THIRTY-SECOND ANNUAL REPORT

OF THE

Maine Agricultural Experiment Station

ORONO, MAINE

1916

STATE OF MAINE.

1917

MAINE AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

ORGANIZATION JANUARY TO JUNE, 1916.

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	WALTER E. CURTIS,	*Scientific Aid*
	ROYDEN L. HAMMOND,	*Seed Analyst and Photographer*
	CHARLES C. INMAN,	*Assistant*

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*Died February 23, 1916.

†In collaboration with U. S. Department of Agriculture.

MAINE AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

ORGANIZATION JULY TO DECEMBER, 1916.

THE STATION COUNCIL.

THE STATION STAFF.

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	WALTER E. CURTIS,	*Scientific Aid*
ROYDEN L. HAMMOND,		*Seed Analyst and Photographer*
CHARLES C. INMAN,		*Assistant*

†In collaboration with U. S. Department of Agriculture.

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

Agricultural Experiment Station,

Orono, Maine.

CONTENTS.

ANNOUNCEMENTS.

Establishment of the Station.

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

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.

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

Offices and Laboratories.

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

Aroostook Farm.

By action of the Legislatures of 1913 and 1915 a farm was purchased in Aroostook County for scientific investigations in agriculture to be under "the general supervision, management, and control" of the Maine Agricultural Experiment Station. The farm is in the town of Presque Isle, about two miles south of the village, on the main road to Houlton. The Bangor and Aroostook railroad crosses the farm. A flag station, "Aroostook Farm," makes it easily accessible by rail.

The farm contains about 275 acres, about half of which is cleared. The eight room house provides an office and home for the farm superintendent. A school house on a lot adjoining the farm was presented to the State by the town of Presque Isle and after being remodeled serves as a boarding house for the help. A green house has been erected at the farm by the U. S. Department of Agriculture for use in coöperative work on potato breeding. The large barn affords storage for hay and grain and has a large potato storage house in the basement.

Highmoor Farm.

The State Legislature of 1909 purchased a farm upon which the Maine Agricultural Experiment Station "shall conduct scientific investigations in orcharding, corn, and other farm crops." The farm is situated in the counties of Kennebec and Androscoggin, largely in the town of Monmouth. It is on the Farmington Branch of the Maine Central Railroad, two miles from Leeds Junction. A flag station, "Highmoor," is on the farm.

The farm contains 225 acres, about 200 of which are in orchards, fields, and pastures. There are in the neighborhood of 3,000 apple trees upon the place which have been set from 20 to 30 years. Fields that are not in orchards are well adapted to experiments with corn, potatoes, and similar general farm crops. The house has two stories with a large wing, and contains about 15 rooms. It is well arranged for the Station offices and for the home of the farm superintendent. The barns are large, affording storage for hay and grain. The basement affords limited storage for apples, potatoes and roots. A substantially constructed building for apple packing was erected in 1912.

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 and in scientific journals, both foreign and domestic. The bulletins for the year make up the annual report. 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 members of the staffs of other Stations and the U. S. Department of Agriculture who asks for them, to all newspapers in Maine, 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 those on the exchange list outside of the State.

BULLETINS ISSUED IN 1916.

No. 246 Field Experiments in 1915. 36 pages.
No. 247 Report of Jersey Sires' Futurity Test. 16 pages.
No. 248 Life Histories of Leafhoppers of Maine. 30 pages, 13 illustrations.
No. 249 Six Years of Experimental Apple Spraying at Highmoor Farm. 16 pages.
No. 250 Studies on Oat Breeding. IV. Pure Line Varieties. 52 pages. 11 illustrations.
No. 251 Control of Apple Maggot by Poisoned Spray Bait. 20 pages. One illustration.
No. 252 Spraying Experiments and Apple Diseases in 1915. 24 pages. 3 illustrations.
No. 253 Syrphidae of Maine. 72 pages. 10 illustrations.
No. 254 Studies on Life Histories of Froghoppers of Maine. 24 pages. 13 illustrations.
No. 255 Dwarf Eggs of the Domestic Fowl. 40 pages. 8 illustrations.
No. 256 Elm Leaf Rosette and Woolly Aphid of Apple. 16 pages. 27 illustrations.

OFFICIAL INSPECTION ISSUED IN 1916.

No. 75 Fungicides and Insecticides. 8 pages.
No. 76 Ice Cream. Evaporated Milk. 12 pages.
No. 77 Extracts and Spirits. 20 pages.
No. 78 Clams, Oysters and Scallops. 12 pages.
No. 79 Commercial Feeding Stuffs, 1915-6. 84 pages.
No. 80 Commercial Fertilizers, 1916. 80 pages.

MISCELLANEOUS PUBLICATIONS ISSUED IN 1916.

No. 522 Spraying Potatoes in 1916. 12 pages.
No. 523 The preparation and Use of Lime Sulphur in Orchard Spraying. 11 pages.
No. 524 Poisoned Sprays as a Bait for the Fly of the Apple Maggot 4 pages.
No. 525 Apple Insects of Maine. 75 pages.
No. 526 New Varieties of Oats. 7 pages.
No. 527 List Station Publications. 4 pages.
No. 528 Spruce Budworm. 11 pages.
No. 529 Available Bulletins of Station. 4 pages.
No. 530 Dwarf Eggs. 4 pages.
No. 531 Potato Growing and Potato Diseases from Maine to California. 20 pages.

BIOLOGY PUBLICATIONS, 1916.

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

93. On a Method of Correcting for Soil Heterogeneity in Variety Tests. By Frank M. Surface and Raymond Pearl. Jour. Agr. Research, Vol. 5, No. 22, pp. 1039-1050.
94. Fecundity in the Domestic Fowl and the Selection Problem. By Raymond Pearl. Amer. Nat., Vol. I, pp. 89-105.
95. Studies on Oat Breeding. III. On the Inheritance of Certain Glume Characters in the Cross *Avena fatua* x *Avena sativa* var. Kherson. By Frank M. Surface. Genetics, Vol. I, pp. 252-286.
96. Studies on Oat Breeding. IV. Pure Line Varieties. By Frank M. Surface and Jacob Zinn. Me. Agr. Expt. Ann. Rept. for 1916, pp. 97-148.
97. Studies on the Physiology of Reproduction in the Domestic Fowl. XVI. Double Eggs. By Maynie R. Curtis. Biol. Bul., Vol. XXXI, No. 3, pp. 181-206.
98. Studies on the Physiology of Reproduction in the Domestic Fowl. XV. Dwarf Eggs. By Raymond Pearl and Maynie R. Curtis. Jour. Agr. Research, Vol. VI, No. 25, pp. 977-1042.
99. A Note on the Inheritance of Eye Pattern in Beans and Its Relation to Type of Vine. By Frank M. Surface. American Naturalist, Vol. L, No. 598, pp. 577-586.

Papers published but not in the numbered series:

a. Methods of Poultry Management at the Maine Agricultural Experiment station (Revised to January, 1916). By Raymond Pearl. Me. Agr. Expt. Stat. Circ. 515, pp. 1-98.

b. On the Effects of Feeding Pituitary Body (Anterior Lobe) Substance, and Corpus Luteum Substance to Growing Chicks. By Raymond Pearl. Proc. Nat. Acad. Sci., Vol. 2, pp. 50-53.

c. On the Degree of Inbreeding which Exists in American Jersey Cattle. By Raymond Pearl and S. W. Patterson. Proc. Nat. Acad. Sci., Vol. 2, pp. 58-61.

d. Report of the First Jersey Sires Futurity Test of the Aroostook Jersey Breeders Association. By Raymond Pearl. Me. Agr. Expt. Stat. Bul. 247, pp. 37-52.

e. On the Effect of Continued Administration of Certain Poisons to the Domestic Fowl, with special reference to the Progeny. By Raymond Pearl. Proceedings American Philosophical Society, Vol. LV, pp. 243-258.

f. The Separate Inheritance of Plumage Pattern and Pigmentation in Plymouth Rocks. By Raymond Pearl. Practical Husbandry of Maine, Vol. VI, pp. 567-568.

g. The Animal Breeding Industry. By Raymond Pearl. Scientific Monthly, Vol. 3, pp. 23-30.

h. The Effect of Parental Alcoholism (and certain other Drug Intoxications) upon the Progeny in the Domestic Fowl. By Raymond Pearl. Proceedings National Academy of Sciences, Vol. 2, pp. 380-384.

i. On the Inheritance of Certain Glume Characters in the Cross *Avena fatua* x *A. sativa* var. Kherson. By Frank M. Surface. Proceedings National Academy of Sciences, Vol. 2, pp. 478-484.

j. Data on the Relation of the Corpus Luteum to Primary and Secondary Sex Characters. A Summary of Some Recent Experimental Work. By Raymond Pearl. Urologic and Cutaneous Review. Technical Supplement. Vol. 4, pp. 29-37.

k. Dwarf Eggs of the Domestic Fowl. By Raymond Pearl and Maynie R. Curtis. Me. Agr. Expt. Stat. Bul. 255, pp. 289-328.

ENTOMOLOGICAL PAPERS FROM THE MAINE AGRICULTURAL EXPERIMENT STATION, 1916.

Ent. 82. Psyllid Gall on Juncus (*Livia maculipennis* Fitch). By Edith M. Patch. Psyche, Vol. XXIII, No. 1.

Ent. 84. Concerning Problems in Aphid Ecology. By Edith M. Patch. Journal of Economic Entomology, Vol. 9, No. 1.

Ent. 85. Studies of Life Histories of Leafhoppers of Maine. By Herbert Osborn. Bul. 248, Me. Agr. Exp. Station.

Ent. 86. Control of Apple Maggot by Poisoned Bait Spray. Soluble Poisons in the Poisoned Bait Spray to control the adult of the Apple Maggot. By Henry H. P. Severin. Bul. 251, Me. Agr. Exp. Station.

Ent. 87. Syrphidae of Maine. By C. L. Metcalf. Bul. 253, Me. Agr. Exp. Station.

Ent. 89. Studies of Life Histories of Froghoppers of Maine. By Herbert Osborn. Bul. 254, Me. Agr. Exp. Station.

Ent. 91. Elm Leaf Rosette and Woolly Aphid of the Apple. By Edith M. Patch. Bul. 256, Me. Agr. Exp. Station.

BULLETIN 246.

FIELD EXPERIMENTS.

Reported by Chas. D. Woods.

The work of investigation at the two experiment station farms (Aroostook Farm, Presque Isle, and Highmoor Farm, Monmouth) is planned by the Director, the Biologists, the Plant Pathologist and the Entomologist. The results of the more scientific phases of the studies are reported from time to time in the bulletins, but it always happens that there are results obtained that lie somewhat outside of the lines of work of any of the Station specialists. Some of the more popular and practical results are here reported. The carrying out of these experiments and the taking of the requisite notes devolved upon different members of the Staff. In general the field work was carried out under the direction of the farm superintendents.

It is planned to report the more scientific aspects of the oat breeding investigations in a bulletin to be published later in the present year.

Drawing Conclusions from Field Experiments.

Field experiments at the best are somewhat uncertain because there are so many factors of soil, temperature, rainfall, and the like, that affect the results which are beyond the control of the experimenter. For this reason it is always planned at this Station to carry the same experiment under as nearly as possible the same conditions through a series of years before attempting to draw any very definite conclusions. The results here reported should be considered more in the light of reports of progress than of completed studies. It may happen that the teaching that a single year's results seem to warrant may be reversed by the repetition of the experiment in other years under different climatic or other conditions.

Fertilizer Experiments on Apple Trees at Highmoor Farm.

As it is pretty generally known, when the State purchased Highmoor Farm it had something over 3,500 apple trees upon it. These trees were about twenty-five years old, but for the most part had been completely neglected, as regards pruning, fertilization, culture and spraying. The first season that the Station had the farm the orchards were plowed, cultivated and sprayed. Pruning was begun and has been continued until at the present time the orchards are in pretty fair shape. It was, of course, not desirable or practical to thin the trees out at the start to where they should be at the end, but the pruning while rather severe each year has been gradually decreased in amount.

The orchards were annually fertilized at the rate of 1,000 pounds per acre of a commercial fertilizer carrying 4 per cent of nitrogen, 8 per cent of available phosphoric acid and 7 per cent potash. At the end of the third year the orchards had so far responded that they gave a good crop and since that time fertilizer experiments have been carried on in various portions of the orchards, as follows:

The use of highly nitrogenous fertilizers has been advocated as a means of forcing trees into bearing and in some parts of the State has been tried with results that seemed to be gratifying. This method was first suggested by Doctor Fisher of Massachusetts and was tried by the Station several years ago in cooperative work with Mr. Pope in his orchard at Manchester without very decisive results. At Highmoor Farm a row of 32 Baldwin trees was divided into three sections. The trees were treated alike so far as the application of standard fertilizer was concerned, but 10 of the trees at each end of the row received in addition nitrate of soda at the rate of 100 pounds per acre. Also the Baldwin orchard was divided into two parts so that part of it received the usual treatment and in addition received 100 pounds of nitrate of soda per acre per year.

Exact records of yields and measurements of growth have been taken since the experiment was begun. No differences that could be attributed to the additional nitrogen in the fertilizer have been noticed. It may be that when at the end of a period of years the data are carefully analyzed, results may be found that are not noticeable from general observations. The experiment will be continued in 1916.

In experiments carried out at the New York State Experiment Station it has been found that with their deep clay soils well suited to apple tree growth and apple bearing, there is no effect from the use of fertilizers either upon the growth of young trees, the wood growth on matured trees, or in the amount, coloring, or size of the fruit. To see if anything like this would hold with Maine conditions, particularly with the rather shallow soil and with the stubborn subsoil upon Highmoor Farm, an experiment was begun in 1912. It is to be remembered that the orchard had been cultivated and fertilized for the three preceding years and brought into good condition. About 400 trees were divided into three plots containing 12 rows extending clear across the large No. 1, Ben Davis orchard. Plot A (rows 1 to 4) has received no fertilizer since 1912. Plot B (rows 5 to 8) has received annually since 1912, 500 pounds per acre of a fertilizer carrying 4 per cent of nitrogen, 8 per cent of available phosphoric acid and 7 per cent of potash. Plot C (rows 9 to 12) has received annually since 1912, 1,000 pounds per acre of a commercial fertilizer carrying 4 per cent of nitrogen, 8 per cent of available phosphoric acid and 7 per cent of potash.

Careful records of growth shown by measure, and of yields of fruit as shown by weight, are made of all of the trees in the orchards at Highmoor Farm. No person examining the twelve rows of apple trees, part of which have been fully fertilized, part partially fertilized and part not fertilized at all for the past three years, could detect differences whereby he would be able to pick out the treated from the untreated rows.

Each tree occupies 25x25 ft. or 625 sq. ft. This is about 70 (69.5) trees per acre. At the rate of 1,000 lbs. per acre this is 14.4 lbs. per tree. Fertilizer at $40 per ton costs 2 cents a pound, making a total cost of 28.8 cents per tree, not allowing for the cost of application.

The crop on this orchard was too small in 1913 to give results that could have any meaning on the apple bearing of the trees. In 1914 and in 1915 there were fair crops and while from observation no differences were apparent, the actual yields of fruit were larger on the fertilized plots. The yields are given in the table that follows, but it will apparently be necessary to wait a number of years before decisive results are obtained. The yields for 1915 show consistent increase with the amount of fertilizer applied.

Orchard Fertilizer Experiment
Yields of Apples in Pounds Per Tree.

Plot No.	1914		1915		2-year average yield per tree.—Lbs.
	No. trees.	Average yield per tree.—Lbs.	No. trees	Average yield per tree.—Lbs.	
6A	132	172.8	132	121.1	147.0
6B	129	158.8	130	131.8	145.3
6C	123	194.2	124	157.4	175.8

It is to be remembered that in all of these experiments nothing has been grown upon the land except apple trees and apples. An orchard cover crop of rye is sown in the fall, is plowed under early in the spring, and the land is kept cultivated until well into August when the cover crop is again sown. The plant food stored up in the wood growth and that which has been removed in the apple crop has been taken from the soil, but beyond that the soil has not been made to pay tribute to any other crop.

This experiment is to be continued for many years, or until decisive results are obtained and the unfertilized rows show evidence of need of plant food.

Acid Phosphate and Florida Rock as Fertilizer for Oats.

Shortly before planting time in the spring of 1915 the Station was asked to test the efficiency of raw phosphate on Aroostook Farm. The experiments for the year had already been planned and the land remaining was not very suitable for experimental purposes. However, it was decided to make a preliminary test of acid phosphate and raw ground Florida rock, using oats as the test crop.

Four one-half acre plots were laid out on as even a piece of ground as could be obtained. The plots were crossed by a small runway in which there was some water shortly before planting. Even at the time of planting a strip about 50 feet wide in each plot was quite wet. Over this area the stand was quite poor and the yield was undoubtedly greatly affected. However, since the conditions were practically the same in each plot, the results are comparable one with another. The absolute yield is lower than that obtained on more favorable soil.

The land had been plowed the preceding fall. In order to insure a supply of nitrogen, a good coating of manure was applied to the two acres in the spring and the land plowed again.

All plots were seeded with Prosperity oats using 3 bushels to the acre. Owing to the pressure of other work it was found impossible to thresh the grain from each plot separately. Instead the total weight of the unthreshed grain from each plot was recorded. In this way a very good estimate of the yield of grain can be obtained.

Of the 4 plots, the first received no commercial fertilizer at all. The second plot received 150 pounds of a 16 per cent acid phosphate. This is equivalent to about 48 pounds of *available* phosphoric acid per acre. The third plot received finely ground Florida rock phosphate at the rate of 500 pounds per acre. This raw rock analyzed about 31.45 per cent of total phosphoric acid, making the application of *total* phosphoric acid about 150 pounds per acre. The fourth plot received a 5-8-7 commercial fertilizer at the rate of 500 pounds per acre.

The first 3 plots yielded at approximately the same rate. The total weight of the straw and grain from these plots was at the rate of about 2,800 pounds per acre. This corresponds with a grain yield of about 40 bushels per acre. The variations between the yields of the different plots were not great enough to be significant. The fourth plot which received the complete fertilizer gave 3,900 pounds of grain and straw per acre. This corresponds to a yield of about 56 bushels of grain. This shows an increase of 16 bushels or 40 per cent over the plots receiving no fertilizer or phosphoric acid alone.

The results of this experiment indicate that phosphoric acid is not a controlling factor in the yield of oats under Aroostook Farm conditions. There was no significant difference between the yield of the control plot and the plots containing either acid phosphate or Florida rock. When a complete fertilizer was used, however, a very significant increase (40 per cent) in the yield occurred. The experiment was not planned in such a way as to indicate whether this latter increase was due to the nitrogen or to the potash.

It is not expected to repeat this experiment in 1916. But it is planned to begin the preliminary cropping of a suitable area for the purpose of establishing a series of plot experiments with fertilizers at Aroostook Farm. Raw phosphates will be used on some of these plots.

Commercial Varieties of Oats at Aroostook Farm in 1915.

A preliminary test of different varieties of oats was carried out on Aroostook Farm in 1914. For several reasons the results obtained in 1914 were not entirely satisfactory. The farm was purchased very late in the fall of 1913 and there was little opportunity to learn anything by observation of the land until planting time was come. Because of everything being new to the staff it was impossible to get the oats planted as early as they should have been. The very loose character of the soil allowed the heavy disk drill used in seeding to put the seed too deeply in the ground. All of these things tended to lower the yields.

In 1915 the work at the Farm was very much better organized and more favorable results were obtained. Fifteen different varieties were grown each in a single half acre plot. These varieties were all sown with a large disk drill. In order to prevent the seed going into the ground too deep the land was rolled before drilling. The seeding was at the rate of 3 bushels per acre.

The yields for the year are given in the table that follows.

Tests of Commercial Varieties of Oats at Aroostook Farm in 1915.

Variety.	Grain—Bushels per acre	Straw—Pounds per acre
Early Pearl	73.7	2543
Siberian	70.6	2622
Kherson	67.6	2173
Prosperity	66.7	2504
Silver Mine	64.9	2294
Maine No. 246	62.3	2531
Ligowo	62.1	2294
Gold Rain	61.5	2241
Daubeney	60.8	2420
Banner	55.9	2032
Irish Victor	53.5	2032
Garton No. 5	52.9	2275
Imported Scotch	49.9	1788
Senator	49.9	2734
Swedish Select	49.5	1787
Average	60.1	2285

It will be noted that the two highest yielding varieties were the Early Pearl and the Siberian, 74 and 71 bushels per acre respectively. These two varieties are the latest maturing varieties in our collection. It was supposed that some of the earlier maturing varieties would prove best for Aroostook. For the present year such does not seem to have been the case. It is, however, unsafe to generalize upon the results of one year. The use of early varieties has much to commend it for Aroostook conditions. The earlier varieties mature in time so that harvesting does not interfere with potato digging, while many of the later varieties are not ready to harvest before that time.

The variety which ranked third in this year's test was the Kherson with a yield of 68 bushels. The Kherson is one of the early varieties, maturing about 10 days before the medium varieties. The Daubeney, another early variety, gave 61 bushels per acre. The Kherson is a yellow oat, while the Daubeney is a white. They mature at about the same time.

The Prosperity variety gave 67 bushels per acre. This variety is being used as a farm oat at the present time. It is a very good standard variety, maturing in about 110 days in Aroostook.

The Silver Mine, Gold Rain, Ligowo and Maine No. 246 yielded above 60 bushels per acre. The latter variety is one of our own breeding produced at Highmoor Farm.

The Banner, Irish Victor and Garton No. 5 yielded in the neighborhood of 55 bushels and the remaining varieties, Imported Scotch, Senator and Swedish Select, gave about 50 bushels per acre.

