	–	8.3	"Imitation Grape Jelly Made from apple juice, .500; corn syrup .499; tartaric acid, .001. Artificially colored. Jos. Middleby, Jr., Inc., Boston, Mass." Shaw, Hammond & Carney, Portland.	Contains 67 per cent. glucose; 0.7 per cent. cane sugar; 0.66 per cent. ash. Considerable starch.
9565	–	9.0	"Imitation Peach Jelly. Made from apple juice, .55; glucose, .499; tartaric acid, .001; Jos. Middleby, Jr., Inc., Boston, Mass." Shaw, Hammond & Carney, Portland.	Contains 65.9 per cent. glucose; no cane sugar; 0.66 per cent. ash. Large amount of starch.
9564	–	8.3	"Imitation Raspberry Jelly. Made from apple juice, .500; glucose, .499; tartaric acid, .001. Artificially colored. Jos .Middleby, Jr., Inc., Boston, Mass." Shaw, Hammond & Carney, Portland	Contains 65.5 per cent. glucose; 2.15 per cent. cane sugar; 0.63 per cent ash. Large amount of starch.
9563	–	9.3	"Imitation Strawberry Jelly. Made from apple juice, .500; glucose, .499; tartaric acid, .001. Artificially colored. Jos. Middleby, Jr., Inc., Boston, Mass." Shaw, Hammond & Carney, Portland	Contains 66.7 per cent. glucose, 0.58 per cent. cane sugar; 0.61 per cent ash; large amount of starch.
9544	–	8.1	"Imperial Brand Apple Jelly. Currant Flavor. Absolutely pure. Jos. Middleby, Jr., Boston, Mass." Conant, Patrick Co., Portland.	Contains 20.3 per cent. cane sugar; 0.54 per cent. ash. No preservative, artificial color or glucose found
9551	–	32.1	"Lemon Flavor Pie Filling. Compounded from granulated sugar, 375; glucose, 250; eggs, 100; lemon juice and oil, 105; starch, .060; water, .055; butterine, .050; citric acid, .004; sodium benzoate, .001. Artificially colored with analine color. Jos. Middleby, Jr., Inc., Boston, Mass." Milliken-Tomlinson Co., Portland.	Contains 0.075 per cent. benzoate of soda. Colored with coal tar color, apparently Napthol Yellow S No further examination made.
9553	–	35.4	"Shawmut Brand Apple and Raspberry Preserves. Raspberries, 20 per cent.; granulated sugar, 10 per cent.; apple juice, 25 per cent.; corn syrup, 45 per cent.; preserved with 1–10 of 1 per cent. sodium benzoate. Artificially colored. Jos. Middleby, Jr , Inc., Boston, Mass." Milliken-Tomlinson Co , Portland.	Contains 58.7 per cent. glucose; 5.6 per cent. cane sugar; 0.007 per cent. benzoate; small amount of starch. Artificial color not identified.

Table showing the results of examinations of jams, jellies and preserves purchased by the inspectors. Samples arranged alphabetically by States and Towns where the goods were made—Continued.

Station Number.	Price, cents	Net weight, ounces	BRAND, MAKER AND DEALER.	RESULTS OF EXAMINATION.
9552	–	36.7	"Shawmut Brand Apple and Strawberry Preserves. Strawberries, 20 per cent.; granulated sugar, 10 per cent.; apple juice, 25 per cent.; corn syrup, 45 per cent.; preserved with 1-10 of 1 per cent. sodium benzoate. Artificially colored. Jos. Middleby, Jr., Inc., Boston, Mass." Milliken-Tomlinson Co., Portland.	Contains 69.6 per cent. glucose; 1.7 per cent. cane sugar; 0.056 benzoate; considerable starch. Artificial color not identified.
9584	10	8.2	"True Fruit Brand Fancy Plum, Apple and Sugar Jelly. 30 per cent. plum juice, 30 per cent. apple juice; 40 per cent. granulated sugar. Net weight 8 ozs. St. Louis Syrup & Preserving Co., St. Louis, Mo." W. L. Wilson & Co., Portland.	Contains 32.2 per cent. cane sugar; 0.56 per cent. ash; large amount of starch. No preservatives or glucose found.
9503	25	13.7	"Beechnut Strawberry Jam. Beechnut Packing Company, Johain, N. Y., Home Style." Trefethen & Sweet Co., Portland.	Contains 18 per cent. cane sugar. No preservative, artificial color, foreign matter or glucose found.
9591	40	10.3	"Blackberry Jelly. Gordon & Dillworth, New York City." Geo. C. Shaw Co., Portland....	Contains 33.4 per cent. cane sugar; 0.61 per cent. ash. No preservative, artificial color, foreign matter or glucose found.
9570	–	16.3	"Fresh Fruit Damson Jam. Contains 1-10 of 1 per cent. benzoate of soda. Curtis Bros., Rochester, N. Y." H. S. Melcher Co., Portland.	Contains 1.2 per cent. cane sugar; 0.08 per cent. benzoate. No preservative, artificial color, foreign matter or glucose found.
9569	–	14.6	"Fruit Red Currant Jam. Contains 1-10 of 1 per cent. benzoate of soda. Curtis Bros., Rochester, N. Y." H. S. Melcher Co., Portland...........	Contains 1.6 per cent. cane sugar; 0.108 per cent. benzoic acid. No preservative, artificial color, foreign matter or glucose found.
9573	–	15.5	"Grape with 10 per cent. apple juice fresh fruit jam. Curtis Bros. Co., Rochester, N. Y.; 40 per cent. each fresh fruit and granulated sugar with addition of 10 per cent. each fresh apple juice and corn syrup. Contains 1-10 of 1 per cent. benzoate of soda." H. S. Melcher Co., Portland.	Contains 5.3 per cent. cane sugar; 0.13 per cent. benzoate. No glucose. No artificial color found.
9571	–	15.6	"Raspberry with 10 per cent. apple juice fresh fruit jam. 40 per cent. each fresh fruit and granulated sugar with addition of 10 per cent. each fresh apple juice and corn syrup. Contains 1-10 of 1 per cent. benzoate of soda. Curtis Bros. Co., Rochester, N. Y." H. S. Melcher Co., Portland.	Contains 25.1 per cent. cane sugar; 23.2 per cent glucose; 0.108 benzoate. Small amount of starch. Nc artificial color found.

Table showing the results of examinations of jams, jellies and preserves purchased by the inspectors. Samples arranged alphabetically by States and Towns where the goods were made—Continued.

Station Number	Price, cents.	Net weight ounces.	Brand, Maker and Dealer.	Results of Examination.
9572	–	16.5	"Strawberry with 10 per cent. apple juice fresh fruit jam. 40 per cent each fresh fruit and granulated sugar with addition of 10 per cent each fresh apple juice and corn syrup. Contains 1–10 of 1 per cent. benzoate of soda. Curtis Bros. Co., Rochester, N. Y." H. S. Melcher Co., Portland.	Contains 30.0 per cent. cane sugar; 0.06 per cent. benzoate; small amount of starch; 2.4 per cent. glucose. No artificial color found.
9583	15	12.5	"Seal Brand Compound Damson Jam. Damsons, apple juice, sugar and corn syrup. P. J. Ritter Conserve Co., Philadelphia, Pa." W. L. Wilson & Co., Portland.	Contains 32.5 per cent. of glucose, 1.3 per cent. of cane sugar. No preservative, artificial color or foreign matter found.
9582	25	12.7	"XX Brand Damsons. Selected fresh fruit and granulated sugar. P. J. Ritter Conserve Co., Philadelphia, Pa." W. L. Wilson & Co., Portland.	Contains 7.7 per cent. cane sugar. No preservative, artificial color, foreign matter or glucose found.
9581	25	13.3	"XX Brand Preserves. Strawberry. Carefully selected fresh fruit and granulated sugar. P. J. Ritter Conserve Co., Philadelphia, Pa." W. L. Wilson & Co., Portland.	Contains 15.6 per cent. cane sugar. No preservative, artificial color, foreign matter or glucose found.
9580	25	16.2	"Strawberry Jam. Strawberries, 45 per cent.; apple juice, 5 per cent.; sugar, 25 per cent.; corn syrup, 25 per cent. P. J. Ritter Conserve Co., Philadelphia, Pa." W. L. Wilson & Co., Portland	Contains 2.9 per cent. cane sugar; 36.8 per cent. glucose. No preservative or artificial color found. Misbranded.
9543	–	14.2	"Reliable Quality Parker House Brand Jam. Mixture raspberries, 11 per cent.; apple juice, 20 per cent.; sugar, 5 per cent.; corn syrup, 64 per cent.; Carmen Lake trace, benzoate of soda, 1–10 of 1 per cent. McMechen Preserving Co., Wheeling, W. Va." Conant Patrick & Co., Portland.	Contains 57.1 per cent. glucose; 3.5 per cent. cane sugar; considerable starch; 0.076 per cent. benzoate of soda. No artificial color found.
9542	–	14.6	"Reliable Quality Parker House Brand Jam. Mixture strawberries, 11 per cent.; apple juice, 20 per cent.; sugar, 5 per cent.; corn syrup, 64 per cent.; Carmen Lake trace; benzoate of soda, 1–10 of 1 per cent. McMechen Preserving Co., Wheeling, W. Va." Conant, Patrick Co., Portland.	Contains 57.4 per cent. glucose; 2.8 per cent. cane sugar; 0.02 per cent. benzoate of soda; considerable starch. No artificial color found.

Table showing the results of examination of sausages purchased by the inspectors in the winter of 1912. Samples are arranged alphabetically by towns.

	Town, Dealer, Brand.	Price per pound—Cents.	Weight sold for one pound—Ounces.	Water—Per cent.	Fat—Per cent.	Protein—Per cent.	Cereal.	Remarks.
10,365	Brunswick, C. A. Lemieux	12	16	44.2	40.7	12.8	None.	
9722	Brunswick, Nelson McFadden	16	–	34.1	46.3	10.4	5.35	
8747	Brunswick, Nelson McFadden	14	–	31.5	50.1	7.8	Present.	
10,366	Brunswick, P. A. Morin	15	17.5	32.9	49.9	8.0	Present.	"Cereal added" on label.
10,363	Brunswick, M. E. Parent	15	16.6	48.2	34.2	10.7	Present.	"Cereal added" on label.
10,364	Brunswick, S. A. Walker	15	16.2	51.7	29.7	10.9	Present.	
10,372	Camden, C. E. Beedy.	15	17.0	48.4	39.5	9.6	Present.	"With cereal" on label.
10,374	Camden, F. O. Clark.	15	16.5	49.7	31.8	11.2		
10,373	Camden, Green's Cash Market	15	14.5	46.3	34.2	14.0	None.	
10,380	Calais, Gove's Cash Store	10	18.3	51.0	28.3	10.3	Present.	
10,381	Calais, Flood Bro.	15	16.9	47.7	39.5	11.1	Trace.	
10,385	Calais, McKay's Market	15	17.5	46.5	40.7	11.3	None.	
10,382	Calais, P. F. Welch	15	16.2	45.2	33.1	12.0	None.	
10,407	Eastport, Gove's Cash Store	15	19.1	–	–	–	Trace.	
10,406	Eastport, Pike & Kilby	16	17.6	37.9	50.9	7.0	None.	
10,392	Ellsworth, Cottle & Son	15	16.6	40.4	45.3	12.0	None.	
10,391	Ellsworth, P. E. Kearns	15	14.8	39.9	47.4	10.1	None.	
10,393	Ellsworth, Austin H. Joy, "John P. Squire Co., Boston, all Pork Sausage"	17	15.8	–	–	–		
10,390	Ellsworth, S. K. Whiting	15	12.5	18.8	71.6	7.8	None.	
9626	Gardiner, Cash Market Co	15	–	38.3	46.8	8.8	Present.	
10,410	Lubec, Gove's Cash Store	15	18.8	42.1	33.7	12.0	Present.	

Table showing the results of examination of sausages purchased by the inspectors in the winter of 1912. Samples are arranged alphabetically by towns.—Concluded.

	Town, Dealer, Brand.	Price per pound—Cents.	Weight sold for one pound—Ounces.	Water—Per cent.	Fat—Per cent.	Protein—Per cent.	Cereal.	Remarks.
10,411	Lubec, W. M. Mowry	15	17.9	–	–	–	Present..	"5% cereal" on package.
10,409	Lubec, Mulholland Bros	15	15.2	54.7	31.2	11.1	Present..	"5% cereal" on package.
10,383	Milltown, Fred Abbott	15	16.7	43.2	42.6	11.1		
10,384	Milltown, S. S. Pineo	15	15.8	44.3	35.2	10.4	Present.	
10,401	Princeton, I. M. Furbish	13	16.3	39.6	44.8	11.1	None.	
10,402	Princeton, C. A. Rolfe	15	16.3	–	–	–	Present..	"With cereal" on label.
10,369	Rockport, Eells Lime Co	13	14.8	37.8	50.0	8.1	Present..	"With cereal" on tag in package.
10,368	Rockport, Rockport Ice Co	13	15.7	37.0	46.3	11.3	Present.	
10,367	Rockport, S. E. & H. L. Shepherd Co	13	14.5	29.2	55.1	10.8	None.	
10,377	Thomaston, O. L. Cram	15	15.5	41.2	45.6	8.7	None.	
10,378	Thomaston, E. L. Dillingham	10	16.0	39.5	48.5	8.8	Present.	
10,376	Thomaston, Job Spear	17	16.2	35.1	50.9	10.8	None.	
10,379	Warren, A. & P. D. Starrett	15	14.7	47.4	31.0	10.8		

Table giving a list of the brands of extract of vanilla collected by the inspectors in the winter of 1912 and examined and passed by the chemists as pure vanilla extracts.

Sta. No.	State, Town, Brand, Maker and Dealer.
	Maine.
10,138	Bangor............."T. & K. Extract of Vanilla. Prepared by Thurston & Kingsbury, Bangor, Me." Hayes & Howe, Fairfield.
10,419	Cherryfield.........."Superior Extract Vanilla, G. R. Campbell & Co., Cherryfield." G. R. Campbell & Co., Cherryfield.
10,415	Eastport............"Gilt Edge Pure Flavor of Vanilla. Distributed by Gove's Cash Store, Eastport." J. F. Gove & Son, Perry.
10,357	Fort Kent..........."Old Fort Brand Vanilla. Fort Kent Furniture Co., Fort Kent." U. Dumond, Fort Kent.
10,297	Houlton............."Pure Extract Vanilla. Prepared by Wm. Palmer, Houlton." C. E. Lovering, Houlton.
10,020	Portland............"Baker's Pure Extract Vanilla. Baker Extract Co., Portland." Littlefield & Co., Portland.
10,291	Portland............"Concentrated Extract of Vanilla. Cook, Everett & Pennell, Portland." J. W. Smith, Springvale.
10,329	Portland............"Concentrated Extract of Vanilla. Cook, Everett & Pennell, Portland." G. W. Bull, Monticello.
10,272	Portland............"Gould's Pure Extract of Vanilla. Manufactured and Guaranteed by J. E. Gould & Co., Portland." A. H. Spooner, Sherman Mills.
10,443	Portland............"Cumberland Extract Vanilla. Manufactured by John W. Perkins Co., Portland. Below Standard." L. R. Giles Co., East Brownfield.
10,274	Portland............"10 cent size P-C Flavoring Extract Vanilla. The Pettengill Co., distributors, Portland." I. E. Seavey, Sherman Mills.
10,142	Portland............"Our Vanilla. Portland Flavoring Co., Portland." Bassett & Eaton, Winslow.
10,019	Portland............"Foss Pure Extract Vanilla. Prepared by Schlotterbeck & Foss Co., Portland." Littlefield & Co., Portland.
10,159	Portland............"Hatchet Flavoring Extract Vanilla. Made by The Twitchell-Champlin Co., Portland." N. D. Bolster Co., So. Paris.
10,414	Portland............"Solar Brand Pure Vanilla Extract. Put up for C. A. Weston Co., Portland." J. A. Gorman & Co., Rumford.
10,156	Rockland............"Three Crow Brand Extract of Vanilla. The Atlantic Spice Co., Rockland." C. F. Ridlon, Norway.
10,371	Rockland............"Three Crow Brand Extract Vanilla. The Atlantic Spice Co., Rockland." Hart & Holbrook, Rockland.
10,375	Rockland............"Harris Brand Extract Vanilla. John Bird Co., Rockland." Willis Ayer, Rockland.
10,489	Rockland............"White Ribbon Brand Extract of Vanilla. Prepared at laboratory of John Bird Co., Rockland." Madison Union Co-op. Co., Madison.
9,721	Woodfords..........."Extract of Vanilla. Chapman & Wyman, Woodfords." Chapman & Wyman, Woodfords.
	Massachusetts.
10,236	Boston.............."Colman's Extract of Vanilla. Manufactured by Colman Specialty Co., Boston." Curtis & Roberts, Kennebunk.

Table giving a list of the brands of extract of vanilla collected by the inspectors in the winter of 1912 and examined and passed by the chemists as pure vanilla extracts—Continued.

Sta. No.	State, Town, Brand, Maker and Dealer.
10,237	Boston............."Benefit Brand Pure Vanilla Extract. Distributed by the Direct Importing Co., Boston." Direct Importing Co., Kennebunk.
10,191	Boston.............Burnett's Extract Vanilla. Joseph Burnett Co., Boston." E. B. Ingraham, Rockland.
8,722	Boston............."Slade's Absolutely Pure Extra Strong Vanilla. D. & L. Slade Co., Boston." L. F. Doble, Cooperative Grange Store, Farmington.
10,021	Boston............."Slade's Absolutely Pure Extra Strong Vanilla. D. & L. Slade Co., Boston." Littlefield & Co., Portland.
10,298	Springfield.........."Forest City Brand Pure Flavoring Extract Vanilla. Prepared at 27 & 29 Hampden St., Springfield." Akin & Fernald, Alfred.
10,022	Springfield.........."Forest City Brand Pure Vanilla. Prepared at 27 & 29 Hampden St., Springfield." A. Mann, Portland.
	New York.
10,144	Binghampton........"Good Value Extract Pure Vanilla. Frank E. Harris, Binghampton." G. E. Withee, Benton Falls.
10,396	Binghampton........"Good Value Pure Extract Vanilla. Frank E. Harris, Binghampton." C. A. Lemieux, Brunswick.
10,235	Buffalo............."Larkin Vanilla Flavoring Extract. Larkin Co., Buffalo." A. H. Hanson, West Enfield.
10,066	New York City......."Republic Food Products Extract of Vanilla. Austin Nichols & Co., New York." Rowe & Meserve, Portland.
10,162	New York City......."Van Duzer's Standard Quality Vanilla. Van Duzer Extract Co., New York." Hunter & McMaster Co., Pittsfield.
10,211	New York City......."Worth's Pure Flavoring Extract Vanilla. Worth Extract Co., New York." W. H. Martin, Kingman.

Table giving a list of the brands of imitation vanilla flavors collected by the inspectors in the winter of 1912 and examined and passed by the chemists as being properly branded.

Sta. No.	State, Town, Brand, Maker and Dealer.
	Illinois.
10,252	Chicago............"Economy non-alcoholic concentrated Vanilla. F. E. Barr & Co., 308 Dearborn St., Chicago." H. Douglas & Co., Guilford.
	Maine.
,230	Bangor............."Clifford Brand Imitation Vanilla Extract. Contains vanilla, vanillin, coumarin flavor and caramel. Put up for T. R. Savage, Bangor." J. E. Johnson, Springfield.

Table giving a list of the brands of imitation vanilla flavors collected by the inspectors in the winter of 1912 and examined and passed by the chemists as being properly branded —Concluded.

Sta. No.	State, Town, Brand, Maker and Dealer.	
	Maine.	
10,331	Bridgewater.........	"Compound Extract Vanilla. Formula: Vanilla, pure exhibiting flavor of vanilla beans 32 parts, coumarin pure .08 parts, refined sugar 615 parts, alcohol pure 94 per cent., caramel and water enough to make 109 parts. Prepared by Henry L. Clay, Bridgewater." J. H. Farley, Bridgewater.
10,301	Portland............	"Hall Brand Imitation Vanilla. Contains vanilla, vanillin, coumarin flavor and caramel. Prepared at 36 and 38 Brown St., Portland." E. J. Laverty, Westbrook.
10,303	Portland............	"Imitation Vanilla Flavor. Each fluid ounce contains pure vanillin 1¼ grs., coumarin ⅛ gr., colored with a harmless coloring. Cook, Everett & Pennell, Portland." G. W. Bull, Monticello.
10,141	Portland............	"McAndrews Four Ounce Brand Imitation Vanilla Flavor. Mfg. by Dolan & Furnival Co., Portland." Bassett & Eaton, Winslow.
9,995	Portland............	"Imitation Extract Vanilla Flavor. Formula: Vanillin, coumarin, cologne spirits, simple syrups, caramel. Made at 428-430 Fore St., Portland." J. F. Hoffman, Portland.
9,968	Portland............	"Rigby Extracts. Imitation Vanilla. Contains vanillin 30-100%, vanilla bean, 75-100%, alcohol not over 22½%, colored with burnt sugar. R. G. Leighton, Portland." C. S. Johnson, Portland.
10,326	Portland............	"Imitation Vanilla Flavoring. Comprises vanillin, coumarin, caramel to color. Murphy Bros., Portland." W. J. Lewis, East Deering.
10,139	Portland............	"Imitation Extract Vanilla Flavor. Formula: Vanillin, coumarin, cologne spirits, simple syrup, caramel. Bottled for W. O. Pitcher, Portland." David King, Fairfield.
10,299	Portland............	"F. C. T. Brand Vanillin Flavor. Trace of coumarin and color. Less than 10% alcohol. Mfg. by F. C. Tibbetts Mercantile Co., Portland." B. L. Libby, Gorham.
10,417	Portland............	"F. C. T. Brand Vanillin Flavor. Trace of coumarin and color. Less than 10% alcohol. Manufactured by F. C. Tibbetts Mercantile Co., Portland." G. H. Harper & Co., Machias.
9,967	Portland............	"Gilt Edge Brand Imitation Extract Vanilla. Contains vanilla, vanillin, coumarin, prune juice and caramel." Chas. Hatzkelson, Portland.
	Massachusetts.	
10,145	Boston..............	"Eclipse Brand Flavor of Vanilla. Contains vanilla, vanillin, coumarin and caramel. Prepared for Haskell, Adams & Co., Boston." A. P. Marcou, Winslow.
10,572	Brockton............	"Adams Compound Vanilla. Pure vanilla extract 32%, vanillin .5%, coumarin tincture 16%, sugar 16%, color .5%, water 35%. G. D. Barnett & Co., Brockton." Chas. Bartlett, Auburn.
	New York.	
10,334	New York City.......	"St. John's Imitation Vanilla Flavor. Composed of 19.00 pure grain alcohol, 75.00 water sweetened with sugar, artificial vanillin and artificial coumarin a trace. Colored artificially with caramel. St. John & Co., Inc., New York." Tornquist Bros., Caribou.

DISCUSSION OF RESULTS OF ANALYSIS.

Jams, Jellies and Preserves.

In reporting the results of the examination of the jams, jellies and preserves purchased by the inspectors, only those facts which are of interest to the general public are given in the tables. It is gratifying to note that here, as in other food products, the situation has greatly improved during the last few years and that now one can be almost sure of receiving exactly what he purchases if he takes the pains to read the labels on the goods. Preserves and the like which are sold for pure are as a rule properly made from fruit and sugar and put out in attractive packages. Cheap brands of imitation jellies and preserves are still upon the market, but they are almost without exception labeled and sold as such. These imitations are made of materials which are not as expensive as the pure fruit jams, jellies and preserves, but they contain no harmful ingredients and are sold at a price which is not unfair competition with the first-class, pure, fruit goods.

In examining the results of the chemical determinations it will be noted that in some cases only a small percentage of cane sugar was found in some of the goods which are pure. This does not mean that pure cane sugar was not used in liberal amount in the preparation of the goods, but it means that by the cooking which the material has received the sugar used has been inverted and is no longer in the form of cane sugar. Such goods may have received at the time of manufacture as much cane sugar as home-made jams, jellies and preserves and the finished product may be as pure, rich and sweet and exactly as healthful and as good as home-made materials of this kind. In fact home-made jams sweetened before being cooked and from acid fruits will contain but little cane sugar even though originally they contained as much sugar as fruit.

Sausage.

In purchasing the samples of sausage reported in the tables the inspectors entered the store and, like any other customer, called for a pound of pork sausage. The inspector took what was delivered to him, paid for the same, and left the store without explanation. Along with the results of the chemical examination of these goods are reported the number of net ounces delivered and the prices paid for the same. Upon leaving the store with his purchase in each case the inspector transferred the sausage to an air tight jar in which it was kept until it was delivered to the laboratory for analysis, where it was promptly weighed and examined. In those cases where the full pound was delivered to the inspector and there was no cereal present and no other indication of adulteration the goods were passed without comment. Whenever cereal was present without statement of that fact accompanying the goods or whenever the goods delivered were short weight the cases were investigated further by means of hearings, as directed by law.

It is gratifying to note that the general situation in regard to the sale of sausage is, like the trade in nearly every class of food products, much improved throughout the State over what it was a short time ago. Straight pork sausage can be and is made and sold as such. For certain markets the sausage contains cereal and in most cases that fact is stated both upon placards or notices as the goods are displayed in the market or store, and also by means of labels or tags of some kind accompanying each retail package as the customer receives the goods.

Vanilla Extracts.

The source of pure vanilla extract is the vanilla bean, which is the fruit of the plant known botanically as *Vanilla planifolea.* It is a climbing perennial indigenous to Central and South America and the West Indies. The quality of the bean varies considerably with the climate in which it is grown and the method of curing. When the beans are first gathered they are a light greenish color, fleshy, without odor, and their peculiar consistency, color and smell is developed by the fermenting or curing process they are put through, which varies in different countries. The choicest beans which come to this country are cultivated in Mexico and while the different varieties vary in some details the best beans are from 8 to 10 inches long, one-fourth to one-third inch thick, and after curing have a rich dark brown color, a waxy appearance and touch, and are covered with fine frost like crystals of vanillin, a definite chemical compound which gives to vanilla its principal characteristic odor and flavor. There is also contained in the walls of the bean a granular yellowish balsam-like substance that helps to give to the cut bean and the extract the delicious flavor and odor not found in the artificial or cheap extracts. It is to these resinous substances that the Mexican bean owes its popularity and notwithstanding the fact that it is lower in vanillin content than either the Bourbon or Java beans it commands a higher price and makes a more delicately flavored extract.

The Maine standard requires that the extract shall contain the soluble matter equivalent to ten per cent of the beans. Of course the quality of the extract depends entirely on the quality of the bean used and the thoroughness with which the extraction is made. Experiments have shown that if a good bean is used and thoroughly extracted with 100 parts of 35 per cent alcohol solution to every 10 parts of the bean a sufficiently strong extract will be obtained. It is probable that very few manufacturers are using at the present time the Pharmacopoeia method in making their vanillas, it requires too much time and other solvents than alcohol are added to hasten the process.

Since the manufacture of synthetic vanillin, which has exactly the same properties as that found in the bean, a large amount of imitation vanilla flavor has been put on the market. To the artificial vanillin there is usually added some coumarin, which is obtained from the Tonka bean and has a strong flavor somewhat resembling vanillin. The artificial product thus prepared has a rather rank flavor as compared with the best grades of vanilla and lacks that delicate flavor and odor derived from the resins and waxes extracted from the best beans. The artificial compounds contain less alcohol as they have no resins and gums that require alcohol to keep them in solution and they are usually colored with caramel, and some times prune juice is added to imitate the resinous matter of the genuine vanilla. They contain usually 2 to 3 times as much vanillin and in addition some coumarin which gives them a rank flavor which is very objectionable to one who has become accustomed to the delicate flavor of the true vanilla extract.

In judging of the purity of an extract the chemist has to take into consideration many things; the amount of vanillin, the amount and character of the resins, the per cent of alcohol, etc., and when these all come within reasonable limits the article is passed. The presence of coumarin or acetanilide at once brands it as artificial.

SANITATION.

The attention of the public is again directed to the statements published in Official Inspections 39 concerning the protection of food products from the possible dangerous contamination of dust and flies. A campaign for the proper protection of food products of all kinds from the dangerous germs which are blown about the street in the dust and carried from filth and disease laden receptacles to the various kinds of foods which are displayed and offered for sale is widespread and important. This feature of the State Food Law is perhaps the most important to be considered at the present season of the year, and special attention is being given to this feature by the inspectors, and it is hoped that the general public, dealers as well as consumers, will cooperate with the food officials in correcting the evils of this kind which have been widespread and general in the past.