It is expected to continue these experiments in 1916. After the results of several seasons have been obtained, they will undoubtedly indicate which of the more common commercial varieties are best adapted to Aroostook conditions. At the same time efforts are being made to breed new varieties which will be still better adapted to Aroostook conditions. It is clear that there is a need for such varieties, for the yields so far obtained at Aroostook Farm are 10 to 15 bushels per acre less than obtained at Highmoor Farm. It is not believed that these are by any means the maximum that might be expected from well adapted varieties.

Commercial Varieties of Oats Grown at Highmoor Farm in 1915.

The Maine Agricultural Experiment Station has been conducting tests of commercial varieties of oats at Highmoor Farm since 1910. The detailed results of these tests for the four years 1910 to 1913 inclusive have been published in Bulletin 229. The results of the 1915 tests are now available and show many interesting points.

The method used by the Station in recent variety tests has been to plant four plots of each variety. Each plot contains 1-40 of an acre, making in all 1-10 of an acre devoted to each variety. The four plots of a variety are placed in different parts of the field so that the yield of any one variety is less likely to be affected by differences in soil conditions. The average of the four plots is taken as the yield of a given variety for that year.

For a number of years past as many as 20 or more commercial varieties of oats have been tested each year. Owing to the necessity for testing upon a larger scale a number of new varieties of our own breeding this year, it was necessary to decrease the number of commercial varieties in the test. Eleven different commercial varieties were tested in 1915. The majority of these were chosen because of their good yields in former years. A few, like the Kherson and the Senator, were chosen because they represent distinct types of oats.

The yields with the varieties arranged in order of the 3 year average yields are given in the table that follows.

Yields Per Acre of Commercial Varieties of Oats Tested at Highmoor Farm 1913-1915.

Variety.	3-year average Bush.	1915 Yield.	
		Oats Bush.	Straw Lbs.
Early Pearl	84.6	86.6	3723
Minnesota No. 26	83.5	81.7	3460
Gold Rain	81.2	79.8	3623
Banner	80.3	83.3	3605
Irish Victor	77.0	75.4	3107
Siberian	76.0	77.8	4001
Prosperity	75.0	74.5	3436
Imported Scotch	72.2	64.7	2275
Swedish Select	70.7	68.3	3648
Kherson	67.5	64.8	3105
Senator	64.4	55.8	3237
Average	75.7	73.9	3384

The season of 1915 proved to be very good for oats at Highmoor Farm. The yields were not quite so high as in 1914. Part of this was due to the heavy rains at the time of harvest which injured the grain to some extent. Individual plots yielded at the rate of from 50 to 97 bushels per acre.

The variety showing the highest average yield was the Early Pearl. This averaged to yield at the rate of 87 bushels per acre. Three other varieties yielded 80 bushels per acre or above in 1915. These were the Banner (83 bushels), Minnesota No. 26 (82 bushels), and the Gold Rain (80 bushels). Three of these varieties, the Early Pearl, Minnesota No. 26 and the Gold Rain, have headed the list of commercial varieties for the past 3 years. Last year the Minnesota No. 26 ranked first, the Gold Rain second, and the Early Pearl third. The average yield for the 4 years in which these 3 varieties have been tested are the Early Pearl, 82 bushels; Minnesota No. 26, 79 bushels; Gold Rain, 76 bushels.

These 3 varieties are exceptionally promising for central and southern Maine. So far as yield is concerned there is little to choose between these 3 varieties. Each of them has a medium sized grain, an open head and stiff straw. Even in the severe test this year these varieties lodged very little on our plots. The Early Pearl and the Minnesota No. 26 are white oats, while the Gold Rain is a yellow oat.

On the basis of the 4 year test given in Bulletin 229 the Irish Victor, Imported Scotch and Prosperity were mentioned as the best of the varieties tested up to that time. These 3 varieties yielded well in 1915 but not so well as some of the newer varieties mentioned above. The Irish Victor and Prosperity yielded at the rate of 75 bushels per acre each, while the Imported Scotch gave only 65 bushels.

The Swedish Select yielded 68 bushels per acre. This variety has been quite popular in the State but in our experience it has not had the yielding capacity of many of the other varieties. Further, it has a very weak straw and this year all of the Swedish Select plots lodged very badly.

Of the extra early varieties only the Kherson was grown this year. It yielded 65 bushels per acre. These early oats have never yielded as well as the later varieties at Highmoor Farm.

Tests of New Varieties of Oats Originated at Highmoor Farm.

In addition to the testing of commercial varieties of oats, the Maine Agricultural Experiment Station has been engaged for several years in breeding new varieties of oats that it is hoped will be better adapted to the conditions in this State than any of the existing varieties. The first part of this work was begun in 1910 and has now reached a stage where the results may be given to the public.

In 1910 some 350 individual plants were selected for the variety test plots of that year. In 1911 the seed from each of these plants was sown in a separate garden row. Thus the plants in each row were the offspring of a single plant of the year before. Careful notes were taken on each row, and those which showed the most desirable characters were harvested and threshed, each row by itself. The next year the seed of these most promising rows was planted in small plots of 1-2000 acre. This was necessary on account of the small amount of seed. Notes were again made and only the best plots selected. Thus out of 350 plants originally selected the offspring of 33 were regarded as good enough to continue into 1-40 acre plots in 1913.

In 1914, 31 of these "pure lines" were tested for the second time in duplicate plots. These "pure lines" as they are called are essentially new varieties. Each one of them has been developed from a single plant. Since the oat flower is always self-pollinated each plant in one of these pure lines has the same hereditary constitution as every other plant in that line. For this reason plots of these pure lines are much more even in ripening, in yield, in strength of the straw, and other characters than the ordinary commercial varieties. Further, many of these new varieties are proving superior in yield to any of the commercial varieties tested. Out of the 31 pure lines tested for two years 12 have been judged good enough to be offered to the public.

It is believed that these pure lines represent better seed for central and western Maine than can be obtained in commercial varieties. They are strictly pure bred and come true to type without showing any mixture. Further, they ripen very evenly, which is a very desirable character. With varieties which do not ripen evenly a considerable amount of grain is lost from the shattering of over-ripe plants.

These new varieties have not been given names but bear the number by which they are known in our records prefixed by the word "Maine."

The 12 pure lines mentioned above were again tested in 1915. Each pure line was planted in four 1-40 acre plots placed in different parts of the field. The average of the 4 plots was taken as the yield of that pure line.

The table that follows gives the yields for 1915 and the average yields for the past three years.

Yields per Acre of the New Varieties of Oats Bred at Highmoor Farm.

Variety.	3-year average—Bush.	1915 Yield.	
		Oats—Bush.	Straw—Lbs.
Maine No. 340	88.5	82.8	3654
Maine No. 337	85.9	78.8	3260
Maine No. 230	83.8	77.9	3712
Maine No. 336	83.7	74.0	3548
Maine No. 281	82.6	81.3	3723
Maine No. 351	82.6	77.5	3941
Maine No. 247	82.2	80.2	3322
Maine No. 355	81.6	82.2	3947
Maine No. 286	81.6	77.7	3645
Maine No. 357	80.9	79.7	3675
Maine No. 346	80.7	79.7	3335
Maine No. 307	79.9	76.9	3693
Average	82.8	79.1	3621

It will be noted that the average yields of these pure lines run remarkably even. The highest yielded at the rate of 83 bushels per acre and the lowest at the rate of 74 bushels. This uniformity in yield is probably to be expected when it is remembered that these 12 pure lines represent the best out of 350 originally selected plants. The average for these 12 pure lines is 79 bushels per acre, while the average of 11 of the best commercial varieties obtainable grown under the same conditions was only 73 bushels.

While there is little to choose between these different pure lines, Maine No. 340 has shown some points of superiority. In the first place it is particularly high in yield. In 1914 it averaged 109 bushels per acre. This year it gave 83 bushels. Its average for the three years which it has been tested is 88½ bushels. It is a selection out of the Irish Victor variety and this year gave a yield of over 8 bushels more than the parent variety. Furthermore it has a particularly strong straw and even under the severe conditions of the season of 1915 showed practically no lodging.

This variety, Maine No. 340 was grown as the farm oat at Highmoor Farm in 1915. On the entire 15 acres only one small area showed any lodging. Yet the straw grew quite rank and averaged to yield in the neighborhood of 70 bushels of grain per acre.

Of the remaining varieties, Maine No. 355 yielded 82 bushels; Maine No. 281, 81 bushels; Maine No. 247 and No. 346, 80 bushels each.

A considerable amount of seed from Maine No. 340 is available for distribution this year. The seed from the other pure lines will be placed by the Extension Department of the College of Agriculture so that the varieties may have practical farmers' tests and be maintained pure for seed.

Rate of Seeding Oats in Aroostook County.

It is the prevailing custom in Aroostook County to seed very heavily with oats. Perhaps the majority of the farmers sow from 4 to 6 bushels to the acre. It has been the experience in other parts of the country and even in other parts of the State that this is too much seed for the best results. From 2 to 3 bushels per acre have given the best results in the southern part of the State. However, knowing that Aroostook conditions are quite different from those in the other parts of the State, the Station has not thought it best to make any recommendations for the former region.

In 1914 some preliminary rate of seeding experiments were carried out on Aroostook Farm. The results were reported in Bulletin 236.

Injury to certain of the plots, however, made the interpretation of the results somewhat doubtful. In 1915 these experiments were repeated upon duplicate plots under much more favorable conditions.

Six different rates of seeding were used, ranging from 2 to 7 bushels per acre. Each plot was a half acre in area and the experiment was conducted on as uniform a piece of ground as could be obtained. This land was in potatoes in 1914. The seeding was done with a large disk drill. Owing to the loose texture of the ground the land was rolled before seeding and also immediately afterwards. This prevented too deep seeding, which sometimes occurs with the use of a heavy disk drill in the loose soil of Aroostook. The seed used was the Prosperity variety and was grown on Aroostook Farm in 1914.

The results of the experiment calculated to acre yields are given in the table which follows.

Rate of Seeding Experiment, 1915.
Yields of grain and straw per acre.

Plot number	Rate of Seeding per Acre.	Oats—bushels	Straw—pounds
116	8 pecks	56.1	2456
122	8 pecks	50.8	2241
Average		*53.4*	*2349*
117	10 pecks	57.8	1163
123	10 pecks	49.7	1856
Average		*53.8*	*1509*
118	12 pecks	60.3	1990
124	12 pecks	61.5	2743
Average		*60.9*	*2366*
119	14 pecks	67.8	2233
125	14 pecks	66.0	2777
Average		*66.9*	*2505*
120	16 pecks	59.7	2236
126	16 pecks	62.9	2210
Average		*61.3*	*2223*
121	20 pecks	55.9	1844
127	20 pecks	64.9	1955
Average		*60.4*	*1900*

These results are decidedly in favor of the seeding with 14 pecks. They also indicate that when seeded with 3 or 3½ bushels per acre the yield is as great as when seeded with 4 or 5 bushels. The results obtained in 1914 in the main agreed with those of 1915. But, as stated above, they are omitted as there were known errors due to accident in 1914.

From the evidence so far obtained it appears that 3 or 3½ bushels per acre is probably the best rate of seeding for Aroostook conditions when a medium oat like the Prosperity is used. It must be understood, however, that these experiments must be repeated for several years before trustworthy results can be secured. The results obtained this year may not hold good another year when the seasonal conditions are different. The question, for which an answer is sought, is: How much oats should be sown per acre to obtain the best yield in a series of years? Consequently, too much reliance must not be put in the results of any single year It is planned to repeat these experiments in 1916. It is hoped that in time sufficient evidence can be obtained to definitely settle the question as to the proper rate of seeding for Aroostook conditions.

Plant Food in Aroostook Soils.

The shortage of potash in 1915 and its high cost and very limited amount available for 1916 crops makes it necessary to carefully study the fertilizer question from a very different standpoint than at any time in the past. The soils of the older cultivated parts of the State are very uneven in their composition. All types of soil from heavy clay to light sand are jumbled together so that it is not at all unusual to have a half dozen distinct types of soil on the same farm. While the soils of Aroostook County differ considerably and are not uniform, similar to prairie soil, still there is a pretty distinct type of soil that is generally used for the potato crop. On this account chemical analyses throw some light on the soil and fertilizer situation for these fairly similar soils. At different times the Station chemists have examined a total of ten samples of Aroostook soils from the towns of Houlton, Fort Fairfield, Caribou and Presque Isle. The description of the samples and the results of the examination so far as it bears on their content of plant food follow.

Description of Samples.

Except as specially indicated, all of the samples were taken in the fall of the year from newly plowed fields. Samples 549 to 552 were from Aroostook Farm.

Sample No. 549 was taken from the surface soil from a field that had been in grass for three years.

Sample No. 550 was taken from the surface soil from a field that had been in grass for two years, and was in potatoes without any potash in the fertilizer in 1915.

Sample No. 551 was subsoil from the same as the preceding number —550.

Sample No. 552 was taken from a field that had never been plowed and was used for a number of years as pasture. Care was taken to get the sample as free from small roots as possible.

Sample 3403 was taken from a field in Fort Fairfield that had been in grass two years and carried potatoes the year it was sampled. Before the potatoes were planted it had a dressing of stable manure and 1000 pounds of fertilizer to the acre.

Sample 3404 was also from Fort Fairfield from a potato field that had 1,200 pounds of commercial fertilizer the year that it was sampled. It had been in grass for the two preceding years.

Sample 3405 was from Caribou from a field that had been in grass for two years and was in grass the season the sample was taken.

Sample 3406 was also from Caribou from a field that had been cultivated for 13 years and was in oats the year that the samples were taken, potatoes the year before and had been in grass for the two preceding years.

Sample 3407 was from a field in Houlton that had been cultivated for more than 30 years. It was in potatoes for the second consecutive year the season the sample was taken. Fertilizer had been used at the rate of 1,500 pounds to the acre.

Sample 3408 was from a newly cleared field at Houlton, and was unusually light soil for Aroostook County, one part of the field being almost a loam.

Analyses of Aroostook soils by conventional methods showing total nitrogen and potash, and the potash, lime and phosphoric acid that is dissolved out by hot strong hydrochloric acid.

Station number	Total nitrogen	Total potash	Soluble in Strong Acid.		
			Potash	Lime	Phosphoric acid
549	.217	1.45	.310	.176	.211
550	.135	1.70	.354	.198	.151
551	.113	1.46	.313	.190	.172
552	.257	1.57	.369	.308	.262
3403	.281	–	.34	.31	.25
3404	.259	–	.36	.21	.26
3405	.239	–	.28	.11	.26
3406	.238	–	.27	.22	.26
3407	.226	–	.33	.12	.32
3408	.176	–	.35	–	.22

Small as these percentages are, they mean large totals of the constituents in the surface soil of an acre. For instance, the soil to the depth of a foot from which sample 549 was taken would carry about 8,700 pounds of nitrogen, 8,400 pounds acid soluble phosphoric acid and 12,000 pounds acid soluble potash. The amount of these constituents carried off in a single crop of potatoes is insignificant. A crop of 300 bushels of potatoes would remove about 55 pounds of nitrogen, 25 pounds of phosphoric acid and 85 pounds of potash. Added to the top foot of soil these amounts would make only the slightest differences in the percentage composition. Eighty-five pounds of potash in an acre of soil means only .0021 per cent, which is an amount so small that it could not be detected chemically. If it were not that experience and experiment have alike shown that the addition of these comparatively minute amounts of plant food give decisive results—often making the difference between a good crop and a failure—such a treatment would seem absurd. The difference in quality between the plant food added in the fertilizer and that carried by the soil is, for the lack of a better term, called "availability." The plant food of the soil is for the most part unavailable. That of fertilizer is (or should be) available. The subject of soil fertility is a broad one and cannot be here discussed. It is evident that these soils carry potential plant food enough for hundreds of crops. The serious question for 1916 is: "How much of the potash contained in the soil is or can be made available for crops for the coming year?" The data are few and are discussed in a circular of this Station on "Growing Crops Without Potash in 1916." The experiment reported in the next section also throws some light on this question.

Effect of Omitting Potash Fertilization upon the Potato Crop.

Since the introduction of potash in commercial fertilizers in the early seventies of the last century, many experiments have been made and many treatises written showing the value of potash in crop growing. The experimental data on growing crops without potash are very few.

Potatoes are the chief cash crop grown in Maine. It is of first importance for the growers to have what facts are available relative to the likelihood of obtaining a crop in 1916 without the application of potash. Foreseeing the possibility that the fertilizers in 1916 would contain very little, if any, potash, the Station began in 1915 at Aroostook Farm, a series of experiments to determine the effect of different amounts of potash. Four different mixtures were used. In each case the fertilizer contains 4 per cent of nitrogen (5 per cent of ammonia), of which one-third was in the form of nitrate of soda, and 8 per cent of available phosphoric acid. The potash varied as follows: On one plot there was none, on another 2 per cent, on another 5 per cent, and on another 8 per cent. The plots were one-half acre each and they were planted in duplicate.

The land had been in grass for two years, one year in oats and the year before that had been in potatoes. No fertilizer had been used since the potato crop of 1911. In each case the fertilizer was applied at the time of planting, at the rate of 1,500 pounds per acre. Other than the amount of potash used, all the plots were treated exactly alike. Lowell Green Mountain potatoes were used for seed.

These experiments were carried out in duplicate on half acre plots Nos. 137 to 140 and 150 to 153.

The fertilizers were sampled just before planting. The results of the analyses are given in the table that follows:

Analyses of Fertilizers Used in No Potash Experiment, 1915.

Plot Nos.	Nitrogen.				Available phosphoric acid %	Potash %
	As nitrate %	As ammonia %	As organic %	Total %		
137, 150	1.48	1.30	1.63	4.41	8.87	0.00
138, 151	1.35	1.20	1.56	4.11	8.46	2.20
139, 152	1.36	1.16	1.54	4.06	8.08	4.99
140, 153	1.38	1.30	1.52	4.20	8.23	8.13

The planting and harvesting dates are shown in the table.

Dates of Planting and Harvesting.

Plot No.	Date planted	Date harvested	Plot No.	Date planted	Date harvested
137	May 21, 1915	Sept. 30, 1915	150	May 24, 1915	Oct. 6, 1915
138	May 21, 1915	Oct. 1, 1915	151	May 24, 1915	Oct. 6, 1915
139	May 21, 1915	Oct. 1, 1915	152	May 24, 1915	Oct. 6, 1915
140	May 21, 1915	Oct. 1, 1915	153	May 25, 1915	Oct. 6, 1915

All the plots were thoroughly cultivated and sprayed. There was ample rainfall during the growing season. The planting was made after the last heavy rain (May 19) of the spring.

Throughout the growing season the vines on both the no potash plots were a distinctly brighter green and had a thriftier look than on the adjoining plots. The difference was so marked that it attracted much attention from visitors at the farm. The yields are given in the table that follows.

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Yields per acre Obtained in No Potash Experiment with Potatoes—1915.

Plot No.	Amount of Potash.	Merchantable.		Culls.	
		Bbls.	Bush.	Bbls.	Bush.
137	None..................	107	295	4	11
150	None..................	112	309	6	17
Average....	....	*110*	*302*	*5*	*14*
138	2 per cent..............	119	327	6	17
151	2 per cent..............	114	313	7	18
Average....	....	*116*	*320*	*6*	*17*
139	5 per cent..............	110	304	5	14
152	5 per cent..............	123	337	4	12
Average....	....	*116*	*320*	*5*	*14*
140	8 per cent..............	111	304	5	14
153	8 per cent..............	130	358	5	14
Average....	....	*120*	*331*	*5*	*14*

With the exception of the yield on plot 138, which is unexplainably high, the yields are consistent. In the first series there is apparently no effect from the lack of potash. The yields are about 110 barrels. In the second series the larger amounts of potash (5 per cent and 8 per cent) have very appreciable effects upon the yield. The increase is undoubtedly large enough to be significant and to indicate that potash may be expected to increase the yield of potatoes in Aroostook County.

On the other hand, 110 barrels (302 bushels) per acre is a good yield—considerably above the usual average and nearly double the average in the County in 1915. So far as the results of this one year are concerned, they indicate that a profitable yield of potatoes can be obtained on Aroostook soils without the addition of potash for at least one year. In a few farmers' trials made by the various fertilizer companies, in which no exact records were made, satisfactory results were obtained without the use of potash by all the growers from whom the station has heard. It is planned to repeat this experiment in 1916 and add to it a similar experiment on oats.

The kind of fertilizers for 1916 is discussed in a circular on "Growing Crops Without Potash in 1916" which will be sent to any citizen of Maine on application.

Method of Application of Fertilizer upon Potatoes at Aroostook Farm.

It has always been more or less customary in growing potatoes in Maine to apply the fertilizer in the drill or hill at the time of planting. This was largely the practice when farm manures were used in connection with potato growing and has been followed with commercial fertilizers. Although now, when farm manures are used in connection with potatoes they are more likely to be applied broadcast and a smaller amount of fertilizer applied in the drill. There was little question in the minds of practical growers that when 500 to 1000 pounds of fertilizer were applied per acre that it was to the best advantage to apply it in the drill. With the increase up to 1,500 to 2,000 pounds per acre the question has arisen whether it may not be advisable to apply the fertilizer at different times. This led the Station to undertake a series of trials at Aroostook Farm.

In 1914 an experiment was started to extend over a period of years for the purpose of testing the method of applying fertilizer. Something over acre plots were used. Three plots were used in the experiment in 1914. To one plot all of the fertilizer was applied in the planter at planting. To another plot 1,000 pounds of fertilizer was applied at planting and 500 pounds when the potatoes were up. And to a third plot 1,000 pounds was applied broadcast before planting and 500 pounds in the planter at planting. The Lowell Strain of Green Mountain potatoes was used for seed. The crop was well cultivated and sprayed.

The experiment was repeated in 1915 and a plot was added to which all of the fertilizer was applied broadcast before planting. Through a misunderstanding the plot to which 1,000 pounds were added before planting did not have the other 500 pounds applied until the potatoes were up. Plots 133 and 134 were planted to Norcross. Lowell Strain Green Mountain seed was used in the other plots. The yields from these two varieties at Aroostook Farm have been practically identical.

The fertilizer used each year was high grade carrying 4 per cent nitrogen, 8 per cent of available phosphoric acid and 7 per cent of water soluble potash. One-third of the nitrogen was in the form of nitrate of soda, and the remainder was high grade organic nitrogen. The yields are based upon weighings and not upon measure. The potatoes were clean, without adhering soil.

In potato experiments at Highmoor Farm the Station had found that when there was only a small amount of rainfall following the second application of fertilizer that apparently this added fertilizer was not well utilized. Both seasons, however, at Aroostook Farm there was ample water to dissolve and render the plant food in all of the fertilizer available. It has been estimated that it takes about 6 inches of water to successfully grow a crop of potatoes. The rainfall each year totaled over 12 inches in May, June, July and August.

The dates of planting and the yields for both years are given in the tables that follow.

Dates of Planting and of Harvest in 1914.

Plot No.	Date planted	Date harvested	Plot No.	Date planted	Date harvested
81	May 22, 1914	Oct. 8, 1914	84	May 25, 1914	Oct. 6, 1914
82	May 22, 1914	Oct. 7-8, 1914	85	May 25, 1914	Oct. 6, 1914
83	May 23, 1914	Oct. 7, 1914	86	May 25, 1914	Oct. 2, 1914

Yields per acre Obtained in Method of Applying Fertilizer Experiment—1914.

Plot No.	TREATMENT.	Merchantable		Culls		Total	
		Bbls.	Bush.	Bbls.	Bush.	Bbls.	Bush.
82	All in planter	*	–	–	–	134.4	369
85	All in planter	125.3	344.5	2.1	5.8	127.4	350
	Average	–	–	–	–	*130.9*	*359*
83	1000 lbs. in planter, 500 lbs when up	126.0	346.6	0.7	2.0	126.7	348
86	1000 lbs. in planter, 500 lbs when up	119.1	327.4	1.5	4.3	120.6	331
	Average	*122.5*	*337.0*	*1.1*	*3.1*	*123.6*	*340*
81	1000 lbs. broadcast 500 lbs. in planter	*	–	–	–	120.7	331
84	1000 lbs. broadcast, 500 lbs. in planter	124.7	342.8	1.9	5.3	126.6	348
	Average	–	–	–	–	*123.6*	*340*

*In plots 81 and 82 the small and scabby potatoes were weighed together, and the amount of actual culls is not known.

Dates of Planting and Harvesting, in 1915.

Plot No.	Date planted	Date harvested	Plot No.		Date harvested
133	May 20, 1915	Sept. 29, 1915	146	May 24, 1915	Oct. 4, 1915
134	May 20, 1915	Sept. 30, 1915	147	May 24, 1915	Oct. 4, 1915
135	May 21, 1915	Sept. 30, 1915	148	May 24, 1915	Oct. 6, 1915
136	May 21, 1915	Sept. 30, 1915	149	May 24, 1915	Oct. 6, 1915

Yields per acre Obtained in Method of Applying Fertilizer Experiment—1915.

Plot No.	Treatment.	Merchantable		Culls	
		Bbls.	Bush.	Bbls.	Bush.
133	All in planter	99.8	274.5	7.4	20.4
146	All in planter	117.8	323.9	2.9	7.9
	Average	*108.8*	*299.2*	*5.2*	*14.3*
134	1000 in planter, 500 when up	109.1	300.0	2.3	6.3
147	1000 in planter, 500 when up	117.4	322.8	3.7	10.2
	Average	*113.3*	*311.5*	*3.0*	*8.3*
135	1000 broadcast, 500 when up	98.9	271.9	3.4	9.4
148	1000 broadcast, 5000 when up	119.1	327.5	2.2	6.1
	Average	*109.0*	*299.7*	*2.8*	*7.8*
136	All broadcast	100.3	275.8	2.0	5.5
149	All broadcast	126.2	347.1	3.2	8.8
	Average	*113.3*	*311.5*	*2.6*	*7.2*

The results for the two years are summarized in the following table.

Method of Applying Fertilizer.
Yield in Barrels per Acre.

Method.	1914	1915	Average
1500 pounds in planter	130.9	108.8	*119.9*
1000 pounds in planter, 500 pounds when up	123.6	113.3	*118.5*
1000 pounds broadcast, 500 pounds when up	123.4	109.0	*116.2*
1500 pounds broadcast	–	113.3	–

The two years results indicate there is little to choose between the methods. It is planned to repeat this experiment in 1916.

Sulphate of Ammonia Compared with Nitrate of Soda as a Source of Nitrogen in Potato Fertilizers at Aroostook Farm.

A few years ago there was quite a general failure of the crop of potatoes in Aroostook County where a certain brand of fertilizer was used. This fertilizer was analyzed by the Station chemists and found to be high grade. While it was not quite up to its guaranty in some particulars it did carry enough nitrogen, phosphoric acid and potash to more than grow a good crop of potatoes. This fertilizer carried none of its nitrogen in the form of nitrate of soda, but it was all in the form of sulphate of ammonia and high grade organic materials. This led to the stronger reaffirming of the position which the Station had taken relative to the use of nitrate nitrogen on the potato crop. In earlier publications it has been pointed out that the potato makes its demands for nitrogen early in the season and that in the cold, late springs so common in Aroostook County, the crop demands that part of the nitrogen should be immediately available. For this reason the Station has strongly urged that about one-third of the nitrogen in a potato fertilizer be nitrate nitrogen.

In the process of making gas and coke from coal there is developed a large amount of sulphate of ammonia, which in many coke and gas plants is still going to waste. In some plants this now is being conserved and many thousand tons of sulphate of ammonia are thus obtained each year. With the increasing use of high grade organic nitrogen for food of animals, the price of tankage has been going higher and higher year by year. It is, of course, desirable, if it can be done, that as much as possible of this sulphate of ammonia, which is a comparatively cheap source of nitrogen, be used in Maine fertilizers.

Because of these facts, arrangements were made to begin in 1914 a series of experiments to run over a period of several years. The "base" which was used in these goods was made by the wet process, whereby nitrogen from rather low grade goods is made as available as from high grade goods. The available phosphoric acid was furnished in the form of acid phosphate and the potash in the form of sulphate of potassium. The fertilizer was free from chlorides so as to preclude the possibility of the formation of poisonous ammonium chloride. The base carried approximately one-third of the nitrogen that went into the formula. The remainder of the nitrogen was furnished in the form of nitrate of soda and sulphate of ammonia, as indicated in the following plan:

Plot 1. Basal mixture and 2-3 of the nitrogen in form of nitrate of soda.

Plot 2. Basal mixture and 2-3 of the nitrogen in form of sulphate of ammonia.

Plot 3. Basal mixture and 1-3 of the nitrogen in form of nitrate of soda and 1-3 in form of sulphate of ammonia.

Plot 4. Basal mixture and 1-3 of the nitrogen in form of high grade organic and 1-3 in form of nitrate of soda.

Plot 5. Basal mixture and 1-3 of the nitrogen in form of high grade organic and 1-3 in form of sulphate of ammonia.

The 1914 Experiment.

There was about an acre in each plot. The Lowell Strain of Green Mountain potato was used for seed in 1914. The fertilizer was applied at the rate of 1500 pounds per acre, and supplied about 60 pounds of nitrogen, 120 pounds of available phosphoric acid and 105 pounds of water soluble potash per acre. Other than the fertilizer used the plots were planted, cultivated, sprayed and cared for in all particulars alike. The fertilizers used in 1914 were not analyzed at the Station.

The plots were planted on the following dates: Plot 87, May 29; Plots 88 and 89, May 30; Plot 90, partly May 30 and finished June 1; Plot 91, June 1. They were harvested as follows: Plot 87, October 1; Plot 88, September 30; Plot 89, September 29; Plot 90, partly on September 28 and remainder on September 29; Plot 91, September 28.

May and June were rather cool months and hence would be favorable to the nitrate of soda. The mean temperature for May was 53.2 degrees, for June 56.0 degrees, July 63.5 degrees, August 60.1 degrees, and September 55.8 degrees. There were several cold nights with frosts in June. May 4 the thermometer went to 25 degrees, May 5 to 32 degrees, June 9 to 30 degrees, and June 28 to 31 degrees, and on this latter date there was quite a heavy frost so that it injured potatoes, not in these experiments but on some other plots at Aroostook Farm. The lowest temperature in July was 40. The lowest temperature in August was on the 28th when it was 35 degrees. It was, however, colder than this at some of the lower parts of Aroostook Farm, where there was a slight frost on the night of August 28. The rainfall for May was 2.74 inches, for June 4.80 inches, July 2.23 inches, and for August 2.35 inches, making a total of 12.62 inches during the growing months of 1914.

The tabulated results of the yields for 1914 follow.

Sulphate of Ammonia and Nitrate of Soda Experiment—1914. Yields of Potatoes.

	Treatment	Merchantable Yield		Culls Yield	
		Bbls.	Bush.	Bbls.	Bush.
87	⅔ nitrate of soda	120.2	330.5	7.0	19.3
88	⅔ sulphate of ammonia	110.3	303.4	11.0	30.3
89	⅓ nitrate of soda, ⅓ sulphate of ammonia	116.3	319.8	5.8	15.9
90	⅓ nitrate of soda, ⅓ organic	119.8	329.6	6.2	17.0
91	⅓ sulphate of ammonia, ⅓ organic	110.2	303.1	7.8	21.5

The 1915 Experiment.

The experiment was repeated for 1915, using duplicate plots. There were no essential differences in the soil and treatment from those of 1914. The fertilizers were especially made by the same company and were applied at the same rate. The nitrate of soda for Plots 128 and 141 were not added to the fertilizer until used at planting.

The first series, Plots 128 to 132, were planted with Norcross potatoes. The duplicate plots, Nos. 141 to 145, were planted with Lowell Strain Green Mountain. The analyses of the fertilizers used, the dates of planting and harvesting and the yields are given in the tables that follow.

Sulphate of Ammonia and Nitrate of Soda Experiment—1915.
Analyses of Fertilizers Used on the Different Plots.

Plots	Nitrogen				Available phosphoric acid %	Potash %
	As nitrate %	As ammonia %	As organic %	Total %		
128, 141	2.27	0.17	1.15	3.59	8.43	6.77
129, 142	0:12	2.34	1.20	3.66	9.20	6.59
130, 143	1.12	1.24	1.20	3.56	8.47	6.91
131, 144	1.14	0.18	2.22	3.54	8.50	6.88
132, 145	0.15	1.24	2.29	3.68	8.90	6.84

Sulphate of Ammonia and Nitrate of Soda Experiment—1915.
Dates of Planting and Harvesting.

Plot No.	Date planted	Date harvested	Plot No.	Date planted	Date harvested
128	May 18, 1915	Sept. 28, 1915	141	May 22, 1915	Oct. 1, 1915
129	May 18, 1915	Sept. 28, 1915	142	May 22, 1915	Oct. 2, 1915
130	May 18, 1915	Sept. 28, 1915	143	May 22, 1915	Oct. 2, 1915
131	May 18, 1915	Sept. 29, 1915	144	May 22, 1915	Oct. 4, 1915
132	May 20, 1915	Sept. 29, 1915	145	May 22, 1915	Oct. 4, 1915

Sulphate of Ammonia and Nitrate of Soda Experiment—1915.
Yields of Potatoes per Acre.

Plot No.	Treatment	Merchantable		Culls	
		Bbls.	Bush.	Bbls.	Bush.
128	⅔ nitrate of soda	107.4	295.4	10.2	28.1
141	⅔ nitrate of soda	118.9	326.9	3.2	8.8
	Average	*113.2*	*311.2*	*6.7*	*18.5*
129	⅔ sulphate of ammonia	117.4	322.9	5.8	15.9
142	⅔ sulphate of ammonia	121.5	334.1	5.9	16.2
	Average	*119.5*	*328.5*	*5.9*	*16.1*
130	⅓ nit. of soda, ⅓ sulphate of ammonia	113.0	310.8	5.7	15.7
143	⅓ nit. of soda, ⅓ sulphate of ammonia	122.7	337.4	2.2	6.1
	Average	*117.9*	*324.1*	*4.0*	*10.9*
131	⅓ nitrate of soda, ⅓ organic	101.6	279.4	6.6	18.2
141	⅓ nitrate of soda, ⅓ organic	121.2	333.3	4.6	12.7
	Average	*111.4*	*306.4*	*5.6*	*15.4*
132	⅓ sulphate ammonia, ⅓ organic	99.2	272.8	9.8	26.9
145	⅓ sulphate ammonia, ⅓ organic	119.3	328.1	3.9	10.7
	Average	*109.3*	*300.5*	*6.9*	*18.9*

The mean temperature for May, 1915 was 49.5 degrees, for June 60.6 degrees, July 64.1 degrees, and August 61.8 degrees. During June the thermometer did not go below 36 after the second day and 45 was the lowest the thermometer went in July. The rainfall for May was 4.05 inches, June 1.95 inches, July 3.40 inches and for August 3.50 inches, making a total of 12.90 inches during the growing months of 1915.

In 1914 the sulphate of ammonia gave smaller yields than the nitrate of soda plots. In 1915 the sulphate of ammonia plots of the first series gave larger yields than the nitrate of soda plots and in the second series practically the same yields were obtained irrespective of whether the nitrogen was as nitrate or ammonia. June, 1914, was 4 degrees colder than June, 1915, and there were quite hard frosts up to the end of the month. This gave a poorer chance for the nitrifying organisms to render the sulphate of ammonia available. This may account for the reduced yields from the sulphate of ammonia in 1914. Plots 128 to 131 in 1915 were planted May 18. May 19 there was a rainfall of one and a half inches. While sulphate of ammonia is as easily dissolved in water as is nitrate of soda, it does not leach out of soil nearly as fast. It would seem, comparing the results from the first series with the duplicate series, that the heavy rain of the 19th carried off much of the nitrate of soda which reduced the yield because of the lack of available nitrogen thus brought about. The higher temperature (average of 4 degrees) of June 1915 over 1914 seems to explain the yields from the duplicate plots being practically the same with nitrate of soda as with sulphate of ammonia.

The average yields from the different test plots for the two years are given in the table on the page that follows.

It will be noted that for the two years the sulphate of ammonia plots have somewhat larger yields than those obtained from the nitrate of soda plots. The organic nitrogen does not appear to be as completely available as either that of the nitrate of soda or the sulphate of ammonia. This is in accord with earlier trials made at Houlton where the organic nitrogen seemed to delay the maturing of the crop, thereby decreasing the yield. Experiments of this kind can give conclusive results only after a number of years trials. This experiment is to be repeated in 1916.

Sulphate of Ammonia and Nitrate of Soda Experiment, 1914 and 1915.
Yield in Barrels Per Acre.

Treatment.	Merchantable.			Total		
	1914	1915	Average	1914	1915	Average
⅔ nitrate of soda............	120.2	113.2	116.7	127.2	119.9	123.6
⅔ sulphate of ammonia......	110.3	119.5	114.9	121.3	125.4	124.5
⅓ nitrate of soda, ⅓ sulphate of ammonia................	116.3	117.9	117.1	123.1	121.9	122.5
⅓ nitrate of soda, ⅓ organic..	119.8	111.4	115.6	126.0	117.0	121.5
⅓ sulphate of ammonia, ⅓ organic....................	110.2	109.3	109.8	118.0	116.2	117.1

Preparing Land with Dynamite.

There has been extensive propaganda by the interested makers of dynamite as to its agricultural use. Trials were undertaken at Highmoor Farm in 1912 with dynamite in the field and in the orchard. The actual work of preparing the land with dynamite was under the direction of an expert sent out by one of the powder companies.

EXPERIMENTS WITH FIELD CROPS.

An acre and a half of land, the soil of which is fairly uniform, that was in pasture and apparently had not been in crop for twenty-five or more years, was made free from stone, divided into three uniform plots of a half acre each, and treated as follows in September, 1912: One-half acre was plowed and then sub-soil plowed. Another half acre, the middle one, was prepared by boring holes 30 to 36 inches deep a rod apart and discharging one-half pound stick of 20 per cent dynamite in each hole. The third plot was plowed in the usual way. The plan involved leaving the whole field to be treated alike each year to see if any difference could be noted in the resulting crops due to the three different methods of preparation.

The soil is the usual rather moderately heavy loam of Highmoor Farm which is underlain with a very difficultly penetrable sub-soil. In the spring of 1913 the whole field was plowed and the proper seed bed made for the planting of potatoes. The field was planted to potatoes in 1913, to corn in 1914, and to rape in 1915. Careful records were made during growth and at the time of harvest. There were no appreciable differences in the crop on the different plots.

This experiment seems to clearly indicate that under the soil conditions at Highmoor Farm there is no advantage whatever in the use of dynamite for loosening soil for field crops.

EXPERIMENT IN SETTING APPLE TREES.

Also in 1913 it was necessary to reset part of the Baldwin orchard. Part of these trees were set in the usual way, by digging holes in the spring with a spade, thoroughly mixing the soil and setting out as commonly practiced by orchardists, and part by loosening the soil by the explosion of sticks of dynamite in the fall of 1912 and setting the trees in the spring of 1913.

The soil on Highmoor Farm is a rather moderately heavy, reddish loam underlain with a very difficultly penetrable sub-soil. In the orchard in question the surface soil contains rather more sand, and is consequently somewhat lighter than on most of the farm. The sub-soil runs from 7 to 15 inches under the top soil. It is sandy but is "greasy" and will hold water, as the puddles show. Regardless of the presence of sand the sub-soil is very compact and impenetrable.

The topography is such in this orchard, for the most part a gentle slope to the west, that good, natural surface drainage is secured. The only pockets where water was likely to stand or where the surface drainage was poor have been underlain with tile.

In blowing holes for setting the trees the charge of dynamite was inserted at the depth of from 30 to 36 inches. The material encountered toward the bottom of the holes consisted of a very resistant hardpan which was very hard to break, therefore one stick of extra 20 per cent dynamite was used in each hole, instead of one-half stick as was originally planned. The expert reported as follows regarding a test hole put down to a depth of 36 inches and loaded with one cartridge: "This blew but a small amount of dirt out of the hole. A man was put to work digging out loose material, and we found that there was very satisfactory loosening to a depth of 36 inches with lines of breakage extending in all directions from the point of the shot. This was considered very satisfactory, so we proceeded to blast the other holes in like manner." In writing of digging into another hole on similar soil on another part of the farm he said: "This shattering seemed to dip slightly upward in all directions."

In the spring of 1913, 126 young Baldwin trees were set where the holes were blasted with dynamite the fall before. At the same time 52 other trees from the same lot and similar in every respect were set in the same orchard in the usual manner by digging the holes with a shovel. In both cases, whether dynamited or without, a large hole was dug and then filled with top soil to where the tree was to be set. This was necessary in both instances for the object of dynamiting was to shatter the sub-soil rather than to simply make a hole. Therefore, little or no hand labor was saved by the use of dynamite. So far as the location of the trees in the orchard was concerned, the conditions were ideal from an experimental standpoint. Since they were to replace trees which had been removed in different parts of the orchard for one cause or another chance rather than design determined where they should be placed. Consequently they were scattered indiscriminately through the orchard, and those which were dynamited or simply shovel dug were mixed in with each other without any particular order.

The primary object of the experiment was to see whether or not the trees would make a better or more vigorous growth where the subsoil had been shattered with dynamite. So far as could be judged no difference in this respect occurred as the result of growth in 1913 and 1914. In the spring of 1915 some rather unexpected, comparative results were obtained.

Good growth was made during both seasons and in the fall of 1914 all of the trees appeared vigorous and healthy. Early in the spring of 1915 it was evident that a considerable amount of winter injury had occurred, and that many trees were killed back to within 12 to 18 inches of the ground. Some of these, however, were killed nearly or quite to the soil line.

In the latter part of June, when it was felt that the full extent of injury would be apparent, the Station pathologist made a careful inspection of all of these Baldwin trees which had been set in 1913. The object of this inspection was to obtain accurate data as to the character and extent of the injury on each individual tree, simply as a matter of record. Up to the time of making this record he had only a very general knowledge of the dynamiting experiment and knew nothing of the plan followed with reference to the distribution of the dynamited and non-dynamited trees in the orchard.

In taking the record it was very evident that there was no relation between the location of individual trees in the orchard and the amount of winter injury observed, but some striking results were obtained when the observations were tabulated in comparison with method used in setting the trees. Out of 126 trees in holes previously dynamited 49 or nearly 39 per cent were either killed or badly injured. In the case of the 52 trees set in shovel dug holes only 4, or less than 8 per cent suffered in like manner.

No attempt was made or should be made to draw general conclusions from these figures obtained in this single orchard. What happened here might not occur under different soil conditions. Nevertheless, it is quite evident that the method of dynamiting followed is not adapted to setting trees in the soil on this individual farm. The use of dynamite the preceding fall in no way decreased the cost of setting the trees in the following spring. There was no greater growth where dynamite was used than where it was not. The losses from winter injury were 5 times greater where dynamite was used. Based on the results where the trees were set in shovel-dug holes the probable loss from winter injury among the entire 178 would be approximately 14 trees. Similarly had all the trees been set in dynamited holes, the expected loss would be about 69.

Are Sheep Profitable in Maine?

The Station Council at its meeting in April, 1914, authorized the purchase of grade sheep sufficient to stock Highmoor Farm for the purpose of studying the question as to whether sheep can or cannot be profitably raised in Maine. The sheep were not to be pure bred or of fancy type. This was to preclude their being sold at high price because of breeding. Nor were they to be early bred to produce "hot house" lambs for the high price of the early market. They were to be just plain sheep such as any ordinary farmer could carry. They were to be good grade stock, bred for wool and lambs. The income was to be from wool and meat sold and from the manure produced as a by-product. While care was to be exercised in handling the sheep, no high priced labor was to be used. Nor was a special "shepherd" to be employed.