The inspectors have been instructed to report at this office whenever they find unprotected from dust and flies pastry or any other cooked foods; confectionery, candies, sweetmeats, etc., of all kinds; all soft fruits such as strawberries, raspberries, blackberries, etc.; all fruits such as apples, pears, plums, cherries, or any others which are likely to be eaten without the removal of the skin; and all cuts of meat which are exposed outside of a shop unprotected; and any other conditions which in their opinion should be remedied or improved.

July, 1912

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

ANALYSTS

James M. Bartlett **Herman H. Hanson**
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Albert Verrill

INSPECTORS

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Official Inspections.

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FERTILIZER INSPECTION.

The reports of the analyses of the samples collected by the inspectors of the fertilizers found on sale in Maine in 1912 are here published together with such other information as seems pertinent.

CHIEF REQUIREMENTS OF THE LAW.

The following are the chief points of the law and the regulations. The full text of the law will be sent on application made to the Director of the Maine Agricultural Experiment Station, Orono, Maine.

1. *Kind of materials coming under the law.* The law applies to the sale, distribution, transportation, or the offering or

exposing for sale, distribution or transportation, any materials used for fertilizing purposes the price of which exceeds $10 per ton.

For many years the sale of materials other than mixed goods was so small that no notice was taken of it. As time went on, however, with the propagation of the ideas of home mixing, the demand for chemicals increased. For the last few years the most common chemicals such as acid phosphate, ground bone, nitrate of soda and the various potash salts are regularly licensed by the companies handling them. In the case chiefly of companies manufacturing in the State it happens that other fertilizing constituents are sold in small amounts and primarily for experimental purposes. While the law is explicit there will until further notice, be no prosecutions made by the Director of the Maine Agricultural Experiment Station for the sale without license of small amounts of these more unusual fertilizing constituents, provided the company can show that these goods were sold in good faith for experimental purposes. As a part of the indication that the goods were thus sold it should be explained to the customer exactly under what conditions the goods are sold; that they are unlicensed; that they have not been or are not likely to be analyzed by the Director of the Maine Experiment Station and that the Director holds himself in no way responsible for the quality of these unlicensed goods sold for experimental purposes. Their sale is allowed because the Director does not regard it as the purposes of the law to either hamper ordinary business or hinder experiments on the part of the farmer. Whenever any goods thus offered experimentally come to be sold in considerable amount they must be licensed the same as other fertilizing materials.

2. *The Brand.* Every lot or package shall be plainly marked with:

The number of net pounds in the package.

The name or trade mark under which it is sold.

The name and principal address of the manufacturer or shipper.

The minimum percentage of nitrogen, or its equivalent in ammonia, in available form.

The minimum percentage of potash.

The minimum percentage of available phosphoric acid (soluble and reverted).

The minimum percentage of total phosphoric acid.

If a fertilizer is sold in bulk or put up in packages belonging to the purchaser, upon the request of the purchaser he shall be furnished with a copy of the statements named above.

3. *Manufacturers' certificate.* Before manufacturing, selling or distributing a commercial fertilizer a certified copy of the statements named in 2 shall be filed with the Director of the Maine Experiment Station.

4. *Manufacturers' sample.* When the Director shall so request, the manufacturer shall furnish a sealed package containing not less than two pounds of the commercial fertilizer.

5. *Registration fee.* A registration fee is assessed on any brand offered for sale, distribution or transportation in the State as follows: $10 for the nitrogen, $10 for the phosphoric acid and $5 for the potash contained or said to be contained in the fertilizer. The filing of the certificate and the payment of the fee is required from only one person for a given brand.

6. *Registration may be refused or canceled.* The Director of the Station may refuse to register any commercial fertilizer which bears a name that is misleading or deceptive or which would tend to mislead or deceive as to the materials of which it is composed. The Director also has power to cancel the registration of a fertilizer manufactured, sold, distributed or transported in violation of any of the provisions of the law.

7. *Adulteration.* A fertilizer is adulterated if its weight, composition, quality, strength or purity varies from its fixed guaranty or if it contains any materials deleterious to growing plants.

8. *Misbranding.* A fertilizer is misbranded if: the package or label carries any statement, design or device that is false or misleading in any particular; the container does not carry the statements named in 2; the printed statements attached to the container differ from the statements in the certificate; and if the registration fee has not been paid.

9. *Analysis for correspondents.* A special law provides that the station shall analyze samples of fertilizers on sale in Maine taken in accordance with the law and the directions of the director and the payment of an analysis fee of $10. If the analysis proves to be of public importance the analysis fee will be returned. Otherwise the money will be used in the enforce-

ment of the law. Blanks with full directions will be furnished on request.

10. *Written guaranty, the dealers' safeguard.* No prosecution will lie against any person handling commercial fertilizers provided he obtains at the time of purchase a written guaranty signed by the person residing in the United States from whom the purchase was made to the effect that the commercial fertilizer is not adulterated or misbranded within the meaning of the Maine law regulating the sale of commercial fertilizers. After a person has been notified by the Director of the Maine Agricultural Experiment Station that an article of commercial fertilizer appears to be adulterated or misbranded the written guaranty will not protect further sales.

11. *Hearing.* The person who is believed to have violated the law regulating the sale of commercial fertilizer will be granted a hearing at which he may appear in person, or by attorney, or by letter. The notice of the hearing will name the time and place of the hearing and a copy of the charge. Failure to appear will not prejudice the case. The hearing will be private and every opportunity will be given for explanation and the establishment of innocence. If the time appointed is not a convenient one, postponement within reasonable limit will be granted.

12. *Penalty.* Violations of the law are punishable by a fine not exceeding one hundred dollars for the first offense and not exceeding two hundred dollars for each subsequent offense.

13. *Executive.* The Director of the Station is directed to collect and analyze samples of fertilizers on sale in the State; to publish the results of the analyses together with additional information of public benefit; and to diligently enforce the provisions of the law.

Fertility and Plant Food.

To produce profitable crops and at the same time to maintain and even to increase the productive capacity of the soil may rightly be termed "good farming." Many farmers are able to do this, and the knowledge of how to do it has been largely acquired through years of experience, during which the character of the soil, its adaptability for crops, and the methods of its management and manuring have been made the subjects of careful study, without, however, any definite and accurate knowledge concerning manures and their functions in relation to soils and crops. Those who desire to study these questions, are invited to write to the Superintendent of the Extension Department of the College of Agriculture, University of Maine, Orono, Maine, who will gladly send a list of suitable books and give full information relative to correspondence courses on this subject.*

Soils vary greatly in their capabilities of supplying food to crops. Different ingredients are deficient in different soils. The way to learn what materials are proper in a given case is by observation and experiment. The rational method for determining what ingredients of plant-food a soil fails to furnish in abundance, and how these lacking materials can be most economically supplied, is to put the questions to the soil with different fertilizing materials and get the reply in the crops produced. How to make these experiments is explained in Circular No. 8 of the Office of Experiment Stations of the U. S. Department of Agriculture. A copy of this circular can be had by applying to the Secretary of Agriculture, Washington, D. C.

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

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* This Station has a circular on Home Mixed Fertilizers that may be had on request to Director Chas. D. Woods, Orono. Farmers' Bulletin 44 of the U. S. Department of Agriculture discussing commercial fertilizers will be sent to any address on application to the Secretary of Agriculture, Washington, D. C. The Maine Bulletin, Vol. XI, No. 5, discusses The Restoration of Fertility and Commercial Fertilizers. This can be obtained by writing the College of Agriculture, Orono, Maine.

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.

CONSTITUENTS OF FERTILIZERS.

The only ingredients of plant-food which we ordinarily need to consider in fertilizers are potash, lime, phosphoric acid, and nitrogen. The available supply of lime is often insufficient; hence one reason for the good effect so often observed from the application of lime, and of plaster, which is a compound of lime and sulphuric acid. The remaining substances, nitrogen, phosphoric acid and potash, are the most important ingredients of our common commercial fertilizers, both because of their scarcity in the soil and their high cost. It is in supplying these that phosphates, bone manures, potash-salts, guano, nitrate of soda, and most other commercial fertilizers are chiefly useful.

The term "form" as applied to a fertilizing constituent has reference to its combination or association with other constituents which may be useful, though not necessarily so. The form of the constituent, too, has an important bearing upon its availability, and hence upon its usefulness as plant food. Many materials containing the essential elements are practically worthless as sources of plant-food because the form is not right; the plants are unable to extract them from their combinations; they are "unavailable." In many of these materials the forms may be changed by proper treatment, in which case they become valuable not because the element itself is changed, but because it then exists in such form as readily to feed the plant.

* *Nitrogen* is the most expensive of the three essential ferti-ing elements. It exists in three different forms, organic nitrogen, ammonia and nitrate.

Organic nitrogen exists in combination with other elements either as vegetable or animal matter. All materials containing organic nitrogen are valuable in proportion to their rapidity of

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*The availability of nitrogen from different sources is discussed on page 127.

decay, because change of form must take place before the nitrogen can serve as plant food. Organic nitrogen differs in availability not only according to the kind of material which supplies it, but according to the treatment it receives.

Nitrogen as ammonia usually exists in commercial manures in the form of sulphate of ammonia and is more readily available than organic nitrogen. While nitrogen in the form of ammonia is extremely soluble in water, it is not readily removed from the soil by leaching, as it is held by the organic compounds of the soil.

Nitrogen as nitrate exists in commercial products chiefly as nitrate of soda. Nitrogen in this form is directly and immediately available, no further changes being necessary. It is completely soluble in water, and diffuses readily throughout the soil. It differs from the ammonia compounds in forming no insoluble compounds with soil constituents and may be lost by leaching.

Phosphoric acid is derived from materials called phosphates, in which it may exist in combination with lime, iron, or alumina as phosphates of lime, iron or alumina. Phosphate of lime is the form most largely used as a source of phosphoric acid. Phosphoric acid occurs in fertilizers in three forms: That soluble in water and readily taken up by plants; that insoluble in water but still readily used by plants and known as "reverted;" and that soluble only in strong acids and consequently very slowly used by the plant. The "soluble" and "reverted" together constitute the "available" phosphoric acid. The phosphoric acid in natural or untreated phosphates is insoluble in water, and not readily available to plants. If it is combined with organic substances as in animal bone, the rate of decay is more rapid than if with purely mineral substances. The insoluble phosphates may be converted into soluble forms by treatment with strong acids. Such phosphates are known as acid phosphates or superphosphates. The "insoluble phosphoric acid" of a high cost commercial fertilizer has little or no value to the purchaser because at the usual rate of application the quantity is too small to make any perceptible effect upon the crop, and because its presence in the fertilizer excludes an equal amount of more needful and valuable constituents.

Potash in commercial fertilizers exists chiefly as muriates and sulphates. With potash the form does not exert so great an influence upon availability as is the case with nitrogen and phosphoric acid. All ordinary forms are freely soluble in water and are believed to be nearly if not quite equally available as food. The form of the potash has an important influence upon the quality of certain crops. For example, the results of experiments seem to indicate that the quality of tobacco, and certain other crops, is unfavorably influenced by the use of muriate of potash, while the same crops show a superior quality of materials free from chlorides have been used as the source of potash.

Valuation of Fertilizers.

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 the ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce. The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the trade-value of the above-named ingredients a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use.

For many years this Station has not printed an estimate of the commercial value of the different brands licensed in the State. If any one wishes to calculate the commercial value he can do so by using the trade values adopted for 1912 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, 1912, in ton lots at tide water in southern New England. On account of the greater distance from the large markets the prices for Maine at tide water would probably be somewhat higher than those quoted.

TRADE VALUES OF FERTILIZING INGREDIENTS FOR 1912.

		Cents per pound.
Nitrogen	in nitrates	16½
	in ammonia salts	16½
Organic nitrogen	in dry and fine ground fish and blood	22
	in cottonseed meal and castor pomace	20
	in fine bone and tankage and in mixed fertilizers	19
	in coarse bone and tankage	15
Phosphoric acid,	water-soluble	4½
	citrate-soluble	4
	in fine ground bone and tankage	4
	in cottonseed meal, castor pomace	4
	in coarse bone, tankage and ashes	3½
	in mixed fertilizers, if insoluble in ammonium citrate	2

Potash as high grade sulphate and in forms free from muriate (chloride)	5¼
as muriate	4¼
in cottonseed meal and castor pomace	5
as carbonate	8

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 0.8 by the percentage of available phosphoric acid.

Multiply 0.4 by the percentage of insoluble phosphoric acid.

Multiply 1.05 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,	0.8 × 8.00	6 40
Insoluble phosphoric acid,	0.4 × 1.00	40
Potash,	1.05 × 6.00	6 30
		$25 64

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.

Available Nitrogen.

The availability of mineral nitrogen is well known and also that of the best forms of organic nitrogen. With the great increase in demand and consequent increase in price, and in accord with the modern idea of conservation, it has been necessary to press into use all obtainable forms of organic nitrogen. Under existing conditions if no examination of the quality of the organic nitrogen were made there would be a chance that low grade materials might be rated as high grade with a consequent injustice to both the consumer and honest manufacturer. Nitrogen from such sources as garbage tankage, leather waste, hair, etc., is usually of low availability and only slowly taken up by the plant.

For several years chemists have recognized this condition and many attempts have been made to devise practical laboratory methods for determining the quality of the nitrogen in mixed goods. Some of these methods while fairly accurate are too time consuming to admit of their use in inspection work. The method which seems to promise to be quite satisfactory is the so-called alkalin permanganate method which was suggested from the use of this chemical to determine albuminoid nitrogen in water analyses. As far back as 1893-4 some work was done with permanganate of potash in this laboratory in an attempt to use it to determine whether leather waste was being used in some fertilizers. Later Mr. S. H. T. Hayes, a former assistant in this Station, worked out the method while a post-graduate student at Cornell University. Mr. Hayes' paper was published in Bulletin 47 of the Bureau of Chemistry, U. S. Department of Agriculture, in which is given both the alkaline and acid permanganate methods. Since that time a few experiment stations have continued investigations in this line.

At a meeting of the directors of the New England States, New York and New Jersey, held in Boston in March 1910, the whole question of the quality of the organic nitrogen in commercial fertilizers was thoroughly discussed and the urgent need of an adequate discriminatory method was generally recognized. A committee was appointed, consisting of the chemists of the Vermont, Connecticut (State) and Rhode Island Stations to further investigate the applicability of chemical methods to the determination of availability of organic nitrogen and report at a similar meeting in March 1911. As a result of this investigation the alkaline permanganate method, somewhat modified, was adopted to be used by the several states represented in determining the grade of organic nitrogen in fertilizers inspected.

The alkaline permanganate method adopted is open to some criticism. It is assumed in this method that all organic nitrogen soluble in water is available or active. This assumption is probably generally correct, but may not be always, as it has been found that some soluble forms of leather treated with alkali are not more available than the raw material. Again in the case of a high grade fertilizer such as is generally used in the potato growing region of this State, often not more than 0.3 per cent of water insoluble nitrogen is found to be present. In order to follow the method exactly it is sometimes necessary to take 16 or more grams of the material, an impracticable amount with which to work. In using such large amounts, more than 15 grams, so much organic matter other than the nitrogen is introduced that the permanganate is very quickly used up and too low results may be obtained. For this reason in this laboratory whenever the amount of insoluble nitrogen in the fertilizer was so small that more than 15 grams would need to be taken to follow the method, the determinations have not been made.

Not enough vegetation tests in comparison with the laboratory methods have been made to warrant drawing too close an application of the results to mixed goods. It is not claimed that it will show absolute agricultural value but vegetation tests carried on at the Rhode Island Experiment Station on materials subjected to both tests indicate a quite close agreement. It is, however, far better than no method and in a general way makes it possible to compare the availability of the nitrogen from different sources and in different brands of mixed fertilizers. Its adoption by the States named is a distinct progress in fertilizer control work. As time goes on the method will be checked up with more vegetative tests and it will doubtless be possible to more correctly apply the results obtained in the laboratory as a check upon the results that may be expected in the field.

Explanation of the Tables.

Under the head of "Nitrogen" in the tables are found eight columns of figures under the following headings:

1. *The nitrogen from nitrates.* In this column is given the percentage of nitrogen present as nitrate. See page 123. Nitrate nitrogen is wholly and quickly available.

2. *Nitrogen from ammonia salts.* In this column is given the nitrogen from ammonium salts, chiefly sulphate. See page 123. Ammonia nitrogen while not usually as quickly available to the growing plant as nitrate nitrogen is completely available.

3. *Water soluble organic nitrogen.* This is the nitrogen from organic materials, (See page 123) such as dried blood, dried fish or meat, tankage, cottonseed meal, etc. It dissolves in water and is supposed to be quickly and completely available to the plant.

4. *Active water insoluble organic nitrogen.* The nitrogen in this column is that portion of the organic nitrogen which is insoluble in water but is converted into ammonia by the action of the permanganate of potash solution. This is probably quite readily available to plants.

5. *Inactive organic nitrogen.* This is the portion of the organic nitrogen that is not converted into ammonia by the action of the permanganate solution. It is probably only slowly available to plants.

6. *Available or active nitrogen.* In this column is given the sum of the percentages found in the first four columns, viz: nitrate nitrogen, ammonia nitrogen, water soluble organic nitrogen and active water insoluble organic nitrogen.

7. *Total nitrogen found.*

8. *Total nitrogen guaranteed.*

Phosphoric Acid. Under the head of "phosphoric acid" are given the usual columns with the exception that inverted and insoluble phosphoric acids are this year omitted. If it is desired to know what the insoluble phosphoric acid is it may be found by subtracting the available from the total as given in the table. If it is desired to know what the reverted phosphoric acid is for a given sample this may be found by subtracting the soluble phosphoric acid from the available.

Potash. No change is made in the arrangement of the potash results.

The Meaning of the Results Found for Nitrogen.

In order to obtain an idea of the value of the organic nitrogen in any given brand from the figures given in the table, it is necessary to compare the columns of active insoluble and inactive insoluble nitrogen, and also take into consideration the amount of soluble organic nitrogen. That is, the organic nitrogen is valuable in proportion as the percentage of the active is greater than the inactive, and the amount of water soluble is large or small. A fertilizer showing more than twice as much active as inactive insoluble nitrogen would be rated as high grade. Also in one carrying a quite large percentage of water soluble and small amounts of active and inactive water insoluble the nitrogen would be likewise rated as high grade. One showing a small amount of water soluble and a larger amount of inactive than active would be classed as a poor grade of organic nitrogen. The percentage of inactive as compared with the total organic is the measure of the value of the organic nitrogen in the goods. With a fair amount of organic nitrogen soluble in water, a large per cent of active and a small amount of inactive, the organic nitrogen is considered good. If but a small amount is soluble in water and less active than inactive is found the organic nitrogen would be considered low grade.

The column headed "available nitrogen" is somewhat analogous to the available phosphoric acid column which has been used for years. It cannot, however, be ralied upon without reference to the other results reported in the table. While as a general rule the nearer the figures in the available column approach to the figures in the total nitrogen column the better the grade of nitrogen in the goods this must be construed in connection with the other preceding figures. The mineral nitrogen is all available and consequently must be taken into consideration in estimating the availability of the organic nitrogen. This may be illustrated as follows: If a fertilizer contains 3.50 per cent total nitrogen and the percentage in the available column is 3 per cent or more the nitrogen would be considered high grade, particularly if the nitrogen is largely organic, i. e., contains only a small per cent of mineral nitrogen. If, however, a fertilizer of the above nitrogen content carried over 2 per cent of its nitrogen as mineral, an availability of only 3 per cent would show the organic nitrogen to be of a poorer quality.

That is, such a fertilizer would carry only 1 per cent of organic nitrogen and half of that is inactive indicating low grade material.

RESULTS OF INSPECTION.

A few years ago practically all of the fertilizer used in this State was distributed from a few large warehouses located at tide water. It was then comparatively an easy matter to sample practically all of the different brands of fertilizers registered for sale in the State and obtain good representative samples from large lots by visiting these large warehouses. With the rapid increase in the use of commercial fertilizers there has come to the manufacturer a realization of the importance of the Maine trade. Within the last few years many new companies have come into the State and there is great competition among the agents of these companies. With this growth in competition there has been an increase in the practice of selling goods in small lots directly to the farmers. At present a large number of the brands offered for sale are not stored in the State for any length of time, but are shipped in car lots and used within a few days after their arrival. These conditions have increased the dicffiulty of obtaining samples of all the different brands for analysis. This explains why several blank spaces occur in the table. The table contains not only the results of analyses, but a complete list of the various brands registered for 1912.

The results obtained in determining the quality of the organic nitrogen this year, while they may only approximate the agricultural value, are valuable in bringing to light certain facts. Only relatively high grade nitrogenous materials can be used in the manufacture of high grade goods. In some instances manufacturers do not use the same grade of nitrogenous material in different lots of the same brand of fertilizer. As great differences were found between different lots of the same brand as between dieffrent brands.

It certainly does not seem to be unreasonable to insist that a high priced and high grade brand of fertilizer be as uniform in the forms of nitrogen that it carries as in its total nitrogen. For instance, it is believed to be necessary in this climate for best results that a potato fertilizer contain about one-third of its nitrogen as nitrate. If much more is present it is liable to loss from leaching. If much less is present the plant will not have enough immediately available nitrogen. Most of the manufacturers do not appear to attach sufficient importance to this feature. They frequently substitute ammonium sulphate or organic nitrogen for nitrate nitrogen, seeming to have only the total nitrogen in mind. The figures given in the tables appear to bear out this statement.

This is indicated by the following variations in different samples of high grade brands. In each instance the total nitrogen was up to the guarantee. The sources of nitrogen, as indicated by the variations in nitrate nitrogen, differed greatly in different lots of the same brand, as shown by the following examples:

Great Eastern High Grade Potato Manure, nitrate nitrogen varies from .51 per cent to 1.72 per cent.

Bowker's Potato and Vegetable Phosphate, nitrate nitrogen varies from none to .76 per cent.

Buffalo 4-6-10, nitrate nitrogen varies from 0.34 per cent to 1.30 per cent.

Bradley's Potato Fertilizer, nitrate nitrogen varies from 0.36 per cent to 1.13 per cent.

Crocker's Special Potato Manure, nitrate nitrogen varies from 0.51 per cent to 1.10 per cent.

The above brands represent some of the highest priced fertilizers sold in the State. It would seem that one should have the right to expect that they would be uniformly made and mixed. The variations in nitrate nitrogen content seem to indicate that too little importance is attached by the manufacturer to the forms of nitrogen in a definite brand.

The sources and kinds of plant food entering into a fertilizer are frequently as important to the planter as are the total amounts of nitrogen, phosphoric acid and potash. The chief reason for many planters using home-mixed goods is the knowledge they have of their composition. Now that the attention of the planter is being called to these variations in the makeup of fertilizers he may demand changes in the fertilizer law so that the kind and amount of constituents entering into the manufacture of a given brand of fertilizer must be stated as part of the brand. It is largely up to the manufacturer to determine by his practice whether such legislation will have to be sought.

If the manufacturer makes his brands so uniform that analyses of different lots of a given brand will agree as to the sources of nitrogen as they now do to the amount of nitrogen no further legislation would seem necessary.

The Weight of Fertilizers.

The law requires that packages of fertilizers carry, among other things, a plainly printed statement giving the net weight of the contents. Fertilizers contain materials which are subject to change in weight because of the difference of atmospheric conditions. In dry air they will dry out and lose in weight and in wet they will be likely to absorb moisture and gain in weight. Consequently it is not expected that fertilizers will weigh as close as would packages of grain to the weight claimed for them. During the spring the inspectors examined large numbers of packages from different manufacturers and with the exception of the Atlantic Fertilizer, which is discussed by itself, there were no shortages found that seemed to be unreasonable.

The Atlantic Fertilizer Company.

After the regular fertilizer inspection was finished a complaint was received from Limestone, Maine, that a lot of the Atlantic Fertilizer Company's Rawson & Hodges Peerless Brand Fertilizer was short weight and in very poor mechanical condition.

An inspector sent to investigate this complaint found that the goods in question were all in barrels which had been shipped as 250 pounds each. Over 200 weighings of unopened barrels and empties were obtained and the average net weight of the packages was found to be about 236 lbs., a shortage of between five and six per cent. Three samples of this brand were obtained from unopened packages and the results of analysis are here given.

Rawson & Hodges Peerless Brand Fertilizer.

Nitrogen guaranteed 3.70 per cent, found 3.4, 3.6, 3.6 per cent. Available phosphoric acid guaranteed 7 per cent, found 7.1, 7.9, 7.3 per cent. Total phosphoric acid guaranteed 8 per cent, found 8.1, 8.4, 8.0 per cent. Potash guaranteed 10 per cent, found 10.9, 9.0, 10.4 per cent. The moisture on these three samples was 10.6, 9.9, 10.9 per cent.

Descriptive List of Fertilizer Samples, 1912

Station number.	Manufacturer, Place of Business and Brand.
	AMERICAN AGRICULTURAL CHEMICAL CO. NEW YORK CITY.
1847	A A Potato Grower
1521	A. A. C. Co. Aroostook Complete Manure
1756	A. A. C. Co. Aroostook Complete Manure
1580	A. A. C. Co. Aroostook High Grade
1637	A. A. C. Co. Aroostook High Grade
1762	A. A. C. Co. Aroostook High Grade
1579	A. A. C. Co. Grass & Oats Fertilizer
1744	A. A. C. Co. Grass & Oats Fertilizer
1533	A. A. C. Co. Northern Maine Potato Special
1731	A. A. C. Co. Northern Maine Potato Special
1528	A. A. C. Co. Peerless Potato Manure
1674	A. A. C. Co. Peerless Potato Manure
1525	A. A. C. Co. Sweet Corn Special
1539	Bradley's Alkaline Bone with Potash
1643	Bradley's Alkaline Bone with Potash
1940	Bradley's Complete Manure for Corn & Grain
1546	Bradley's Complete Manure for Potatoes & Vegetables
1642	Bradley's Complete Manure for Potatoes & Vegetables
1750	Bradley's Complete Manure for Potatoes & Vegetables
1548	Bradley's Complete Manure with 10% Potash
1681	Bradley's Complete Manure with 10% Potash
1761	Bradley's Complete Manure with 10% Potash
1545	Bradley's Corn Phosphate
1641	Bradley's Corn Phosphate
1755	Bradley's Corn Phosphate
1570	Bradley's Eureka Fertilizer
1640	Bradley's Eureka Fertilizer
1759	Bradley's Eureka Fertilizer
1582	Bradley's Niagara Phosphate
1657	Bradley's Niagara Phosphate
1735	Bradley's Niagara Phosphate
1532	Bradley's Potato Fertilizer
1645	Bradley's Potato Fertilizer
1754	Bradley's Potato Fertilizer
1550	Bradley's Potato Manure
1644	Bradley's Potato Manure
1560	Bradley's X L Super-Phosphate of Lime
1639	Bradley's X L Super-Phosphate of Lime
1760	Bradley's X L Super-Phosphate of Lime
1575	Clarks Cove Bay State Fertilizer
1659	Clarks Cove Bay State Fertilizer
	Clarks Cove Bay State Fertilizer for Seeding Down
1648	Clarks Cove Bay State Fertilizer GG
1848	Clarks Cove Bay State Fertilizer GG
	Clarks Cove Defiance Complete Manure

Analysis of Fertilizer Samples, 1912

Station number.	Nitrogen. As nitrate.	Nitrogen. As ammonia.	Nitrogen. Organic. As water soluble.	Nitrogen. Organic. As active insoluble.	Nitrogen. Organic. As inactive insoluble.	Nitrogen. Available.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble in water.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
1847	0.62	1.22	0.37	0.89	0.56	3.10	3.66	3.70	5.42	8.26	7.0	10.05	8.0	10.62	10.0
1521	0.19	1.14	0.06	0.69	0.33	2.09	2.42	2.47	3.51	7.07	6.0	7.58	7.0	10.05	10.0
1756	0.57	0.10	.....	0.44	0.22	2.11	2.33	2.47	3.70	6.51	6.0	7.66	7.0	10.37	10.0
1580	1.98	0.14	0.58	0.75	0.67	3.45	4.12	4.11	4.31	8.46	7.0	9.95	8.0	6.62	7.0
1637	1.36	0.18	0.33	1.80	0.82	3.67	4.49	4.11	4.56	8.16	8.0	8.82	8.0	7.63	7.0
1762	0.64	1.54	0.21	1.18	0.58	3.57	4.15	4.11	5.34	8.44	7.0	9.97	8.0	7.50	7.0
1579	.....	.....	.....	.....	.....	.....	.....	.....	9.09	11.58	11.0	12.92	12.0	2.30	2.0
1744	.....	.....	.....	.....	.....	.....	.....	.....	7.10	11.31	11.0	11.88	12.0	2.19	2.0
1533	0.58	1.34	0.30	1.18	0.50	3.40	3.90	3.70	5.10	7.70	7.0	9.33	8.0	10.21	10.0
1731	0.54	1.38	0.03	1.22	0.53	3.17	3.70	3.70	4.86	7.34	7.0	8.93	8.0	10.90	10.0
1528	0.80	1.58	0.10	0.41	0.45	2.89	3.34	3.29	5.50	8.01	8.0	9.89	9.0	7.02	7.0
1674	0.64	1.58	0.34	0.51	0.27	3.07	3.34	3.29	6.62	8.62	8.0	10.21	9.0	7.17	7.0
1525	0.67	0.75	0.07	0.44	0.21	1.93	2.14	2.06	5.26	8.38	8.0	9.17	9.0	6.39	6.0
1539	.....	.....	.....	.....	.....	.....	.....	.....	8.85	11.33	11.0	12.44	12.0	2.14	2.0
1643	.....	.....	.....	.....	.....	.....	.....	.....	5.74	9.96	11.0	11.24	12.0	2.40	2.0
1940	1.44	0.10	0.67	0.95	0.50	3.16	3.66	3.29	4.71	8.97	8.0	10.05	9.0	7.30	7.0
1546	0.97	1.20	0.09	0.65	0.39	2.91	3.30	3.29	5.18	8.22	8.0	9.71	9.0	7.49	7.0
1642	1.70	0.14	.....	0.90	0.42	2.74	3.16	3.29	4.31	8.00	8.0	9.97	9.0	7.16	7.0
1750	0.86	1.30	0.10	0.63	0.39	2.89	3.28	3.29	5.10	8.60	8.0	10.00	9.0	7.49	7.0
1548	0.71	1.61	0.20	0.28	0.42	2.80	3.22	3.29	4.12	6.91	6.0	8.80	7.0	10.30	10.0
1681	1.41	0.98	0.20	0.58	0.28	3.17	3.45	3.29	3.75	6.14	6.0	7.42	7.0	10.65	10.0
1761	0.66	1.32	0.50	0.61	0.35	3.09	3.44	3.29	3.94	6.93	6.0	8.93	7.0	10.00	10.0
1545	0.48	0.77	0.09	0.53	0.25	1.87	2.12	2.06	4.91	8.25	8.0	9.73	9.0	1.66	1.5
1641	0.44	0.76	0.33	0.45	0.29	1.98	2.27	2.06	5.39	8.43	8.0	10.41	9.0	1.80	1.5
1755	0.43	0.71	0.28	0.48	0.26	1.90	2.16	2.06	5.14	8.46	8.0	10.37	9.0	1.68	1.5
1570	.....	0.60	.....	0.34	0.33	0.94	1.27	1.03	4.83	8.07	8.0	9.73	9.0	2.11	2.0
1640	.....	0.41	0.29	0.44	0.32	1.14	1.46	1.03	4.35	8.13	8.0	9.60	9.0	2.22	2.0
1759	0.07	0.27	0.17	0.39	0.27	0.90	1.17	1.03	4.90	8.24	8.0	9.73	9.0	2.29	2.0
1582	0.06	0.49	0.15	0.23	0.22	0.93	1.15	0.82	4.86	7.72	7.0	8.80	8.0	1.67	1.0
1657	.....	0.42	0.17	0.26	0.19	0.85	1.04	0.82	4.74	7.05	7.0	8.80	8.0	1.57	1.0
1735	0.42	0.12	0.05	0.29	0.18	0.88	1.06	0.82	4.31	7.05	7.0	8.77	8.0	1.89	1.0
1532	0.44	0.75	.....	0.60	0.29	1.79	2.08	2.06	4.47	8.31	8.0	9.97	9.0	3.17	3.0
1645	1.13	0.39	.....	0.31	0.23	1.83	2.06	2.06	4.86	7.61	8.0	9.20	9.0	3.98	3.0
1754	0.36	0.88	0.05	0.50	0.29	1.79	2.08	2.06	5.26	8.14	8.0	9.89	9.0	3.54	3.0
1550	0.59	1.08	0.07	0.28	0.39	2.01	2.41	2.47	4.02	8.80	6.0	10.32	7.0	4.95	5.0
1644	0.96	0.77	0.02	0.32	0.36	2.07	2.53	2.47	3.75	6.30	6.0	7.83	7.0	6.40	5.0
1560	0.83	0.28	0.42	0.89	0.42	2.42	2.84	2.47	6.14	9.92	9.0	11.58	10.0	2.00	2.0
1639	0.58	1.28	0.02	0.49	0.40	2.36	2.76	2.47	5.52	9.00	9.0	10.43	10.0	2.34	2.0
1760	0.73	0.29	0.26	0.90	0.38	2.18	2.56	2.47	6.03	9.29	9.0	11.24	10.0	2.16	2.0
1575	0.76	0.30	0.40	0.69	0,62	2.15	2.77	2.47	5.97	9.49	9.0	11.34	10.0	2.17	2.0
1659	0.81	0.23	0.70	0.40	0.35	2.14	2.49	2.47	7.02	10.38	9.0	13.40	10.0	2.29	2.0
.....	.....	.....	.....	.....	.....	.....	.....	1.03	.....	.....	8.0	.....	9.0	.....	2.0
1648	0.83	0.24	0.31	0.40	0.24	1.78	2.02	2.06	4.42	7.86	8.0	10.02	9.0	1.77	1.5
1848	0.08	0.80	0.20	0.60	0.40	1.68	2.08	2.06	5.31	8.31	8.0	10.73	9.0	2.31	1.5
.....	.....	.....	.....	.....	.....	.....	.....	0.82	.....	.....	7.0	.....	8.0	.....	1.0

Descriptive List of Fertilizer Samples, 1912

Station number.	MANUFACTURER, PLACE OF BUSINESS AND BRAND.
1543	Clarks Cove Great Planet Manure for Potatoes, Onions, Cabbage and Market Garden Truck A. A
1566	Clarks Cove King Philip Alkaline Guano for all Crops
1537	Clarks Cove Potato Fertilizer
1656	Clarks Cove Potato Fertilizer
1574	Clarks Cove Potato Manure
1896	Clarks Cove Potato Manure
1569	Cleveland Fertilizer for all Crops
1535	Cleveland High Grade Complete Manure
1526	Cleveland Potato Phosphate
1515	Cleveland Super-Phosphate
1529	Complete Manure with 10% Potash
1577	Crocker's Ammoniated Corn Phosphate
1673	Crocker's Ammoniated Corn Phosphate
1734	Crocker's Ammoniated Corn Phosphate
1573	Crocker's Aroostook Potato Special
1678	Crocker's Aroostook Potato Special
1578	Crocker's New Rival Ammoniated Super-Phosphate
1670	Crocker's New Rival Ammoniated Super-Phosphate
1758	Crocker's New Rival Ammoniated Super-Phosphate
1514	Crocker's Potato, Hop & Tobacco
1671	Crocker's Potato, Hop & Tobacco
1732	Crocker's Potato, Hop & Tobacco
1581	Crocker's Special Potato Manure
1685	Crocker's Special Potato Manure
1730	Crocker's Special Potato Manure
1542	Cumberland Potato Fertilizer
1651	Cumberland Potato Fertilizer
1540	Cumberland Super-Phosphate
1658	Cumberland Super-Phosphate
1828	Darling's Blood, Bone & Potash
	Fine Ground Bone
1855	Fisher Formula
	Grass & Lawn Top Dressing
1553	Great Eastern General Fertilizer
1677	Great Eastern General Fertilizer
1558	Great Eastern High Grade Potato Manure
1638	Great Eastern High Grade Potato Manure
1679	Great Eastern High Grade Potato Manure
1531	Great Eastern Northern Corn Special
1672	Great Eastern Northern Corn Special
1728	Great Eastern Northern Corn Special
1538	Great Eastern Potato Manure
1669	Great Eastern Potato Manure
1729	Great Eastern Potato Manure
1547	High Grade Fertilizer with 10% Potash
1662	High Grade Fertilizer with 10% Potash
1741	High Grade Fertilizer with 10% Potash

Analysis of Fertilizer Samples, 1912.

Station number.	Nitrogen. As nitrate.	As ammonia.	Organic. As water soluble.	Organic. As active insoluble.	Organic. As inactive insoluble.	Available.	Total. Found.	Total. Guaranteed.	Phosphoric Acid. Soluble in water.	Available. Found.	Available. Guaranteed.	Total. Found.	Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
1543	0.95	1.39	0.05	0.40	0.50	2.79	3.29	3.29	4.75	9.05	8.0	10.30	9.0	7.10	7.0
1566	.....	0.28	0.30	0.36	0.32	0.94	1.26	1.03	4.71	8.16	8.0	9.63	9.0	2.04	2.0
1537	0.45	0.80	.....	0.59	0.40	1.84	2.24	2.06	4.86	8.89	8.0	10.61	9.0	3.54	3.0
1656	0.85	0.28	0.37	0.28	0.22	1.78	2.00	2.06	5.34	8.05	8.0	10.32	9.0	3.09	3.0
1574	0.65	1.22	0.10	0.33	0.31	2.30	2.61	2.47	4.15	6.65	6.0	8.28	7.0	5.27	5.0
1896	0.42	1.10	0.41	0.37	0.21	2.30	2.51	2.47	4.15	6.01	6.0	7.86	7.0	4.88	5.0
1569	.....	0.29	0.27	0.34	0.31	0.90	1.21	1.03	4.64	8.28	8.0	9.65	9.0	2.19	2.0
1535	0.66	0.65	0.68	0.85	0.45	2.84	3.29	3.29	6.86	9.44	8.0	11.16	9.0	6.90	7.0
1526	0.87	0.36	0.14	0.58	0.25	1.95	2.20	2.06	6.30	10.10	8.0	11.01	9.0	3.44	3.0
1515	0.47	0.82	0.42	0.26	0.27	1.97	2.24	2.06	4.66	8.13	8.0	9.62	9.0	1.90	1.5
1529	0.74	1.46	0.14	0.36	0.44	2.70	3.16	3.29	3.51	6.44	6.0	7.97	7.0	9.89	10.0
1577	0.45	0.92	0.11	0.40	0.32	1.88	2.20	2.06	4.67	8.18	8.0	9.49	9.0	2.09	1.5
1673	0.30	0.60	0.41	0.46	0.29	1.77	2.06	2.06	7.38	7.87	8.0	10.29	9.0	1.85	1.5
1734	0.63	0.80	0.02	0.50	0.28	1.95	2.23	2.06	5.79	8.16	8.0	9.54	9.0	2.20	1.5
1573	1.02	0.25	0.24	0.45	0.38	1.96	2.34	2.06	4.47	8.12	8.0	9.65	9.0	6.32	6.0
1678	0.50	0.92	0.32	0.34	0.25	2.08	2.33	2.06	6.14	7.80	8.0	9.01	9.0	6.77	6.0
1578	.....	0.32	0.14	0.34	0.34	0.80	1.14	1.03	4.74	8.34	8.0	9.81	9.0	2.32	2.0
1670	0.03	0.73	0.12	0.25	0.18	1.13	1.31	1.03	5.10	8.07	8.0	9.09	9.0	2.80	2.0
1758	0.04	0.18	0.07	0.53	0.30	0.82	1.12	1.03	3.91	8.51	8.0	10.32	9.0	2.36	2.0
1514	0.41	0.77	0.09	0.61	0.29	1.88	2.17	2.06	4.58	8.20	8.0	10.18	9.0	3.06	3.0
1671	.....	1.00	0.43	0.52	0.33	1.95	2.28	2.06	6.16	8.16	8.0	10.97	9.0	3.15	3.0
1732	0.51	0.95	0.04	0.49	0.18	1.99	2.17	2.06	4.12	7.33	8.0	9.12	9.0	3.38	3.0
1581	1.10	1.30	0.26	0.32	0.30	2.98	3.28	3.29	2.95	6.22	6.0	7.88	7.0	10.08	10.0
1685	0.58	1.50	0.39	0.61	0.21	3.08	3.29	3.29	4.74	6.15	6.0	8.13	7.0	10.15	10.0
1730	0.51	1.55	0.26	0.53	0.23	2.85	3.08	3.29	4.85	7.38	6.0	9.20	7.0	9.94	10.0
1542	0.50	0.72	0.05	0.64	0.28	1.81	2.19	2.06	5.22	8.48	8.0	10.22	9.0	3.17	3.0
1651	0.81	0.27	0.47	0.27	0.20	1.82	2.02	2.06	5.50	8.15	8.0	10.29	9.0	3.08	3.0
1540	0.54	0.84	0.16	0.31	0.41	1.85	2.26	2.06	4.94	8.12	8.0	9.49	9.0	1.77	1.5
1658	0.93	0.24	0.13	0.36	0.28	1.66	1.94	2.06	4.58	8.66	8.0	10.80	9.0	2.09	1.5
1828	1.42	0.20	0.80	1.27	0.63	3.69	4.32	4.11	3.91	7.35	7.0	9.01	8.0	7.80	7.0
......	.....	.....	.....	.....	.....	.....	.....	2.47	.....	.....	.....	.....	22.9	.....	.....
1855	.....	.....	.....	.....	.....	8.14	8.14	8.20	2.87	3.53	3.0	3.59	3.0	13.92	11.0
......	.....	.....	.....	.....	.....	.....	.....	3.91	.....	.....	5.0	.....	6.0	.....	2.0
1553	0.17	0.35	0.04	0.12	0.20	0.68	0.88	0.82	6.49	9.22	8.0	10.24	9.0	3.66	4.0
1677	0.11	0.64	0.20	0.26	0.12	1.21	1.33	0.82	5.34	7.61	8.0	9.01	9.0	4.27	4.0
1558	1.03	1.41	0.11	0.35	0.30	2.90	3.20	3.29	3.52	6.43	6.0	8.31	7.0	10.23	10.0
1638	1.72	0.82	0.20	0.44	0.24	3.18	3.42	3.29	3.21	6.39	6.0	7.58	7.0	10.24	10.0
1679	0.51	1.46	0.51	0.59	0.33	3.07	3.40	3.29	5.26	6.99	6.0	8.20	7.0	10.29	10.0
1531	0.50	0.86	0.03	0.37	0.47	1.76	2.23	2.06	4.86	8.14	8.0	8.57	9.0	1.95	1.5
1672	0.40	0.48	0.36	0.55	0.26	1.79	2.05	2.06	4.63	7.67	8.0	10.13	9.0	2.06	1.5
1728	0.43	0.79	0.22	0.53	0.28	1.97	2.25	2.06	4.61	7.90	8.0	9.41	9.0	1.97	1.5
1538	0.48	0.80	0.09	0.61	0.24	1.98	2.22	2.06	4.48	8.42	8.0	10.21	9.0	3.19	3.0
1669	0.08	0.60	0.55	0.51	0.37	1.74	2.11	2.06	5.38	8.61	8.0	11.16	9.0	3.34	3.0
1729	0.43	0.92	0.05	0.52	0.22	1.92	2.14	2.06	3.67	7.32	8.0	9.17	9.0	3.27	3.0
1547	0.54	1.03	0.14	0.39	0.24	2.10	2.34	2.47	3.60	6.73	6.0	8.04	7.0	10.08	10.0
1662	0.52	0.70	0.62	0.28	0.24	2.12	2.26	2.47	4.82	6.52	6.0	9.01	7.0	10.49	10.0
1741	0.60	0.91	0.06	0.42	0.25	1.99	2.24	2.47	3.22	6.38	6.0	8.52	7.0	9.87	10.0

Descriptive List of Fertilizer Samples, 1912

Station number.	Manufacturer, Place of Business and Brand.
	High Grade Sulphate of Potash
1583	Lazaretto Aroostook Potato Guano
1565	Lazaretto Corn Guano
1536	Lazaretto High Grade Potato Guano
1585	Lazaretto Propeller Potato Guano
1708	Muriate of Potash
1748	Muriate of Potash
1745	Nitrate of Soda
1837	Otis Potato Fertilizer
1838	Otis Super-Phosphate
1588	Pacific Dissolved Bone & Potash
1572	Pacific Grass & Grain Fertilizer
1655	Pacific Grass & Grain Fertilizer
1544	Pacific High Grade General Fertilizer
1846	Pacific Nobsque Guano for all Crops
1527	Pacific Potato Special
1690	Pacific Potato Special
1571	Packers Union Animal Corn Fertilizer
1676	Packers Union Animal Corn Fertilizer
1564	Packers Union Gardeners Complete Manure
1757	Packers Union Gardeners Complete Manure
	Packers Union Maine Central Fertilizer
1568	Packers Union Potato Manure
1668	Packers Union Potato Manure
1584	Packers Union Universal Fertilizer
1675	Packers Union Universal Fertilizer
1763	Packers Union Universal Fertilizer
	Plain Superphosphate
1765	Plain Superphosphate
1839	Quinnipiac Climax Phosphate for all Crops
	Quinnipiac Corn Manure
	Quinnipiac Market Garden Manure
	Quinnipiac Potato Manure
	Quinnipiac Potato Phosphate
1518	Read's Farmer's Friend Super-Phosphate
1653	Read's Farmer's Friend Super-Phosphate
1737	Read's Farmer's Friend Super-Phosphate
1541	Read's High Grade Farmer's Friend Super-Phosphate
1680	Read's High Grade Farmer's Friend Super-Phosphate
1530	Read's Potato Manure
1650	Read's Potato Manure
1587	Read's Practical Potato Special
1661	Read's Practical Potato Special
1576	Read's Standard Super-Phosphate
1654	Read's Standard Super-Phosphate
1738	Read's Standard Super-Phosphate
1589	Read's Sure Catch Fertilizer
1652	Read's Sure Catch Fertilizer
1567	Read's Vegetable & Vine Fertilizer

Analysis of Fertilizer Samples, 1912.

Station number.	Nitrogen. As nitrate.	Nitrogen. As ammonia.	Nitrogen. Organic. As water soluble.	Nitrogen. Organic. As active insoluble.	Nitrogen. Organic. As inactive insoluble.	Nitrogen. Available.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble in water.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
......	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	48.0
1583	0.17	0.39	0.13	0.16	0.18	0.85	1.03	0.82	4.63	7.88	8.0	8.77	9.0	4.20	4.0
1565	.....	0.86	0.16	0.42	0.36	1.44	1.80	1.64	5.10	8.83	8.0	10.13	9.0	2.55	2.0
1536	0.81	1.44	0.36	0.25	0.38	2.86	3.25	3.29	3.43	7.02	6.0	8.61	7.0	10.27	10.0
1585	0.97	0.28	0.16	0.46	0.35	1.87	2.22	2.06	4.27	8.17	8.0	9.57	9.0	6.48	6.0
1708	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	52.48	49.0
1748	.....	.....	.....	.....	.....	.....			.....	.....	.....	.....	.....	49.96	49.0
1745	.....	.....	.....	.....	.....	.....	15.12	15.00	.....	.....	.....	.....	.....	.....	.....
1837	0.12	0.84	0.46	0.43	0.35	1.85	2.20	2.06	6.86	8.41	8.0	9.81	9.0	3.79	3.0
1838	0.10	0.86	0.60	0.57	0.37	2.13	2.50	2.06	6.06	8.89	8.0	10.61	9.0	2.14	1.5
1588	.....	.....	.....	.....	.....	.....	.....	.....	8.82	10.48	10.0	11.48	11.0	2.85	2.0
1572	0.05	0.51	0.13	0.22	0.25	0.91	1.16	0.82	4.71	8.01	7.0	9.38	8.0	1.61	1.0
1655	0.25	0.51	0.03	0.31	0.21	1.10	1.31	0.82	4.99	7.25	7.0	9.25	8.0	1.93	1.0
1544	0.79	1.53	0.18	0.36	0.50	2.86	3.36	3.29	6.38	8.51	8.0	9.95	9.0	7.05	7.0
1846	.....	0.24	0.28	0.48	0.34	1.00	1.34	1.03	4.39	7.86	8.0	9.65	9.0	2.52	2.0
1527	0.48	0.74	0.01	0.52	0.31	1.75	2.06	2.06	4.78	8.39	8.0	10.21	9.0	3.17	3.0
1690	0.54	0.94	0.01	0.34	0.23	1.83	2.06	2.06	6.00	8.14	8.0	9.65	9.0	3.58	3.0
1571	0.84	0.26	0.38	0.71	0.61	2.19	2.80	2.47	5.82	9.31	9.0	11.16	10.0	2.14	2.0
1676	0.08	1.42	0.32	0.40	0.25	2.22	2.47	2.47	6.14	9.62	9.0	12.04	10.0	2.58	2.0
1564	.....	1.41	0.30	0.71	0.44	2.42	2.86	2.47	3.67	6.15	6.0	7.34	7.0	10.07	10.0
1757	0.22	1.20	0.14	0.61	0.30	2.17	2.47	2.47	3.43	6.21	6.0	7.42	7.0	10.20	10.0
......	.....	.....	.....	.....	.....	.....	.....	3.29	.....	.....	6.0	.....	7.0	.....	10.0
1568	0.86	0.21	0.29	0.44	0.43	1.80	2.23	2.06	4.71	8.34	8.0	9.81	9.0	5.90	6.0
1668	0.40	1.00	0.08	0.36	0.26	1.84	2.10	2.06	5.58	8.13	8.0	9.09	9.0	7.18	6.0
1584	0.36	0.39	0.01	0.18	0.19	0.94	1.13	0.82	5.15	8.53	8.0	9.49	9.0	3.32	4.0
1675	0.05	0.64	0.33	0.23	0.12	1.27	1.39	0.82	5.34	8.11	8.0	9.17	9.0	4.65	4.0
1763	0.03	0.23	0.08	0.25	0.31	0.59	0.90	0.82	8.18	8.35	8.0	10.48	9.0	4.02	4.0
......	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.0	.....	13.0	.....	.....
1765	.....	.....	.....	.....	.....	.....	.....	.....	8.45	10.69	14.0	11.72	15.0	.....	.....
1839	.....	0.23	0.31	0.35	0.26	0.89	1.15	1.03	5.90	8.71	8.0	10.37	9.0	2.19	2.0
......	.....	.....	.....	.....	.....	.....	.....	2.06	.....	.....	8.0	.....	9.0	.....	1.5
......	.....	.....	.....	.....	.....	.....	.....	3.29	.....	.....	8.0	.....	9.0	.....	7.0
......	.....	.....	.....	.....	.....	.....	.....	2.47	.....	.....	6.0	.....	7.0	.....	5.0
......	.....	.....	.....	.....	.....	.....	.....	2.06	.....	.....	8.0	.....	9.0	.....	3.0
1518	0.42	0.81	0.15	0.46	0.34	1.84	2.18	2.06	4.94	8.51	8.0	10.32	9.0	3.17	3.0
1653	1.01	0.27	0.25	0.27	0.26	1.80	2.06	2.06	6.14	8.23	8.0	10.40	9.0	3.09	3.0
1737	0.52	0.94	0.08	0.44	0.28	1.98	2.26	2.06	3.43	7.22	8.0	9.01	9.0	3.46	3.0
1541	1.02	1.33	0.00	0.43	0.52	2.78	3.30	3.29	3.27	6.16	6.0	7.69	7.0	10.41	10.0
1680	1.04	0.99	0.43	0.37	0.19	2.83	3.02	3.29	4.15	6.26	6.0	8.45	7.0	10.34	10.0
1530	0.70	0.95	0.01	0.52	0.30	2.09	2.39	2.47	3.75	6.57	6.0	8.45	7.0	10.06	10.0
1650	0.75	0.77	0.30	0.28	0.22	2.12	2.34	2.47	3.64	6.80	6.0	8.85	7.0	10.23	10.0
1587	0.45	0.31	.....	0.21	0.21	0.97	1.18	0.82	2.87	4.77	4.0	5.66	5.0	8.15	8.0
1661	0.47	0.24	.....	0.26	0.19	0.97	1.16	0.82	4.12	5.02	4.0	6.20	5.0	7.40	8.0
1576	0.13	0.32	0.24	0.14	0.15	0.83	0.98	0.82	5.66	8.75	8.0	10.13	9.0	4.00	4.0
1654	0.10	0.16	0.46	0.21	0.23	0.93	1.16	0.82	5.26	8.23	8.0	10.97	9.0	4.72	4.0
1738	0.10	0.14	0.17	0.42	0.29	0.83	1.12	0.82	4.35	8.14	8.0	9.89	9.0	3.86	4.0
1589	.....	.....	.....	.....	.....	.....	.....	.....	8.53	11.06	10.0	12.14	11.0	2.93	2.0
1652	.....	.....	.....	.....	.....	.....	.....	.....	6.75	9.13	10.0	10.69	11.0	4.20	2.0
1567	0.70	0.17	0.40	0.48	0.31	1.75	2.06	2.06	4.69	8.47	8.0	10.00	9.0	5.82	6.0

Descriptive List of Fertilizer Samples, 1912

Station number.	MANUFACTURER, PLACE OF BUSINESS AND BRAND.
1736	Read's Vegetable & Vine Fertilizer
1688	Soluble Pacific Guano
1563	Standard A Brand
1646	Standard A Brand
1586	Standard Bone & Potash
1649	Standard Bone & Potash
1517	Standard Complete Manure
1686	Standard Complete Manure
1733	Standard Complete Manure
1516	Standard Fertilizer
1660	Standard Fertilizer
1693	Standard Guano for All Crops
1534	Standard Special for Potatoes
1647	Standard Special for Potatoes
	Tankage
1692	Williams & Clark Americus Ammoniated Bone Super-Phosphate
1687	Williams & Clark Americus Corn Phosphate
1689	Williams & Clark Americus High Grade Special for Potatoes & Vegetables
1667	Williams & Clark Americus Potato Manure
1691	Williams & Clark Royal Bone Phosphate for all Crops
	ARMOUR FERTILIZER WORKS, BALTIMORE, MD.
1814	All Soluble
1869	All Soluble
1791	Bone, Blood & Potash
1818	Bone, Blood & Potash
1820	Bone, Blood & Potash
1787	Complete Potato
1812	Complete Potato
1815	Corn Grower
1865	Corn Grower
1933	Double Value
1817	Fruit & Root Crop Special
1864	Fruit & Root Crop Special
1891	Fruit & Root Crop Special
1813	High Grade Potato
1921	High Grade Potato
1816	Wheat, Corn & Oat Special
	ATLANTIC FERTILIZER CO., BALTIMORE, MD.
	Rawson & Hodges Maine Potato Grower
*	Rawson & Hodges Peerless Brand
	Rawson & Hodges Potato Special
	Rawson & Hodges Rival Brand
	Rawson & Hodges "Success"
	BOWKER FERTILIZER CO., BOSTON, MASS.
	Bowker's Acid Phosphate
1753	Bowker's Blood, Bone & Potash
1830	Bowker's Complete Manure for Potatoes and Vegetables

* See discussion page 133.

Analysis of Fertilizer Samples, 1912.