ITEMS OF COST.

There will always be an expense for fitting up and maintaining pastures, buildings, etc., for sheep that will vary on different farms and with different farmers. The overhead charges, such as interest, taxes, and the like will also vary with varying conditions. In an experiment conducted by the Station, where it is necessry to keep individual records, buttons for the ears and time involved in note taking are expense items that the ordinary farmer need not be at. The cost of fencing the pastures, erecting shelters in the pastures, fitting up the barns for winter quarters, expenses for piping water, water troughs, sheep dipping tanks, shearing machine, root and feed cutters, rent of land for pastures and crops for the sheep, while necessary expenses that must be taken into account by the practical farmer, are omitted from this account. The items included are initial cost of sheep, cost of labor in care of sheep and growing crops for the sheep, cost of purchased food and allowance for hay and straw fed, the cost of dips and other medicines, and the cost of the seed for crops fed.

THE FLOCK.

The sheep were purchased from what is probably the largest sheep farm in New England. The proprietor is a great believer in sheep. And although he does not keep an at all accurate account of income and outgo on his sheep proposition believes them to be profitable. His interest in the proposed project at Highmoor Farm was one strong reason for its being undertaken. He sold to us 75 ewes and their lambs to be delivered in the early summer of 1914. These were to be grade Hampshire of two and three years of age. The lambs that were to come with them were to be sired by pure bred registered Hampshire bucks. The lambs with the ewes were, therefore, at least three-quarter Hampshire. It was stated that the ewes would probably average rather more than a lamb each. The whole selection of the stock was left by us to the owner and his shepherd. Three registered Hampshire bucks were purchased in the fall of 1914 from the same grower. The lambs of 1915 are from the ewes purchased. None of the 1914 lambs were bred that year.

The expenditures and receipts are shown in the tabulation that follows. The items are discussed beyond the table.

**Sheep Account for Year July 1, 1914, to June 30, 1915.*

Inventory and Expenditures.

75 ewes at $5	$375 00
55 lambs at $3	165 00
3 bucks at $25	75 00
Bran and middlings, 7,000 pounds	105 60
Oil meal and gluten meal, 900 pounds	15 95
Corn meal, 2,400 pounds	38 40
Ground oats, 54 bushels	28 60
Hay, 45,600 pounds	273 60
Straw, 6,000 pounds	15 00
Salt, 4 bushels	1 24
Rape and turnip seed for field planting	3 23
Tobacco, dips, etc.	27 46
Man labor on sheep and crops for sheep, 1,012 hrs.	180 10
Horse labor on crop, 19 hrs.	2 45
	$1,306 63

Receipts and Inventory.

Sheep and lambs sold	$127 25
Wool sold	158 62
Manure (estimated value when drawn to the fields)	24 00
67 old ewes on hand June 30, 1915	335 00
22 yearling ewes on hand June 30, 1915	110 00
42 ewe lambs on hand June 30, 1915	126 00
31 buck lambs on hand June 30, 1915	93 00
3 registered bucks on hand June 30, 1915	75 00
Loss on operation for year	257 76
	$1,306 63

*Pasturage, use of land for crops and buildings for summer shelter and winter housing, interest on investment and other overhead charges are not included in this account.

EXPENDITURES.

The Cost of the Sheep. The sheep were shipped about the first of July and were unloaded from the cars the evening of the day they were loaded at the shipping point. There were 75 ewes and 55 lambs with them. The price paid was (including freight) $755.15 for 75 ewes, 55 lambs, and 3 registered Hampshire bucks. In order to bring the financial calculations to a comparable basis, the sheep are considered in the account as though they cost $5 each and the lambs $3 each, as that is the value the farm superintendent used in the 1915 inventory. The bucks are carried in the inventory at the price paid, deducting shipping charges. This depreciation in valuation has no bearing at all on the question of whether we did or did not pay a fair price for the sheep. It is merely to put the matter on a comparable basis. Some of the sheep were older than was agreed. One experienced handler of sheep claimed that a few of them were as old as 8 years. But as there is no way of telling a sheep's age after she is 4 the statement of the seller's shepherd that none of them was over 6 years old may be accepted. The oldest ewes have been replaced by the yearling ewes of our own raising. The sheep as sent were a good looking lot and have steadily improved under Highmoor Farm management and conditions.

The Food. The three pastures have about 100 acres. They are fenced with a very heavy wire fence that is dog-proof and nearly man-proof. They are well equipped with shelters and supplied with abundant water. They are adjacent to the fields where crops are grown to supplement the pasture in case of shortage. Rape is grown and fed by cutting or by pasturing, according to circumstances. Turnips are grown for winter feed. Only first quality hay is produced on the farm. There are no fine, light yielding grasses on the farm. Hence, hay must be valued at what hay is worth to sell. Probably no man who keeps a labor account would continue to grow June grass for hay, as keeping account of time and yields would show the high cost per ton of such hay.

About 95 sheep, lambs and bucks, were carried through the winter of 1914-15. They ate about 6 tons of grain and 23 tons of hay, which at cost for the grain and selling value of

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the hay at the barn, aggregated $477, or about $5 each. They were also fed some cull apples and the turnips that were grown on an acre and a half of land.

The seed for crops is for two years, and the labor includes the planting of the 1915 as well as the cost of the 1914 crops.

Disease and Parasites. The cost for dips is out of all proportion to what it will be in succeeding years. The sheep as received had a good many ticks and two dippings were necessary. They were cleaned up so thoroughly that careful examination failed to show a single tick this fall. During the year there were the usual parasitic troubles, but they were successfully handled without loss.

Labor. No labor is charged against the sheep except for time actually put in necessary care of the flocks, the pastures and the crops for the sheep. The farmer who does not keep a labor account has little notion of the large amount of time that is used in "chores." On both of the Station farms daily records and weekly reports are made of the time of all employees. From these records it is possible to tell exactly what each person was doing at any hour of any day. Most of the labor is for work of investigation in which labor cost cannot be taken into account. The sheep problem is the only one on farm management that has been undertaken. The study of the records on this experiment discloses, as it doubtless would on any other similar study, that labor is a very large item of expense. The labor cost for the year was about $2 a sheep.

Losses. There were two deaths that autopsies did not satisfactorily explain. There was little loss of lambs at lambing time. Not all of the ewes proved to be with lamb and these have been sold for meat.

RECEIPTS AND INVENTORY.

Sales. The wool, sheep and lambs sold were probably as well marketed as the average farmer could expect. No attempt to market in any unusual way was attempted as that would have been contrary to the plan of the experiment.

Manure. The plant food in the feed consumed was worth at usual fertilizer values in the neighborhood of $200. It may be that the farm superintendent underestimated the value of the sheep manure, and that it was worth more than is credited. It is not the fault of the sheep if faulty handling of the manure results in loss. The manure was left under the sheep during the winter as is customary with all handlers of sheep the writer has knowledge of in the East or the Middle West. It is commonly supposed that the compacting of the manure and the moistening from the liquid excretions will prevent losses. From our experience this seems more than doubtful. The present year (1915-6) it is proposed to know the exact value of the manure. For this purpose a water tight, covered manure receptacle has been built and the manure will be moved to this monthly. Swine are being kept on the manure. A financial account is being kept with swine. The manure will be sampled and analyzed when hauled to the fields. In this way it is hoped to give an exact credit value to the manure for 1915-6.

The Inventory. The sheep are in excellent condition. The increase in flock for 1915 is very good—something more than a lamb to a ewe.

Summary. The cost of the operation for the year 1914-5 was $1,306.63. The sales and inventory aggregated $1,048.67. The total loss without any consideration of overhead charges, depreciation of plant, rent of land, interest on investment, or taxes that a farmer would pay, was $257.76, or about $3.45 for each of the old ewes.

CRITICISM OF THE EXPERIMENT.

The flock has been visited at times by experts who have expressed themselves pleased with the sheep and the way they are handled. Helpful suggestions have been constantly sought. When it was found that the operation for 1914-5 had been at a loss a statement was sent to leading sheep men for criticism and suggestions. Later practically the same statements were given wide circulation through publicity letters. An attempt by the help of the Station Directors and Commissions of Agriculture of the New England States was made to learn if there were any people in New England keeping sheep on at all large scale that knew they were making a success of the business. A few were found who were supposed to be making money from sheep husbandry but none of these had kept account of the cost of labor and of home-grown food consumed.

Thus far no criticisms have come to our attention that point out reasons for failure other than those outlined in the publicity letter and in this article. Were it not for the fact that the balance is on the wrong side of the account the Station would feel content with everything in the experiment other than the care of the manure. The sheep have done well and look well. Comparisons with exact feeding experiments made at other places indicate that the cost of feed is not greater than is to be expected with purchased food. There are few data relative to labor costs in sheep feeding experiments.

THE EXPERIMENT IS BEING REPEATED.

It is recognized that there were a number of things that interfered with the success of the trial. For this reason the loss for 1914-5 was charged off and the whole experiment started over again, without prejudice, July 1, 1915. The older sheep were disposed of, the yearling lambs are bred to registered sires, and enough of the ewe lambs were kept to replace the ewes that should be removed another year. These are all inventoried at meat prices. Barring accidents, there would seem to be no reason why the sheep will not have the best possible chance to make good this year.

BULLETIN 247.

REPORT OF THE FIRST JERSEY SIRES' FUTURITY TEST OF THE AROOSTOOK JERSEY BREEDERS' ASSOCIAION.

RAYMOND PEARL.

THE VALUE OF SIRES' FUTURITY TESTS.

Some readers may wonder what relation such a Sires' Futurity Test as that discussed in this report has to the investigational work of the Maine Agricultural Experiment Station along cattle breeding lines. Superficially it might be supposed that the only value of such a Sires' Futurity Test was in its advertising worth to the winning party. In the judgment of the writer of this report such a conclusion would be very far from the truth. On the contrary, it is believed that such Sires' Futurity Tests as that here reported have in them possibilities of very great value for the improvement of live stock. Just what the nature of these possibilities is will be set forth briefly in the following paragraphs.

Certainly a most significant result which has come out of the investigations in animal breeding which have been carried on by the Maine Agricultural Experiment Station during the past eight years is that which has demonstrated that the only certain test of the breeding worth of an individual in breeding for performance is the progeny test. This is true whether one is dealing with egg production in poultry, or milk production in cattle. In the present state of knowledge certainly (and probably the same will always be true) it is not possible to make any *sure* prediction either from the appearance of an animal alone as to whether its progeny will be uniformly high producers of milk, eggs, or whatever other qualities we are seeking. The only certain way to test this is by measuring the performance of the progeny. This is the same principle which has proven so fruitful in plant breeding work.

Now a Sires' Futurity Test, such as that here reported, is in principle nothing whatever but a progeny test. Such a Sires' Futurity Test is a direct practical application of the teachings which have come out of the theoretical investigations of the Maine Agricultural Experiment Station. On that account the Station is interested in such tests. We believe that they form one of the surest ways of helping towards the improvement of the cattle in any community. The Station stands ready at any time to help other associations to inaugurate such Sires' Futurity Tests just insofar as its resources of time and money will permit.

While the Station does no extension work in the ordinary sense of that term, it is, and must necessarily always be, interested in helping towards the practical application of the results of its theoretical investigations. As a general policy in this direction it seems desirable for the Station in the first instance to work out, considerably in detail, in actual cooperation with the farmer or association of farmers, the methods of making such application. This is what we have tried to do in connection with this Aroostook Jersey Sires' Futurity Test. Once having worked out such a set of detailed plans, and having found by actual experience that they operate satisfactorily in practice, there is then no need for the Station to continue in the future doing the same thing over again. With the suggestions and results set forth in this present report it should be possible for any breeder's association or cow test association to carry through the plan of a Sires' Futurity Test on their own account, and without any help from the Station other than advice, if needed, and possibly arrangement as to official supervision of the test.

At the outstart the absolute magnitude of the records made in such tests are not of primary importance. The great thing is to find out just exactly by comparative test what a sire is transmitting in the way of milk producing qualities. To reach their highest value such tests should include more animals than did this Aroostook Test here reported. Efforts should be made if possible to include two or three daughters at least from each sire entered. This will not only add to the interest of the contest but immeasurably to its value.

This idea of Sires' Futurity Test work might very well be incorporated into the activities of the cow test associations. As at present carried out cow test association work pays little or no attention to matters of breeding. But, beyond doubt or question, a permanent, productive, livestock husbandry rests, in final analysis, on breeding. The dairy husbandman cannot regularly or indefinitely depend on buying his stock from other people. He must if he is to stay permanently in the business and get the maximum profit out of it breed his own animals. In the improvement of his herd by breeding lies his best hope of increasing profits as time goes on. No better means than the progeny test can be found for helping such progress along.

History of the Aroostook Jersey Sires' Futurity Test.

The first Sires' Futurity Test of the Aroostook Jersey Breeder's Association was held at Aroostook Farm, Presque Isle, Maine, November 15, 1915, under the auspices of the Maine Agricultural Experiment Station.

The following brief summary of the facts regarding the inauguration of this Sires' Futurity Test deserves permanent record for its historical interest. At a meeting of the Aroostook Jersey Breeder's Association held at Mapleton, March 20, 1912, it was decided to hold a Sires' Futurity Test. Mr. E. L. Tarbell, Mr. A. E. Mooers, and Mr. E. L. Johnston were made a committee to arrange for it. It was voted that the entrance fee for the bulls should be $5.00 each and that the entries should be closed July 1, 1912. At a meeting of the Association held in Houlton, June 21, 1912, it was voted that the entry fee for the heifers should be $1.00 at the time of entry (which should be on or before December 31, 1913) and $1.00 additional to be paid before the actual test was made.

At a meeting held in Presque Isle, December 10, 1912, a committee was appointed to formulate rules for conducting the Test. This committee consisted of Mr. A. E. Mooers, Mr. E. L. Johnston and Mr. J. M. Cottle. At a meeting held in Easton, March 11, 1913, it was voted to reopen the Futurity Test to bulls in service in 1912 and closed the same on April 30, 1913.

At a meeting held in Presque Isle in December, 1913, the Committee on Rules presented their report. Inasmuch as the rules adopted were subsequently modified it does not appear necessary to give the report of the Committee in detail here. The most important points of the report were that the milking test of the heifers be held in November, 1915; that this test should be for 7 days; that all the heifers should be tested in one barn and looked after by one man; and that the tester shall be qualified according to the rules of the American Jersey Cattle Club, that is he must be a representative of the Maine Agricultural Experiment Station.

The treasurer reported at a meeting in Westfield, March 19, 1914, that 16 heifers had been entered in the Sires' Futurity Test in addition to 6 bulls and that $50.00 derived from the entry fees of these animals was on deposit.

At a meeting of the Association held in Stockholm, June 24, 1915, final arrangements of the details of the Futurity Test were discussed by the Association in consultation with the writer of this report and the rules set forth in a later section were adopted. It was voted to instruct the treasurer to receive entries until October 1, 1915, of bulls complying with the rules, at $10.00 for each bull and one heifer, and $3.00 each for each additional heifer.

Following this meeting at Stockholm the late Mr. E. J. Tarbell, Secretary of the Aroostook Jersey Breeder's Association, whose untimely death removed from the ranks of Jersey breeders in Maine one of their keenest, ablest and most progressive personalities, and the present writer, took up with the American Jersey Cattle Club the question of a suitable prize for the sire winning the Futurity Test.

Realizing the importance and value of a Futurity Test as an aid in the improvement of the Jersey Cattle of the State, the officers of the American Jersey Cattle Club donated a magnificent silver cup, of a value of $100, to be awarded annually to the sire winning the Test under the rules set forth in a later section of this report.

The Purpose of the Jersey Sires' Futurity Test.

The idea underlying the inauguration of the Sires' Futurity Test was that the surest indication that anyone can have of the breeding worth or value of an animal lies in the performance of its progeny. The only way to tell whether a Jersey bull has the ability to transmit high milking qualities to his daughters is to see by actual test whether a fair sample of those daughters are high producers of milk and butter fat. In drawing up the general plans for the Sires' Futurity Test it was decided in the first place that heifers should be eligible to compete in this test even though they were not eligible for registration in the Herd Book of the American Jersey Cattle Club. Or, in other words, a heifer out of an unregistered dam might compete in the Test provided her sire was a registered Jersey bull and had been duly entered for the Sires' Futurity Test. The only bulls eligible to entry in the Test were such as were actually registered as pure bred Jersey cattle in the Herd Book of the American Jersey Cattle Club.

It might at first thought be supposed that the Test should have been restricted to pure bred registered heifers rather than opened to grade heifers as well. This point of view would appear to be too narrow. One of the very important functions of a pure bred bull in any farming community is to bring about the improvement of the grade stock kept in that community. It is quite as much, or even indeed more, to the credit of a sire if his get from grade dams is of superior quality as well as his get from pure bred dams.

There can be no question that the Sires' Futurity Test idea is one of the soundest and best methods for the improvement of the average quality of the live stock in a community or state that can be devised. It is greatly to be hoped that the same idea will be taken up in this State for other breeds as well as the Jersey, and that we shall see county and state wide tests of this sort as annual affairs.

Rules Under Which the 1915 Test Was Conducted.

Since the whole matter of a Sires' Futurity Test based on performing ability in milk production was an entirely new one, the members of the Association and the writer of this report felt it not only desirable but necessary to proceed somewhat tentatively in formulating rules. In this section of the report it is proposed to set forth briefly the rules and conditions under which this first test actually was carried out, together with some explanation of the reasons for the rules. It should be understood that these rules are not to be regarded as ideal in the minds of their formulators, nor as final. The definitive rules for the conduct of future tests have not yet been drawn up by the Aroostook Jersey Breeders' Association. The only definite and final rules in connection with the whole matter are those governing the award of the American Jersey Cattle Club's cup. These rules are set forth in the next section (see p. 45).

As actually carried out the first test operated under the following rules:

1. Heifers dropped in the calendar year 1913 were eligible to compete in the Test.

2. The production of butter fat in a period of 7 days, all of the heifers being tested at the same time in the same barn, was taken as a basis for the placing of the awards.

3. In order to put all heifers on a perfectly fair and equitable comparative basis, the actual milk and fat production records were corrected for the age and stage of lactation of each heifer at the time when the Test was made. These corrections for age and stage of lactation were based on correction tables covering these points which have been worked out in the Biological Laboratory of the Maine Agricultural Experiment Station and will shortly be published in full. The corrections rest on a much sounder scientific basis than those made by any other plan hitherto devised. In particular they are much more just and accurate than the rules for taking account of age in the testing of cows for advanced registry by any of the registry associations in this country. The actual table on the basis of which the records of the 1915 Futurity Test were corrected is published as Table 2 of the present writer's "Report of Progress on Animal Husbandry Investigations in 1915", page 5*.

4. Each owner having one or more heifers entered in the Test was required to provide whatever he wanted fed to his animals beyond hay and potatoes. These parts of the ration were furnished by the Station. Each owner was allowed perfect choice as to what his animals should be fed during the Test. This seemed much fairer than it would have been to put all the heifers on the same ration. In case any owner failed to furnish instructions as to how his animals should be fed

*Me. Agr. Expt. Station Circular No. 519, Dec. 1915, pp. 1-28.

they were to be given a standard grain ration. As a matter of fact no owner failed to specify how he wanted his animals fed.

5. Any owner might have his heifers milked as many times during the day as he desired. As a matter of fact, all agreed on three milkings per day, morning, noon and night.

6. Samples of the milk from each milking were taken by the Supervisor of the Test, Mr. C. H. White, a member of the staff of the Maine Agricultural Experiment Station, and shipped to the Station. The determinations of fat percentage were made by the Station chemists. The Supervisor of the Test weighed the milk from each cow at each milking, took all weights of feed, etc. The Test was officially under the direction and supervision of the present writer, Mr. White acting as his agent.

7. That heifer was adjudged the winner which produced in the 7 days the largest total number of pounds of butter fat after proper correction for age and stage of lactation as set forth above. That heifer was adjudged second in the Test which produced the next largest total number of pounds of butter fat after correction, and so on.

ADDITIONAL SUGGESTIONS REGARDING METHODS OF CARRYING OUT SIRES' FUTURITY TESTS.

There are some points in the rules set forth in the preceding section which possibly require further comment. One of the first points needing consideration is in regard to the bringing of the animals all to one place for testing. This regulation is likely to be opposed by the wealthy breeder who is doing advanced registry work. To him it is perfectly easy to arrange for a 7-day test at any time in his own barn as a part of his regular work, even the official tester in some cases being a person already in his own employ. Under these circumstances it would be much more convenient for such breeders to have a Futurity Test conducted, so far as his own animals are concerned, in his own barn. The situation is very different, however, in regard to the small breeder in an outlying section of the state, where no official tester is located near at hand. If a plan of the sort mentioned were adopted it would mean that the small breeder could never by any possibility compete, or enter animals, because the expense of having a tester for his heifer or heifers *alone* for a period of seven days would be absolutely prohibitive. It would cost him so much that he would be foolish to enter the contest, even though he were sure to win.

Another factor enters here too. The men who are doing advanced registry work are, to a considerable extent, well-to-do or wealthy breeders, who are able and willing to hire expert herdsmen, and give them special training in regard to the fitting and handling of animals to make high advanced registry records. The fitting and handling of animals for these high records is a matter requiring the skill of an expert. The results obtained may or may not have a significant bearing upon the question of the true innate inherited capacity of the animal in regard to milk production. Now the basic purpose of a Sires' Futurity Test is *to get trustworthy evidence on a practical breeding problem.* It aims to find out the true breeding worth of different individuals and strains of blood. This means that the test must be made under what might be called average working conditions for cattle. The scientific correction of records with respect to age and stage of lactation makes it possible to carry out a Sires' Futurity Test at a central place and at one time for all animals competing, and still get absolutely reliable and perfectly fair results. This plan of testing heifers all at the same time, regardless of when they freshen, and then correcting the results on a scientific basis so as to make them all strictly and justly comparable, eliminates for all practical purposes the element of expert skill in jockeying cows for high records, and puts the animals of the small and inexperienced breeder on a fair basis of competition with those of the larger breeder, who from long experience in advanced registry work knows all the "tricks of the trade."