Station number.	Nitrogen.								Phosphoric Acid.					Potash.	
			Organic.				Total.			Available.		Total.			
	As nitrate.	As ammonia.	As water soluble.	As active insoluble.	As inactive insoluble.	Available.	Found.	Guaranteed.	Soluble in water.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
1736	0.57	1.02	.....	0.47	0.29	2.06	2.35	2.06	6.78	8.51	8.0	9.89	9.0	6.56	6.0
1688	0.56	0.90	0.03	0.42	0.15	1.91	2.06	2.06	7.61	8.28	8.0	9.81	9.0	2.11	1.5
1563	.....	0.49	0.04	0.22	0.25	0.75	1.00	0.82	4.39	7.53	7.0	8.61	8.0	1.47	1.0
1646	0.09	0.44	0.13	0.26	0.21	0.92	1.13	0.82	4.63	7.09	7.0	8.85	8.0	1.42	1.0
1586	.....	.....	.....	.....	.....	.....	.....	.....	7.73	10.42	10.0	11.48	11.0	3.08	2.0
1649	.....	.....	.....	.....	.....	.....	.....	.....	7.30	9.90	10.0	11.37	11.0	2.52	2.0
1517	0.81	1.48	0.36	0.31	0.33	2.96	3.29	3.29	6.62	8.88	8.0	10.05	9.0	6.90	7.0
1686	0.64	1.58	0.36	0.48	0.24	3.06	3.30	3.29	6.06	7.98	8.0	9.73	9.0	7.30	7.0
1733	0.68	1.74	0.02	0.61	0.29	3.05	3.34	3.29	7.66	9.37	8.0	11.64	9.0	7.96	7.0
1516	0.42	0.73	0.11	0.57	0.36	1.74	2.10	2.06	4.55	8.15	9.0	9.46	9.0	1.83	1.5
1660	0.81	0.32	0.01	0.42	0.29	1.70	1.99	2.06	4.37	7.91	8.0	10.21	9.0	1.81	1.5
1693	.....	0.36	0.30	0.45	0.25	1.11	1.36	1.03	6.78	8.14	8.0	9.89	9.0	2.34	2.0
1534	0.61	0.67	0.13	0.45	0.35	1.86	2.21	2.06	5.90	9.12	8.0	10.93	9.0	3.37	3.0
1647	0.95	0.30	0.28	0.28	0.25	1.81	2.06	2.06	5.53	8.25	8.0	10.29	9.0	3.03	3.0
.....	.....	.....	.....	.....	.....	.....	.....	4.94	.....	.....	.....	.....	13.7	.....	.....
1692	0.46	1.18	0.06	0.50	0.28	2.20	2.48	2.47	6.28	9.02	9.0	10.53	10.0	2.39	2.0
1687	0.42	0.98	0.11	0.44	0.24	1.95	2.19	2.06	6.14	8.00	8.0	7.33	9.0	2.18	1.5
1689	1.90	0.15	.....	0.79	0.64	2.84	3.48	3.29	4.94	7.90	8.0	9.81	9.0	7.38	7.0
1667	0.46	0.90	.....	0.42	0.21	1.78	1.99	2.06	6.22	8.23	8.0	9.89	9.0	3.18	3.0
1691	0.11	0.28	0.28	0.47	0.26	1.14	1.40	1.03	4.78	7.57	8.0	9.31	9.0	2.33	2.0
1814	1.30	0.84	0.32	0.23	0.22	2.69	2.91	2.88	4.78	8.09	8.0	8.98	8.5	4.82	4.0
1869	1.39	0.26	0.46	0.72	0.49	2.83	3.32	2.88	7.34	8.31	8.0	9.33	8.5	4.92	4.0
1791	1.83	0.12	1.35	0.83	0.19	4.13	4.32	4.11	5.34	8.20	8.0	8.77	8.5	7.18	7.0
1818	1.57	0.80	0.51	0.78	0.51	3.66	4.17	4.11	6.03	8.42	8.0	9.25	8.5	7.70	7.0
1820	1.43	0.17	0.83	1.45	0.64	3.88	4.52	4.11	6.97	8.65	8.0	9.35	8.5	7.76	7.0
1787	1.15	0.15	0.88	0.85	0.47	3.03	3.50	3.29	2.97	6.25	6.0	6.70	6.5	10.02	10.0
1812	1.26	1.18	0.20	0.37	0.32	3.01	3.33	3.29	3.11	6.60	6.0	7.81	6.5	10.43	10.0
1815	0.58	0.22	0.44	0.38	0.35	1.62	1.97	1.65	4.27	8.08	8.0	9.33	8.5	2.71	2.0
1865	0.66	0.34	0.32	0.37	0.39	1.69	2.08	1.65	4.75	8.07	8.0	9.09	8.5	3.58	2.0
1933	0.94	1.26	1.16	0.78	.....	4.14	4.14	4.11	6.86	8.12	8.0	8.50	8.5	9.50	10.0
1817	0.85	0.09	0.26	0.51	0.35	1.71	2.06	1.65	6.38	8.73	8.0	10.13	8.5	5.20	5.0
1864	0.74	0.14	0.04	0.48	0.32	1.40	1.72	1.65	6.83	9.14	8.0	10.29	8.5	5.04	5.0
1891	0.34	0.12	0.43	0.46	0.31	1.35	1.66	1.65	5.74	8.66	8.0	9.81	8.5	5.06	5.0
1813	0.23	0.67	0.24	0.30	0.26	1.44	1.70	1.65	6.30	8.45	8.0	9.09	8.5	10.66	10.0
1921	0.48	0.34	0.22	0.41	0.47	1.45	1.92	1.65	6.38	8.71	8.0	9.79	8.5	10.42	10.0
1816	0.22	0.12	0.41	0.32	0.21	1.07	1.28	0.82	3.99	7.27	7.0	8.29	7.5	1.45	1.0
.....	.....	.....	.....	.....	.....	.....	.....	4.12	.....	.....	8.0	.....	9.0	.....	7.0
.....	.....	.....	.....	.....	.....	.....	.....	3.70	.....	.....	7.0	.....	8.0	.....	10.0
.....	.....	.....	.....	.....	.....	.....	.....	3.29	.....	.....	8.0	.....	9.0	.....	7.0
.....	.....	.....	.....	.....	.....	.....	.....	3.29	.....	.....	6.0	.....	7.0	.....	10.0
.....	.....	.....	.....	.....	.....	.....	.....	4.12	.....	.....	8.0	.....	9.0	.....	7.0
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14.0	.....	15.0	.....	.....
1753	0.98	0.56	0.49	1.44	0.72	3.47	4.19	4.11	4.58	8.44	7.0	10.16	8.0	6.37	7.0
1830	1.31	0.68	0.38	0.48	0.28	2.85	3.13	3.29	4.78	6.68	6.0	8.21	7.0	10.04	10.0

Descriptive List of Fertilizer Samples, 1912

Station number.	Manufacturer, Place of Business and Brand.
1555	Bowker's Corn Phosphate
1715	Bowker's Corn Phosphate
1591	Bowker's Early Potato Manure
1713	Bowker's Farm and Garden Phosphate
1742	Bowker's Farm and Garden Phosphate
1712	Bowker's Fresh Ground Bone
1716	Bowker's Hill & Drill Phosphate
1554	Bowker's Market Garden Fertilizer
1749	Bowker's Market Garden Fertilizer
	Bowker's Muriate of Potash
	Bowker's Nitrate of Soda
1862	Bowker's Potash Bone
1912	Bowker's Potash Bone
1561	Bowker's Potato & Vegetable Fertilizer
1722	Bowker's Potato & Vegetable Fertilizer
1562	Bowker's Potato & Vegetable Phosphate
1752	Bowker's Potato & Vegetable Phosphate
1557	Bowker's Square Brand Bone & Potash
1714	Bowker's Square Brand Bone & Potash
1747	Bowker's Square Brand Bone & Potash
1549	Bowker's Sure Crop Phosphate
1743	Bowker's Sure Crop Phosphate
	Bowker's Tankage
1892	Fisher Formula
1556	Stockbridge Manure "A" for Potatoes
1717	Stockbridge Manure "A" for Potatoes
1829	Stockbridge Manure "B" for Potatoes
1524	Stockbridge Special Complete Manure for Corn & All Grain Crops
1718	Stockbridge Special Complete Manure for Corn & All Grain Crops
1739	Stockbridge Special Complete Manure for Corn & All Grain Crops
1513	Stockbridge Special Complete Manure for Potatoes & Vegetables
1709	Stockbridge Special Complete Manure for Potatoes & Vegetables
1710	Stockbridge Special Complete Manure for Seeding Down, Permanent Dressing and Legumes
1740	Stockbridge Special Complete Manure for Seeding Down, Permanent Dressing and Legumes
1590	Stockbridge Special Complete Manure for Top Dressing and for Forcing
1711	Stockbridge Special Complete Manure for Top Dressing and for Forcing
1746	Stockbridge Special Complete Manure for Top Dressing and for Forcing
1751	Superphosphate with Potash
1886	Superphosphate with Potash
	BUFFALO FERTILIZER CO., HOULTON, ME.
1623	Buffalo Farmer's Choice
1631	Buffalo Five-Eight-Seven
1621	Buffalo Five-Eight-Nine
1622	Buffalo Four-Six-Ten
1860	Buffalo Four-Six-Ten
1866	Buffalo Four-Six-Ten

Analysis of Fertilizer Samples, 1912.

Station number.	Nitrogen. As nitrate.	Nitrogen. As ammonia.	Nitrogen. Organic. As water soluble.	Nitrogen. Organic. As active insoluble.	Nitrogen. Organic. As inactive insoluble.	Nitrogen. Available.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble in water.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
1555	.....	0.84	0.25	0.51	0.24	1.60	1.84	1.65	5.02	8.19	8.0	9.73	9.0	2.42	2.0
1715	0.08	0.68	0.32	0.40	0.28	1.48	1.76	1.65	6.83	9.15	8.0	12.15	9.0	1.98	2.0
1591	0.96	1.34	0.10	0.52	0.41	2.92	3.33	3.29	5.34	8.23	8.0	9.76	9.0	7.39	7.0
1713	0.11	0.74	0.25	0.38	0.26	1.48	1.74	1.65	6.70	9.23	8.0	12.23	9.0	2.39	2.0
1742	0.14	0.80	0.14	0.40	0.29	1.48	1.77	1.65	4.96	8.38	8.0	10.45	9.0	2.26	2.0
1712	0.06	0.20	0.90	1.33	0.42	2.38	2.80	2.47	.....	.....	.....	24.24	22.9	.....	.....
1716	0.72	0.28	0.66	0.44	0.30	2.10	2.40	2.47	7.10	10.60	9.0	13.56	10.0	2.29	2.0
1554	0.51	1.12	0.02	0.41	0.28	2.06	2.34	2.47	4.55	7.34	6.0	8.93	7.0	9.44	10.0
1749	0.24	1.16	0.44	0.57	0.11	2.41	2.52	2.47	4.35	6.62	6.0	7.77	7.0	10.08	10.0
......	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	49.0
......	.....	.....	.....	.....	.....	.....	.....	15.0	.....	.....	.....	.....	.....	.....	.....
1862	0.09	0.19	0.26	0.30	0.30	0.84	1.14	0.82	6.38	8.20	6.0	9.73	7.0	2.65	2.0
1912	0.03	0.20	0.29	0.40	0.22	0.92	1.14	0.82	4.86	6.39	6.0	7.73	7.0	2.26	2.0
1561	0.63	1.01	0.09	0.50	0.31	2.23	2.54	2.47	5.52	8.92	8.0	10.77	9.0	4.24	4.0
1722	0.56	0.92	0.40	0.43	0.24	2.31	2.55	2.47	5.71	8.33	8.0	10.69	9.0	4.00	4.0
1562	0.76	0.24	0.08	0.55	0.27	1.63	1.90	1.65	4.86	8.36	8.0	9.76	9.0	2.57	2.0
1752	.....	1.04	0.23	0.40	0.23	1.67	1.90	1.65	5.26	8.00	8.0	9.47	9.0	2.30	2.0
1557	0.50	0.42	0.12	0.64	0.24	1.68	1.92	1.65	3.80	7.11	6.0	8.93	7.0	2.34	2.0
1714	0.63	0.58	0.17	0.22	0.18	1.60	1.78	1.65	4.23	6.79	6.0	8.17	7.0	2.57	2.0
1747	0.10	0.95	0.43	0.31	0.19	1.79	1.98	1.65	4.42	6.96	6.0	8.53	7.0	2.01	2.0
1549	0.15	0.18	0.02	0.46	0.26	0.81	1.07	0.82	5.02	8.68	8.0	10.43	9.0	2.52	2.0
1743	0.10	0.68	.....	0.23	0.19	1.01	1.20	0.82	5.34	8.42	8.0	9.38	9.0	3.57	2.0
......	.....	.....	.....	.....	.....	.....	.....	4.94	.....	.....	.....	.....	13.7	.....	.....
1892	.....	.....	.....	.....	.....	8.44	8.44	8.23	2.87	3.65	3.0	3.91	3.0	13.22	11.0
1556	1.79	1.36	0.12	0.46	0.26	3.73	3.99	4.11	5.82	8.89	7.0	10.46	8.0	9.90	10.0
1717	1.92	0.91	0.39	0.37	0.27	3.59	3.86	4.11	5.34	7.95	7.0	10.69	8.0	10.97	10.0
1829	0.87	1.17	0.52	0.43	0.31	2.99	3.30	3.29	3.83	10.88	10.0	13.24	11.0	7.09	7.0
1524	1.09	1.12	0.11	0.54	0.29	2.88	3.17	3.29	4.86	10.24	10.0	12.79	11.0	7.00	7.0
1718	0.88	1.14	0.08	0.81	0.39	2.91	3.30	3.29	7.66	10.18	10.0	11.48	11.0	7.73	7.0
1739	0.58	1.82	0.24	0.38	0.27	3.02	3.29	3.29	7.59	10.32	10.0	11.06	11.0	7.28	7.0
1513	0.63	1.41	0.36	0.50	0.38	2.90	3.28	3.29	4.04	6.87	6.0	8.53	7.0	10.07	10.0
1709	0.85	1.19	0.05	0.81	0.30	2.90	3.20	3.29	4.10	6.58	6.0	7.73	7.0	10.02	10.0
1710	0.78	1.22	0.10	0.40	0.20	2.50	2.70	2.47	6.78	9.88	10.0	11.64	11.0	7.75	8.0
1740	0.62	1.03	0.24	0.40	0.22	2.29	2.51	2.47	9.01	10.31	10.0	11.42	11.0	7.49	8.0
1590	1.66	1.45	0.81	0.50	0.50	4.42	4.92	4.94	2.47	7.19	4.0	8.98	6.0	6.21	6.0
1711	1.87	0.87	0.42	1.16	0.52	4.32	4.84	4.94	2.34	5.61	4.0	7.59	6.0	5.92	6.0
1746	2.27	2.13	0.63	.....	.....	5.03	5.12	4.94	2.63	3.89	4.0	5.74	6.0	5.86	6.0
1751	.....	.....	.....	.....	.....	.....	.....	.....	7.78	10.34	10.0	11.77	11.0	2.83	2.0
1886	.....	.....	.....	.....	.....	.....	.....	.....	8.53	10.54	10.0	11.24	11.0	2.41	2.0
1623	0.59	0.12	0.05	0.38	0.31	1.15	1.46	0.82	5.93	8.86	8.0	9.54	9.0	5.77	5.0
1631	1.87	0.11	0.38	0.85	0.69	3.21	3.91	4.10	3.59	8.28	8.0	9.57	9.0	8.02	7.0
1621	1.67	0.18	0.63	1.17	0.48	3.65	4.13	4.10	3.64	8.04	8.0	9.15	9.0	9.65	9.0
1622	1.60	0.16	0.22	0.73	0.49	2.71	3.20	3.28	3.73	6.48	6.0	7.02	7.0	11.28	10.0
1860	1.30	0.18	0.42	0.76	0.64	2.66	3.30	3.28	4.47	6.96	6.0	7.66	7.0	10.33	10.0
1866	0.34	0.10	1.51	0.72	0.61	2.67	3.28	3.28	1.75	6.66	6.0	7.42	7.0	10.13	10.0

Descriptive List of Fertilizer Samples, 1912

Station number.	Manufacturer, Place of Business and Brand.
1629	Buffalo Four½-Eight-Nine
1627	Buffalo Grass Top Dresser
1870	Buffalo Grass Top Dresser
1630	Buffalo Nine-Three
1624	Buffalo Three-Six-Ten
1868	Buffalo Three-Six-Ten
1626	Buffalo Two-Eight-Ten
1628	Buffalo Two-Eight-Two
1867	Buffalo Two-Eight-Two
1877	Buffalo Two-Eight-Two
1625	Buffalo Two-Nine-Five
1871	Buffalo Two-Nine-Five
	CHESAPEAKE CHEMICAL CO., BALTIMORE, MD.
1840	C. C. Co.'s Celebrated Mixture
1900	C. C. Co.'s Excelsior Fertilizer for Corn & Grain
1902	C. C. Co.'s Grangers Special Fertilizer
1636	C. C. Co.'s Maine Special Fertilizer
1826	C. C. Co.'s Maine Special Fertilizer
1841	C. C. Co.'s National Crop Grower for Grain & Grass
1901	C. C. Co.'s Potato Producer Fertilizer
	C. C. Co.'s Rapid Trucker Fertilizer
1827	C. C. Co.'s Special Compound
	E. D. CHITTENDEN CO., BRIDGEPORT, CONN.
1843	Chittenden's High Grade Potato
	Chittenden's 10% Potato
	E. L. CLEVELAND CO., HOULTON, ME.
1824	Cleveland's Aroostook Special Formula B. Mixture
1825	Cleveland's Blood, Bone & Potash, Formula C. Mixture
1823	Cleveland's Special Improved Formula A. Mixture
	COE-MORTIMER CO., NEW YORK CITY, N. Y.
1506	E. Frank Coe's Blood, Bone & Potash
1766	E. Frank Coe's Blood, Bone & Potash
	E. Frank Coe's High Grade Potato Fertilizer
1503	E. Frank Coe's Celebrated Special Potato Fertilizer
1885	E. Frank Coe's Celebrated Special Potato Fertilizer
1501	E. Frank Coe's Columbian Corn Fertilizer
1773	E. Frank Coe's Columbian Corn Fertilizer
1778	E. Frank Coe's Columbian Corn Fertilizer
1511	E. Frank Coe's Columbian Potato Fertilizer
1918	E. Frank Coe's Columbian Potato Fertilizer
1507	E. Frank Coe's Complete Manure with 10% Potash
1768	E. Frank Coe's Complete Manure with 10% Potash
1505	E. Frank Coe's Double Strength Potato Manure
1772	E. Frank Coe's Double Strength Potato Manure
1780	E. Frank Coe's Double Strength Potato Manure

Analysis of Fertilizer Samples, 1912.

Station number.	Nitrogen.								Phosphoric Acid.					Potash.	
			Organic.				Total.			Available.		Total.			
	As nitrate.	As ammonia.	As water soluble.	As active insoluble.	As inactive insoluble.	Available.	Found.	Guaranteed.	Soluble in water.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
1629	1.75	0.24	0.35	0.70	0.50	3.04	3.54	3.69	4.29	8.46	8.0	9.22	9.0	8.49	9.0
1627	3.72	0.16	0.01	0.65	0.90	4.54	5.44	5.75	4.85	6.88	6.0	7.19	7.0	7.22	5.0
1870	1.97	0.13	2.15	0.52	0.51	4.77	5.28	5.75	4.94	6.43	6.0	6.94	7.0	7.28	5.0
1630	.....	.....	.....	.....	.....	.....	.....	.....	6.09	8.79	9.0	9.22	9.0	3.39	3.0
1624	1.03	0.15	0.11	0.67	0.59	1.99	2.55	2.47	4.67	7.34	6.0	8.21	7.0	10.28	10.0
1868	0.38	0.08	0.81	0.96	0.61	2.23	2.84	2.47	2.31	6.24	6.0	7.26	7.0	11.32	10.0
1626	0.72	0.16	0.11	0.39	0.29	1.38	1.67	1.64	7.00	8.47	8.0	8.98	9.0	10.02	10.0
1628	1.21	0.14	0.14	0.21	0.32	1.70	2.02	1.64	7.86	8.73	8.0	9.30	9.0	4.01	2.0
1867	0.22	0.14	0.74	0.53	0.47	1.67	2.10	1.64	2.34	8.02	8.0	9.17	9.0	3.57	2.0
1877	0.56	0.08	0.58	0.30	0.36	1.52	1.88	1.64	6.70	8.65	8.0	9.41	9.0	3.54	2.0
1625	1.24	0.14	0.02	0.28	0.23	1.68	1.91	1.64	1.32	9.61	9.0	10.02	10.0	6.06	5.0
1871	0.69	0.10	0.42	0.23	0.34	1.44	1.78	1.64	7.10	9.70	9.0	10.53	10.0	5.60	5.0
1840	.....	.....	.....	.....	.....	.....	.....	.....	4.47	11.77	10.0	12.92	11.0	2.79	2.0
1900	0.62	0.10	0.94	0.50	0.42	2.16	2.58	2.46	3.35	8.00	8.0	9.33	9.0	4.48	4.0
1902	0.62	0.98	0.11	0.34	0.30	2.05	2.35	2.46	4.15	7.25	6.0	8.53	7.0	10.60	10.0
1636	1.10	1.91	0.35	0.54	0.42	3.90	4.32	4.10	5.84	8.71	8.0	9.09	9.0	7.22	7.0
1826	1.10	2.20	.....	0.30	0.26	3.60	3.86	4.10	6.95	8.58	8.0	10.05	9.0	6.80	7.0
1841	0.52	0.96	0.14	0.50	0.48	2.12	2.60	1.64	2.31	8.95	8.0	9.97	9.0	2.86	2.0
1901	0.48	1.38	.....	0.33	0.38	2.76	3.14	3.28	4.31	7.80	6.0	9.01	7.0	8.91	10.0
.....	.....	.....	.....	.....	.....	.....	.....	3.28	.....	.....	8.0	.....	9.0	.....	7.0
1827	0.76	1.92	0.20	0.46	0.35	3.34	3.69	3.69	4.15	7.57	7.0	8.21	8.0	10.69	10.0
1843	0.59	2.20	0.75	0.32	0.22	3.86	4.08	4.10	8.05	8.64	8.0	9.09	10.0	7.14	7.0
.....	.....	.....	.....	.....	.....	.....	.....	3.30	.....	.....	6.0	.....	7.0	.....	10.0
1824	0.91	2.19	0.18	0.32	0.28	3.60	3.88	4.10	6.62	8.22	8.0	9.81	9.0	7.44	7.0
1825	0.67	1.45	0.37	0.57	0.44	3.06	3.50	3.28	2.36	6.66	6.0	7.42	7.0	10.10	10.0
1823	0.47	1.86	0.49	0.45	0.42	3.27	3.69	3.69	3.91	7.09	7.0	8.05	8.0	10.54	10.0
1506	1.41	1.59	0.08	0.64	0.51	3.72	4.23	4.11	3.64	8.20	8.0	8.96	9.0	7.24	7.0
1766	0.96	1.92	0.34	0.48	0.40	3.70	4.10	4.11	2.87	8.28	8.0	9.17	9.0	7.50	7.0
.....	.....	.....	.....	.....	.....	.....	.....	2.47	.....	.....	8.0	.....	9.0	.....	6.0
1503	0.21	0.83	0.30	0.20	0.28	1.54	1.82	1.65	4.43	8.17	8.0	10.21	9.0	4.20	4.0
1885	0.10	0.80	0.29	0.20	0.19	1.39	1.58	1.65	6.46	8.39	8.0	9.51	9.0	4.08	4.0
1501	0.14	0.66	0.15	0.15	0.22	1.10	1.32	1.23	5.31	8.86	8.5	10.77	9.5	2.85	2.5
1773	0.22	0.78	0.12	.....	.....	*1.12	1.33	1.23	4.86	8.45	8.5	9.93	9.5	2.60	2.5
1778	0.24	0.66	0.20	0.26	0.18	1.36	1.54	1.23	1.12	8.52	8.5	11.01	9.5	3.07	2.5
1511	0.26	0.71	0.18	0.14	0.22	1.29	1.51	1.23	5.10	9.23	8.5	11.02	9.5	3.22	2.5
1918	0.16	0.52	0.43	.....	.....	*1.01	1.31	1.23	4.86	8.74	8.5	10.53	9.5	2.41	2.5
1507	0.81	1.21	0.13	0.12	0.11	2.26	2.40	2.47	2.42	6.92	6.0	7.18	7.0	10.30	10.0
1768	0.75	1.35	0.22	0.17	0.16	2.49	2.65	2.47	1.99	6.97	6.0	7.42	7.0	9.98	10.0
1505	1.39	1.48	0.42	0.16	0.31	3.45	3.76	3.70	2.63	7.89	7.0	9.01	8.0	10.06	10.0
1772	0.96	1.64	0.39	0.39	0.26	3.38	3.64	3.70	2.47	7.00	7.0	8.21	8.0	10.65	10.0
1780	1.00	1.76	0.45	0.31	0.27	3.52	3.79	3.70	2.55	7.11	7.0	8.69	8.0	10.81	10.0

*Active insoluble not determined.

Descriptive List of Fertilizer Samples, 1912

Station number.	Manufacturer, Place of Business and Brand.
1504	E. Frank Coe's Excelsior Potato Fertilizer
1781	E. Frank Coe's Excelsior Potato Fertilizer
1502	E. Frank Coe's Famous Prize Brand Grain & Grass Fertilizer
1774	E. Frank Coe's Gold Brand Corn Manure
1917	E. Frank Coe's Gold Brand Corn Manure
1512	E. Frank Coe's Grass & Grain Special
1769	E. Frank Coe's Grass & Grain Special
1508	E. Frank Coe's High Grade Ammoniated Bone Superphosphate
1770	E. Frank Coe's High Grade Ammoniated Bone Superphosphate
1510	E. Frank Coe's Red Brand Excelsior Guano (for Market Gardening)
1775	E. Frank Coe's Red Brand Excelsior Guano (for Market Gardening)
1777	E. Frank Coe's Red Brand Excelsior Guano (for Market Gardening)
1509	E. Frank Coe's Standard Potato Fertilizer
1767	E. Frank Coe's Standard Potato Fertilizer
1779	E. Frank Coe's Standard Potato Fertilizer
1776	Thomas Phosphate Powder (Basic Slag Phosphate)
	DEEP COVE MFG. CO., EASTPORT, ME.
1924	Fish & Potash
1925	Fish & Potash
1926	Potato & Vegetable Phosphate
1927	Potato & Vegetable Phosphate
	ESSEX FERTILIZER CO., BOSTON, MASS.
	Essex A 1 Superphosphate
1878	Essex Complete Corn, Grain & Grass
1810	Essex Complete Manure for Potatoes, Roots & Vegetables
1880	Essex Complete Manure for Potatoes, Roots & Vegetables
1809	Essex Grain, Grass & Potato Fertilizer
	Essex High Grade Special, with 10% Potash
	Essex Market Garden & Potato Manure
	Essex Peerless Potato Manure
	Essex Potato Grower, with 10% Potash
	Essex Special Corn Fertilizer
	Essex Special Potato Phosphate, for Potatoes & Roots
1881	Essex XXX Fish and Potash, For All Crops
	E. W. FERNALD, PRESQUE ISLE, ME.
1632	Fernald's 5-8-7 High Grade
1633	Fernald's 4-6-10 Special
	GERMAN KALI WORKS, BALTIMORE, MD.
	Kainit
	Muriate of Potash
	Sulfate of Potash
	HUBBARD FERTILIZER CO., BALTIMORE, MD.
1842	Hubbard's Aroostook Special Fertilizer
1721	Hubbard's Blood, Bone & Potash
1785	Hubbard's Blood, Bone & Potash
	Hubbard's B. & P. 10 & 2
1720	Hubbard's Farmers' I. X. L. for Grain & Grass
1784	Hubbard's Farmers' I. X. L. for Grain & Grass

Analysis of Fertilizer Samples, 1912.

Station number.	Nitrogen. As nitrate.	Nitrogen. As ammonia.	Nitrogen. Organic. As water soluble.	Nitrogen. Organic. As active insoluble.	Nitrogen. Organic. As inactive insoluble.	Nitrogen. Available.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble in water.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
1504	0.96	1.23	0.16	0.09	0.11	2.44	2.57	2.47	3.43	7.43	7.0	7.94	8.0	8.12	8.0
1781	0.93	1.04	0.31	.....	.....	*2.28	2.56	2.47	3.51	7.50	7.0	9.22	8.0	8.03	8.0
1502	.....	.....	.....	.....	.....	.....	.....	.....	4.71	10.50	10.0	11.20	11.0	2.47	2.0
1774	1.08	1.14	0.19	.....	.....	*2.41	2.69	2.47	5.50	8.76	8.0	11.16	9.0	5.89	6.0
1917	0.92	1.08	0.14	.....	.....	*2.14	2.46	2.47	4.39	8.55	8.0	9.25	9.0	5.95	6.0
1512	0.20	0.62	0.10	0.15	0.04	0.07	1.11	0.80	5.10	8.82	8.5	10.70	9.5	1.67	1.5
1769	0.16	0.60	0.22	.....	.....	*0.98	1.19	0.80	4.82	9.36	8.5	10.53	9.5	1.64	1.5
1508	0.24	1.14	0.14	0.17	0.29	1.69	1.98	1.85	4.07	8.20	8.0	9.54	9.0	3.44	3.0
1770	0.19	1.11	0.26	0.22	0.19	1.78	1.97	1.85	4.02	8.35	8.0	9.49	9.0	3.78	3.0
1510	1.11	1.49	0.22	0.15	0.33	2.97	3.30	3.30	3.96	8.93	8.0	9.86	9.0	7.63	7.0
1775	1.05	1.57	0.20	0.22	0.20	3.04	3.24	3.30	3.62	8.10	8.0	9.89	9.0	6.93	7.0
1777	1.04	1.68	0.18	0.22	0.16	3.12	3.28	3.30	3.83	8.31	8.0	10.13	9.0	7.00	7.0
1509	1.40	1.68	0.14	0.16	0.34	3.38	3.72	3.30	1.60	7.36	7.0	8.42	7.0	11.01	10.0
767	1.03	1.53	0.34	0.35	0.23	3.25	3.48	3.30	1.80	6.50	6.0	7.81	7.0	9.79	10.0
1779	1.04	1.68	0.18	0.18	0.14	3.08	3.22	3.30	3.80	6.69	6.0	7.97	7.0	9.97	10.0
1776	.....	.....	.....	.....	.....	.....	.....	.....	.....	16.08	15.0	18.10	17.0	.....	.....
1924	1.56	0.08	0.25	0.94	0.61	2.83	3.44	3.29	4.07	6.57	6.0	7.26	7.0	10.52	10.0
1925	1.38	0.08	0.28	1.06	0.64	2.80	3.44	3.29	3.91	6.73	6.0	7.37	7.0	12.00	10.0
1926	0.72	0.12	0.41	0.45	0.30	1.70	2.00	1.65	7.54	9.50	8.0	10.05	9.0	3.50	2.0
1927	1.07	0.08	0.09	0.41	0.25	1.65	1.90	1.65	7.78	9.67	8.0	10.24	9.0	3.50	2.0
.....	.....	.....	.....	.....	.....	.....	.....	1.25	.....	.....	7.0	.....	8.0	.....	2.0
1878	0.18	0.12	1.10	1.40	0.88	2.80	3.68	3.28	6.30	7.41	6.0	8.37	7.0	10.81	10.0
1810	0.08	0.13	3.13	.....	.....	*3.34	3.60	3.28	5.06	6.61	6.0	7.89	7.0	10.62	10.0
1880	0.07	0.12	1.37	1.40	0.90	2.96	3.86	3.28	5.90	7.29	6.0	8.05	7.0	10.37	10.0
1809	0.07	0.07	0.90	0.33	0.19	1.37	1.56	0.82	6.78	9.40	8.0	10.61	9.0	4.18	4.0
.....	.....	.....	.....	.....	.....	.....	.....	3.69	.....	.....	7.0	.....	8.0	.....	10.0
.....	.....	.....	.....	.....	.....	.....	.....	2.00	.....	.....	8.0	.....	9.0	.....	5.0
.....	.....	.....	.....	.....	.....	.....	.....	4.10	.....	.....	7.0	.....	8.0	.....	8.0
.....	.....	.....	.....	.....	.....	.....	.....	2.46	.....	.....	6.0	.....	7.0	.....	10.0
.....	.....	.....	.....	.....	.....	.....	.....	2.00	.....	.....	8.0	.....	9.0	.....	3.0
.....	.....	.....	.....	.....	.....	.....	.....	2.46	.....	.....	8.0	.....	9.0	.....	6.0
1881	0.40	0.08	0.78	0.48	0.26	1.74	2.00	2.00	6.83	8.63	8.0	9.33	9.0	3.18	3.0
1632	1.13	1.81	0.16	0.57	0.52	3.67	4.19	4.10	7.42	8.34	8.0	9.00	9.0	7.08	7.0
1633	0.88	1.50	.....	0.58	0.43	2.96	3.39	3.28	2.78	7.01	6.0	7.34	7.0	10.30	10.0
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.0
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	50.0
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	48.0
1842	0.76	1.84	0.21	0.33	0.44	3.25	3.69	3.69	3.99	7.59	7.0	8.29	8.0	10.59	10.0
1721	0.80	1.56	0.07	0.37	0.40	2.80	3.20	3.28	4.55	8.45	8.0	10.77	9.0	6.95	7.0
1785	0.79	1.56	0.38	0.42	0.36	3.15	3.51	3.28	4.51	8.35	8.0	10.10	9.0	7.55	7.0
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10.0	.....	11.0	.....	2.0
1720	0.07	0.83	0.37	0.27	0.32	1.54	1.86	1.64	3.70	8.84	8.0	11.23	9.0	2.12	2.0
1784	0.08	0.86	0.36	0.30	0.25	1.60	1.85	1.64	3.13	8.43	8.0	10.69	9.0	2.65	2.0

* Active insoluble not determined.

Descriptive List of Fertilizer Samples, 1912

Station number.	Manufacturer, Place of Business and Brand.
1863	Hubbard's Maine Potato Grower Fertilizer
1913	Hubbard's Maine Potato Grower Fertilizer
1915	Hubbard's Royal Ensign for Corn & Grain
1783	Hubbard's Special Potato Fertilizer
	Hubbard's 10% Potash Guano for Potatoes
	LISTERS AGRICULTURAL CHEMICAL WORKS, NEWARK, N. J.
	Listers Bone Meal
1819	Lister's 5-7-7 Potato Fertilizer
1520	Lister's Grain & Grass Fertilizer
1664	Lister's Grain & Grass Fertilizer
1552	Lister's High Grade Special for Spring Crops
1683	Lister's High Grade Special for Spring Crops
1522	Lister's Potato Manure
1665	Lister's Potato Manure
1519	Lister's Special Corn Fertilizer
1682	Lister's Special Corn Fertilizer
1523	Lister's Special Potato Fertilizer
1684	Lister's Special Potato Fertilizer
1559	Lister's Success Fertilizer
1663	Lister's Success Fertilizer
1551	Lister's 10% Potato Grower
1666	Lister's 10% Potato Grower
	MERROW BROS. & CO., AUBURN, ME.
1782	Merrow's Bone Meal
	MORISON BROS., BANGOR, ME.
1599	Acid Phosphate
1596	Animal Tankage
	Basic Slag
1600	Morison Bros. "A" Brand Potato Fertilizer
1594	Morison Bros. "C" Brand for all Crops
1595	Morison Bros. 3-8-10 Fertilizer
1592	Morison Bros. "Xtra" High Grade Potato Fertilizer
1598	Muriate of Potash
1597	Nitrate of Soda
1593	Sulphate of Potash
	NATIONAL FERTILIZER CO., BOSTON, MASS.
1937	Chittenden's Ammoniated Bone Phosphate
1789	Chittenden's Aroostook Special
1790	Chittenden's Complete Root & Grain Fertilizer
1936	Chittenden's Eureka Potato Fertilizer
1788	Chittenden's Excelsior Potato Fertilizer
1908	Chittenden's Excelsior Potato Fertilizer
1914	Chittenden's Excelsior Potato Fertilizer
1939	Chittenden's Extra High Grade Manure
1938	Chittenden's Market Garden Special
	NEW ENGLAND FERTILIZER CO., BOSTON, MASS.
1612	New England Complete Manure
1909	New England Complete Manure
1916	New England Complete Manure

Analysis of Fertilizer Samples, 1912.

Station number.	Nitrogen. As nitrate.	Nitrogen. As ammonia.	Nitrogen. Organic. As water soluble.	Nitrogen. Organic. As inactive insoluble.	Nitrogen. Organic. As active insoluble.	Nitrogen. Available.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble in water.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
1863	0.40	2.32	0.34	0.56	0.42	3.62	4.04	4.10	5.90	8.63	8.0	9.20	9.0	7.16	7.0
1913	0.86	1.96	0.35	0.48	0.37	3.65	4.02	4.10	6.01	8.16	8.0	8.80	9.0	7.02	7.0
1915	0.06	1.50	0.56	0.46	0.27	2.58	2.85	2.46	5.50	8.69	8.0	9.97	9.0	5.94	4.0
1783	0.69	1.86	0.13	0.37	0.23	3.05	3.28	3.28	2.15	6.05	6.0	7.26	7.0	10.68	10.0
.....	.....	.....	.....	.....	.....	.....	.....	2.46	.....	.....	6.0	.....	7.0	.....	10.0
.....	.....	.....	.....	.....	.....	.....	.....	2.67	.....	.....	.....	.....	22.9	.....	.....
1819	1.60	0.62	0.99	0.57	0.30	3.78	4.08	4.11	5.26	7.60	7.0	8.88	8.0	7.21	7.0
1520	.....	.....	.....	.....	.....	.....	.....	.....	6.86	10.43	10.0	11.68	10.0	2.00	2.0
1664	.....	.....	.....	.....	.....	.....	.....	.....	8.29	10.02	10.0	11.40	10.0	2.29	2.0
1552	0.15	0.25	0.50	0.54	0.52	1.44	1.96	1.65	5.10	8.09	8.0	10.26	9.0	11.04	10.0
1683	0.05	0.24	0.78	0.54	0.49	1.61	2.10	1.65	7.43	8.13	8.0	10.53	9.0	10.33	10.0
1522	0.02	2.28	0.41	0.28	0.50	2.99	3.49	3.29	6.01	8.35	8.0	10.05	9.0	7.80	7.0
1665	.....	2.28	0.41	0.40	0.39	3.09	3.48	3.29	7.66	8.23	8.0	9.89	9.0	7.67	7.0
1519	0.06	0.22	0.53	0.33	0.33	1.14	1.47	1.23	6.38	8.10	8.0	9.89	9.0	3.62	3.0
1682	0.03	0.21	0.65	0.39	0.37	1.28	1.65	1.23	7.54	8.14	8.0	10.05	9.0	3.28	3.0
1523	0.15	0.32	0.52	0.48	0.37	1.57	1.94	1.65	5.10	8.33	8.0	10.69	9.0	3.53	3.0
1684	0.06	0.30	0.77	0.50	0.41	1.63	2.04	1.65	5.04	8.11	8.0	10.37	9.0	3.72	3.0
1559	0.19	0.18	0.52	0.20	0.46	1.09	1.55	1.23	7.02	9.03	9.0	10.59	10.0	2.36	2.0
1663	0.05	0.19	0.59	0.35	0.34	1.18	1.52	1.23	7.93	9.22	9.0	11.16	10.0	2.31	2.0
1551	0.06	1.92	0.76	0.52	0.46	3.26	3.72	3.29	4.19	6.44	6.0	8.61	7.0	11.27	10.0
1666	0.11	1.86	0.69	0.48	0.41	3.14	3.55	3.29	5.02	6.34	6.0	8.53	7.0	10.80	10.0
1782	.....	.....	0.88	0.52	0.40	1.40	1.80	1.25	.....	.....	.....	28.87	30.0	.....	.....
1599	.....	.....	.....	.....	.....	.....	.....	.....	14.36	17.10	16.0	17.23	.....	.....	.....
1596	.....	.....	1.67	1.66	2.05	3.33	5.38	5.76	.....	8.84	14.0	16.75	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14.8	.....	.....	.....	.....
1600	1.62	0.12	0.25	0.70	0.76	2.69	3.45	3.00	6.14	8.71	8.0	9.41	.....	11.36	10.0
1594	1.20	0.03	.....	0.38	0.59	1.61	2.20	2.20	8.93	11.66	10.0	12.36	.....	5.82	6.0
1595	1.05	0.12	.....	0.49	0.81	1.66	2.47	2.47	6.94	9.97	8.0	10.57	.....	9.44	10.0
1592	2.30	0.14	0.59	0.73	0.94	3.76	4.70	4.12	5.45	7.41	7.0	8.05	.....	9.92	10.0
1598	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	50.20	50.0
1597	.....	.....	.....	.....	.....	15.56	15.56	15.0	.....	.....	.....	.....	.....	.....	.....
1593	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	49.24	48.0
1937	0.06	0.72	0.48	0.43	0.27	1.69	1.96	1.65	6.86	8.94	8.0	11.56	9.0	2.53	2.0
1789	2.03	0.11	0.80	1.22	0.48	4.16	4.64	4.11	4.53	7.82	7.0	10.05	8.0	6.25	7.0
1790	1.64	0.11	0.41	0.76	0.37	2.92	3.29	3.29	6.11	8.95	8.0	10.77	9.0	5.88	6.0
1936	0.80	0.92	0.13	0.49	0.24	2.34	2.58	2.47	4.23	6.50	6.0	7.26	7.0	9.52	10.0
1788	1.22	0.78	0.65	0.45	0.23	3.10	3.33	3.29	4.66	6.96	6.0	8.55	7.0	9.73	10.0
1908	0.66	1.04	0.77	0.42	0.25	2.89	3.14	3.29	4.71	7.05	6.0	8.45	7.0	10.46	10.0
1914	0.88	1.36	0.10	0.57	0.38	2.91	3.29	3.29	3.94	6.69	6.0	7.58	7.0	10.01	10.0
1939	2.03	0.09	0.32	1.32	0.52	3.76	4.28	4.11	3.19	7.62	7.0	9.73	8.0	9.63	10.0
1938	0.74	0.76	0.47	0.35	0.26	2.32	2.58	2.47	4.78	7.56	6.0	10.05	7.0	5.08	5.0
1612	1.52	0.10	0.53	0.60	0.30	2.96	3.24	3.28	4.58	6.45	6.0	7.02	7.0	10.26	10.0
1909	0.10	0.14	1.10	1.32	0.88	2.66	3.54	3.28	4.99	6.90	6.0	7.86	7.0	10.88	10.0
1916	1.10	0.08	0.64	0.94	0.59	2.76	3.35	3.28	4.94	6.49	6.0	7.89	7.0	10.20	10.0

Descriptive List of Fertilizer Samples, 1912

Station number.	Manufacturer, Place of Business and Brand.
1849	New England Corn Phosphate
1614	New England Corn & Grain Fertilizer
1616	New England High Grade Potato Fertilizer
1910	New England High Grade Potato Fertilizer
1608	New England High Grade Special, with 10% Potash
1920	New England High Grade Special, with 10% Potash
1919	New England Market Garden Manure
1602	New England Potato Fertilizer
1607	New England Potato Grower
1725	New England Potato Grower
1811	New England Potato Grower
	New England Potato & Vegetable Manure
1610	New England Superphosphate, For All Crops
1724	New England Superphosphate, For All Crops
1808	New England Superphosphate, For All Crops
	NITRATE AGENCIES CO., NEW YORK CITY, N. Y.
1792	Acid Phosphate
1834	Acid Phosphate
1882	Basic Slag (Thomas Phosphate Powder)
1793	Muriate of Potash
1832	Muriate of Potash
1833	Muriate of Potash
1794	Nitrate of Soda
1831	Nitrate of Soda
1795	Sulphate of Potash
1884	Sulphate of Potash
1835	Tankage
1883	Tankage
	NOVA SCOTIA FERTILIZER CO., HALIFAX, N. S.
1931	High Grade Potato
	10% Potato
	PARMENTOR & POLSEY FERTILIZER CO., BOSTON, MASS.
1609	P. & P. "AA" Brand
1603	P. & P. Aroostook Special
1911	P. & P. Aroostook Special
	P. & P. Grain Grower
1618	P. & P. Maine Potato Fertilizer
1613	P. & P. Plymouth Rock Brand, For All Crops
	P. & P. Potato Fertilizer
	P. & P. Potato Grower, with 10% Potash
1606	P. & P. Special Potato Fertilizer
	P. & P. Star Brand Superphosphate
	E. W. PENLEY, AUBURN, ME.
1853	Penley's Auburn
1851	Penley's 4-6-10 Potato
1854	Penley's Seeding Down
1852	Penley's 3-6-10 Potato

Analysis of Fertilizer Samples, 1912.

Station number.	Nitrogen.								Phosphoric Acid.					Potash.	
	As nitrate.	As ammonia.	Organic.			Available.	Total.		Soluble in water.	Available.		Total.			
			As water soluble.	As active insoluble.	As inactive insoluble.		Found.	Guaranteed.		Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
1849	0.36	0.06	0.86	0.29	0.23	1.57	1.80	1.64	6.46	8.69	8.0	9.97	9.0	4.02	3.0
1614	0.08	0.10	0.60	0.36	0.21	1.14	1.35	1.23	5.26	7.42	7.0	8.21	8.0	2.18	2.0
1616	1.13	0.11	0.37	0.57	0.21	2.18	2.39	2.46	6.46	8.68	8.0	9.25	9.0	6.03	6.0
1910	1.04	0.04	0.50	0.55	0.33	2.13	2.46	2.46	6.17	8.10	8.0	8.37	9.0	5.64	6.0
1608	1.81	0.14	0.50	0.62	0.30	3.30	3.60	3.69	5.74	7.44	7.0	8.29	8.0	10.73	10.0
1920	0.08	0.14	0.96	1.79	0.93	2.97	3.90	3.69	5.07	7.39	7.0	8.58	8.0	10.76	10.0
1919	0.84	0.92	0.85	1.00	0.49	3.61	4.10	4.10	5.42	7.96	7.0	8.53	10.0	7.30	7.0
1602	0.05	0.43	0.73	0.30	0.36	1.51	1.87	1.64	4.47	7.78	7.0	8.42	8.0	4.27	4.0
1607	1.01	0.27	0.41	0.51	0.37	2.20	2.57	2.46	4.78	6.53	6.0	7.10	7.0	10.22	10.0
1725	0.12	0.06	2.14	0.39	0.26	2.71	2.97	2.46	2.65	6.35	6.0	7.50	7.0	10.01	10.0
1811	0.08	1.12	0.63	0.43	0.31	2.26	2.57	2.46	4.42	6.79	6.0	7.94	7.0	10.37	10.0
....	....	....	....	....	....	....	....	3.28	....	....	8.0	....	9.0	....	7.0
1610	0.74	0.14	0.78	0.42	0.20	2.20	2.40	2.46	6.70	8.35	8.0	9.01	9.0	4.40	4.0
1724	0.64	0.14	1.14	0.49	0.23	2.41	2.64	2.46	6.78	8.70	8.0	10.21	9.0	4.10	4.0
1808	0.73	0.10	1.07	0.46	0.24	2.36	2.60	2.46	6.94	8.55	8.0	9.38	9.0	4.02	4.0
1792	....	....	....	....	....	....	....	....	12.28	14.70	14.0	16.27	14.0	....	....
1834	....	....	....	....	....	....	....	....	14.83	15.43	14.0	16.83	14.0	....	....
1882	....	....	....	....	....	....	....	....	....	16.21	14.5	19.14	17.0	....	....
1793	....	....	....	....	....	....	....	....	....	....	....	....	....	47.56	50.0
1832	....	....	....	....	....	....	....	....	....	....	....	....	....	49.52	50.0
1833	....	....	....	....	....	....	....	....	....	....	....	....	....	50.80	50.0
1794	....	....	....	....	....	15.66	15.66	15.5	....	....	....	....	....	....	....
1831	....	....	....	....	....	15.76	15.76	15.5	....	....	....	....	....	....	....
1795	....	....	....	....	....	....	....	....	....	....	....	....	....	48.60	48.0
1884	....	....	....	....	....	....	....	....	....	....	....	....	....	51.92	48.0
1835	....	....	1.60	2.34	1.49	3.94	5.43	6.50	....	....	....	17.47	....	....	....
1883	....	....	4.06	1.63	0.81	5.69	6.50	6.50	....	5.69	5.0	8.37	15.0	....	....
1931	0.60	0.40	0.57	1.15	0.54	2.72	3.26	3.28	0.48	6.54	6.0	9.73	8.0	9.72	10.0
....	....	....	....	....	....	....	....	2.05	....	....	6.0	....	8.0	....	10.0
1609	1.54	0.13	1.34	0.82	0.11	3.83	3.94	4.10	5.74	8.32	7.0	9.17	8.0	8.36	8.0
1603	1.73	0.08	0.57	0.38	0.48	3.08	3.56	3.69	5.02	7.06	7.0	7.89	8.0	10.59	10.0
1911	0.08	0.12	1.51	1.27	0.75	2.98	3.73	3.69	5.98	8.38	7.0	9.57	8.0	10.27	10.0
....	....	....	....	....	....	....	....	1.23	....	....	7.0	....	8.0	....	2.0
1618	1.04	0.14	0.34	1.12	0.36	2.74	3.10	3.28	5.23	6.92	6.0	8.13	7.0	10.17	10.0
1613	0.92	0.04	0.85	0.46	0.25	2.27	2.52	2.46	6.99	8.97	8.0	9.73	9.0	4.78	4.0
....	....	....	....	....	....	....	....	1.64	....	....	6.0	....	7.0	....	6.0
....	....	....	....	....	....	....	....	2.46	....	....	6.0	....	7.0	....	10.0
1606	1.02	0.16	0.82	0.81	0.37	2.81	3.18	3.28	6.06	8.33	8.0	9.09	9.0	7.93	7.0
....	....	....	....	....	....	....	....	1.64	....	....	7.0	....	8.0	....	4.0
1853	0.94	0.06	0.17	1.01	0.66	2.18	2.84	2.47	6.06	9.56	8.0	10.96	9.0	5.11	4.0
1851	1.22	0.12	0.73	0.97	0.52	3.04	3.56	3.29	5.26	8.34	6.0	9.49	7.0	10.79	10.0
1854	0.36	0.08	0.26	0.46	0.42	1.16	1.58	1.03	7.02	9.78	8.0	10.16	9.0	2.62	2.0
1852	1.08	0.06	0.42	0.81	0.37	2.37	2.74	2.47	4.58	7.99	6.0	8.82	7.0	11.29	10.0

Descriptive List of Fertilizer Samples, 1912

Station number.	Manufacturer, Place of Business and Brand.
	PORTLAND RENDERING CO., PORTLAND, ME.
1801	Bone Dust Tankage
1836	Bone Dust Tankage
	READING BONE FERTILIZER CO., READING, PA.
	Aroostook A A A A
	Aroostook Prize Winner
1935	Reading's Potato Special
	P. H. REED, FT. FAIRFIELD, ME.
1932	Reed's Special Potato Grower
	ROGERS & HUBBARD CO., MIDDLETOWN, CONN.
1797	Hubbard's "Bone Base" Complete Phosphate
	Hubbard's "Bone Base" Fertilizer for Oats and Top-Dressing
1929	Hubbard's "Bone Base" Grass & Grain Fertilizer
1798	Hubbard's "Bone Base" New Market Garden Phosphate
1796	Hubbard's "Bone Base" Potato Phosphate
	Hubbard's "Bone Base" Soluble Corn and General Crops Manure
	Hubbard's "Bone Base" Soluble Potato Manure
1928	Hubbard's "Bone Base" Soluble Tobacco Manure
	Hubbard's Pure Raw Knuckle Bone Flour
	Hubbard's Strictly Pure Fine Bone
	ROYSTER GUANO CO., BALTIMORE, MD.
1948	Royster's 14% Acid Phosphate
	SAGADAHOC FERTILIZER CO., BOWDOINHAM, ME.
1699	Acid Phosphate
1707	Aroostook Potato Manure
1697	Dirigo Grass & Grain Fertilizer
1856	Fisher Formula for Fruit Trees
1698	Muriate of Potash
1702	Nitrate of Soda
1635	Sagadahoc 5-8-7 Fertilizer, for Potatoes
1701	Sagadahoc 5-8-7 Fertilizer, for Potatoes
1634	Sagadahoc 4-6-10 Fertilizer, for Potatoes
1706	Sagadahoc 4-6-10 Fertilizer, for Potatoes
1696	Sagadahoc High Grade Superphosphate
	Sagadahoc Honeysuckle Fertilizer
1700	Sagadahoc 6 6-6 Fertilizer, for Potatoes
1695	Sagadahoc Special Corn Fertilizer
1694	Sagadahoc Special Potato Fertilizer
1705	Sagadahoc 3-6-10 Fertilizer, for Potatoes
1703	Sagadahoc Yankee Fertilizer, for All Crops
1704	XX Chemical Brand, for top dressing and grain
	PROF. J. W. SANBORN, PITTSFIELD, N. H.
	Prof. Sanborn's Fertilizer for Grass and Grain
	Prof. Sanborn's Fertilizer for Hill and Drill Use
1850	Prof. Sanborn's Fertilizer for Potatoes and for Corn

Analysis of Fertilizer Samples, 1912.

Station number.	Nitrogen. As nitrate.	As ammonia.	Organic. As water soluble.	Organic. As active insoluble.	Organic. As inactive insoluble.	Available.	Total. Found.	Total. Guaranteed.	Phosphoric Acid. Soluble in water.	Available. Found.	Available. Guaranteed.	Total. Found.	Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
1801	.....	.....	1.34	2.40	1.43	3.74	5.17	5.75	.....	.....	.....	15.31	14.5	.....	.....
1836	.....	.....	2.87	2.54	1.89	5.41	7.30	5.75	.....	.....	.....	14.20	14.5	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	4.10	.....	.....	8.0	.....	.....	.....	7.0
.....	.....	.....	.....	.....	.....	.....	.....	3.28	.....	.....	6.0	.....	.....	.....	10.0
1935	0.02	3.16	0.09	0.40	0.45	3.67	4.12	4.10	4.78	7.61	7.0	8.69	8.0	9.54	10.0
1932	1.02	1.46	.....	0.55	1.13	3.03	4.16	4.10	5.76	8.18	8.0	8.69	9.0	6.93	7.0
1797	0.23	0.17	0.56	0.78	0.38	1.74	2.12	1.50	5.18	7.55	7.0	8.85	8.0	6.13	5.0
.....	.....	.....	.....	.....	.....	.....	.....	8.50	.....	.....	4.5	.....	8.0	.....	8.0
1929	0.34	0.26	0.91	1.07	0.62	2.58	3.20	2.20	0.40	10.12	6.5	17.00	16.0	11.83	12.0
1798	0.80	0.12	0.16	0.73	0.36	1.81	2.17	2.00	4.08	6.89	6.0	8.29	7.0	11.30	10.0
1796	0.56	0.05	.....	0.66	0.97	1.27	2.24	2.00	6.64	9.69	9.0	11.09	10.0	5.99	5.0
.....	.....	.....	.....	.....	.....	.....	.....	2.50	.....	.....	6.0	.....	8.0	.....	8.0
.....	.....	.....	.....	.....	.....	.....	.....	5.00	.....	.....	7.0	.....	10.0	.....	5.0
1928	2.22	0.16	0.59	1.56	0.81	4.53	5.34	5.00	1.07	8.37	7.0	11.44	10.0	10.95	10.0
.....	.....	.....	.....	.....	.....	.....	.....	3.82	.....	.....	.....	.....	24.7	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	2.85	.....	.....	.....	.....	22.0	.....	.....
1948	.....	.....	.....	.....	.....	.....	.....	.....	9.79	18.00	14.0	18.66	14.5	.....	.....
1699	.....	.....	.....	.....	.....	.....	.....	.....	13.24	15.97	16.0	16.75	17.0	.....	.....
1707	0.50	0.37	0.13	0.20	0.34	1.20	1.54	1.05	6.78	7.73	6.0	8.02	7.0	5.26	4.0
1697	.....	0.16	0.22	0.90	0.48	1.28	1.76	1.00	5.18	8.97	5.0	10.88	7.0	4.76	2.0
1856	.....	.....	.....	.....	.....	8.68	8.68	6.80	3.91	4.01	3.0	4.07	3.5	11.32	11.0
1398	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	48.70	50.0
1702	.....	.....	.....	.....	.....	15.32	15.32	15.0	.....	.....	.....	.....	.....	.....	.....
1635	2.86	1.06	0.11	0.15	0.24	4.18	4.42	4.12	7.00	8.85	8.0	8.85	9.0	7.49	7.0
1701	1.71	0.40	0.31	0.76	0.59	3.18	3.77	4.12	6.62	8.55	8.0	8.93	9.0	9.52	7.0
1634	1.82	0.66	0.35	0.20	0.30	3.03	3.33	3.29	5.95	8.07	6.0	8.15	7.0	10.77	10.0
1706	1.59	0.33	0.21	0.80	0.61	2.93	3.54	3.29	6.62	7.89	6.0	8.21	7.0	9.84	10.0
1696	0.70	0.41	0.15	0.28	0.36	1.54	1.90	1.50	8.34	9.30	6.0	9.57	7.0	5.19	3.0
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.0	.....	8.0	.....	5.0
1700	3.24	0.26	0.31	1.00	0.58	4.81	5.39	4.94	6.91	7.89	6.0	7.89	7.0	6.45	6.0
1695	0.85	0.56	0.14	0.36	0.29	1.91	2.20	2.20	7.02	10.88	8.0	12.04	9.0	5.36	4.0
1694	1.00	0.30	0.11	0.41	0.40	1.82	2.22	2.00	7.89	9.47	7.0	9.89	8.0	8.69	8.0
1705	1.26	0.42	0.23	0.40	0.47	2.31	2.78	2.47	6.60	7.98	6.0	8.45	7.0	10.44	10.0
1703	0.09	0.11	0.42	.....	.....	*0.62	0.84	0.40	6.89	9.86	6.0	10.37	7.0	4.81	2.0
1704	4.90	0.08	2.47	.....	.....	7.45	7.74	6.00	0.46	9.15	3.0	11.61	6.0	10.02	8.0
.....	.....	.....	.....	.....	.....	.....	.....	4.85	.....	.....	4.5	.....	6.0	.....	5.8
.....	.....	.....	.....	.....	.....	.....	.....	2.30	.....	.....	6.0	.....	12.0	.....	3.8
1850	1.09	0.08	1.08	1.25	0.62	3.50	4.12	3.30	6.86	9.89	7.0	11.40	9.5	8.49	7.5

*Active insoluble not determined.