In carrying out such Sires' Futurity Tests at a central place and at a given time it is by no means necessary to have large transportation costs or to subject the animals to dangerous risks of catching cold, etc. In the first place the actual milking tests should be made more or less local affairs, the heifers being brought to some center readily accessible to a group of entrants. For example, it would be perfectly fair at any time to require that heifers competing in such a test within the borders of Aroostook county should be brought to Aroostook Farm at

Presque Isle for testing. If such a test were to be held in the southern part of the state, it would be equally fair to require that heifers entered from Kennebec, Franklin or Androscoggin counties should be sent to Highmoor Farm at Monmouth for testing. Cow test associations undertaking the work in other parts of the state could arrange to have the milking test brought off at the barn of some one of their members whose location was central, and who had sufficient barn room to accommodate for a week the heifers entered.

In regard to the time of year when the test is held, it is probably to be regarded as generally undesirable to hold a test so late in the fall of the year as this Aroostook test was held. It would seem much more desirable to make the test a summer affair. Of course the only thing that it is necessary to take account of if one is to change the date of the test is also to change the dates within which an animal will be eligible for entry. Thus to take a concrete example, suppose it were thought desirable to hold a Sires' Futurity Test in June. As a matter of fact, June would in some respects be a good month in which to hold such a test. It is a month in which the weather conditions are favorable and it comes after the heavy work of planting and before the beginning of haying and other summer operations. In case such a test were planned, let us say, for June 1916 it would then seem desirable to make the requirement that any heifer would be eligible for entry in this competition which was dropped between the dates of September 1, 1913. and September 1, 1914.

RULES GOVERNING THE AWARD OF THE AMERICAN JERSEY CATTLE CLUB'S CUP.

1. This cup, valued at $100.00 will be awarded annually under the conditions hereinafter specified, to the owner who entered the winning sire in the Maine Jersey Sires' Futurity Test, held annually under the auspices of the Aroostook Jersey Breeder's Association.

2. Any animal to be eligible for competition for this cup must be a pure-bred Jersey bull, registered in the Herd Book of the American Jersey Cattle Club, and properly entered in the Maine Sires' Futurity Test according to the rules and regulations of that test.

3. Of eligible bulls, as specified in paragraph 2, that bull shall be adjudged, in each year, the winner of the American Jersey Cattle Club's Maine Sires' Futurity Test Cup, which has the highest total performance score to his credit.

4. The total performance score of a bull shall be calculated in the following manner:

a. All heifers in the test will be graded in order of the total pounds of butter fat produced in the seven days of the test, after correction for exact age and stage of lactation, as set forth in detail in the general rules of the Maine Sires' Futurity Test

b. The corrected butter production (in pounds and tenths) of each heifer shall be treated as follows in determining the total performance score of her sire:

1. The corrected butter fat production of the first or winning heifer shall be multiplied by 5.

2. The corrected butter fat production of the heifer having the second highest record shall be multiplied by 4.

3. The corrected butter fat production of the heifer having the third highest record shall be multiplied by 3.

4. The corrected butter fat production of all heifers finishing fourth or lower in the test shall be multiplied by 1.

5. No corrected butter fat production of less than 10 lbs. in the seven days shall be counted in any manner in making up the total performance score of a bull.

6. The *sum* of the figures, obtained in the above described manner, for all of the daughters properly entered and completing the test of any sire, shall constitute the Total Performance Record of that sire.

5. The name and registry number of each bull winning the cup, and the name of the owner of that bull at the time of his entry into the Maine Jersey Sires' Futurity Test shall be engraved upon the cup.

6. If any bull shall win the cup three times whether in succession or not, the cup shall then become the permanent property of the owner of that sire; provided, however, that the bull shall be owned by the same person at the time of each such winning.

Animals in the 1915 Test.

While a considerable number of animals were entered for the 1915 Sires' Futurity Test, the great majority of these animals failed to appear at the time of the Test. There were various reasons for this failure. In most of the cases the reason was that since the time when the entry was made the heifer in question had been sold.

The actual test included 4 heifers. The facts regarding these were as follows:

Heifer No. 1—Mollie's Bessie. Owned by Mr. E. L. Johnston, of Easton, Maine.

Sire—Daisy's Pogis of Meadow Farm (98184).
Dam—Mollie, a grade Jersey.
Dropped—May 13, 1913. Freshened—August 9, 1915.
Weight—980 pounds.

Heifer No. 2—Daisy. Owned by Mr. Coleman Green, of Easton, Maine.

Sire—Brackett Farm Poet (77588).
Dam—A grade cow.
Dropped—June 10, 1913. Freshened—August 25, 1915.
Weight—800 pounds.

Heifer No. 3—Kellen of Oak Knoll (332981). Owned by E. L. and A. J. S. Tarbell, of Mapleton, Maine.

Sire—King's Exile of Oak Knoll (94425).
Dam—Flying Fox's Golden Kathleen (221117).
Dropped—May 3, 1913. Freshened—July 1, 1915.
Weight—825 pounds.

Heifer No. 4—Miss Stella Pogis (329706). Owned by Mr. L. H. Denton, of Caribou, Maine.

Sire—Belle's Pogis (99879).
Dam—Torono's Gem of Meadow Farm (79914).
Dropped—April 20, 1913. Freshened—Sept. 16, 1915.
Weight—770 pounds.

Milk and Fat Production.

The tables that follow give the details regarding the production of the four animals in the test during the week. The upper half of the table in each case gives the uncorrected figures; the lower half gives the final results corrected for age and stage of lactation.

Performance of Heifer No. 1, Mollie's Bessie.

UNCORRECTED.

Date	Morning			Noon			Night			Total	
	Milk lbs.	% fat	Fat lbs.	Milk lbs.	% fat	Fat lbs.	Milk lbs.	% fat	Fat lbs.	Milk lbs.	Fat lbs.
Nov. 15.......	10.3	5.2	.54	10.5	4.8	.50	10.1	5.2	.53	30.8	1.57
Nov. 16.......	10.4	5.0	.52	9.6	5.2	.50	10.1	5.2	.53	30.1	1.55
Nov. 17.......	9.0	5.0	.45	9.4	5.2	.49	9.3	5.0	.47	27.6	1.41
Nov. 18.......	9.0	5.2	.47	10.2	5.0	.51	9.6	5.0	.48	28.7	1.46
Nov. 19.......	9.7	5.2	.50	9.7	5.0	.49	10.0	5.0	.50	29.5	1.49
Nov. 20.......	10.4	5.3	.55	10.2	5.0	.51	10.4	5.4	.56	30.9	1.62
Nov. 21.......	9.7	5.0	.49	8.9	5.0	.45	10.9	5.0	.55	29.5	1.49
Total.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	201.1	10.59

CORRECTED.

Date	Morning			Noon			Night			Total	
	Milk lbs.	% fat	Fat lbs.	Milk lbs.	% fat	Fat lbs.	Milk lbs.	% fat	Fat lbs.	Milk lbs.	Fat lbs.
Nov. 15.......	12.6	5.2	.66	12.8	4.8	.61	12.3	5.2	.64	37.6	1.91
Nov. 16.......	12.7	5.0	.63	11.7	5.2	.61	12.3	5.2	.64	36.7	1.88
Nov. 17.......	11.0	5.0	.55	11.5	5.2	.60	11.3	5.0	.57	33.7	1.72
Nov. 18.......	11.0	5.2	.57	12.4	5.0	.62	11.7	5.0	.59	35.0	1.78
Nov. 19.......	11.8	5.2	.61	11.8	5.0	.59	12.2	5.0	.61	36.0	1.81
Nov. 20.......	12.7	5.3	.67	12.4	5.0	.62	12.7	5.4	.69	37.7	1.98
Nov. 21.......	11.8	5.0	.59	10.9	5.0	.55	13.3	5.0	.67	36.0	1.81
Total.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	252.7	12.89

Performance of Heifer No. 2, Daisy.

UNCORRECTED.

Date	Morning			Noon			Night			Total	
	Milk lbs.	% fat	Fat lbs.	Milk lbs.	% fat	Fat lbs.	Milk lbs.	% fat	Fat lbs.	Milk lbs.	Fat lbs.
Nov. 15.......	5.5	5.6	.31	5.6	5.7	.32	5.4	5.6	.30	16.4	.93
Nov. 16.......	5.8	5.4	.31	5.7	5.8	.33	6.1	5.2	.32	17.1	.96
Nov. 17.......	6.5	5.8	.38	6.7	5.5	.37	6.6	5.7	.38	19.8	1.13
Nov. 18.......	6.2	5.4	.33	7.0	5.8	.41	6.4	5.8	.37	19.6	1.11
Nov. 19.......	6.8	5.4	.37	7.3	5.4	.39	7.1	5.4	.38	21.2	1.14
Nov. 20.......	8.3	5.3	.44	8.4	5.4	.45	7.9	5.2	.41	24.6	1.30
Nov. 21.......	7.9	5.2	.41	7.2	5.0	.36	9.2	5.3	.49	24.3	1.26
Total.....	.....	.....	.....	.....	.....	.....	....	.....	.....	143.0	7.83

CORRECTED.

Date	Morning			Noon			Night			Total	
	Milk lbs.	% fat	Fat lbs.	Milk lbs.	% fat	Fat lbs.	Milk lbs.	% fat	Fat lbs.	Milk lbs.	Fat lbs.
Nov. 15.......	6.3	5.6	.35	6.4	5.7	.36	6.2	5.6	.35	18.7	1.06
Nov. 16.......	6.6	5.4	.36	6.5	5.8	.38	7.0	5.2	.36	19.5	1.10
Nov. 17.......	7.4	5.8	.43	7.6	5.5	.42	7.5	5.7	.43	22.6	1.28
Nov. 18.......	7.1	5.4	.38	8.0	5.8	.46	7.3	5.8	.42	22.3	1.26
Nov. 19.......	7.8	5.4	.42	8.3	5.4	.45	8.1	5.4	.44	24.2	1.31
Nov. 20.......	9.5	5.3	.50	9.6	5.4	.52	9.0	5.2	.47	28.0	1.49
Nov. 21.......	9.0	5.2	.47	8.2	5.0	.41	10.5	5.3	.56	27.7	1.44
Total......	.....	.....	.....	.....	.....	.....	.....	.....	.....	163.0	8.94

Performance of Heifer No. 3, Kellen of Oak Knoll.

UNCORRECTED

Date.	Morning			Noon			Night			Total	
	Milk lbs.	% fat	Fat lbs.	Milk lbs.	% fat	Fat lbs.	Milk lbs.	% fat	Fat lbs.	Milk lbs.	Fat lbs.
Nov. 15.......	7.5	5.0	.37	8.1	4.8	.39	7.6	5.0	.38	23.2	1.14
Nov. 16.......	7.5	4.6	.35	8.0	4.7	.38	8.6	4.7	.40	24.1	1.13
Nov. 17.......	7.9	4.6	.36	8.7	4.8	.42	7.7	4.4	.34	24.4	1.12
Nov. 18.......	7.4	4.4	.33	8.7	4.8	.42	7.9	4.7	.37	23.9	1.12
Nov. 19.......	7.4	4.6	.34	8.3	4.8	.40	7.9	4.7	.37	23.5	1.11
Nov. 20.......	7.3	4.4	.32	8.5	4.8	.41	7.6	4.5	.34	23.1	1.07
Nov. 21.......	7.6	4.8	.36	6.9	5.2	.36	8.5	5.2	.44	23.0	1.16
Total.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	165.2	7.85

CORRECTED

Date.	Morning			Noon			Night			Total	
	Milk lbs.	% fat	Fat lbs.	Milk lbs.	% fat	Fat lbs.	Milk lbs.	% fat	Fat lbs.	Milk lbs.	Fat lbs.
Nov. 15.......	9.7	5.0	.49	10.5	4.8	.50	9.9	5.0	.49	30.2	1.48
Nov. 16.......	9.7	4.6	.45	10.4	4.7	.49	11.2	4.7	.53	31.3	1.47
Nov. 17.......	10.3	4.6	.47	11.3	4.8	.54	10.0	4.4	.44	31.7	1.45
Nov. 18.......	9.6	4.4	.42	11.3	4.8	.54	10.3	4.7	.48	31.1	1.44
Nov. 19.......	9.6	4.6	.44	10.8	4.8	.52	10.3	4.7	.48	30.5	1.44
Nov. 20.......	9.5	4.4	.42	11.1	4.8	.53	9.9	4.5	.45	30.0	1.40
Nov. 21.......	9.9	4.8	.48	9.0	5.2	.47	11.1	5.2	.58	29.9	1.53
Total.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	214.7	10.21

Performance of Heifer No. 4, Miss Stella Pogis.

UNCORRECTED

Date	Morning			Noon			Night			Total	
	Milk lbs.	% fat	Fat lbs.	Milk lbs.	% fat	Fat lbs.	Milk lbs.	% fat	Fat lbs.	Milk lbs.	Fat lbs.
Nov. 15.......	6.7	4.7	.31	6.2	4.6	.29	7.7	5.6	.43	20.7	1.03
Nov. 16.......	6.7	5.2	.35	6.8	4.8	.33	8.3	4.7	.39	21.8	1.07
Nov. 17.......	7.3	4.6	.34	8.1	5.2	.42	8.4	5.0	.42	24.8	1.18
Nov. 18.......	7.7	6.4	.49	7.8	6.2	.48	7.4	5.5	.41	23.0	1.38
Nov. 19.......	7.9	5.8	.46	8.0	6.0	.48	7.8	5.5	.43	23.7	1.37
Nov. 20.......	8.6	6.0	.52	7.8	5.8	.45	7.6	5.4	.41	23.9	1.38
Nov. 21.......	7.6	5.4	.41	6.5	6.0	.39	7.7	5.6	.43	21.8	1.23
Total.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	159.7	8.64

CORRECTED

Date	Morning			Noon			Night			Total	
	Milk lbs.	% fat	Fat lbs.	Milk lbs.	% fat	Fat lbs.	Milk lbs.	% fat	Fat lbs.	Milk lbs.	Fat lbs.
Nov. 15,......	7.6	4.7	.36	7.1	4.6	.33	8.8	5.6	.49	23.6	1.18
Nov. 16.......	7.6	5.2	.40	7.8	4.8	.37	9.5	4.7	.45	24.9	1.22
Nov. 17.......	8.3	4.6	.38	9.2	5.2	.48	9.6	5.0	.48	28.3	1.34
Nov. 18.......	8.8	6 4	.56	8.9	6.2	.55	8.4	5.5	.46	26.2	1.57
Nov. 19.......	9.0	5.8	.52	9.1	6.0	.55	8.9	5.5	.49	27.0	1.56
Nov. 20.......	9.8	6.0	.59	8.9	5.8	.52	8.7	5.4	.47	27.2	1.58
Nov. 21.......	8.7	5.4	.47	7.4	6.0	.44	8.8	5.6	.49	24.9	1.40
Total.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	182.1	9.85

From these tables it is evident that the animals stand in the following order:

Mollie's Bessie, No. 1, was the winner with 12.89 lbs. fat in 7 days; average fat percentage 5.11 per cent. The sire of this heifer, Daisy's Pogis of Meadow Farm (98184) was the winner of the American Jersey Cattle Club Cup.

Kellen of Oak Knoll, No. 3, is second with 10.21 lbs. of fat; average fat percentage 4.75 per cent.

Miss Stella Pogis, No. 4, is third with 9.85 lbs. of fat; average fat percentage 5.41 per cent.

Daisy, No. 2, is fourth with 8.94 lbs. of fat; average fat percentage 5.48 per cent.

While none of the records made in this Test were extraordinarily high, yet they are very creditable performance records all things considered. Ten and one-half pounds of butter fat in 7 days produced by a two-year old heifer three months along in lactation, while not phenomenal, is good.

Feeding During the Test.

The grain rations furnished by the different owners had the following compositions:

Grain Mixture Fed Mollie's Bessie.

Union Grains. Ubiko Milling Co............	200 pounds
Schumacher Stock Feed. Quaker Oats Co.....	225 pounds
Wheat bran	100 pounds

Grain Mixture Fed Daisy.

Union Grains. Ubiko Milling Co..............

Grain Mixture Fed Kellen of Oak Knoll.

Schumacher Stock Feed. Quaker Oats Co....	150 pounds
Union Grains. Ubiko Milling Co............	125 pounds
Cottonseed meal	100 pounds

Grain Mixture Fed Miss Stella Pogis.

Schumacher Stock Feed. Quaker Oats Co.....	200 pounds
Cottonseed meal	100 pounds
Wheat bran	200 pounds

Showing the Feed Consumed During the Test.

(About 5 lbs. of hay was fed twice a day, morning and night).

	Mollie's Bessie		Daisy		Kellen of Oak Knoll		Miss Stella Pogis	
	Grain lbs.	Potatoes lbs.	Grain lbs.	Potatoes lbs.	Grain lbs.	Potatoes lbs.	Grain lbs.	Potatoes lbs.
Nov. 15, A. M. .	4½	15	2¾	10	5	15	2	10
Nov. 15, Noon. .	4½	15	2¾	10	5	15	2	10
Nov. 15, P. M. .	4½	15	2¾	12	4¾	15	2	10½
Nov. 16, A. M. .	5¼	15	3	13	5	11¾	3	10
Nov. 16, Noon. .	4¼†	15	3	10	5	12	2¾	10
Nov. 16, P. M. .	5	15	3	10	5	12	3	10
Nov. 17, A. M. .	5	15	3	12	5	12	3	10
Nov. 17, Noon. .	3¾*	15	3	12	5	12	3	10
Nov. 17, P. M. .	4½*	15	3¾	13	5	12	3½	10
Nov. 18, A. M. .	4¾	–	3½	–	5	12	3½	–
Nov. 18, Noon. .	4	15	3½	12½	5	12	3½	10
Nov. 18, P. M. .	4¾	15	3¾	13	5	12	3¾	10
Nov. 19, A. M. .	4½	15	3¾	12	5	12	3¾	10
Nov. 19, Noon. .	4½	15	3½	12	5	12	3¾	10
Nov. 19, P. M. .	4½	15	3½	13	5	12	3¾	10
Nov. 20, A. M. .	4¾	15	3½	13	5	13	3¾	10
Nov. 20, Noon. .	4½	15	3½	13	5	12	3½	10
Nov. 20, P. M. .	4½	15	3½	13	5	13	4	10
Nov. 21, A. M. .	4½	15	3½	13	5	12	3¾	10
Nov. 21, Noon. .	4½	15	3½	13	5	12	3¾	10
Nov. 21, P. M. .	4	15	½	13	5	12	3¾	10

* 1 lb. of cotton seed meal was added to each of these rations and the Union Feed left out.

† 4 oz. of linseed oil meal was added to the ration fed at this time and the Union Feed left out.

THE NUTRIENTS IN THE FEED.

In the following table there is given the estimated pounds of digestible nutrients in 100 pounds of the different grain mixtures, the hay and the potatoes.

Pounds of Digestible Nutrients in 100 Pounds of the Feeding Stuffs Used.

Kind of Feed	Protein	Fat	Carbohydrates
Grain mixture fed Mollie's Bessie.	11.9	4.4	50.0
Grain mixture fed Daisy.	17.0	6.7	46.0
Grain mixture fed Kellen of Oak Knoll	16.1	4.9	43.3
Grain mixture fed Miss Stella Pogis. .	13.5	3.6	41.9
Mixed hay.	4.5	1.6	43.9
Potatoes.	1.0	0.0	14.8

From the data given in the preceding tables and the weight of the animals as given on page 50, the digestible protein and the total digestible nutrients per 1000 pounds live weight are readily computed. In the table that follows these are compared with the modified Wolf-Lehman standards for milch cows producing the amount and quality of milk these heifers gave.

Protein and total digestible nutrients per 1000 pounds live weight in the daily ration used by each animal in the test, compared with the modified Wolf-Lehman standards for cows giving the weight of milk and per cent of butter fat these heifers gave per day.

Name of Heifer and Standard.	Protein lbs.	Total digestible nutrients. lbs.
Mollie's Bessie	2.55	21.20
Standard	*2.64*	*19.58*
Daisy	3.11	21.75
Standard	*2.13*	*16.75*
Kellen of Oak Knoll	3.95	25.45
Standard	*2.22*	*17.06*
Miss Stella Pogis	2.68	19.89
Standard	*2.31*	*17.76*

BULLETIN 248.

STUDIES OF LIFE HISTORIES OF LEAFHOPPERS OF MAINE.*

HERBERT OSBORN, Consulting Entomologist.

The following report includes the results of studies in Maine during the summer of 1914 and are in the nature of a continuation of the survey of the leafhoppers of the state begun in 1913. As a result of that seasons work a few species considered as of special economic importance were selected for a more exhaustive study and during the season of 1914 when I devoted about ten weeks to the study, observations were made upon the species discussed in this paper.

The leafhoppers and the froghoppers (*Jassidae* and *Cercopidae*) while belonging to distinct families and possessing some very different habits agree in so many details and especially so much in the nature of their work and the injury occasioned to similar crops that they can very properly be treated in connection. Moreover there are a number of general considerations that can very properly be grouped together so that the introduction may be counted as applying to members of both groups.

Except for the notable production of the frothy masses it is probable that agriculturists generally would count them all as one general group of plant sucking hoppers.

The studies of the season have centered especially on the species injurious to grass and grain crops. The work dealing with leafhoppers is presented in this paper and that devoted to froghoppers is in the main reserved for treatment in a separate bulletin soon to be issued by this Experiment Station.