Descriptive List of Fertilizer Samples, 1912

Station number.	Manufacturer, Place of Business and Brand.
	STANDARD GUANO CO., BALTIMORE, MD.
1845	Standard Blue Ribbon Potato Manure
1764	Standard Eclipse Potato Manure
1861	Standard Eclipse Potato Manure
1889	Standard Grant Potato Grower
	Standard Grain & Grass Fertilizer
1844	Standard Maine Potato Guano
	SWIFT'S LOWELL FERTILIZER CO., BOSTON, MASS.
1872	Acid Phosphate
1905	Acid Phosphate
1895	Fisher Formula
1876	High Grade Sulphate of Potash
1875	Kainit
1874	Muriate of Potash
1873	Nitrate of Soda
1906	Nitrate of Soda
1604	Swift's Lowell Animal Brand, for All Crops
1726	Swift's Lowell Animal Brand, for All Crops
1894	Swift's Lowell Apple Tree Special
1903	Swift's Lowell Apple Tree Special
1617	Swift's Lowell Bone Fertilizer, for Corn & Grain
1723	Swift's Lowell Bone Fertilizer, for Corn & Grain
1807	Swift's Lowell Cereal Fertilizer
	Swift's Lowell Corn & Vegetable
1605	Swift's Lowell Dissolved Bone & Potash
	Swift's Lowell Empress Brand, for Corn, Potatoes & Grain
1904	Swift's Lowell Ground Bone
1907	Swift's Lowell Ground Tankage
	Swift's Lowell Perfect Potato Brand
1601	Swift's Lowell Potato Grower with 10% Potash
1727	Swift's Lowell Potato Grower with 10% Potash
1805	Swift's Lowell Potato Grower with 10% Potash
1615	Swift's Lowell Potato Manure
1806	Swift's Lowell Potato Manure
1620	Swift's Lowell Potato Phosphate
1804	Swift's Lowell Potato Phosphate
1611	Swift's Lowell Special Potato Fertilizer with 10% Potash
1802	Swift's Lowell Special Potato Fertilizer with 10% Potash
1888	Swift's Lowell Special Potato Fertilizer
1619	Swift's Lowell Superior Fertilizer with 10% Potash
1803	Swift's Lowell Superior Fertilizer with 10% Potash
	TUSCARORA FERTILIZER CO., BALTIMORE, MD.
1859	Aroostook Special
1898	Aroostook Special
1922	Aroostook Special
1857	Complete Potato
1899	Complete Potato

Analysis of Fertilizer Samples, 1912.

Station number.	Nitrogen. As nitrate.	Nitrogen. As ammonia.	Nitrogen. Organic. As water soluble.	Nitrogen. Organic. As active insoluble.	Nitrogen. Organic. As inactive insoluble.	Nitrogen. Available.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble in water.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
1845	2.11	0.28	0.65	0.71	0.49	3.75	4.24	4.12	8.05	8.90	8.0	9.73	8.5	7.30	7.0
1764	0.12	1.78	0.56	0.65	0.25	3.11	3.36	3.30	4.94	6.23	6.0	6.83	6.3	9.21	10.0
1861	0.10	2.35	0.35	0.29	0.21	3.09	3.30	3.30	5.26	6.76	6.0	7.10	6.3	9.38	10.0
1889	0.41	2.33	0.14	0.20	0.20	3.08	3.28	3.25	6.83	8.40	8.0	8.53	8.5	6.99	7.0
.....	.....	.....	.....	.....	.....	.....	.....	1.64	.....	.....	8.0	.....	8.5	.....	3.0
1844	0.96	0.98	0.51	0.77	0.46	3.22	3.68	3.70	6.38	8.08	7.0	8.53	7.4	10.09	10.0
1872	.....	.....	.....	.....	.....	.....	.....	.....	9.94	12.14	12.0	13.67	13.0	.....	.....
1905	.....	.....	.....	.....	.....	.....	.....	.....	13.00	15.35	12.0	16.75	13.0	.....	.....
1895	.....	.....	.....	.....	.....	7.60	7.60	8.00	3.51	4.39	2.6	4.71	.....	11.21	11.0
1876	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	49.68	48.0
1875	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13.95	12.0
1874	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	48.44	50.0
1873	.....	.....	.....	.....	.....	15.40	15.40	15.00	.....	.....	.....	.....	.....	.....	.....
1906	.....	.....	.....	.....	.....	15.48	15.48	15.00	.....	.....	.....	.....	.....	.....	.....
1604	1.11	0.07	0.57	0.32	0.38	2.07	2.45	2.46	6.22	8.17	8.0	9.25	9.0	4.33	4.0
1726	0.70	0.14	1.01	0.43	0.26	2.28	2.54	2.46	7.86	8.42	8.0	9.25	9.0	4.14	4.0
1894	0.10	0.20	0.75	0.81	1.24	1.86	3.01	3.00	3.91	7.53	6.0	8.61	7.0	8.43	8.0
1903	0.10	0.18	1.36	0.64	0.76	2.28	3.04	3.00	4.39	7.55	6.0	8.85	7.0	8.22	8.0
1617	0.65	0.07	0.44	0.50	0.18	1.66	1.84	1.64	6.46	8.48	8.0	9.60	9.0	3.33	3.0
1723	0.42	0.10	0.76	0.30	0.22	1.58	1.80	1.64	7.15	9.15	8.0	10.69	9.0	3.12	3.0
1807	.....	0.19	0.56	0.38	0.24	1.13	1.37	0.82	5.38	7.61	7.0	8.53	8.0	1.43	1.0
.....	.....	.....	.....	.....	.....	.....	.....	3.28	.....	.....	8.0	.....	9.0	.....	7.0
1605	0.45	0.10	0.70	0.26	0.23	1.51	1.74	1.64	7.50	10.06	9.0	11.72	10.0	2.64	2.0
.....	.....	.....	.....	.....	.....	.....	.....	1.24	.....	.....	7.0	.....	8.0	.....	2.0
1904	0.16	0.02	0.80	1.29	0.45	2.27	2.72	2.46	.....	.....	.....	27.59	23.0	.....	.....
1907	.....	.....	3.00	1.50	1.10	4.50	5.60	4.92	.....	.....	.....	15.79	14.0	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	4.10	.....	.....	7.0	.....	8.0	.....	8.0
1601	1.39	0.16	0.42	0.60	0.37	3.01	3.28	3.28	4.23	6.24	6.0	6.94	7.0	10.36	10.0
1727	0.51	0.64	0.91	0.83	0.37	2.89	3.26	3.28	4.86	6.66	6.0	7.42	7.0	10.07	10.0
1805	1.05	0.20	0.96	0.60	0.32	2.81	3.13	3.28	4.63	6.38	6.0	7.34	7.0	10.43	10.0
1615	0.10	0.40	0.39	0.54	0.27	1.43	1.70	1.64	4.78	7.76	7.0	8.69	8.0	4.58	4.0
1806	0.10	0.34	0.84	0.44	0.28	1.72	2.00	1.64	4.94	7.70	7.0	8.72	8.0	4.27	4.0
1620	1.12	0.10	0.40	0.61	0.24	2.23	2.47	2.46	6.78	8.27	8.0	9.01	9.0	6.60	6.0
1804	1.02	0.20	0.69	0.66	0.29	2.57	2.86	2.46	6.86	8.49	8.0	9.28	9.0	6.29	6.0
1611	0.78	0.44	0.32	0.56	0.30	2.10	2.40	2.46	4.71	6.61	6.0	7.18	7.0	10.27	10.0
1802	0.90	0.12	0.92	0.53	0.25	2.47	2.72	2.46	4.51	6.72	6.0	7.42	7.0	9.77	10.0
1888	0.08	1.08	0.70	0.44	0.26	2.30	2.56	2.46	5.38	6.56	6.0	7.26	7.0	10.14	10.0
1619	1.88	0.12	0.66	0.71	0.23	3.37	3.60	3.69	7.42	7.67	7.0	8.37	8.0	10.63	10.0
1803	1.23	0.11	1.16	0.70	0.31	3.20	3.51	3.69	5.74	7.28	7.0	7.66	8.0	10.48	10.0
1859	0.80	0.82	0.22	0.48	0.46	2.32	2.78	2.47	6.78	7.47	7.0	8.68	7.5	9.35	8.0
1898	0.43	0.70	0.45	0.51	0.45	2.09	2.54	2.47	5.98	7.55	7.0	8.53	7.5	8.20	8.0
1922	0.74	0.72	0.18	0.53	0.43	2.17	2.60	2.47	5.85	7.68	7.0	8.64	7.5	10.18	8.0
1857	0.67	0.86	0.73	0.61	0.42	2.87	3.29	3.29	3.27	6.27	6.0	7.10	6.5	11.09	10.0
1899	0.58	0.18	0.76	1.33	0.65	2.85	3.50	3.29	2.28	5.90	6.0	7.69	6.5	9.80	10.0

Descriptive List of Fertilizer Samples, 1912

Station number.	Manufacturer, Place of Business and Brand.
1897	Fruit and Potato
1821	Trucker
1858	Trucker
	UNION CHEMICAL WORKS, NORTH WALES, PA.
1800	Johnson Seed Potato Co.'s Ideal Potato Manure (Hoeing Brand)
1799	Johnson Seed Potato Co.'s Ideal Potato Manure (Planting Brand)
	UNITED STATES FERTILIZER CO., BALTIMORE, MD.
1946	"Farm Bell" Aroostook Champion
1945	"Farm Bell" Blood, Bone & Potash
1947	"Farm Bell" Potato King
1944	"Farm Bell" Potato Special
	"Farm Bell" Trucker's Ideal
	JOHN WATSON CO., HOULTON, ME.
1822	Watson's Improved Potato Fertilizer

Analysis of Fertilizer Samples, 1912.

Station number.	Nitrogen.								Phosphoric Acid.					Potash.	
			Organic.				Total.			Available.		Total.			
	As nitrate.	As ammonia.	As water soluble.	As active insoluble.	As inactive insoluble.	Available.	Found.	Guaranteed.	Soluble in water.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
1897	0.44	0.10	0.40	0.36	0.36	1.30	1.66	1.65	6.86	8.57	8.0	9.78	8.5	13.64	10.0
1821	1.56	0.16	0.83	1.13	0.59	3.68	4.27	4.11	6.22	8.37	8.0	9.33	8.5	7.58	7.0
1858	1.78	0.16	0.67	1.04	0.62	3.65	4.28	4.11	5.26	9.06	8.0	9.44	8.5	9.36	7.0
1800	0.47	1.56	0.30	0.63	0.52	2.96	3.48	3.28	7.62	9.05	8.0	9.25	8.0	9.50	10.0
1799	0.20	1.70	0.48	0.52	0.43	2.90	3.33	3.28	7.54	8.75	8.0	9.23	8.0	9.85	10.0
1946	0.30	1.58	1.02	0.86	0.44	3.76	4.20	4.11	3.83	8.19	8.0	9.59	9.0	9.10	9.0
1945	0.86	1.20	0.51	1.20	0.48	3.77	4.25	4.11	6.78	8.44	8.0	9.01	9.0	7.66	7.0
1947	0.30	1.50	0.83	0.80	0.40	3.43	3.83	4.11	4.71	7.19	7.0	8.53	8.0	8.44	7.0
1944	0.04	1.08	0.57	1.13	0.48	2.82	3.30	3.29	5.18	6.42	6.0	7.18	7.0	9.71	10.0
.....	.....	.....	.....	.....	.....	.....	.....	4.11	.....	.....	7.0	.....	8.0	.....	8.0
1822	0.86	1.86	0.43	0.59	0.36	3.74	4.10	4.11	6.22	8.28	8.0	9.17	9.0	7.07	7.0

August, 1912.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

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Official Inspections

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OPENED SHELL FISH.

The definition of opened shell fish under the published food standards for Maine is: Opened shellfish are from unpoluted beds, and are opened, packed and shipped under sanitary conditions in sanitary containers without the addition of water or direct contact with ice.

In 1911 samples of opened oysters and clams were obtained from dealers in different parts of the State. It is expected to collect samples of oysters, clams and scallops the present season and to enforce the above standard for these goods.

Oysters.

During the fall and winter of 1911 and 1912 samples of oysters were again examined at this Station. In Official Inspections 30, in which the last examination of oysters was published, there appeared some statements and explanations which may here be repeated.

In October 1909, the following standard was published for Maine: "Opened oysters sold in bulk shall not contain ice or added water, nor more than 17 per cent by weight of free liquids, nor less than 10 per cent by weight of total dry solids." These limits were adopted after careful examination of both solid packed and adulterated goods. It was found that the free liquids which were drained from pure oysters would not exceed 16 per cent and usually ran much under that figure, while the free liquids from the iced oysters sometimes ran as high as 65 per cent. It was found further that the oysters themselves after being freed from the liquid had taken in water so that the actual meat of the watered stock was only 8.6 per cent, whereas the meat of the solid pack was 13.4 per cent. Although the present definition of shell fish does not mention the chemical composition, oysters that come within these limits are passed so far as added water is concerned.

In Official Inspections 30 the results of the examination of 56 different samples of oysters, purchased in different parts of the State, were reported. Of these 71 per cent were passed as within the above limits and as being reasonably good. Since those results were published the Station has examined 55 samples of oysters taken, as before, in various parts of the State, and the results of the examination of these samples were found to be practically the same as the first lot. 70 per cent of the 55 were passed as being within the limits of the standard as good unadulterated oysters. In most of the cases where the oysters carried too much water prosecutions were commenced and the dealers paid a fine without carrying the cases to court. A few of the cases were dropped without prosecution after obtaining a second sample which proved to be much better than the first.

The results here published, compared with those published over a year ago, do not show the improvement in the conditions under which these goods are sold which should be shown, and as the oyster season is again about to commence the dealers are cautioned to exercise all care that the goods which they handle are above standard. *When the oysters are purchased written guarantees should be obtained, stating that these goods are in accord with the requirements of the Maine Food Law. Water should not be sold as oysters, and if in trans-*

portation free liquids separate and rise to the top of the can, this free liquid should be poured off before the oysters are dipped out and sold. Ice should never be placed in the same receptacle as the oysters, as the melting of the ice will lead to adulteration with water.

A few years ago it was the almost universal practice in this State to sell oysters preserved with borax or boric acid. It is belived that this practice has entirely ceased, for not for many years has any of this preservative been detected in any of the oysters examined.

The results of the examination are given in the tables on pages 161 and 162. The column headed "free liquids" indicates the amount of liquid which would run from the oysters through a colander in 10 minutes, and the dry solids were obtained by drying down a weighed amount of drained oysters to constant weight at 100 degrees C.

Clams.

In Official Inspections 30 there was also given the results of the examination of a large number of samples of clams. In the present Official Inspections are given the results of those which have been examined since the appearance of that publication. The situation in regard to clams has not seemed to improve very materially. 65 per cent of the samples here reported carried over 25 per cent of free liquids. There would seem to be no reason why clams should not be sold in as solid a condition as oysters. Clams when properly dug, washed, opened, rinsed and drained will not carry much, if any, more free liquids than the best oysters which are found upon the markets, and clams which are not soaked in any way should contain at least 20 per cent total dry matter.

In Official Inspections 35 a description of the method of digging and preparing clams in this State was given. The dealers and shippers of clams in this State nearly all agreed that clams would not keep much longer than 24 hours in their own liquid, and it seems to be the almost universal practice to open the clams as promptly as possible after digging and throw the clam liquids away and then wash the clams in fresh water. The practice of leaving some or all of this fresh water in contact with the clams, as has been done in the past, results in a swelling of the clam meat in a manner similar to the results obtained from the floating of oysters, and results in fraud, and dealers and producers are warned that prosecutions will be commenced in all cases where evidence is obtained that the clams have been soaked or adulterated in any way.

The same cautions which have been given in regard to oysters apply in the handling of clams. *Written guarantees should be obtained from the people from whom these goods are purchased. Water should not be sold as clams. Ice should not at any time be placed in the receptacle in which clams are stored.* That the floating or soaking of clams with the resulting adulteration can be detected has been clearly demonstrated by samples opened and examined in this laboratory.

Apparently none of the samples of clams reported in the following table are free from adulteration. The best sample of all, No. 10259, does not contain as much dry solid matter as unadulterated, unsoaked clams contain, and this sample does contain more free liquids than should be present. The amount of free liquids in the clams can practically be regulated at will by the dealer, and there is no excuse for selling water as clams.

Among the samples of clams reported there is not one which does not contain much more free liquids than the best oysters which are reported, and there is not one which contains the amount of total solid matter which unsoaked clams should contain. It is the intention to have the inspectors obtain samples of clams during the coming season, and in all cases where there is evidence of adulteration and fraud hearings will be appointed and prosecutions commenced.

The results of the examination are given in the table on page 163. The free liquids and the dry solids were obtained in the same manner as with oysters.

Results of Examination of Oysters Purchased and Examined During the Fall and Winter of 1911-1912.

Station Number.	Town and Dealer.	Price per pint.	Weight as purchased.	Weight drained oysters.	Free liquids.	Dry solids.	Remarks.
		Cts.	Ozs.	Ozs.	%	%	
9,458	Auburn, G. M. Burleigh	18	16.8	13.2	21.19	16.88	Liquids high.
9,691	Auburn, G. M. Burleigh	–	16.3	13.9	14.50	14.66	
10,112	Auburn, Murphy's Market	20	16.9	14.1	16.32	20.09	
9,716	Augusta, W. H. Bruce Concern	17	17.8	15.1	14.68	15.94	
10,153	Bangor, F. H. Drummond	25	16.7	15.9	4.44	16.09	
10,148	Bangor, Frank Foster	20	18.1	16.5	8.36	17.58	
10,150	Bangor, F. L. Frank	25	15.7	13.3	15.28	21.16	
10,152	Bangor, Gallagher Bros	25	15.0	13.1	12.50	24.03	
10,149	Bangor, Alfred Jones Sons	25	18.1	15.5	14.40	21.86	
10,146	Bangor, C. H. Jones & Co	25	16.6	14.8	11.02	20.78	
10,151	Bangor, H. E. McDonald	25	19.3	17.4	9.52	24.60	
10,154	Bangor, Thompson & Waldron	25	17.0	15.8	6.84	21.09	
10,147	Bangor, Wentworth's Market	25	17.5	16.5	5.25	23.95	
10,225	Biddeford, Allen's Fish Market	23	17.2	13.3	22.70	15.57	Liquids high.
10,223	Biddeford, J. H. Holman & Sons	23	17.8	15.4	12.90	19.09	
10,220	Biddeford, J. B. E. Tarte	20	17.9	15.0	15.94	16.15	
10,257	Brownville, E. M. Chase	25	19.4	17.0	12.50	16.89	
10,255	Brownville, O. P. Gerry	–	17.0	16.2	4.97	21.61	
10,096	Fairfield, J. M. Goodridge	25	16.8	14.8	11.95	19.22	
10,251	Guilford, H.Stewart	25	18.1	15.4	14.98	19.29	
9,718	Gardiner, Cash Market Co	18	18.3	14.1	22.80	15.84	Liquids high.
9,717	Gardiner, Metropolitan Market, H. H. Ring	23	17.1	15.3	10.33	19.67	
10,117	Lewiston, Atwood's Market	20	16.4	13.8	15.27	22.39	
10,109	Lewiston, Harvey's Market	20	16.9	13.3	21.25	18.54	Liquids high.
10,113	Lewiston, F. Lagasse	18	15.1	9.0	40.42	13.94	Liquids high.
10,116	Lewiston, The Mohican	20	17.4	16.0	8.10	19.97	
10,115	Lewiston, Palmer's Market	18	16.9	11.8	29.47	20.61	Liquids high.
10,548	Lewiston, Palmer's Market	20	17.5	13.7	21.33	16.31	Liquids high.
10,110	Lewiston, Robert Stewart	18	16.5	11.4	30.70	16.68	Liquids high.
10,114	Lewiston, Walker Bros	20	16.3	14.3	12.31	22.27	
10,213	Lincoln, Libby's Grocery	23	18.6	11.1	39.73	18.23	Liquids high.

Results of Examination of Oysters— CONCLUDED.

Station Number.	TOWN AND DEALER.	Price per pint.	Weight as purchased.	Weight drained oysters.	Free liquids.	Dry solids.	Remarks.
		Cts.	Ozs.	Ozs.	%	%	
10,214	Lincoln, G. B. Whittier	23	18.5	14.0	23.85	17.61	Liquids high.
10,155	Mechanic Falls, G. W. Coffin	23	18.4	13.9	24.47	17.56	Liquids high.
10,157	Mechanic Falls, C. O. Cole	20	17.7	16.0	9.54	20.96	
10,254	Milo, Peak's Market	23	17.2	14.4	16.02	17.78	
10,256	Milo, Thompson Co	23	16.7	15.9	4.65	19.10	
10,161	Norway, O. P. Brooks	25	16.3	14.7	9.72	20.85	
9,724	Oakland, Sanford's Market	–	16.2	14.9	7.42	15.32	
10,245	Portland, Doughty & Jewett	20	17.4	13.4	23.08	19.56	Liquids high.
10,238	Portland, R. D. Hamilton & Co.	23	18.2	16.9	6.60	20.85	
10,246	Portland, Manhattan Market	23	17.7	15.7	11.15	18.34	
10,240	Portland, James H. McDonald	23	17.6	14.8	15.26	18.01	
10,193	Rockland, Linscott's Fish Market	38	17.4	11.7	32.39	21.71	Liquids high.
10,194	Rockland, P. J. Thomas	38	18.0	15.2	15.32	19.79	
10,218	Saco, E. S. Carl	25	17.5	13.0	25.45	17.23	Liquids high.
10,219	Saco, C. H. Colbeth	25	18.0	14.2	20.82	16.86	Liquids high.
10,217	Saco, F. S. Wallace	25	18.6	17.0	8.71	19.91	
10,158	South Paris, E. N. Wright	25	15.4	11.0	28.67	19.40	Liquids high.
10,167	Waterville, E. W. Allen	23	16.0	15.4	3.53	20.34	
10,172	Waterville, H. J. Collins	23	17.5	16.0	8.28	19.07	
10,171	Waterville, Hersom & Bonsall	23	17.6	13.2	24.85	18.34	Liquids high.
10,170	Waterville, F. E. McCallum	23	16.3	15.1	7.36	21.99	
10,168	Waterville, Robinson-Davison Co.	20	16.7	16.1	3.59	21.52	
10,169	Waterville, S. E. Whitcomb	23	16.4	15.8	3.45	19.07	
10,234	West Enfield, H. B. Laing	25	18.1	16.4	9.16	19.75	

Results of Examination of Clams Purchased and Examined During the Fall and Winter of 1911 and 1912.

Station Number.	Town and Dealer.	Price per pint.	Weight as purchased.	Weight drained oysters.	Free liquids.	Dry solids.	Remarks.
		Cts.	Ozs.	Ozs.	%	%	
9,459	Auburn, G. M. Burleigh	13	16.6	12.1	26.88	18.72	Liquids high.
10,165	Augusta, W. H. Bruce Concern	11	16.6	12.8	22.34	15.31	
10,222	Biddeford, F. F. Beauregard & Co.	8	18.5	12.4	34.35	13.35	Liquids high.
10,221	Biddeford, Biddeford Grocery Co	10	18.7	15.2	18.30	14.35	
10,224	Biddeford, John B. Clouthier	8	16.7	10.2	39.03	15.91	Liquids high.
10,097	Fairfield, G. N. Snell	13	17.9	12.0	32.74	14.57	Liquids high.
10,111	Lewiston, Linney Bros	13	14.8	9.5	35.87	13.52	Liquids high.
10,259	Pine Point, Leavitt Bros	–	17.8	14.0	21.38	18.29	
10,242	Portland, C. E. Cross	10	18.1	13.3	26.46	13.52	Liquids high.
10,241	Portland, E. C. Dyer	10	17.7	11.8	32.73	13.39	Liquids high.
10,244	Portland, Wm. H. Hill	10	16.5	11.7	29.12	17.25	Liquids high.
10,239	Portland, Wm. H. Kennedy	10	16.4	13.1	20.43	17.37	
10,260	Portland, C. W. Lombard	13	17.8	13.4	24.70	13.02	
10,243	Portland, Geo. Wilcox	10	16.3	12.3	24.19	14.72	
10,195	Rockland, Willis I. Ayer	10	17.4	11.0	36.51	17.43	Liquids high.
10,196	Rockland, Henry L. Higgins	–	17.4	10.9	36.99	15.77	Liquids high.
10,197	Rockland, Mason's Market	10	17.6	10.3	41.28	16.56	Liquids high.

PROSECUTION.

After due hearings it seemed the duty of the executive to bring prosecutions under the law in a number of cases. The following were settled by compromise as provided in the law out of court and in most cases before actual proceedings had been commenced. A few cases are pending.

List of Cases Settled Without Trial on Payment of Penalty in the Quarter Ending June 30, 1912.

Name and Town of Defendant.	Nature of Complaint.
Adams Co., The J. W., Westfield	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Allen, R. M., Columbia Falls	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Anderson, Lewis, Stockholm	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.

List of Cases Settled Without Trial—CONCLUDED.

NAME AND TOWN OF DEFENDANT.	NATURE OF COMPLAINT.
Ashland Grange Store, Ashland	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Benner & Chute, Waldoboro	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Buckley, Leo J., Riley & Buckley, Newport	Adulterated sweet spirit of nitre. Low in ethyl nitrite.
Campbell & Co., G. R., Cherryfield	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Capen Corporation, G. W., Eastport	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Cleveland, Geo. H., Camden	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Curtis, J. C., Camden	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Dillingham, E. L., Thomaston	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Farrand, Spear & Co., Rockland	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Fort Kent Mill Co., Ft. Kent	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Freeman Co., G. H., Presque Isle	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Gagnon, H. A., Van Buren	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Gardner Co., A. L. R., Dennysville	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Grindal, C. W., Ellsworth	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Hahn, A. C., Rockland	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Hanly, George B., Warren	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Harvey, Fred D., Portland	Adulterated sweet spirit of nitre. Low in ethy nitrite.
Island Falls Grange Store, Island Falls	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Jackson, F. S., Winthrop	Adulterated sweet spirit of nitre. Low in ethyl nitrite.
Lane, Geo. E., Danforth	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Lewis, W. H., Sherman Mills	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Lisbon Falls Cooperative Association, Lisbon Falls	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Littlehale Grain Co., L. N., Rockland	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Littlehale Grain Co., L. N., Rockland	Adulterated and misbranded grass seed. Below the guarantee in percentage of purity.
Longfellow & Co., L. W., Machias	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Marriner & Knight, No. Vassalboro	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Merrill Bros., Augusta	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Pineo, S. S., Milltown	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Pinkham & Philbrick, Augusta	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Seavey, Irving E., Sherman Mills	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Spear & Co., F. L., Easton	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Umphrey, Arthur, Washburn	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Vannah, Chute & Co., Winslow's Mills	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Walker, W. A., Castine	Adulterated sweet spirit of nitre. Low in ethyl nitrite.
Wingate, Frank S., Hallowell	Adulterated and misbranded grass seed. Below the guarantee in percentage of purity.
Wood & Son, Wm. M., Gardiner	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Woodman, J. L., Washburn	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.

October, 1912.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

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Official Inspections

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CREAMERY SANITATION.

No class of foods is more universally used than the kind known as dairy products—milk, cream and butter. Milk is used not only in every household either in cooking or as a food by itself, or both, but it is used more extensively than any other one thing as a food for infants and invalids. Without question, therefore, these products should be as clean and pure and wholesome as it is possible for them to be produced. Unfortunately it is a fact that milk and cream are among the best mediums known for the growth and multiplication of bacteria of all kinds, including those responsible for tuberculosis, typhoid fever, scarlet fever, and many other diseases. It has been repeatedly demonstrated that epidemics of typhoid fever and other diseases have been spread by means of a contaminated milk supply; and it is possible for milk to receive this contamination not only at the dairy where it is produced but at any point during its manipulation or transportation before it reaches the customer. The dust of the city streets contains the germs of tuberculosis from the dried sputum of people in all stages of tuberculosis; flies swarm upon such sputum and frequent outhouses, closets, stables, and all kinds of refuse and decaying matter and whatever happens to be present in the way of bacteria is carried upon the flies to whatever food products they may next go. If the creameries where milk is received, strained, separated, churned, etc., are not well screened flies will be found in great abundance in every such place. If there is in the near neighborhood any possible chance for these flies to become infested with germs of disease they will bring these germs into the creamery and to the milk itself. If the creamery is located upon a city street from which the dust blows in clouds upon a breezy day, here again the danger of contamination is ever present.

A few years ago the fly was looked upon as a nuisance surely but not as a danger. It is now known that the fly is the most dangerous menace to the public health with which we have to contend. The proprietors and managers of creameries, or other places where milk is produced, stored, manipulated, distributed, etc., should understand these facts and should without compulsion and without question see that their places are at all times thoroughly screened, and clean, and sanitary in every way.

The following is quoted from a circular issued by the Dairy Division of the United States Department of Agriculture, and gives the opinion of the highest authorities in the country on the construction and sanitation of creameries:

"In building creameries careful attention should be given to the construction, for if properly constructed it is much easier to keep the surroundings in a sanitary condition and in any event a certain standard of sanitation must always be maintained. Creameries should always be provided with suitable and sufficient drainage properly equipped with traps for disposing of the sewage. Also a system of ventilation that will carry off quickly steam and other vapors as well as offensive and obnoxious odors that may be present. Floors made of concrete or similar materials are desirable and should always be kept clean. Walls, partitions, platforms and stairways should be kept clean and painted, and when the material used in any part of the structure becomes old and decayed it should be replaced with new. Doors and windows should be washed frequently and provision should be made for protecting the interior of the building and the products from flies. Walks and outside platforms should be always kept clean to prevent tracking dirt into the building. All utensils used in the handling of milk, cream or butter should be thoroughly cleaned each day by washing in warm water with a suitable cleaning material, then thoroughly sterilized with live steam. Pumps and pipes used for conveying milk or cream should be of the sanitary type and should be taken apart and cleaned after use each day. Employees should wear clean clothing and keep their hands clean at all times. They shoud also give particular attention to their boots and shoes. Creameries should be provided with toilet rooms and dressing rooms but such should be entirely separate from the compartments where butter or other dairy products are handled. No person should be employed in a creamery who is affected with tuberculosis or other communicable disease and any employee suspected of being affected should be examined by a physician immediately. If creamery operators and owners would give more consideration to the various items enumerated and improve the sanitary conditions of their plants, the value of their products would be increased and the cause for much unfavorable comment, frequently heard, would be removed. As this question is one affecting public health, it will probably receive the attention of health officers sooner or later unless operators make such action unnecessary by removing all causes of complaint."

CREAMERY INSPECTION.

There are special laws regulating the sale of milk, cream, butter and butter substitutes of which the Commissioner of Agriculture is the executive. These laws do not contemplate the inspection of creameries. His representatives however endeavored to correct matters by calling the attention of the management to needed changes. For the most part these suggestions were not followed. Therefore the present Commissioner desired us to make sanitary inspection of these places. For this purpose two members of his department were appointed as deputies under the food law. The inspections here reported are the joint work of the two departments. Part of the creameries were visited by representatives of the Commissioner of Agriculture and part of them by the deputies of the Director of this Station.

No prosecutions have thus far been made as a consequence of any apparently unsanitary conditions of creameries noted. The object of the food laws is to correct faults and insure the future rather than to punish for any neglect or shortcoming of the past. It is earnestly desired by the executive of the Maine Food Law that the owners and managers of creameries cooperate in affecting the desired changes and make the creameries of the State models of cleanliness.

By far the greater number of criticisms made in regard to the creameries has been upon the lack of screens or other protection from flies, but other serious faults have been observed, among them dirty floors and walls; dirty windows, in some cases covered with cob-webs; bad drainage with sour, dirty water standing upon the floor; sink or vat full of dirty, sour water; unsanitary condition or location of toilet; lack of ventilation and condensing steam dropping into milk vats; ill smelling or improperly ventilated refrigerators; unnecessary exposure of milk and cream bottle caps to dust and flies; workmen spitting about the creamery; pools of dirty water and sour milk under the creamery with cracks through the floor so that flies, odors, etc., would come directly through into the buildings. Other faults also have been observed which any manager should correct without having attention called to them by a pure food official.

There are in this State nearly 60 establishments passing under the name of "creameries." In some of these, however, milk is simply received and shipped, in others it is separated; while in others, which may justly be called creameries, the milk is received, separated and butter made. With possibly one or two exceptions, all of these establishments have been visited the present season by deputies working under the Maine Food Law, and some of the places have been visited several times. When investigating these establishments the deputies have had instructions to carefully observe the following points in detail: The surroundings of the building, whether clean or tidy; the general conditions of the inside of the place, as to cleanliness and tidiness of the floors, walls, benches, utensils, etc., whether the place is provided with screens, and whether flies were observed inside or outside of the building; whether the building is well lighted and ventilated; whether the toilets, if there are such, are properly located and if they are kept clean and under sanitary conditions; whether or not the employees are apparently neat and healthy in appearance. In addition to the above definite questions the deputy is instructed to note carefully any condition which exists that in his opinion is unsanitary or should be changed in order to improve the condition of the creamery.

It is a pleasure to note that in almost every instance conditions have been found improved upon the second visit. Most of the serious faults to which attention has been called have been remedied and promises have been obtained from practically all of the creameries where any criticism was made that the suggestions as to the improvement of conditions would be acted upon.

Following is a tabulated list of the establishments visited arranged in three groups: First, creameries where butter is made; second, skimming stations where milk is received, skimmed and forwarded to creameries proper; and, third, receiving stations where milk is received, iced and shipped to some other point. The creameries were passed as being sanitary in all respects other than noted under "remarks" in the tabulated report.

Table giving the list of creameries visited and a summary of the conditions as found at the time of inspection.

CREAMERIES MAKING BUTTER.

NAME AND ADDRESS OF CREAMERY.	REMARKS.
Carabasset Creamery, East New Portland	No screens except on cream room. Clean and sanitary except as above.
Gardiner Creamery, Gardiner	No screens; doors and windows open; not protected from flies; light and ventilation poor; tanks of milk uncovered; floor dirty. Unsanitary.
Hillside Creamery East Corinth	Partailly screened; doors open; flies inside; milk tank unprotected; windows dirty.
Hillside Creamery Exeter	Partially screened; many flies inside; windows dirty; milk tank not covered; floors dirty.
Hiram Creamery Association, Hiram	Screened; no flies inside; clean, well lighted and ventilated; well kept.
Houlton City Creamery, Houlton	No screens except cover for vat: otherwise condition good.
Maine Creamery Association, Bangor	Conditions much improved since first visit; building old but well lighted, ventilated and screened. Conditions now good.
New England Creamery Co., Livermore Falls	Not visited since 1911. Not clean at time of visit; many flies inside; not protected from flies; toilet not properly located or sanitary; light not good in butter room. Condition not good.
Poland Creamery, Poland	Clean; well lighted and ventilated, but no screens; some flies in the building. Not sanitary.
Portland Creamery, (Highland Creamery) Bridgton	No screens; no attempt to protect from flies; windows dirty; many flies inside.
Portland Creamery, Portland	Conditions much improved over first visit; screened, well lighted and ventilated; clean. Condition good.
Skowhegan Jersey Creamery, Skowhegan	Conditions good, except for no screens although at time of visit there were no flies in evidence.
Solon Creamery, Norridgewock	No screens; many flies in building; condition of refrigerator unsanitary.
Trout Brook Farm Creamery, Winterport	No screens; otherwise condition good.
Turner Center Dairying Association, Auburn	Clean; well screened; light and ventilation fair; well kept.
Turner Center Dairying Association, Turner Center	Clean; well screened; light and ventilation good; well kept.
Turner Creamery, Turner Center	Well screened, except churn room; light and ventilation good; windows dirty; general condition fair.
Warren Creamery, South Warren	No screens; flies inside building; doors open; condition of refrigerator not sanitary; floors and walls clean; light and ventilation good.
Waterford Creamery, South Waterford	Well screened; no flies; light fair; ventilation good; general condition very good.

SKIMMING STATIONS.

NAME AND ADDRESS OF CREAMERY.	REMARKS.
D. Whiting & Sons, Belfast	No screens, but no flies at time of visit. Conditions have been improved since the first visit. Fairly clean; light and ventilation could be improved in places.
D. Whiting & Sons, Bucksport	No screens; flies inside; tanks not protected from flies; floors, walls, etc., clean; light and ventilation good.
D. Whiting & Sons, Canton	No screens; flies inside; floors and walls clean; light and ventilation good; tanks mostly covered and protected; general condition fair.
D. Whiting & Sons, Corinna	Partially screened; some flies inside; milk mostly protected; floors and walls clean; light and ventilation good.
D. Whiting & Sons, Dexter	Partially screened; some flies inside; floors and walls clean; light and ventilation good.
D. Whiting & Sons, Foxcroft	Well screened; clean; light and ventilationi good; new building; good condition.
D. Whiting & Sons, Guilford	Well screened; light and ventilation good; floors and walls clean; good condition.
D. Whiting & Sons, Pittsfield	No screens, but no flies at time of visit; light and ventilation fair except in basement; damp and foul odor present; walls clean; conditions could be improved.
D. Whiting & Sons, South Newburg	No screens; some flies inside; light and ventilation good; floors and walls clean.
D. Whiting & Sons, Thorndike	No screens; some flies in building; floors and walls clean; light and ventilation good; all vats screened and protected from flies.
D. Whiting & Sons, Winterport	Screens on front, but back doors open; also doors open through engine room; some flies in building; not protected from dust and flies; floors and walls clean; light and ventilation good.
Enterprise Creamery, Dexter	Partially screened and protected from flies; some flies in the building; floors and walls clean; light and ventilation good.
H. P. Hood & Sons, Brooks	Screened; well lighted and ventilated; clean and sanitary.
H. P. Hood & Sons, Unity	No screens, some flies in building; vats screened; floors and walls clean; light and ventilation good.
H. P. Hood & Sons, Winthrop	Well screened, lighted and ventilated; clean; sanitary.
Maine Creamery Association, Charleston	No screens; some flies in building; floors and walls clean; light and ventilation good.
Maine Creamery Association, East Dixmont	No screens; some flies in building; light and ventilation bad; unsanitary.
Maine Creamery Association, Houlton	No screens on building, but no flies in building; vats well screened and milk protected; floors and walls clean; light and ventilation good.
Maine Creamery Association, Newburg	No screens; many flies in building; not sanitary.

SKIMMING STATIONS—CONCLUDED.

NAME AND ADDRESS OF CREAMERY.	REMARKS.
Maine Creamery Association, New Sweden	No screens, but no flies in building at time of visit; floors and walls clean; light and ventilation good; condition good.
Portland Creamery, South Paris	No screens; many flies inside; light good except in cellar; ventilation good; drainage bad; condition could be much improved.
Solon Creamery, Harmony	Well screened, lighted and ventilated; clean; condition good.
Solon Creamery, Solon	Well screened, lighted and ventilated; clean; condition good.
Staples, J. J., North Newburg	No screens; many flies inside; floors and windows dirty; bad drainage; employees not particular about sanitation; condition bad.
Turner Center Dairying Association, Carmel	No screens on building; flies inside; tank and milk partially protected by screen cloth covers.
Turner Center Dairying Association, East Jackson	No screens; flies inside; otherwise condition good.
Turner Center Dairying Association, East Troy	Partially screened; many flies inside; floors and walls fairly clean; light and ventilation good.
Turner Center Dairying Association, Richmond	Partially screened; no flies inside at time of visit; clean; neat; condition good.
Turner Center Dairying Association, Unity	Well screened, lighted and ventilated; clean; condition good.
Turner Center Dairying Association, West Benton	Well screened, lighted and ventilated; no flies; condition good.
Turner Center Dairying Association, West Farmington	No screens; flies inside; ventilation good; floors and walls clean.
Turner Center Dairying Association, Wiscasset	No screens; flies inside; toilet not properly located; light and ventilation good; floors and walls clean.

RECEIVING STATIONS.

H. P. Hood & Sons, Belfast	No screens; no flies at time of visit; condition good except for water bath which had offensive odor at time of visit.
Maine Creamery Association, Foxcroft	Building closed at time of visit.
Maine Creamery Association, Monroe	No screens; few flies; milk for most part well protected; place clean; light and ventilation fair.
Turner Center Dairying Association, Livermore	No screens; flies in building; clean; light and ventilation good; milk protected from dust and flies.

WEIGHT OF BUTTER.

Some time ago complaints were received that short weight butter was being sold throughout the State by various creameries and dairies. A set of standardized weights was, therefore, procured, by means of which the scales in the various stores visited by the deputies could be accurately tested and then when correct such scales could be used in weighing up the various brands of butter found on sale.

The results of the investigation of the weights of butter have been surprising. They are tabulated and will be found on pages 174-178. In some cases an occasional short weight brick has been found mixed with others that weighed a pound or over. No attempt at prosecution has been made in such cases. Where the results of the weighings have shown that the majority of the goods, or an important proportion weighed below 16 ounces, hearings were appointed. Several short weight butter cases have already been settled by the payment of fines ranging from $5 to $20. Some cases are still under advisement and unsettled. Some of the bricks sold as a pound have been found to weight as little as 12½ ounces. Most of the short weight cases, however, are based upon samples which run about 15 ounces.

Various excuses have been made by the manufacturers of these goods to account for the shortage in weight. A common excuse is the use of an old mould which through constant scraping has become worn off so that it will not under any condition hold a pound of butter. One such mould brought to this office, along with a new one of the same make, was found to be one-eighth of an inch shorter than the new mould. The butter made in this old mould was an ounce short in weight. One creamery manager explained that a mould used in printing out some packed butter, which was very solid, was afterwards used without readjustment to print out fresh churned butter and this being less dense resulted in a brick weighing less than a pound. Some manufacturers had no excuse to offer whatever, simply stating that they supposed they were making and selling a pound of butter.

While cases have not been brought against the dealer handling short weight butter he is at fault. It is so easy for the dealer to know whether the butter that he handles is full weight or not that there is no excuse for selling short weight butter.

Table giving report of butter weighed by the inspectors at dealers. The samples are arranged as creamery and dairy butter alphabetically by the names of the makers.

CREAMERY BUTTER.

MAKER AND BRAND, IF ANY	Where Found.	Number bricks weighed.	*Number bricks short weight.
Armour & Co., Chicago, Ill., "Clover-bloom"	Chebeague Cash Store, Chebeague Island	3	None.
Armour & Co., Chicago, Ill., "Clover-bloom"	J. A. S. Dyer, So. Portland	3	None.
Armour & Co., Chicago, Ill., "Clover-bloom"	M. W. Sawyer, Milford	5	None.
Brown, L. E., Bangor, (no brand)	C. A. Mills, Old Town	8	None.
Cummings Bros., (Distributors) Portland, "Pure Creamery Butter C-B"	M. B. Fuller & Son, So. Portland	2	None.
Corinth Creamery Assoc., East Corinth	A. E. Baker, Bangor	3	1
Corinth Creamery Assoc., East Corinth	C. J. Hamilton, Orono	4	1
Corinth Creamery Assoc., East Corinth	C. J. Hamilton, Orono	3	None.
Corinth Creamery Assoc., East Corinth	J. I. Park, Orono	6	None.
Corinth Creamery Assoc., East Corinth	Rich & Heald, Orono	5	None.
Corinth Creamery Assoc., East Corinth	M. W. Sawyer, Milford	8	8
Fox River Butter Co., (Distributors) "Beechwood Creamery Butter"	J. A. S. Dyer, So. Portland	3	None.
Fox River Butter Co., (Distributors) "Meadow Gold Butter"	J. A. S. Dyer, So. Portland	3	None.
Hillside Creamery, Bangor, "Hillside Butter"	A. E. Baker, Bangor	3	None.
Hillside Creamery, Bangor, "Hillside Butter"	Beauleau Bros., Old Town	7	7
Hillside Creamery, Bangor, "Hillside Butter"	S. A. Fish, Old Town	5	5
Hillside Creamery, Bangor, "Hillside Butter"	C. J. Hamilton, Orono	4	3
Hillside Creamery, Bangor, "Hillside Butter"	Old Town Tea Store, Old Town	6	6
Hillside Creamery, Bangor, "Hillside Butter"	Arthur Page, Orono	5	5
Hillside Creamery, Bangor, "Hillside Butter"	C. T. Page, Orono	3	1
Hillside Creamery, Bangor, "Hillside Butter"	C. T. Page, Orono	10	9
Hillside Creamery, Bangor, "Hillside Butter"	C.T.Page, Orono,	9	9

* No brick considered short weight unless shortage was more than one-quarter ounce.

CREAMERY BUTTER—CONTINUED.

MAKER AND BRAND, IF ANY.	Where Found.	Number bricks weighed.	*Number bricks short weight.
Hillside Creamery, Bangor, "Hillside Butter"	C. T. Page, Orono, (Mill St. store)	8	8
Hillside Creamery, Bangor, "Hillside Butter"	J. I. Park, Orono	7	None.
Hillside Creamery, Bangor, "Hillside Butter"	Penney's Market, Old Town	6	6
Hillside Creamery, Bangor, "Hillside Butter"	E. J. Peters, Orono	12	11
Hillside Creamery, Bangor, "Hillside Butter"	Rich & Heald, Orono	6	None.
Hillside Creamery, Bangor, "Hillside Butter"	Spruce Bros., Milford	4	4
Hillside Creamery, Bangor, "Hillside Butter"	C. M. Stevens, Old Town	6	6
Hillside Creamery, Bangor, "Hillside Butter"	James Walker Co., Orono	9	9
Maine Creamery Association, Bangor, "Kineo Butter"	A. E. Baker, Bangor	3	None.
Maine Creamery Association, Bangor, "Kineo Butter"	F. L. Frank, Bangor	3	1
Maine Creamery Association, Bangor, "Kineo Butter"	Gallagher Bros., Bangor	3	None.
Maine Creamery Association, Bangor, "Kineo Butter"	Lunt's Cash Store, Old Town	8	3
Maine Creamery Association, Bangor, "Kineo Butter"	H. E. McDonald, Bangor	3	None.
Maine Creamery Association, Bangor, "Kineo Butter"	Old Town Supply Co., Old Town	6	None.
Maine Creamery Association, Bangor, "Kineo Butter"	J. I. Park, Orono	10	10
Maine Creamery Association, Bangor, "Kineo Butter"	Spruce Bros., Milford	5	None.
Maine Creamery Association, Bangor, "Kineo Butter"	James Walker Co., Orono	5	5
Maine Creamery Association, Bangor, "Kineo Butter"	James Walker Co., Orono	15	4
Poland Dairy Co., Poland, Me., "Poland Butter"	Fred T. Hall, Bangor	1	1
Poland Dairy Co., Poland, Me., "Poland Butter"	Jos. Stride & Co., Biddeford	11	10
Portland Creamery, Portland, Me.	C. E. Cash, So. Portland	3	None.
Portland Creamery, Portland, Me.	G. W. Cash, So. Portland	3	1
Portland Creamery, Portland, Me.	S. F. Hamilton, Chebeague Island	5	2
Portland Creamery, Portland, Me.	F. H. Libby, Portland	4	None.

*No brick considered short weight unless shortage was more than one-quarter ounce.

CREAMERY BUTTER—CONCLUDED.

MAKER AND BRAND, IF ANY.	Where Found.	Number bricks weighed.	*Number bricks short weight.
Portland Creamery, Portland, Me.	W. J. McKenney, So. Portland	2	1
John P. Squire & Co., "Arlington Brand"	C. J. Hamilton, Orono	6	None.
John P. Squire & Co., "Arlington Brand"	E. J. Peters, Orono	3	3
John P. Squire & Co., "Arlington Brand"	E. J. Peters, Orono	7	None.
John P. Squire & Co., "Arlington Brand"	E. J. Peters, Orono	2	None.
John P. Squire & Co., "Arlington Brand"	E. H. White, Orono	4	None.
Swift & Co., Bangor, Me., "Brookfield Extra Creamery Butter"	Knightville Grocery Co., South Portland	3	None.
Swift & Co., Bangor, Me., "Brookfield Extra Creamery Butter"	E. J. Peters, Orono	11	1
Swift & Co., Bangor, Me., "Brookfield Extra Creamery Butter"	Rich & Heald, Orono	6	None.
Swift & Co., Bangor, Me., "Brookfield Extra Creamery Butter"	Skillin Bros., So. Portland	3	None.
S. & S. Co., Bangor, Me	B. F. Piers, Great Works	6	None.
Turner Center Creamery	W. Gray, Old Town	8	None.
Turner Center Creamery	Fred T. Hall, Bangor	2	None.
Turner Center Creamery	Wm. Pratt, Farmington	6	None.
Turner Center Creamery	Staples & Griffin, Bangor	3	None.

DAIRY OR COUNTRY BUTTER—SOURCE KNOWN.

Mrs. K. C. Allen, Hampden Highlands, Me	J. A. Stewart, Bangor	4	2
Babb, Levant, Me	Fred T. Hall, Bangor	3	3
Chester Baker, Orrington, Me	G. W. Jordan, Brewer	10	None.
F. H. Bickford, No. Dixmont, Me	F. H. Drummond, Bangor	3	None.
Bert Black, Holden, Me	N. H. Hall, Brewer	7	7
Mrs. Boyce, Holden, Me	E. J. Pooler, Brewer	9	1
V. S. Brown, West Levant, Me	F. H. Drummond, Bangor	8	3
Buber, Hudson, Me	H. E. McDonald, Bangor	3	None.
Carrabasset Stock Farm, North Anson, Me	A. A. Morse, Bath	6	None.
W. F. Chute, Holden, Me	W. F. White, Bangor	10	None.
C. L. Clark, Holden, Me	A. C. Moore, Brewer	3	None.

*No brick considered short weight unless shortage was more than one-quarter ounce.

DAIRY OR COUNTRY BUTTER—SOURCE KNOWN—CONCLUDED.

Maker and Brand, if Any.	Where Found.	Number bricks weighed.	*Number bricks short weight.
I. E. Cluley, Holden, Me	A. C. Moore, Brewer	8	None.
David Crockett, Durham, Me	A. A. Moore, Bath	6	None.
L. Decker & Son, Hinckley, Me	C. A. Mills, Old Town	10	2
L. Decker & Son, Hinckley, Me	Old Town Tea Store, Old Town	7	1
A. A. Dority & Son, Charleston, Me	N. H. Whitman, Bangor	7	3
E. C. Dow, Bradford, Me	C. J. Hamilton, Orono	14	14
E. C. Dow, Bradford, Me	C. J. Hamilton, Orono	22	12
E. C. Dow, Bradford, Me	E. J. Peters, Orono	19	None.
Geo. Emerson & Son, Bangor, Me	C. H. Wood, So. Brewer	4	None.
Falcom's	A. A. Worksum, Mechanic Falls	4	None.
Walter Fickett, E. Orrington, Me	N. H. Hall, Brewer	2	None.
C. E. Foster, E. Corinth, Me	H. E. McDonald, Bangor	3	None.
Foster's	A. A. Worksum, Mechanic Falls	5	None.
Daniel Gould, So. Corinth, Me	N. W. Whitman, Bangor	5	1
C. A. Guery, E. Corinth, Me	H. E. McDonald, Bangor	3	None.
N. D. Haskell	A. A. Worksum, Mechanic Falls	4	4
Joseph John, Lee, Me	J. I. Park, Orono	8	1
Amos Johnson, Bucksport, Me	Danforth, Marsh & Co., Bangor	6	None.
Levenseller, Houlton, Me	E. J. Pooler, Brewer	5	None.
O. F. Milliken, Scarboro, Me	M. B. Fuller & Son, So. Portland	2	None.
Alex. Murphy, Brewer, Me	Danforth, Marsh & Co., Bangor	7	1
Mrs. Chas. Page, Orono, Me	Arthur Page, Orono	6	1
W. E. Rowell, Corinth, Me	F. H. Drummond, Bangor	7	None.
C. Smith, Sebec, Me	Geo. A. Chapman, Bangor	9	1
Henry Southards, Hudson, Me	Lunt's Cash Store, Old Town	13	1
Tasker, Charleston, Me	W. S. Averill, Orono	2	None.
Tescott, Hudson, Me	W. S. Averill, Orono	6	None.
Torrents, Holden, Me	G. W. Jordan, Brewer	7	1
A. L. Ulmer, Holden, Me	G. W. Jordan, Brewer	9	None.
Whitten's, Saco, Me	Joel Bean & Sons, Biddeford	6	1
E. H. Williams & Son, Canaan, Me	James Walker Co., Orono	13	13
E. H. Williams & Son, Canaan, Me	James Walker Co., Orono	7	7
E. M. Wilson, Kenduskeag, Me	N. W. Whitman, Bangor	2	None.
John Woodard, Holden, Me	E. J. Pooler, Brewer	5	1
Young's	A. A. Worksum, Mechanic Falls	6	None.

*No brick considered short weight unless shortage was more than one-quarter ounce.

DAIRY OR COUNTRY BUTTER—SOURCE NOT KNOWN.

MAKER AND BRAND, IF ANY	Where Found.	Nnmber bricks weighed.	*Number bricks weighed.
Not known	L. Alford, Old Town	5	None.
" "	N. L. Butterfield, Great Works	6	None.
" "	M. B. Fuller & Son, So. Portland	2	2
" "	Fred T. Hall, Bangor	4	1
" "	P. A. Horn & Co., Stillwater	5	None.
" "	A. W. Joy Co., Bangor	8	None.
" "	G. W. & C. S. Leighton, Bangor	4	None.
" "	Old Town Tea Store, Old Town	4	None.
" "	Old Town Tea Store, Old Town	6	None.
" "	M. W. Sawyer, Milford	4	None.
" "	Sawyer & Rand, Old Town	5	2
" "	Spruce Bros., Milford	5	1
" "	Staples & Griffin, Bangor	3	1

RENOVATED OR PROCESS BUTTER.

Not known	E. E. McPheters, Great Works	5	None.
" "	Sawyer & Rand, Old Town	4	None.

*No brick considered short weight unless shortage was more than one-quarter ounce.

PROSECUTIONS.

After due hearings it seemed the duty of the executive to bring prosecutions under the law in a number of cases. The following were settled by compromise as provided in the law out of court and in most cases before actual proceedings had been commenced. A number of cases are still pending.

List of Cases Settled Without Trial on Payment of Penalty in the Quarter Ending September 30, 1912.

Name and Town of Defendant.	Nature of Complaint.
Black, Bert, Dedham	Short weight butter.
Boucher, G. & A., Biddeford	Adulterated ice cream. Below standard.
Breton, Octave, Bath	Adulterated ice cream. Below standard.
Corinth Creamery Association, Corinth	Short weight butter.
Dow, E. C., Bradford	Short weight butter.
Haskell Implement & Seed Co., Lewiston	Unregistered insecticides on sale.
Paolino, Michael, Portland	Adulterated ice cream. Below standard.
Small, E. L., East Machias	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Stone, F. C., Edgecomb	Misbranded grass seed. Not marked with name or guaranteed percentage of purity.
Swett Co., L. B., Bath	Adulterated ice cream. Below standard.
Thomas, Chas. P. S., Portland	Adulterated ice cream. Below standard.
Tibbetts, C. M., Rockland	Adulterated ice cream. Below standard.
Urvanta Lunch, S. W. Gordon, Prop., Saco	Adulterated ice cream. Below standard.
West End Dairy Co., Portland	Adulterated ice cream. Below standard.
Zakarian, John, Portland	Adulterated ice cream. Below standard.

Cases Nol-prossed by County Attorney Bates.