Considering the importance of the hay crop, which in Maine ranks first in the agricultural products of the state, there is

*Papers from the Maine Agricultural Experiment Station; Entomology No. 85.

abundant reason to study the insect pests that serve to limit the yield and injure the quality of the crop. Statistics for 1913 (U. S. Dept. Agriculture) show 1,194,000 acres devoted to the crop with yield of 1,194,000 tons and value of 16,597,000 dollars. This estimate is lower than that of previous years and does not include pasturage which, from the fact that the state has 259,000 cattle valued at near ten millions of dollars, must represent a considerable factor in the agriculture of the state.

The insect depredations on grass are of such a character as to escape due recognition, partly because of the minuteness of most of the insects concerned and the obscure nature of their attack, partly because the injury consists of a steady drain through the season and seldom results in the total destruction of plants, and partly because the injury and loss if noticed at all is very likely to be charged to other agencies such as weather conditions, exhaustion of soil, "running out" of the meadow, etc.

While demonstration is somewhat difficult there is good reason to believe that a considerable part of the "running out" is due to the multiplication of insect pests in the meadow and that if these could be eliminated the yield would be greatly increased or the period of rotation could be very much extended.

Some rather striking illustrations of the extent of the injury have come to light during the season and may be presented here as a suggestion at least, as to the cause of rapid decrease in yield in fields which in other respects have best of conditions for an average crop.

A very good opportunity to compare the conditions in a field that had been in grass but a short time and one where grass had been growing for a number of years was afforded in a field on the university farm where timothy had been growing for a couple of years and in a near by field, the meadow to the south of the library building, where the grass had been growing for some twelve years. I was told that this latter field had been well manured and had for some years produced good crops but in late years a much lower yield and the appearance of the field would bear out this statement though I did not secure exact figures of yield so as to make a complete comparison.

In the new timothy field, planted in 1912, I counted forty good stems with large heads inside a square foot which would equal 1,000 to twenty-five square feet while in the old field in an equal space there were but 67 good plants.

In the library field the space five feet square gave:

Large healthy stems with full heads	67
Small full formed heads apparently healthy	172
Injured heads small or blasted	673
Undeveloped plants, no heads	1052

The condition of this patch is shown in the photograph the scattering tall plants with fully developed heads showing above the general level while the blighted or undeveloped plants are seen to form a much lower level. Fig. 9a.

The contrast in these plants may also be seen in the height of plants measured and photographed. Fig. 10.

Height of 20 uninjured plants, 3 to 4 feet
Height of injured or blighted plants, 1 to 2 feet
Length of healthy fully developed heads 3 1-2 to 5 1-2 inches
Length of blighted or injured heads 1 to 3 inches

In weight there is also quite a striking contrast as shown in figures from these same samples.

Weight of 20 uninjured plants freshly cut, 100 grms; dry, 62 grms.
Weight of 20 injured plants freshly cut, 30.5 grms; dry, 20 grms.

The weight for the freshly cut samples was taken July 13th and the weights for the dry samples on July 20th.

It may be argued that a larger number of stems or leaves for the defective plants would meet or offset some of this discrepancy in individuals and this is in part true but there must be a great difference in total weight as well.

In order to compare the nutritive value of the injured and uninjured plants a chemical analysis of the samples seemed desirable and this was very kindly undertaken by the Station chemist, Prof. Bartlett. His report is as follows:

Timothy 20 stems stunted plants with blasted heads No. 5532; weight freshly cut, 30.5 gms., dried 20 gms.

Moisture.	Ash.	Nitrogen.	Protein found.	Fiber.	Nitrogen, free extract.	Fat. found.
4.54	3.54	0.78	4.88	26.31	58.83	1.00
Water free	3.71	0.82	5.11	27.56	61.63	1.99

Timothy 20 stems healthy plants with heads in blossom No. 5533; weight freshly cut 100 gms., dried 62 gms.

Moisture.	Ash.	Nitrogen.	Protein found.	Fiber.	Nitrogen, free extract.	Fat.
7.07	4.28	0.83	51.8	33.95	47.29	2.23
Water free	4.61	0.89	5.57	36.53	50.81	2.40

The significant points in this analysis appear to be the greater proportion of protein and fat the most important flesh and fat forming constituents of the hay in the uninjured plants as compared with the injured ones. This bears out what might naturally be expected and what I have long felt must be recognized in the attacks of these pests, that they not only reduce the quantity but lessen the food value of the crop attacked. It would of course be unwarranted to claim that all this difference is due to the insect attack although without very much more precise methods of differentiating the factors concerned in the maturing of the grass crop it will be impossible to measure all the agencies concerned. Nor is it claimed that all this loss is due to leafhoppers as there are other insects present and in this particular field there were considerable numbers of the capsid, *Leptoterna dolobrata* which must have had some influence in the growth of the grass but the dominant forms here were the leafhoppers and froghoppers and I feel confident that these insects must be charged with a large share in the losses that are manifest.

It is very evident that a crop of one or one and a half tons of inferior hay to the acre (an average of one ton to the acre is shown in the statistics for 1913) where there should be a crop of two and a half to three tons of good hay is a matter of some concern to the grower. Or, if the field is used for pasturage, it is as evident that there is much less of forage for the stock pastured on a given area.

The numbers of the different species may vary from year to year and I am quite sure that the abundance of certain of the species may bear some relation to the length of time during which the field may have been in grass. It appears that the six-spotted leafhopper is one of the first to invade a new field since it produces several generations and is quite migratory in habit. After this, for Maine, the *Deltocephalus minki* appears to be one of the earliest to appear in open fields, later the froghoppers and *Acocephalus striatus* come in abundance and one of the latest, perhaps the least migratory, is the *Acocephalus albifrons* which has been found living down in the ground around the crowns of timothy.

Hibernation in General.

In order to determine the place of hibernation of such of the species as might be present, cages were placed in timothy meadows on Dr. Patch's farm. These cages, two eighteen inches square and two one foot by four feet were set out in early spring before insects had become active and before any migration had been possible. They were crowded down close to the surface of the ground but not below the surface of the soil. While it would be possible for insects of some kinds at least to burrow under the frames there would certainly be no probability that any of the Jassids would, if they were to fly into the field from adjacent fence rows or thickets, do this and it is a fair assumption that species found living within the cages on the grass had hibernated in one stage or another on the spot. The same assumption, while less certain for some other kinds of insects, or for spiders, phalangids, etc., is a fair one especially if the content of the cages agrees well in proportion with the surrounding grassland.

While the primary purpose of these cages was to determine this fact of hibernation in the field, examination showed such an interesting association of animals and one so fairly typical of the meadow complex that it seemed worth while to make a careful record of the contents of one or two of the cages at least.

Cage 1 was examined and part of the contents secured on July 19th, and part on July 20th, all the actively migrating species being taken on the former day, so that there was no opportunity of loss or gain in the interval. Cage 2 was examined July 20th and in this case from one to two inches of the soil, including practically all loose earth and the roots, as well as all the vegetation in the cage was removed and carefully examined, the insects and other animals sorted and a record kept of number as well as of the species found. This record with identifications as far as carried may be inserted here.

Record of Cage Number 1.

Acocephalus albifrons L.	113	(50 on 19th, 63 on 20th.)
Acocephalus striatus L.	7	2 adult males, rest nymphs
Deltocephalus configuratus	1	
Deltocephalus sayi, Fitch	4	
Deltocephalus minki, Fieb.	1	
Agallia sanguinolenta Prov.	2	
Phytonomus sp.	1	
Phytonomus punctatus	2	
Elaterid, (Coleoptera)	1	
Crambus (Lepidoptera)	1	
Ants	2	
Spiders	5	

Record of Cage Number 2.

Acocephalus albifrons L.	108	
Acocephalus striatus L.	13,	10 nymphs, 3 adult males
Deltocephalus sayi Fh.	1	
Athysanus curtisii Fh.	1	
Dicraneura sp.	1	
Agallia sanguinolenta Prov.	4	3 adult, 1 nymph
Agallia 4-punctata Prov.	1	
Philaenus spumarius, L.	3	
Aphids (Nectarophora destructor).	8	
Leptoterna dolobrata (Capsid).	1	
Labops sp. (Capsid).	3	
Agalliastes sp. (Capsid).	2	
Halticus sp. (Capsid).	3	

Record of Cage Number 2.—Concluded.

Phytonomus sp. (Weevils).	18	4 adult, 7 pupae, 7 larvae
Elaterids	2	
Staphylinidae	1	
Tingid Acalypta ?	1	
Syrphid ? puparium	1	
Ants two sps.	15	1 large black, 14 small red
Spiders two sps.	11	6 adult ? 5 small young ?
Mite (Trombidium sp ?)	1	
Harvestmen (Phalangids)	3	2 adult, 1 small young
Sow bugs (Crustacea)	6	
Snail (Mollusc)	1	

It may be noted that cage 1 would doubtless have shown more of certain kinds if the soil had been thoroughly sifted and also that the small number of the commoner Jassids may be attributed to the presence of the spiders and phalangids which had evidently been making a good living inside the cage. The most noteworthy point probably is the enormous number of *Acocephalus albifrons* which were around the crowns of the grass and even down under the litter and in some cases under loose earth, leading an almost subterranean life.

A cage in another field included capsids, *Leptoterna dolobrata, Philaenus spumarius, Draeculacephala mollipes, Cicadula 6-notata, Acocephalus striatus, Deltocephalus minki* and *sayi, Agallia 4-punctata* and a species of *Dicraneura* aside from other forms not of special importance in this connection.

The Six-spotted Leafhopper.

(*Cicadula sexnotata* Fallen.)

This species presents some very interesting questions and, in connection with its very evident ability to cause serious injuries to various crops, merits a careful study.

It is a very widely distributed species occurring in Europe and North America in the latter being known from Alaska to Florida and a number of records of its destructive habits have been given but it has received rather scant attention on the part of economic entomologists. While the insect may be found in numbers the attacks made by the larval stages are often so obscure that they may be overlooked or attributed to other causes.

In referring to the species in my report to the department of agriculture in 1912 I called attention to the rather remarkable fact that while the species is so generally distributed and abundant throughout the United States there was no published record of its occurrence in this country prior to 1884, a fact that very naturally suggests that it might be an introduced species. This supposition is somewhat strengthened by the fact that it is so common to the cultivated cereals. As stated in the article.

"Unfortunately we can not safely assume that lack of record by earlier entomologists is in this case any positive proof that the species was not present. While Say, Harris, Fitch, and Uhler all gave attention to this group of insects, and their studies together run back to 1820, they naturally could not be expected to recognize all that might have occurred, even in their respective localities. However, absence of records, especially in the case of such good collectors and acute observers, is in some degree presumptive evidence of non-occurrence in the case of a species so abundant as this, and if we assume an introduction of the species at some period closely prior to its first notice we must recognize a rapid spread over the whole country, as it is stated by Van Duzee in 1914 to 'occupy North America from Ontario and Connecticut to Alaska and California and South to Mississippi.' There is in the records concerning the species in this country no sequence of dates which furnishes us any basis for tracing any dispersal from some center of introduction, as records for such widely separated points as Illinois, Iowa, Ontario, Washington, D. C., California, and Tennessee appear all within five years of its first notice."*

Whatever the time and mode of its appearance in this country it is now one of the species that must be reckoned with in our agriculture and therefore a knowledge of its habits and life-history is needed. While some information on these points has been published the data are very meager and as stated in the paper previously mentioned, "The life history of the species has never been given in detail, though brief statements concerning the nymphal period appear in some cases. Leonardi barely mentions 'larva and nimfe' in connection with reference to the

*Since the above was written I have seen in looking over the Harris collection in the Boston Society of Natural History, a specimen of this species probably collected between 1840-50 and which would indicate the occurrence of the species at a much earlier date than shown by published records. However, the absence of records would indicate lack of abundance for the species.

species as a pest of cereals." I gave a short description of the nymphal stage but was unable to give the stages in detail or to determine as to the number of generations annually. While we still lack some of these details it has been possible this season to trace the development through from egg to adult and for the latitude of Maine at least the facts secured will furnish a much better basis for measures of control that have previously been available.

Crops Affected.

This species has quite a wide range of foodplants and consequently is liable to become a pest to a number of crops but in Maine its most important attacks I believe will be found to be directed upon the meadow grasses and oats.

Its presence in meadows is almost universal and while it is not so abundant here as some of the other species probably because of its migration to adjacent grain fields, it must be counted as a constant drain especially in meadows of several years standing. On account of its numerous broods rapid development of the nymphs and ready flight of the adults it is more rapidly distributed into new fields than most of our meadow species and consequently rotation may not be as effective in its control.

As a pest of oats it is one of the most conspicuous in its attack of any of the oat-feeding species although its work is very easily mistaken for that of plantlice or thrips. In Maine the attack on oats begins almost as soon as the plants are above ground when their succulent character is evidently a distinct attraction to the leafhopper and at this time adults may be swept in numbers from oat fields especially if they are adjacent to old meadows. It is possible that there are two broods here before the ripening of the crop but we have complete evidence of the development of one generation both by rearing on plants in cages and by field observation. This generation begins with egg depositions in the oat leaves in early July as detailed under life history and matures by the middle of August or before the ripening of the grain and is then ready for flight to fields of more succulent character than the oat stubble.

The appearance of the infested oat plants is fairly characteristic though as suggested above may resemble attacks of thrips or plantlice.

The most evident effect is the production of numerous spots on the leaves these spots being at first whitish then turning to yellow then to brown and later to black often a black or brown center being surrounded by a reddish or yellow border and very much resembling a fungus affected spot. This resemblance is so great that the presence of fungi has often been suspected and efforts made to determine it. In fact I have often been in doubt whether certain spots could be charged to insect attack or fungus and have hesitated to assign the injury to the insect. The presence of eggs in the infested leaves or the demonstration of punctures where the hoppers have been sucking the plant cells however will leave no question as to the cause. Prof. Morse of this station who has made careful studies of these injuries states that he has been unable to find fungi present in connection with the spots except late in the season and when they may very probably have followed as a sequence of the hopper punctures.

The egg punctures and the feeding punctures are different enough so that they usually may be distinguished with the aid of a lens and the egg punctures do not as a rule show the coloring which follows the punctures and sucking of sap where the insects feed. The eggs are deposited mainly in the upper part of the leaf sheath or close to the stem on the basal part of the leaf blade. They are forced in beneath the epidermis usually close to the under epidermis but not through it and thus lie in the layer of cells between the two epidermal surfaces of the leaf. The result is a transparent spot that is usually quite apparent especially if the leaf is held up to the light.

The feeding puncture is by itself a very minute affair scarcely to be detected except by magnification but the sucking of the cell contents produces a deadened spot which as already described changes color with time until it becomes brown or black. The change in color may be assisted by the injection of some secretion in the process of feeding which has a poisonous effect on the plant tissues as is the case in some of the other species of leafhoppers notably the species producing curly leaf of the beet (*Eutettix tenella*) which has been described in detail by Dr. E. D. Ball. It seems the more likely since there appears to be a decided tendency for the affected leaves to change color and wither at the tips as well as around the punctured spots and these effects differ from those of the plant lice which are also suctorial and so far as withdrawing sap must act very much like the hoppers.

Inasmuch as the leafhoppers, plantlice and thrips are so commonly found associated even on the same plants a comparison of the effect on the leaves may be useful. It may not be possible in every instance to say positively simply from the looks of injured leaves without the finding of the insect concerned just which one has been at work but from examination of a great many leaves I believe that it is generally possible. Thrips injury on the leaves show as minute dots or lines usually running parallel with the leaf veins and remaining white. If in the larval stage they may be seen with a strong lens running actively about on the leaf surface and some individuals will be found beneath the leaf sheath where their presence is likely to be indicated by whitened spots. In the head they produce the blasted flowerets so well described by Dr. Hewitt. (Jour. Economic Entomology Vol. 7, p. 211.)

The plantlice which may be of two species as determined by Dr. Patch (*Macrosiphum granaria* and *Aphis avenae*) cluster mainly at or near the tips of the leaves or at the base of the flowerets and travel much less freely than either the thrips or the leafhoppers. Their results show in withering of the leaf or floweret but without, for some time at least any particular discoloration. The young leafhoppers on hatching usually crawl out upon the leaf in which the eggs were deposited but they drop or jump readily if disturbed and unless the leaves are examined with great care not to agitate them there is little chance of finding them in connection with the spots which they have produced. Moreover they seem to wander freely so that numerous punctures will be found on leaves where there is no other sign than the punctures that they have been present. The character of the leaf spots made by their punctures may be indicated by the photograph reproduced in Fig. 12, but unfortunately the color features can not be shown without a color plate. There is sufficient agreement in habit between the thrips and the leafhoppers so that this distinction may be of little economic necessity but infestation from plantlice must be from other sources and in any case there is an advantage in knowing the exact nature of the insect that may be most prevalent in any community or field so that such preventive measures as may be possible may be applied intelligently.

Another means of identification for the leafhoppers where the living insects cannot be found or where no eggs are evident is found in the presence of the moulted skins of the nymphs. These retain the form and show the characters of the nymphs and as they remain attached to the leaves, often for some time after the emergence of the insect, they are a good proof of the presence of leafhoppers. Their absence however cannot be considered as proof of no hoppers as they are not firmly attached to the leaves and are easily dislodged by shaking or the brushing of leaves together in the wind. The series of photographs of these moulted skins, Fig. 11, will assist in the identification and they may be readily examined with the aid of a low power lens.

Life History.

There is considerable irregularity in the life history of this species and it is difficult to state any definite periods for the development of the stages especially if any large area of country is considered. In Maine adults are to be found in plenty in late June and early July and there is a pretty well marked brood occurring in July, which is found abundantly in oat fields, and it is this brood which has been the basis for our most definite records as to length of instars and rate of growth. Adults were found with developed eggs July 10th, and from these eggs were dissected for comparison with eggs deposited in the plants, and eggs from adults confined on oat plants in the insectary were laid about the 16th and began hatching on the 23rd.

The eggs were laid in the leaf sheath and at base of leaf blade and a little tuft of white strands mark the place of puncture. The egg lies head end to the opening and in a short time the eyes become quite conspicuous. The eggs often lie in close rows of four to six in a row but also very commonly as scattered single eggs. The arrangement on leaf sheath and blade are shown in the figure and for the cases observed there was about an equal distribution between leaf sheath and blade. The eggs do not pass entirely through the leaf but lie between the epidermal layers so that if the leaf sheath is stripped off the eggs come with it even in very thin parts. A little blister shows on the outside and the eyes appear as minute red dots. The eggs are set obliquely to the vascular bundles and minute reticulations of the inner epidermis may be seen covering the egg if examined with a lens. On the blade they are thrust through from the upper surface but lie closer to the under epidermis. Thirty-seven eggs were counted within the length of an inch on one stem of oat.

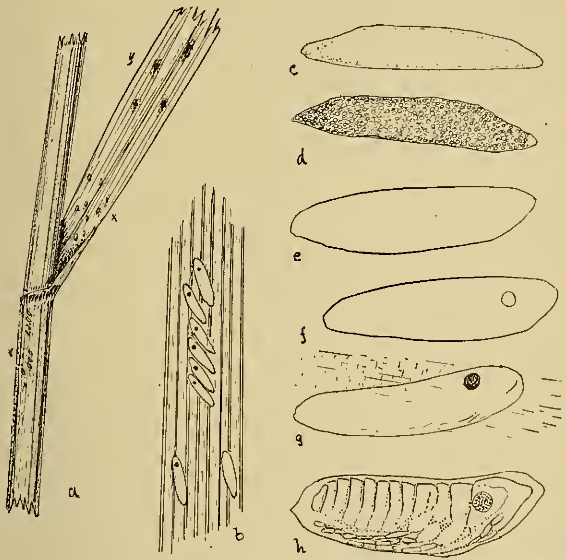

Fig. 1. *Cicadula sexnotata*. Eggs. *a*, Oat stem and blade showing points of egg deposition *x* and feeding punctures *y*; *b*, eggs as seen in plant tissue; *c*, egg dissected from female, surface view; *d*, egg dissected from female, sectional view; *e*, freshly laid from oat stem; *f*, eye spot appearing; *g*, eye distinct egg in network of plant cells; *h*, embryo with segments developed; (Original).

On emergence from the egg the nymph is light yellow with red eyes but they soon become tinged with dusky and will be noticed as minute blackish specks on the leaf surface. The egg punctures after the eggs hatch are still visible but less conspicuous and will be detected as minute white or transparent spots and in many cases the remnants of the egg shell can be seen as proof of the presence of the insects. The incubation period for this time of year is about seven days as shown by different sets of eggs one set laid Aug. 4th hatching Aug. 11th. In these the eyes became conspicuous on the fourth day after deposition.

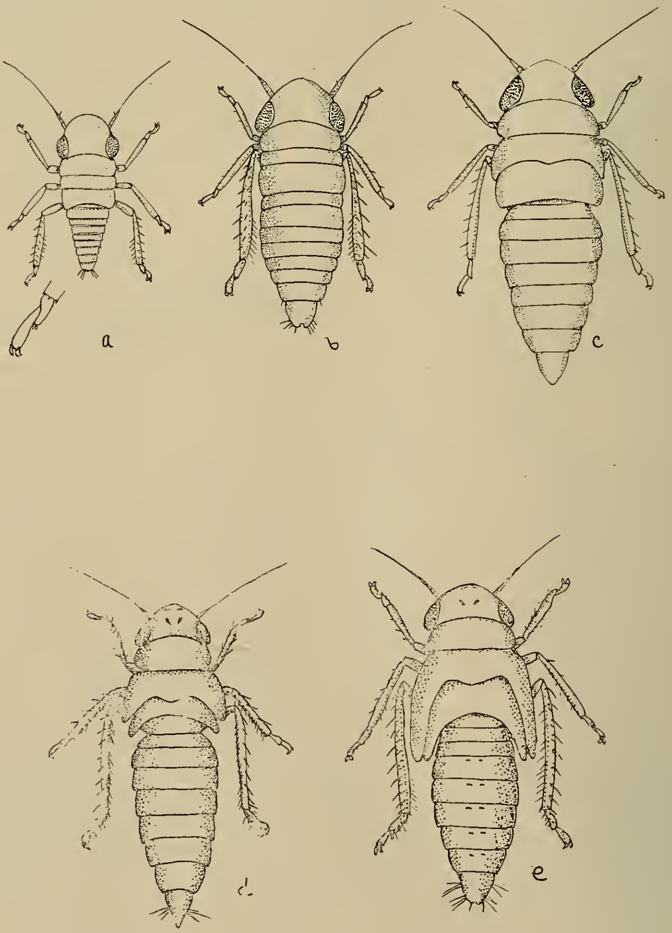

Fig. 2. *Cicadula sexnotata.* *a*, 1st; *b*, 2nd; *c*, 3rd; *d*, 4th; *e*, 5th instars of nymph. *f*, tarsus of *a* much enlarged. a, b, c, drawn to larger scale than d, e. (Original).