In addition to the above cases the ten Portland dealers named below were arrested on criminal warrants for continued violation of the section of the Maine Food Law relating to protection from filth, flies, dust or other contamination:

Charles Hatzhelson, 81 Middle St., bread and fruit.

Harry Katz, 51 Middle St., bread and fruit.

Moses K. Serunian, 199 Congress St., fruit and pickles.

John Erlick, 247 Congress St., bread.

Samuel Elowitch, 445 Fore St., fruit.

Nicola Fraschia, 52 India St., fruit.

Alfonso Frallicciaradi, 42 India St., bread.

Jimmie Ross, cor. Middle and Franklin Sts.; also wagon at cor. Congress and Pearl Sts., fruit.

Samuel Perlman, 42 Hampshire St., bread.

George Sandy, 101 Portland St., fruit.

Each one of these men had been notified in regard to the requirements of the food law concerning sanitary display. Each one had in addition been notified by letter of warning that he was violating the law, and each of the ten appeared to be a persistent violator. Apparently no attention was paid to the letters and notices delivered.

The executive of the Maine Food Law took these matters up with County Attorney Bates of Cumberland County, explaining to him the above facts and was told by the County Attorney that because of the press of business it would not be possible for him (the County Attorney) to give careful attention to these cases at that time, but that he would have them brought in the police court the next morning, have the cases continued for ten days and then would give them his personal attention. On this representation the cases were left in his hands. Upon the next morning, however, when these cases were brought in court County Attorney Bates appeared and nol-prossed the ten without consultation with the executive of the Maine Food Law.

While these arrests and this procedure appeared to have no immediate effect upon the display of foods by these men, shortly afterwards foods displayed for sale by these ten men were properly protected and, according to the reports of the deputies, have been properly protected ever since.

Appealed Cases.

In Bangor also four cases were taken up with the following result:

J. F. Boyd, Main St., fruit,

Floros Bros. (G. Floros and M. Floros), Main St., fruit,

Paul G. Martini, Central and Harlow Sts., fruit,

C. S. Vafiades, Main St., fruit,

were arrested on charges of violation of the section of the Maine Food Law relating to protection from filth, flies, or other contamination, fined $5 and costs each, and the cases were appealed.

December, 1912.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

ANALYSTS

James M. Bartlett
Royden L. Hammond
Edward E. Sawyer
Herman H. Hanson
Albert Verrill
Helen W. Averill

INSPECTORS

Elmer R. Tobey
Edgar A. White

Official Inspections

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CARBONATED BEVERAGES AND ICE CREAMS.

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CARBONATED BEVERAGES.

During the summer of 1912 the investigation of the carbonated beverages manufactured and sold in Maine has been continued. This work was commenced in 1910 and since the first inspection of this industry much improvement has been noted in a number of different ways. During the season just passed not all of the bottling houses have been visited, nor have the products of these houses all been analyzed, but only those places located in towns that the deputies happened to visit and those goods found during the course of regular inspection work have been examined.

The regulations for this class of goods are the same as they have been for several years, and are as follows:—

"No. 143. *Carbonated beverages.* The standards for carbonated beverages, root beer 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, either bottled or sold at fountains. Benzoate of soda may be used in bottled goods if its presence and amount are declared on the label, and at fountains if conspicuous signs are used declaring its presence and the amount used."

"For the present cream soda, sarsaparilla, root beer, birch beer and ginger ale may be sold without statement that they are artificially colored and flavored. If benzoate of soda is present it must be declared."

In Food Inspection Decision 135, issued by the United States Board of Food and Drug Inspection under the Food and Drugs Act, saccharin was prohibited in food products entering interstate commerce. In accordance with the general policy of the executive of the Maine Food Law, that the regulations in this State conform as nearly as possible to those under the National

Act, the use of saccharin in foods was prohibited in Maine after January 1, 1912. No saccharin has been found in any of the goods analyzed the present year.

Artificial Colors.

All of the goods analyzed were examined in order to ascertain the character of the color used. In an increased percentage of the goods it was found that the manufacturers were apparently using a color or combination of colors belonging to the list of seven permitted dyes, there being only a few cases of other kinds of color noted. In all cases where colors other than the seven permitted ones were discovered the goods have been carefully examined for arsenic, but in no case was any present. In several cases natural fruit juices were apparently used, as natural fruit pulp and fruit color were present in connection with the coal tar dye.

Alcohol.

In none of the goods examined during the present year was alcohol detected in any amount. This is an improvement over the examination made during the last two years, as in some instances alcohol has been found in considerable amount.

Misbranding.

Three instances of misbranding have been detected and the cases are now pending. In one case goods sold as "Orange Julep" were found upon examination to be artificially colored. No statement of artificial color was present either upon the label or cap. Two cases of misbranding in which the bottler had used bottles bearing upon them blown in the glass the names of other firms have been found. Sufficient warning has been given in regard to this practice, and in this connection attention is particularly called to Official Inspections 37, containing the results of the inspection of carbonated beverages for 1911. On page 16 this kind of misbranding was particularly noted.

Sanitation.

Probably the worst feature in connection with the carbonated beverages manufactured and sold in the State at the present time is in connection with sanitation. One case observed during the past summer, and not yet settled, was that noted in the table which follows in which a dead fly was found in one of the bottles. Too large a proportion of the bottlers of the State are lax in their precautions against flies and dirt. In too many of the establishments screening precautions are not adequate and the cleansing and sterilization of the bottles before they are filled is not thoroughly done.

In all of the establishments visited during the past summer particular attention was given to the way in which bottles were washed and sterilized before being filled. Some of the bottlers were found to be thoroughly washing and sterilizing. In other cases it was claimed that it was impracticable to do the work in exactly the same manner as it was being done in other establishments. In this connection it is interesting to note what a practical bottler has to say upon this subject, and a quotation is given below from an address by Mr. A. J. Crowe, Hattiesburg, Miss., given in October, 1912, at New Orleans before the Twenty-fourth Annual Convention of the American Bottlers Protective Association. The extract is taken from *The American Bottler:*

"Every bottle should be inspected over an electric light after it is washed and filled. But to start at the first operation in the process of cleaning bottles a plant should be equipped with a soaking machine which carries the bottles through a ten-minute soaking in a hot solution of caustic soda, or some similar preparation that will thoroughly and practically destroy all germs and filth. No soaker is complete without a heating process, by which the caustic soda solution is always hot when the soaker is being operated. For a small plant, where a larger apparatus would be too expensive, or not practical for any reason, a small, inexpensive double-jacket stove, connected by two iron pipes, will do the work in a most satisfactory way, using coal as fuel, at a very small cost. This soaking should remove the rust from the neck of the bottle, and if it fails in this I would consider it a complete failure. I object to any revolving wheel or drum soaker, from which the bottles have to be removed by hand, because if a man's hand can stand the hot solution, the dirt and rust on the bottle necks and in the bottles can pass through without being removed."

"The soaker should be so constructed as to drop the bottles into a container of clear running water, then the strong solution is washed off so the bottle may be taken with a man's hand."

"Next the rinsing process should be done by some machine that forces a revolving bristle brush up into the bottle, because at times bottles will have hard-caked dirt inside that nothing but a brush will remove. Then all bristle brushes are apt to shed bristles, leaving one or more in the bottle occasionally, so it is necessary that the last process should be one of rinsing with clear water forced up into the bottle while in an inverted position—some kind of spring rinser. This process, by careful hands, insures a clean bottle now, but the bottle then has to be put in a container or conveyer and carried to the bottling table. Of course, they should be in an inverted position to drain all the rinsing water out of them, and great care should be exercised in the kind of conveyer or container we use for these bottles after all of the care in getting them clean. The mouth of the bottle may pick up a speck of foreign matter, which will be washed into the bottle in filling and show up as a speck in the finished product."

"When we get the bottle, still clean, to the man who is to fill it, we must use the utmost care to see that the man is clean and careful of how he fills the bottle. He should never start bottling without first having washed his hands and water should never be allowed to stand in the crown container or the crown machine, for such water will soon become dirty."

"If we succeed in keeping out dirt this far, we must now see that our syrup has been properly mixed and kept sanitary. That our water supply has been properly filtered or distilled, which is better. Then we must know that our carbonator has been blown out recently and that the carbonated water is coming to the bottle pure and clear, and that all tanks or reservoirs between the filter and carbonator are not allowed to go too long without cleaning."

"Next, we must see that the bottle caps or crowns have not been exposed to the open air, where dust has accumulated on the cork, for it will certainly wash off into the finished product if it is there. Now we are ready for the bottle to be inspected over the electric light, as explained above."

"This should be done by an intelligent boy or man who can see dirt. His eyesight must be perfect—he must be able to see and know dirt, and be on the alert always—he cannot do his work mechanically and get the necessary result. If the inspector finds a bottle that will not pass the closest inspection it should be "culled" and destroyed. It is better to lose a few bottles than a few customers. Keep one man as inspector as much of the time as possible, and if a dirty product gets by and you know of it place the responsibility, which you can do if only one man has been doing the inspecting."

"Be sanitary, and then let the public know it. Sanitary processes are the best advertisements we can have."

The attention of the trade is called in particular to the sanitary feature of the bottling business. Every bottler in the State is on the mailing list to receive the publications of this Station. Practically all of the bottling establishments in the State have been visited by the deputies, and practically all of the bottlers of the State have received letters and communications of various kinds from this office. The Maine Food Law states that a food is misbranded "if in the manufacture, sale, distribution, transportation, or in the offering or exposing for sale, distribution or transportation, it is not at all times securely protected from filth, flies, dust and other contamination, or other unclean, unhealthful or unsanitary conditions." This paragraph applies as much to the manufacturer of bottled sodas as it does to the baker of bread, and sanitary conditions must be maintained in all establishments in the State where foods are manufactured, stored, displayed or offered for sale. Bottling establishments should be well lighted; well ventilated; they should be kept clean and free from dust and cobwebs; flies should be excluded; only the cleanest and best of materials should be used, including the water, carbon dioxide, the syrups and flavors and colors; empty bottles should be thoroughly cleaned and sterilized before being refilled; the caps should be kept protected from dust and dirt; the labels and caps upon the bottles should tell the exact truth about the goods inside the bottles.

Samples Reported Upon.

The samples of carbonated beverages reported in the following table have been examined for saccharin and none has been found. All have been examined at to the nature of the color present with the results noted above. Some have been examined for alcohol, some for arsenic and some for various preservatives and none have been found. All have been found to be in accord with the requirements of the Maine Food Law so far as our examination extends except the cases noted in the table.

Table Showing the Results of Analyses of Samples of Soda Water Collected in Summer of 1912, Arranged Alphabetically by Towns.

Town and Manufacturer.	Samples analyzed.	Remarks.
Auburn, Vincent Bottling Co.	4	Case pending. Orange Julep misbranded because of no statement of artificial color.
Bangor, Bangor Bottling Co.	1	Passed.
Bangor, Copeland & Co.	1	Passed.
Bangor, F. E. Robinson.	1	Passed.
Bangor, J. L. Spratt.	2	Passed.
Bar Harbor, Mt. Kebo Spring Water Co.	2	Passed.
Bath, Bath Bottling Co.	2	Passed.
Bath, Hartleb & Cheltra.	2	Passed.
Biddeford, Hanscom Bottling Co.	3	Passed.
Brewer, Switzer Water Co.	2	Passed.
Brunswick, Pine Spring Water Co.	2	Passed.
Cherryfield, Washington County Bottling Co.	2	Passed.
Dexter, Leslie Curtis.	2	Passed.
Eastport, Frank Malloch.	2	Passed.
Greatworks, W. L. Butterfield.	2	Passed.
Lewiston, Highland Spring Co.	1	Passed. (Ginger Ale).
Lewiston, Maine Bottling Co.	3	Passed.
Lewiston, Somoar Carbonating Co.	4	Case pending. Dead fly in bottle. Adulterated.
Lubec, T. G. Mitchell.	2	Passed.
Norway, A. J. Nevers.	2	Passed.
Portland, Ingalls Bros.	3	Passed.
Portland, Murdock & Freeman Co.	5	Passed.
Rockland, C. E. Havener.	3	Passed.
Rockland, Hewett Bottling Co.	2	Case pending. Misbranded.
Rumford, Rumford Bottling Co.	4	Passed.
Rumford, Virginia Spring Bottling Co.	2	Passed.
Skowhegan, John J. O'Reilley & Son.	1	Passed.
Waterville, J. Tardiff & Son.	2	Passed.

ICE CREAM.

During the summer of 1912 a large number of samples of ice cream were collected in various parts of the State. An attempt was made to cover more thoroughly than ever before the larger towns. More samples than upon previous years have been examined. For the most part the larger manufacturers have been found putting out a good grade of ice cream.

Standards.

In considering this report it should be kept in mind that the standard for ice cream is as follows:

"Ice cream is a frozen product made from cream and sugar, with or without a natural flavoring, and contains not less than fourteen (14) per cent of milk fat. A limited amount of gelatine, starch, eggs, or other healthful food constituents may be added to ice cream without statement of fact, and such goods may be called Ice Cream provided the required per cent of milk fat is maintained. If imitation flavoring materials are used, the label must state that fact, as in the case of imitation extracts."

"Fruit ice cream is a frozen product made from cream, sugar, and sound, clean, mature fruits, and contains not less than twelve (12) per cent of milk fat."

"Nut ice cream is a frozen product made from cream, sugar, and sound, nonrancid nuts, and contains not less than twelve (12) per cent of milk fat."

"Imitation ice cream. Frozen products which contain less milk fat than the standards require, cannot be lawfully sold as ice cream and the word *cream* cannot be lawfully used upon the labels or in any way in connection with such goods, unless it is qualified by some such words as 'imitation' or 'substitute'. Thus a frozen product similar to ice cream or fruit or nut ice cream, except that it carries less milk fat than the standards, may be lawfully labeled 'Imitation ice cream', or 'Ice cream substitute'. If an imitation ice cream contains imitation flavoring matter, this fact must be plainly stated on the label."

"At soda fountains, ice cream rooms, etc., if it is desired to sell frozen products that do not conform to the standards for ice cream, conspicuous signs showing exactly what is being served must be displayed and orders for ice cream can not be lawfully filled by serving substitutes without explaining what they are."

"The regulation relative to ice cream and ice cream substitutes applies equally to hotels and restaurants. All statements upon bills of fare, etc., must be in accord with the above."

As in previous years it was found that in some cases low grade ice cream was caused by using low grade cream in its manufacture. People who make ice cream for sale should be careful to obtain a written guaranty from the person from whom they buy their cream certifying that such will be according to a certain strength, for in this way only can the manufacturer be sure of getting a uniform material.

Samples Reported Upon.

It will be noted upon an examination of the following table that in a number of instances cases have been settled by means of the payment of a fine. In other cases where the faults could be traced directly to the cream used and the manufacturer could fully satisfy the executive that all precautions had been observed the case was passed. In many cases second samples were obtained from the same dealer, and in such cases the dealer had no warning or knowledge that the second sample was to be obtained. The results obtained upon the second sample in such instances had a bearing upon the way in which the first case was settled. In several cases the manufacturers of low grade ice cream have promised not to make any more but to purchase from reputable dealers whenever they have occasion to sell ice cream in the future. In one case it will be noted that the sample was sold as "vanilla ice cream substitute," and was, therefore, properly labeled.

Table Showing the Results of Analyses of Ice Cream Purchased in the Summer of 1912, Arranged Alphabetically by Town and Dealer from Whom Purchased.

Station number.	Town and Dealer.	Milk fat per cent.	Remarks.
10868	Auburn, Round's Restaurant	14.93	Passed.
10870	Auburn, Fred L. Ruggles	15.26	Passed.
10869	Auburn, L. E. Tarr	12.07	Passed. Fruit ice cream.
10725	Bangor, A. L. Boyd & Son	16.05	Passed.
10728	Bangor, G. N. Brountas	17.76	Passed.
10724	Bangor, Buckley Drug Co	14.21	Passed.
10730	Bangor, C. H. Davis	10.80	From G. E. Lufkin.
10739	Bangor, Fifield & Co. (263 Main St.)	9.75	See second sample.
10740	Bangor, Fifield & Co. (267 Main St.)	9.74	See second sample.
10882	Bangor, Fifield & Co. (263 Main St.)	14.16	Passed.
10883	Bangor, Fifield & Co. (267 Main St.)	14.72	Passed.
10738	Bangor, Floros Bros	16.86	Passed.
10723	Bangor, Fowler's Drug Store	15.81	Passed.
10726	Bangor, J. P. Frawley	16.86	Passed.
10735	Bangor, Wm. M. George	5.12	Dealer promised to make no more. Case dropped.
10736	Bangor, L. H. Hamm	12.71	See second sample. From G. E. Lufkin.
10880	Bangor, L. H. Hamm	15.02	Passed. From G. E. Lufkin.
10727	Bangor, G. E. Lufkin	11.96	See second sample.
10881	Bangor, G. E. Lufkin	14.76	Passed.
10741	Bangor, S. Shiro	13.03	Dealer warned.
10737	Bangor, C. S. Vafiades	14.52	Passed.
10729	Bangor, H. A. Witham	15.80	Passed.
10851	Bath, Octave Breton	10.58	Dealer fined.
10847	Bath, J. F. Clary	14.27	Passed.
10849	Bath, Bath Home Bakery	12.44	Difficulty apparently with cream. Case dropped.
10848	Bath, Leonard & Mitchell	14.44	Passed.
10852	Bath, Swett's Drug Store	11.60	Dealer fined.
10850	Bath, Webber's Drug Store	14.56	Passed.
10781	Biddeford, G. & A. Boucher	7.20	Dealer fined.
10784	Biddeford, Thomas Christo	15.90	Passed.
10779	Biddeford, P. Frediani	12.06	See second sample.
10865	Biddeford, P. Frediani	16.54	Passed.
10782	Biddeford, A. Mantis	13.39	Dealer warned.
10780	Biddeford, H. L. Merrill	15.24	Passed.
10783	Biddeford, E. Partigliani	12.28	From P. Frediani.
10778	Biddeford, Geo. Vassill	14.46	Passed.
10799	Brewer, Willis G. Barker	20.48	Passed.
10795	Brewer, Boynton's Pharmacy	10.27	See later samples, also text.
10884	Brewer, Boynton's Pharmacy	11.13	See later sample.
19025	Brewer, Boynton's Pharmacy	19.04	Passed.
10796	Brewer, W. H. Croft	13.49	Dealer warned.
10793	Brewer, S. N. Dooey	18.91	Passed.
10794	Brewer, G. G. Hodgkins	13.18	Dealer warned.

Table Showing the Results of Analyses of Samples of Ice Cream Collected in Summer of 1912, Arranged Alphabetically by Towns—Continued.

Station number.	Town and Dealer.	Milk fat, per cent.	Remarks.
10801	Brewer, Merrill Drug Co.	14.17	Passed.
10798	Brewer, G. Myers	16.79	Passed.
10800	Brewer, B. N. Rowe	7.44	See second sample, also text.
10885	Brewer, B. N. Rowe	13.75	Passed with warning.
10797	Brewer, T. G. Seymour	14.20	Passed.
10846	Brunswick, H. J. Given	9.85	Cream used apparently responsible.
10845	Brunswick, F. E. Hall	11.87	Cream used apparently responsible.
10719	Cape Elizabeth, Anderson Bros.	15.22	Passed.
10716	Cape Elizabeth, J. W. Armstrong	12.72	From West End Dairy Co., Portland, Me.
10803	Ellsworth, C. H. Leland	17.17	Passed.
10805	Ellsworth, H. W. Morey	17.00	Passed.
10804	Ellsworth, Mrs. Joseph Luchini	9.27	Misunderstanding regarding formula.
10871	Lewiston, C. Bilodeau	15.96	Passed.
10875	Lewiston, E. Gregoraky	9.77	Case pending.
10872	Lewiston, A. E. Harlow	14.76	Passed.
10876	Lewiston, Kouranos Bros.	13.27	Dealer warned.
10874	Lewiston, Lewiston Candy Kitchen	13.86	Dealer warned.
10873	Lewiston, H. F. Walker	13.66	Dealer warned.
10771	Old Town, F. X. Boutin	13.47	Dealer warned.
10769	Old Town, H. I. Goldsmith	11.45	Nut ice cream. Dealer warned.
10768	Old Town, Jordan Bros	11.21	Difficulty apparently with cream. See other samples from same manufacturer.
10773	Old Town, Morin Bros	16.08	Passed.
10774	Old Town, W. C. Mutty	13.65	Dealer warned.
10775	Old Town, (Stillwater) H. C. Sibley	15.15	Passed. From Jordan Bros.
10770	Old Town, L. Solomon	10.08	Misunderstanding regarding formula.
10772	Old Town, Wm. Tear	15.42	Passed. From Jordan Bros.
10802	Orono, J. Edward Jordan	8.02	See text.
10791	Portland, J. F. Bennett	14.04	Passed.
10700	Portland, Chapman & Wyman	16.16	Passed.
10705	Portland, B. R. Cleveland	14.43	Passed.
10760	Portland, Thomas Cristo	2.62	See text.
10711	Portland, Dudley-Weed Drug Co	11.80	From West End Dairy Co. Manufacturers fined.
10690	Portland, S. Elowitch	11.16	From Geo. F. Soule.
10861	Portland, B. Feldman	11.80	See second sample.
10940	Portland, B. Feldman	15.53	Passed.
10707	Portland, Nicola Fraschia	9.76	From B. Herberman, Portland.
10709	Portland, Jake Gitlin	15.93	Passed.
10712	Portland, Hammond Drug Co.	13.02	Passed. Fruit ice cream.
10717	Portland, Heseltine & Tuttle Co.	13.69	Dealer warned.
10699	Portland, H. H. Hay Sons	16.66	Passed.
10788	Portland, T. Hilton	14.36	Passed.
10720	Portland, I. F. Lord	19.04	Passed.
10706	Portland, O. S. Maxell	14.66	Passed.
10790	Portland, E. C. McDonough	15.60	Passed.
10691	Portland, Joe Menario	3.01	See text.
10695	Portland, John C. Otis	14.03	Passed.
10708	Portland, Michael Paolino	3.76	Dealer fined.
10789	Portland, Frank H. Power	13.62	Dealer warned.
10689	Portland, F. D. Ricker	16.00	Passed.
10696	Portland, B. S. Rosenburg	11.51	From West End Dairy Co. Manufacturer fined.
10792	Portland, B. S. Rosenberg	14.09	Passed. From West End Dairy Co.
10698	Portland, Geo. E. Sawyer	15.39	Passed.
10718	Portland, J. G. Sawyer	11.01	See second sample.
10765	Portland, J. G. Sawyer	14.03	Passed.
10714	Portland, Smith & Broe	14.30	Passed. From Pierce Ice Cream Co.
10719	Portland, Geo. F. Soule	10.88	Difficulty apparently with cream.
10713	Portland, A. G. Spear	14.12	Passed.
10701	Portland, John M. Stevens	13.67	Passed. Fruit ice cream.
10862	Portland, H. L. Stimson	14.87	Passed.

Table Showing the Results of Analyses of Samples of Ice Cream Collected in Summer of 1912, Arranged Alphabetically by Towns—Concluded.

Station number.	Town and Dealer.	Milk fat, per cent.	Remarks.
10710	Portland, Chas. B. Thomas........	8.61	Dealer fined.
10758	Portland, John J. Thuss...........	17.92	Passed.
10721	Portland, J. Vonyik...............	15.66	Passed.
10692	Portland, John Zakarian..........	4.16	Dealer fined.
10826	Portland, A. H. Allen.............	11.21	Difficulty apparently with cream.
10827	Rockland, Chas. Haskell...........	9.68	From Mrs. E. W. Thurlow, Rockland. Manufacturer fined.
10825	Rockland, Walter Larrabee........	14.26	Passed.
10824	Rockland, J. H. Meservey.........	10.06	Misunderstanding regarding formula.
10822	Rockland, Rockland Confectionery Co..........................	14.64	Passed.
10823	Rockland, C. M. Tibbets..........	6.34	Dealer fined
10828	Rockland R. J. Whitney..........	7.24	Sold as "vanilla ice cream substitute."
10776	Saco, J. Z. Beckwith..............	13.74	Dealer warned.
10777	Saco, S. W. Gordon, Urvanta Lunch	6.36	Dealer fined.
10866	Saco, S. W. Gordon, Urvanta Lunch	13.38	Dealer warned.
10829	Waterville, Lewis Facos...........	15.81	Passed.
10833	Waterville, W. H. Hager..........	15.16	Passed.
10830	Waterville, Silvio Paganucci.......	18.91	Passed. From Verzoni Bros.
10831	Waterville, E. L. Simpson.........	14.17	Passed.
10832	Waterville, Verzoni Bros..........	14.27	Passed.

CREAMS USED IN THE MANUFACTURE OF ICE CREAM.

During the investigation of ice cream the present season the cream used in its manufacture has also been investigated as far as possible. This is particularly true of those cases where the ice cream was found to be below standard. Where possible in such cases the cream itself was sampled and in some cases it was ascertained that the trouble of the manufacturer of ice cream was apparently due to the fact that the cream used was not as rich as it was supposed to be. A special law places the standard for cream at 18 per cent milk fat. As has been repeatedly stated to the trade, a cream of this strength used in connection with the proper amount of sugar, flavoring, and a slight amount of filler, will make an ice cream which carries between 14 and 15 per cent of milk fat.

No attempts at prosecution have been made relative to the samples of cream reported in the following table, although it will be noted that a few are below the standard for cream. In the table the figures given represent the cream which the dealer was supposed to be buying and also the actual strength of the cream determined by analysis.

Table Showing Results of Analyses of Samples of Creams Purchased for Making Ice Cream, Arranged Alphabetically by Towns and Dealer from Whom Purchased.

Station number.	Town and Dealer.	Town and Person from Whom Dealer Purchased.	Purchased for per cent.	Found—per cent.
10687	Augusta, J. G. Johnson	Winthrop, C. H. Higgins	22	21
10818	Bangor, Fifield Drug Co.	Bangor, C. H. Morrison	Thin cream	16.78
10641	Bangor, C. S. Preble	Bangor, L. E. Brown	40	40
10731	Biddeford, P. Frediani	Auburn, Turner Center Creamery Association	18	18.5
10732	Biddeford, H. L. Merrill	Auburn, Turner Center Creamery Association	20	20
10864	Biddeford, H. L. Merrill	Auburn, Turner Center Creamery Association	20	20.8
10640	Brewer, W. H. Croft	Orrington, Norris Hillier	20	16.5
10926	Brewer, G. G. Hodgkins	Bangor, Maine Creamery Assoc.	40	40
10679	Calais, H. D. McKay	Baring, J. E. Haywood	Cream	26
10836	Ellsworth, Mrs. J. Luchini	Ellsworth, A. W. Maddocks	Cream	23.5
10756	Portland, Heseltine & Tuttle Co.	Portland, Maine Dairy Co	20	16.8
10821	Portland, Heseltine & Tuttle Co.	Portland, Portland Creamery	20	20
10754	Portland, C. C. Pooler	Portland, Maine Dairy Co	18	18
10755	Portland, C. C. Pooler	Portland, Maine Dairy Co.	22	21
10763	Portland, C. C. Pooler	Portland, Maine Dairy Co.	18	17.2
10764	Portland, C. C. Pooler	Portland, Maine Dairy Co.	22	20.8
10702	Portland, Portland Creamery	Various sources	18	18
10697	Portland, Geo. E. Sawyer	Portland, Portland Creamery	18	18
10761	Portland, John G. Sawyer	Portland, Portland Creamery	18	17.9
10820	Portland, John G. Sawyer	Portland, Portland Creamery	18	17.7
10694	Portland, Simmons & Hammond	Island Pond, Vt., Brighton Creamery	18	19.6
10693	Portland, Geo. F. Soule	Island Pond, Vt., Brighton Creamery	18	17.8
10819	Portland, Geo. F. Soule	Portland, Portland Creamery	18	18.1
10757	Portland, John J. Thuss	Auburn, Turner Center Dairying Association	20	20.8
10704	Portland, West End Dairy Co.	Colebrook, N. H., Mohawk Dairy Co	17	15.6
10877	Rockland, J. H. Meservey	Source unknown	–	45
10674	Rockland, E. J. Whitney	Rockland, A. M. Mayo	Cream	19.2
10863	Saco, S. W. Gordon, Urvanta Lunch	Portland, Portland Creamery	18	18.1
10683	Waterville, E. L. Simpson	Waterville, Shrewsbury Farm Dairy Co	20	18.5
10684	Waterville, Verzoni Bros	Waterville, Patterson Bros	22	22