Moulting occurred in three days from hatching the 26th of July for the eggs hatching July 23rd, a second moult occurred four days later July 30, the third moult on Aug. 3rd, and the fourth moult on Aug. 6th, with final moult and appearance of adults on Aug. 11th, or twenty days from hatching, about twenty-seven days from egg deposition. Allowing a probable week or ten days in adult stage before egg deposition begins would give us five to six weeks as the period of the summer brood and at this rate it would be an easy matter to have three or four generations in a season for the latitude of central Maine

The nymphs when first hatched cling pretty closely to the leaf but may crawl around and especially toward the tip of the leaf and the leaf becomes spotted with their punctures. These at first appear white but later change to red and then to black and the leaf in severe attacks will shrivel and turn yellow, in bad cases the whole leaf turning yellow and shriveling. The appearance is shown in the photograph reproduced in Fig. 12.

Description of Early Stages.

The eggs as dissected from adults July 10th and as examined from leaves are slender with a length of .8 mm and a width of .16 mm narrowing at either end, the head end wider and with a clear space while the remainder of the egg contains minute globules as seen by transmitted light. Fig. 1 d. The surface of the egg is smooth the chorion with no apparent markings.

1st instar: The nymphs on hatching are .6 mm to .7 mm long and at end of the instar have reached a length of slightly over one millimeter. The head is large and rounded in front much produced, half its length, before the eyes. Prothorax about half the length of the head. mesothorax short, transverse, meta-thorax about the length of the prothorax the sides slightly extended backward and the hind border slightly concave. The hind tibiae bear six spines on the hind border and there are six or eight spines on the end of the abdomen and a comb of three or four short curved spines on the end of the sub-anal plate.

The antennae reach to base of the abdomen and bear on the third segment the usual bristle.

The color is slightly dusky and the moulted skins of this instar have a smoky appearance.

2nd instar: Quite similar to the first but with the head less produced and with fairly distinct transverse bars of dusky color. The hind tibiae have six spines and the terminal segment of abdomen ten or twelve bristles and first tarsal segment of hind legs has two platella.

The color is yellow and the dark markings become quite pronounced toward the time for moulting and the cast skins of this instar show very distinct transverse bands. Length 1.2 mm.

3rd instar: In this instar there is a distinct black mark on the margin between the vertex and front at middle and next the eye and traces of dusky markings on the frontal arcs and across the abdominal segments two to seven. The vertex is distinctly shorter than in the preceding instars and the beginning of the wing pads is distinctly indicated on the mesothorax by expansions of the lateral border but on the metathorax they are scarcely indicated. Length, 2 mm.

4th instar: The color markings are as in the preceding instar. Head shorter, the wing pads more distinctly developed, those of the mesothorax extending back half way on the meta-thorax and those of the meta-thorax reaching the hind border of the first abdominal segment. Length 2.5 mm.

5th instar: The head is but slightly less produced than in the preceding stage and about as in the adult and the black markings are clearly marked. On the abdomen pairs of black transverse spots are distinctly evident on segments four to eight. The spines of hind tibiæ number about eight. The wing pads of the mesothorax are much longer reaching to base of fourth abdominal segment, those of the meta-thorax also longer but reaching only as far as the mesothoracic pads on the base of the abdomen. Length 3 mm.

In all instars there is a nearly uniform number of the tibial and terminal abdominal spines though there seems to be a general increase in number, those of the tibiae ranging from six or seven in the first instar to eight or nine in the last. The beak extends usually to base of the third coxae. The bristle on the third segment of the antennae persists but becomes less and less evident as it does not increase in size in proportion to the other parts.

As nearly as can be determined by the season's observations there seems to be one generation developing in grasslands before July 1st at which time the adults appear in new oat fields. A later generation develops in the oats between July 15th and August 15th and the adults and this generation appear to migrate either to volunteer oats or other cereals or to grassland. A generation develops doubtless between August 15th and October 1st. The autumn generation possibly deposit eggs which hibernate, although this point has not been determined with certainty. The field cages showed few specimens of this species and their exact hibernation is a question for this region.

It will be seen from the habits indicated that the species cannot be controlled upon quite the same basis as some of the other leafhoppers and especially with reference to their attacks upon oats the application of direct treatment would be difficult. Any measure, by rotation or other method, that will reduce the development in grasslands adjacent to oats fields will of course assist in reducing the numbers attacking this crop.

Since the adults appear on the oats while still small it would be possible to run over the oat fields with a hopper dozer, but this would probably need to be raised somewhat on runners in order to give the best results. In autumn the plowing under of stubble land in which volunteer oats may be started and supporting the leafhoppers may be an assistance in reducing the numbers.

Timothy Crown Leafhopper.

Acocephalus albifrons (Linn.)

This species was taken at various points in Maine during the collections of the summer of 1913 but the abundance and economic importance of the species were not appreciated on account of the peculiar habit of the species preventing its collection in the ordinary methods so generally effective for the other species of the group.

During the present season it has been found in great numbers and so many features of interest developed in its habits that it has been studied as carefully as time and conditions would permit.

The most novel feature of its life perhaps consists in its almost subterranean habit, the nymphs, and the adults also in very large part, living beneath the surface litter of the sod and in many cases being found under the earth especially in cavities around the timothy crowns. This habit came to light in connection with a careful digging over of the sod enclosed under one of the cages placed for the determination of the hibernating places of grass feeding species of leafhoppers. One hundred and thirteen individuals, nymphs and adults of both sexes, were counted under a single cage eighteen inches square and examination of surrounding space in the same field and other old meadows showed this abundance to be very general.

Another feature of interest is the apparent restriction of the species to timothy meadows and so far as all observations show a quite close restriction to this one kind of grass. So far no specimens have been found in places where timothy is not present and while it cannot be asserted that it cannot live on other grasses we may confidently assume that this is its principal food plant.

The nymphs and the adult males have a light clay color blending well with the soil and very different from the females, also very different from nymphs of such species as feed above.

The life history of the species appears to follow closely the other species having a single brood each year and which are adapted to rapid development of nymphs during the early summer.

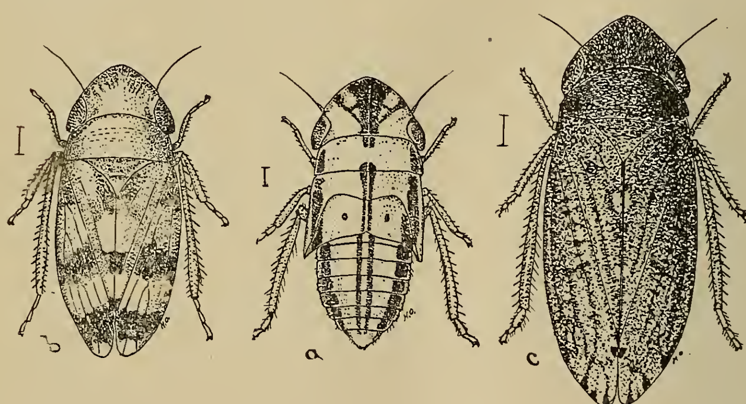

Fig. 3. *Acocephalus albifrons* L. *a*, nymph of last instar; *b*, male; *c*, female. All enlarged, natural size shown in length lines at left of each figure. (Original).

At the time of the first observations on the species both nymph and adults were to be found and there is every reason to believe that the adults were the maturing individuals of the seasons brood of nymphs and that they were develope l from nymphs that had hatched from hibernating eggs. That the eggs are deposited and hibernate in the fields is shown by the finding of the nymphs and adults in the cages placed in early spring. There were no dead adults or remnants of their bodies as might have been expected if the adults hibernated and deposited eggs in spring. The early nymphal stages were not observed but the stages observed in June and early July were well advanced in development and were probably for the most part in the final instar as adults began appearing in early July.

The nymphs of the final instar are 2.3 mm in length for the male and nearly white with black markings. There is a broad central patch on the vertex narrowing behind with lateral bands which merge with the central patch behind the middle, a cross band connecting them in front of center, eyes black center, light border; pronotum white with narrow black stripes at side and a central spot on front and rear margin divided by white line, meso- and meta-thorax with broad lateral stripes covering most of wing pads and a central stripe divided by a broader white line, two spots on meta-thorax lateral broad stripe on abdomen to last segment central double stripe terminating on the base of the last segment.

The female nymphs are similar to the males but larger about four millimeters long head and thorax 1 3-4 abdomen 2 3-4 mm width 1 1-4 mm. The black markings on the dorsum are very distinct the central black spot on vertex narrower and a small marginal spot half way from tip to eye, central double stripe broken into black quadrate spots on abdomen, lateral stripe also of quadrate spots on abdomen interrupted on wing pads. Beneath black on margin of front. Hind legs lined with black, tarsal tips black.

Adults were secured emerging from confined nymphs on July 21. The females were darker below than the males and emerged from nymphs that were lighter and larger than the male nymphs. One female taken in the cage July 21 was very light gray but the females are generally dark gray to blackish and assume this color soon after emergence. The dark gray or blackish color is mottled finely with white and toward the end of the elytra these mottlings merge into transparent spots and even become transparent white with black spots and lineations.

Emergence in some of the confined individuals occurred on grass blades above ground and in one case the nymph crawled up to a height of three inches above the ground to attach itself to the grass stem. In one attached an inch and a fourth from the earth the fore legs were attached and the hind legs stretched out backward to the tip of the abdomen. In many cases however and probably as a quite common, if not the usual plan for the species now, the exuviae are found on the ground.

In the moulted nymphal skin the dorsal slit through which the adult emerges is so closely drawn together that it is hardly possible to distinguish any break. The hind legs are extended backward, the hind tibiae meeting behind the tip of the abdomen and the hind tarsi resting side by side. The nymphal skins retain their appearance of the nymphs so completely that they furnish every character necessary for identification.

Adults become abundant by the middle of July and from this time forward the nymphs decrease in number rapidly till by the last of July practically all are in the adult stage. The first matings were observed July 30th, the mating individuals resting on grass leaf about one inch from the ground.

But little mating was observed however and it appears that this is deferred to late in the season and while oviposition was not observed it is pretty safe to conclude that egg deposition is carried on slowly during late summer and early autumn and that the eggs remain undeveloped till the following spring and hatch, probably in May or early June, reaching maturity in July.

CONTROL.

It is evident from the habits of this species that it must be treated in a different manner than most of the common leafhoppers of timothy meadows as the fact that it is so completely protected under the grass or even down in the sod makes it difficult to reach by the hopper dozer method. It is also doubtful whether it will be as much affected by burning over as some of the other species although this will depend upon whether the eggs are deposited so as to be exposed above ground or well protected down in the crowns of the plants. Exact determination of place of egg deposition is desirable in this connection.

There can be little question that rotation is a most effective treatment for the species. There is apparently very little migration of the adults from one field to another and even if some movement should occur, plowing in late fall or early spring would serve to very effectually destroy all eggs. A very good evidence of the effectiveness of rotation is found in the fact that the species has been found only in old timothy meadows, the worst cases in fields that had been in grass for many years and that none at all have been observed in fields of only two or three years in grass.

Of the natural enemies found with the species it would appear that the spiders must be the most effective as they are abundant in the fields and they work down among the bases of the grass plants where they have excellent opportunities to feed upon the hoppers.

ACOCEPHALUS STRIATUS Linn.

This is one of the species collected in abundance in the summer of 1913 and which it was deemed desirable to follow further for the purpose of getting life-history details that might be a better basis for the determining of measures for control. It was taken in all parts of the state where collections were made and may be considered as of general distribution but it is found in greatest numbers in meadows and pastures and especially in timothy meadows. There appear to be no references to it as an economic species in American works and so far as I know no studies in this country upon its life-history or habits from an economic standpoint. It has been noted in collections from Canada and the New England states for many years and while a well known European species there is little reason to look upon it as a recent introduction.

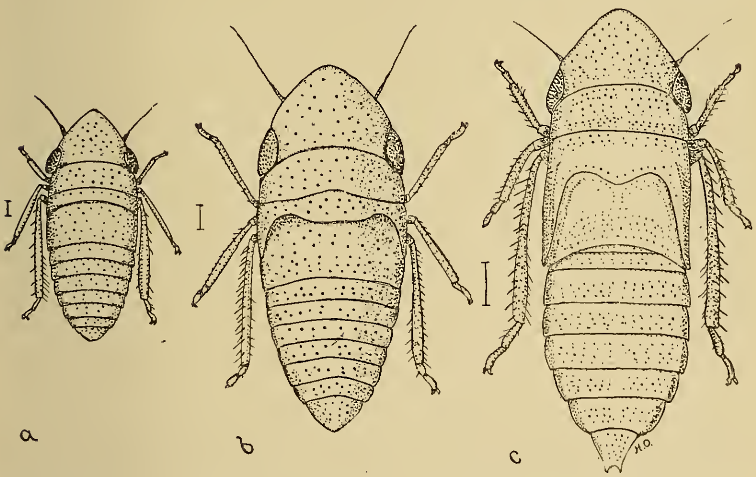

Fig. 4. *Acocephalus striatus.* *a,* young nymph 1st instar (?); *b,* intermediate nymph; *c,* nymph of last instar. All figures enlarged, natural size shown in length lines at left of each figure. (Original).

It has been found associated with a number of different plants but the nymphs have been taken especially in grassland usually where there is an abundance of timothy and if there is any very close restriction in food plant this grass is probably its preference.

The observations confirm pretty positively the occurrence of but one generation each year the adults maturing in July and living on into the fall with pretty certainly fall oviposition and hibernation in the egg stage. Nymphs were found in good numbers in our cages placed in early spring which proves hibernation in the fields and the absence of any signs of adults either dead or alive shows pretty conclusively that eggs are laid and adults die in fall. Furthermore the development of eggs had reached such a stage in August that it would indicate fall oviposition.

The first nymph observed was taken at Eliot on June 26th apparently in the first instar and at Orono young nymphs (1st instar) were taken July 2nd. One in 2nd instar on July 1st and these would indicate hatching in late June probably as early as June 20th for all the southern part of the state.

The nymphal stages are passed rapidly as the period between the first noticed nymphs and earlier adults is but about four weeks. The first adult observed in the fields at Orono was taken July 1st, a male, and these became fairly plenty by the middle of the month. The females mature a little later, the first taken July 18th, than the males but no mating was seen until after August 8th. The latest nymph observed was one in last instar on Aug. 8th. The greatest abundance of nymphs occurred during the first week in July when the different stages were all pretty well represented in field collections. By July 28th adults of both sexes were abundant and scarcely any nymphs were to be found.

Description of Nymphs.

The youngest nymphs found were two millimeters long and were probably first instar individuals but partially grown. They are green in color with outline of the adults but quite different in color, the grass green color of the upper side is flecked with black dots. Below fainter green.

The second stage nymph observed (2nd instar) is three and one-half millimeters long of very much the same shape as the earlier form but with a slight indication of the formation of wing pads in enlargement of the lateral parts of meso- and meta-thorax.

The color is grass green tinged in places with yellowish and above flecked with black dots which are most numerous on the posterior part of the meta-thorax. Beneath there are dots on the face very scant on the clypeus and there are scattered dots on the legs mostly on the upper side.

The face is distinctly roughened in places, the hind tibiae have two rows of strong spines, nine or ten in each row, and the hind tarsi have two platella on first joint, three ventral.

The last instar (3rd) is six millimeters long and longer in proportion than the earlier stages the sides distinctly parallel the wing pads of meso- and meta-thorax well developed extending back on to the base of the abdomen to the 2nd segment.

The color is green a little paler than for the earlier stages and the flecks of dark dots are less evident, being smaller in proportion than for the younger nymphs.

The nymphs are very easily distinguished from the larvae of other leafhoppers by the flattened bodies and the rather sharp margin of the head with the parallel sided form of the abdomen. They have more the general appearance of the nymphs of *Gypona* than for the strict jassid genera.

The figures will assist in recognizing the species in the early stages.

The habits of this species differ somewhat from the typical leafhoppers as they seem adapted to living on the ground or close to the surface though by no means so specialized in this regard as the *Acocephalus albifrons.* The larvae creep around on the ground very commonly but will be found also on the stems of the plants or even well up on grass blades but they do not jump so readily as some species and while taken in fair numbers in the sweep net the numbers caught in this way are not as good an index of the abundance of the species as for many other kinds. Their color is well adapted to protect them in the grass and they may very easily escape notice unless one [illegible] for them. The adults also run around very commonly on the ground but climb up on the stems of plants readily and are taken in abundance in sweeping. At first light green, they change to shades of gray or dull straw color fitting in well with the color of dead leaves and stems. In both larval and adult stages therefore they are admirably fitted to escape attention of the casual observer and it is not at all strange that they have not been associated with the falling off in the hay crop that is noticed in old meadows.

Their attack is made on stems and leaves but for the young especially it is probable that they work at the base of the stems or even down on the crown which offers a juicy point of attack.

Since this species has been found in every timothy field of over two years standing and in many cases has been found in great abundance it must be credited with a considerable share in the drain caused by leafhoppers. Its most serious attack must naturally occur during the growth of the larvae from the middle of June to the middle of July, which coincides with the time when the hay crop should be making its most rapid growth.

Suggestions for Control.

Evidently the most important feature in control for this species is the rotation of crops and, since the species seems to migrate less readily than some of the other forms, this should be effective on fields that are not allowed to remain in grass for more than three or four years. Since the species hibernates in the field and in all probability is represented in the egg stage in stems or leaves of grass, burning where this is practicable should be effective. The insects do not jump quite as readily as some other forms and might not be collected as completely by the hopper dozer as with some other forms but a proportion could be secured in this manner and, if the process is used for the leafhoppers in general, it would assist in reducing their numbers.

Chlorotettix unicolor.

This species was noted as quite abundant, especially in low ground and on the rank grasses in the southern part of the state. It is one of the largest of the leafhoppers and when occurring in abundance must occasion considerable loss. Its life history has not been traced entirely through the year but the nymphal stages have been observed and a description and figure will assist in further recognition of the species. The nymphs observed were evidently in the final instar and have the length of 8 mm. They are light green in color closely matching the color of the grasses on which they occur. The wing pads are yellowish and extend on to the basal segment of the abdomen. The head is somewhat fuller than in the adult stage, and the abdomen tapers from near the base to quite an acute tip. The nymphs occur most abundantly in July and dur-

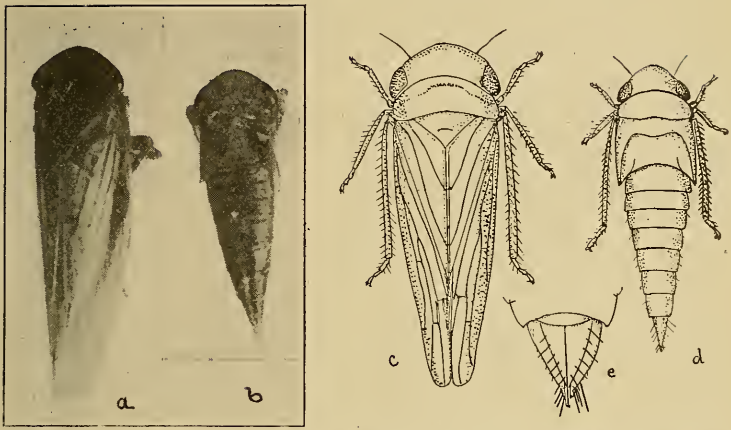

Fig. 5. *Chlorotettix unicolor.* *a,* adult female; *b,* nymph, from photograph; *c,* adult female; *d,* nymph, last instar; *e,* genitatia of male. (Original).

ing July and August adults appear in abundance and in the latter part of the season adults only are observed. It seems probable that a single generation for the year is the rule for the species in Maine but this can not be stated with certainty.

Idiocerus provancheri.

This species recorded as occurring in bogs was collected in July in both nymphal and adult stages. A wider description of the nymphs may be of service in further recognition of the species.

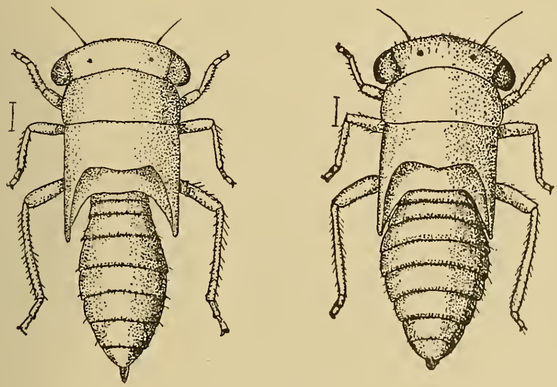

Fig. 6. *Idiocerus provancheri.* *a,* male; *b,* female nymph of last instar. (Original).

The female nymph of the final instar is 4 mm. long and the head 1 1-2 mm.; the abdomen narrower at base but wider than in the male.

The color observed is brown with the vertex yellow and the pronotum yellowish or tinged with yellow; the wing pads brown with the sternum and disc of the venter yellow. There is a pair of round black spots on the vertex in the male and the length is the same as for the female. The general appearance is similar but the abdomen is much more slender and with genital processes much more elongate. The abdomen is much restricted at the base, appearing almost wasp-like and leaving a wide space between its margins and tips of the wing pads. The color in most specimens agreed with that of the females but in one specimen was jet black above and on the base with light yellow on the sternum and disc of the abdomen, otherwise agreeing with the other nymphs. These were collected rather sparingly on July 10th, eight nymphs and twenty adults both were beaten from small bushes in the bog and all the nymphs taken at this time were in the 4 mm. stage. It is quite evident that this is the last instar as no forms intermediate between these and the adults were found at the same time and place. They approach more closely to the nymphs of *maculipennis* than to any other species.

DRAECULACEPHALA ANGULIFERA Walk.

The nymphs of this species agree in color with those of *D. mollipes* but the head is distinctly shorter, the front angle not sharper than a right angle and the dark greenish stripes of the dorsum are different. A pair of dark lines run from near the tip of the vertex to the base of the terminal segment of the abdomen. These enclose a distinctly light dorsal line and outside of the dark stripes, the upper surface is light green. The frontal arcs are quite distinct and both vertex and front slightly tumid. Length of the specimens noted and figured is 6 mm. The nymphs of this species occur during summer and no indication of more than one brood has been noted.

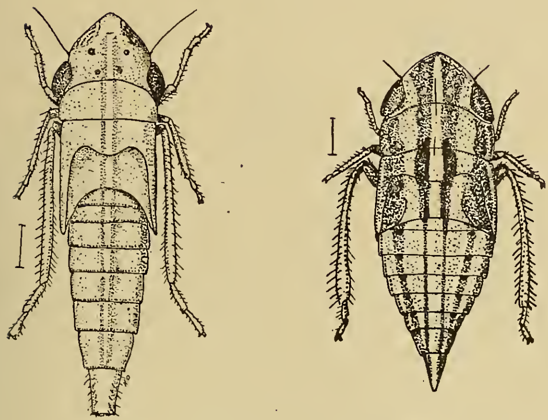

Fig. 7. *a, Draeculacephala angulifera,* last instar nymph; *b, Phlepsius apertus* last instar nymph. (Original).

PHLEPSIUS APERTUS Van D.

The larva referred to this species is quite broad, flattened and with a rather strongly produced vertex. The color is light clay to whitish and there are two broad stripes on the vertex about equally wide on the prothorax, narrower on the meta-thorax and extended as narrow lines on the abdomen to the terminal segment. They are lighter than the vertex, black on the meso- and meta-thorax and abdomen. A broad marginal stripe covers the sides of the thorax and the narrower stripe and lateral border extend from base to tip of abdomen. Length 5 mm.

Two specimens of this have been secured, one of them August 8th in timothy meadow and from its characteristics it is referred somewhat doubtfully to the above species, although it was not possible to rear specimens to the adult stage.

BALCLUTHA PUNCTATA Thunberg

This species is very widely distributed and was mentioned in a previous Bulletin as one of the common forms. It has been taken especially upon Canadian blue grass and during August was found in all stages and while the life cycle has not been followed in complete detail it would be useful to furnish description and figures of the stages observed.

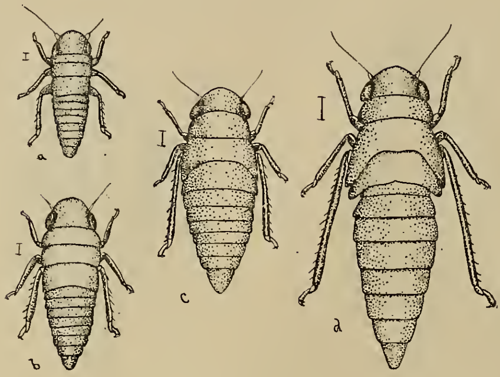

Fig. 8. *Balclutha punctata.* a, b, c, d, 1st, 2nd, 3rd, 4th instars. (Original).

The first instar is 1 mm. in length and there is no indication of wing pads. The head is produced in front of the eyes; the face is dark and the abdominal segments dusky with the sutures lighter, below red with legs dusky.

The second instar is 1 1-2 to 1 6-10 mm. The general color yellowish to light brown streaked with red; face not dotted; the vertical segment slightly produced with faint dusky patches in a medium row on the ventral side of the abdomen. The head is nearly a semi-circle in front of the eyes. The meso-thorax has distinct angles but is not produced into enlargement of wing pads; meta-thorax with sharp hind border, no pads.

The third instar is 2 mm. or more, light yellowish near transparent color, the sutures below lined with red, the wing pads partly indicated and angles with the meso- and meta-thorax.

The fourth instar is 2 3-4 to 3 mm. in length; color light brown to dusky; the wing pads developed so as to reach on to the first abdominal segment. Those of the meso-thorax do not extend to the tip of the under ones.

The fifth instar is 3 1-2 mm. to 4 mm.; color differing, some specimens being distinctly light green and others brown with red; the face and body above, the legs and ventral surface with dusky patches dotted with fuscous points. The wing pads reach to the 3rd abdominal segment, the front ones extending as far as the hind ones. In the female, two lobes and the ovipositor show distinctly and in the male, plates and genitalia.

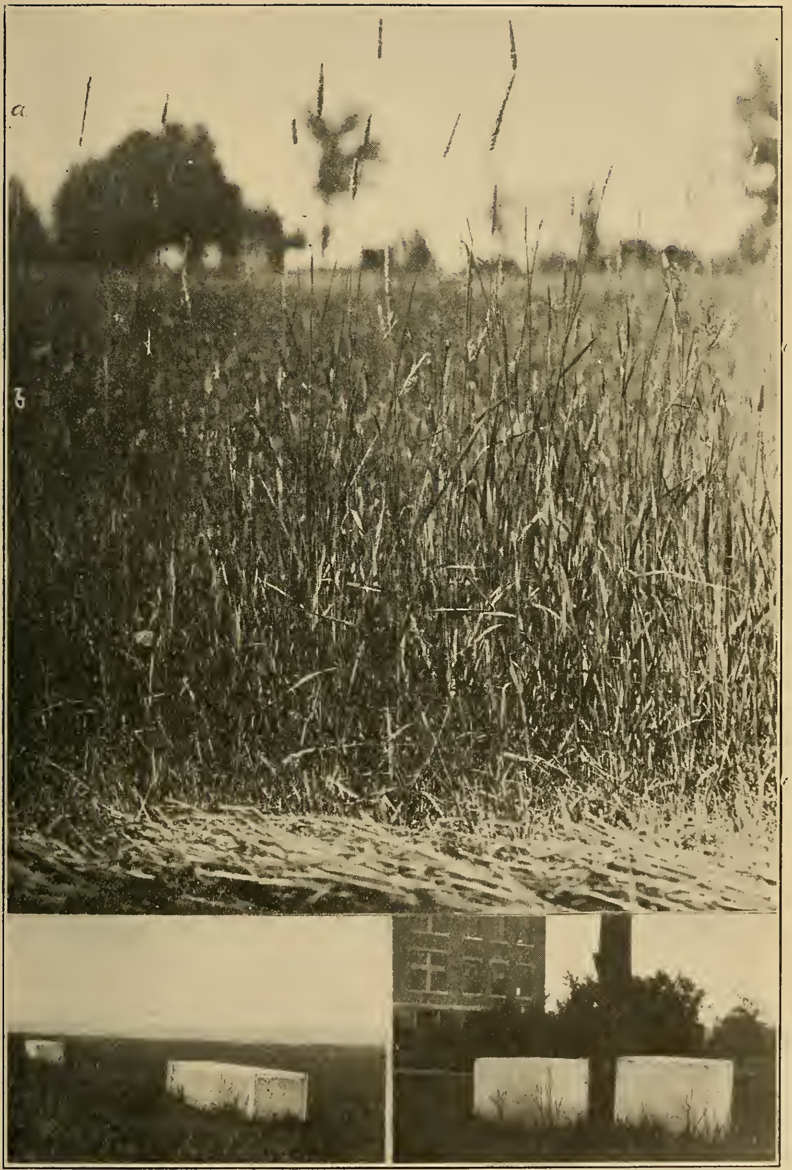

Fig. 9. Above timothy meadow at edge of cut swath showing at *a*, height of normal or healthy plants; at *b*, height of aborted or stunted plants with blasted or imperfect heads; *c*, cages in meadow for testing hibernation; *d*, cages on Experiment Station grounds used for rearing leafhoppers and froghoppers. (Original).

Fig. 10. Timothy from same field; *a* normal or healthy, *b*, aborted or stunted stems with blasted heads. (Original).

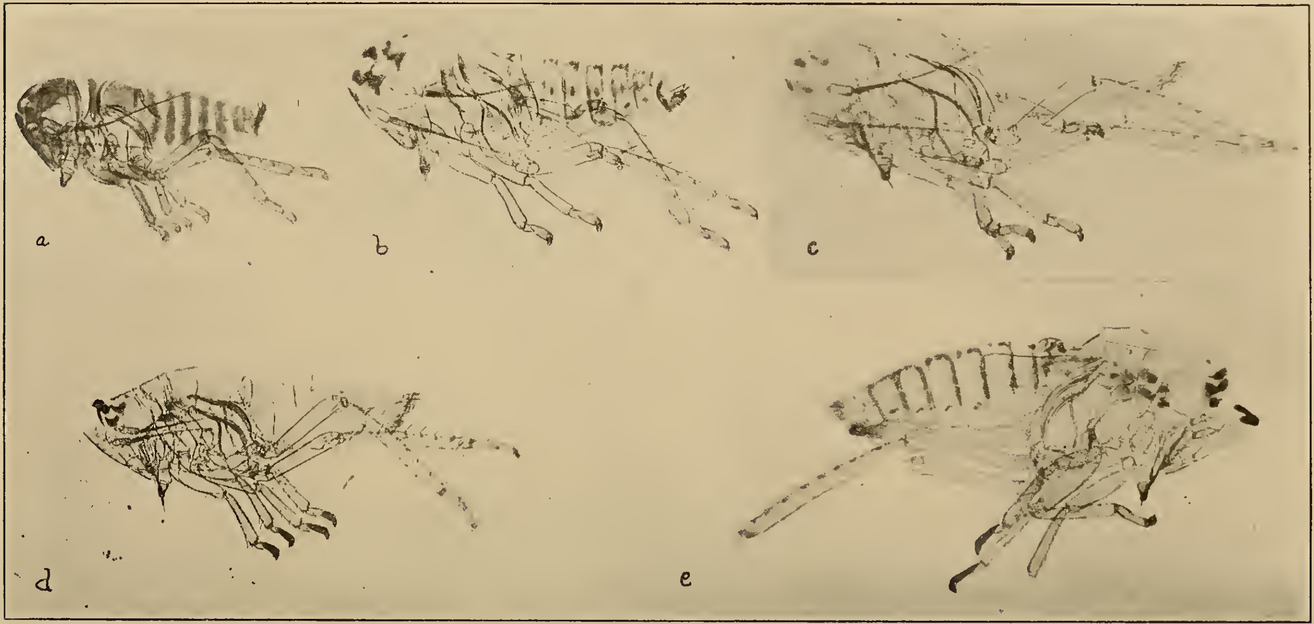

Fig. 11. *Cicadula sexnotata.* Moulted skins *a, b, c, d, e,* 1st, 2nd, 3rd, 4th, 5th, instars, *d,* and *e,* are on smaller scale than the others. (Original).

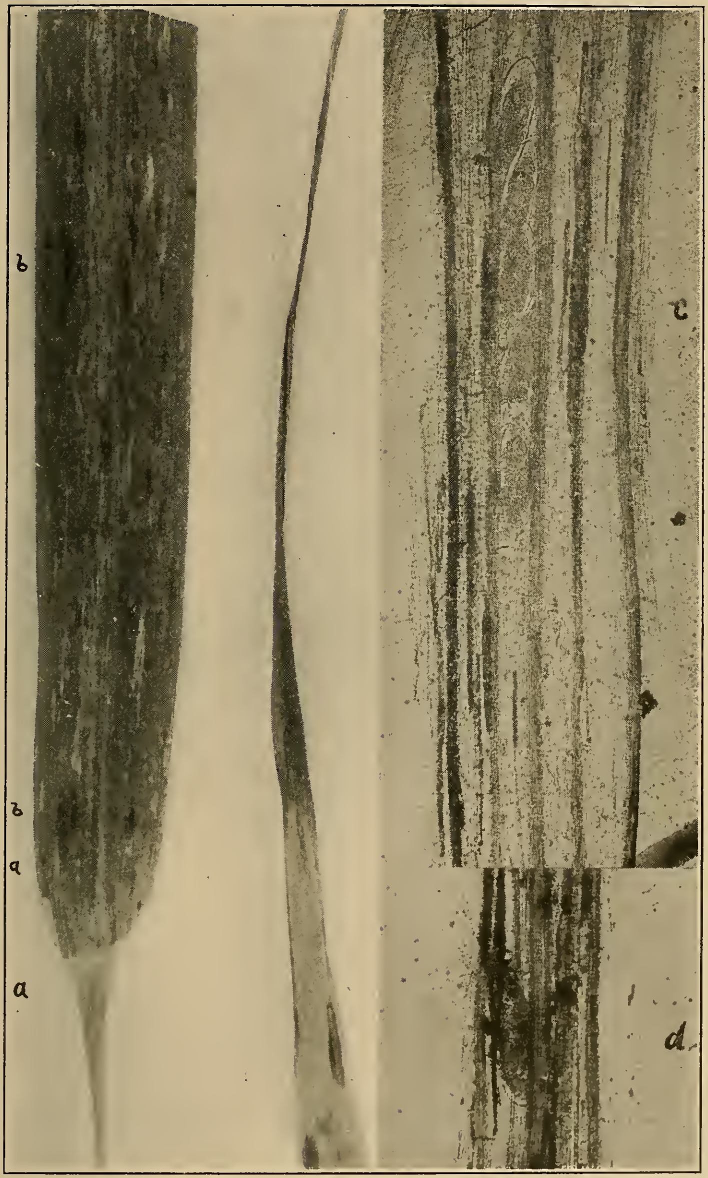

Fig. 12. Eggs and feeding punctures of *Cicadula sexnotata*. Opposite *a*, egg depositions; opposite *b*, feeding punctures; opposite *c*, eggs slightly developed; *d*, embryo well advanced; *e*, withered outer part of blade. *a* and *b*, photographed by reflected light, *c* and *d* photographed by transmitted light to show eggs within leaf. (Original).

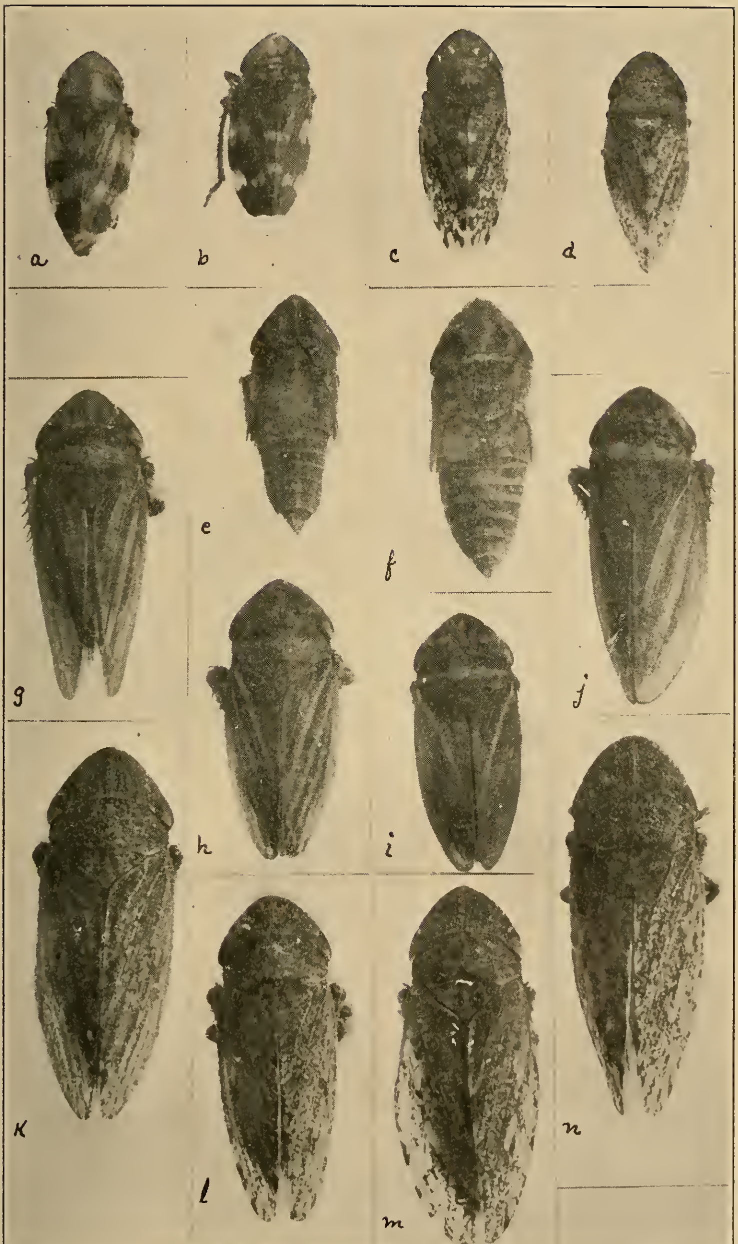

Fig. 13. a, b, males. c, d, females. *Acocephalus albifrons.* e ♂ f ♀ nymph and g to j males, k to n females showing varieties of *Acocephalus striatus.* (Original from photographs by Hammond).

BULLETIN 249

SIX YEARS OF EXPERIMENTAL APPLE SPRAYING AT HIGHMOOR FARM.

W. J. Morse.

Highmoor Farm was purchased by the State for the use of the Maine Agricultural Experiment Station in carrying out investigation work, more especially in connection with orcharding. Since it is located in one of the best apple producing sections of the State, conditions are favorable for this purpose. The farm came under the control of the Station in July, 1909.

The orchards at Highmoor originally consisted of about 5,000 apple trees set about 25 years previous to the time of purchase, but no data were available giving exact records as to the dates of planting. The farm had been in the hands of different owners in the meantime, and certain of these had given the trees some attention. At times they apparently received very indifferent care and at others none at all except to pick what apples were produced and to harvest the grass which was allowed to grow between the trees.

In the fall of 1909 the number of trees in the orchards proper was a little over 3,100, set 25 x 25 feet. Many of these through winter injury and neglect were in very poor condition. Later removal of those whose condition made it apparent that they were past all hope of profitable renovation reduced the number to some over 2,300, including scattering trees. Of these the greatest number were of the Ben Davis variety. Baldwins came next, followed by limited numbers of several other varieties.

The experimental spraying work has always been located in the orchard which has been designated as the Ben Davis No. 2. When the farm was purchased this orchard was by far the most thrifty of all. The trees were well headed, averaged about 20 feet in height and the trunks were about 7 inches in diameter. In the past it had evidently received more attention in the line of plowing and manuring than the others, and at one time had been used as a sheep pasture. Like all the other orchards on the farm the trees were a tangled mat of branches from lack of pruning. Beginning with 1910 this orchard, in common with all others on the farm, has been given good care in the line of pruning, fertilization, and cultivation and nothing but apples and an annual cover crop to be plowed under in early spring has been grown therein. In the fall of 1915 the trunks of the experimental trees had an average diameter of 9 inches, about 24 inches from the ground.

Nature and Extent of Experimental Work. Methods Used.

About the time the farm was purchased the value of lime and sulphur washes as fungicidal sprays for fruit trees was beginning to be recognized. On account of the very favorable results secured by Scott* with self-boiled lime-sulphur for brown rot, scab, and other peach diseases as well as for leaf-spot and bitter rot of the apple, the writer had already started a series of experiments in an orchard at Orono to test the value of this material for controlling apple scab under Maine conditions. The results for 1908 were given in Bulletin 164 of this Station, while those for 1909 were never published on account of their being rendered valueless through circumstances over which the writer had no control.

A more elaborate series of experiments were planned for the following year at Highmoor Farm, using a much larger number of trees, and a number of different kinds of sprays including cooked lime and sulphur or what is now commonly used and known as lime-sulphur. The appointment of Mr. W. W. Bonns as Station horticulturist, stationed at the farm during the summer months, led to his taking over these experiments which remained under his charge for two seasons. Since 1912 they

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*Scott, W. M. A promising treatment for brown rot and other peach diseases. An address before the American Pomological Society, Sept. 1907. Self-boiled lime-sulphur mixture as a promising fungicide. Circular No. 1, Bureau of Plant Industry, U. S. D. A. April, 1908.

have been carried on by the writer and his associates. The results of the season's work have been published each year in a separate bulletin. Several of these annual reports of progress are now out of print. The present publication is an attempt to present a general summary or resumé of the work done and the more important results obtained.

Object of the experiments: The primary object of these experiments centers around the efficient and economical control of apple scab with a minimum amount of injury to fruit and foliage, as applied to Maine conditions. This involves the nature of the spray used, as well as the time, number and manner of the applications.

Certain sprays, including bordeaux mixture, some of the proprietary compounds and other spray mixtures used in the course of the experiments, are very efficient in controlling scab, if applied at the proper time. This avails but little if, as has sometimes been the case, the action of the spray results in the removal of from half to two-thirds of the foliage from the tree. Also bordeaux mixture when used on the Ben Davis, although it has given excellent scab control, has invariably rendered a large part of the fruit, sometimes as high as 90 per cent, unsalable on account of russeting. Bordeaux mixture on the other hand can be used with perfect safety even on the peach in certain of the irrigated sections of the West where the summer rainfall is slight.* Lime-sulphur has been used as a summer spray without injury in the State of Washington much stronger than could be employed with safety under local conditions.† These facts and many others have shown that it is not safe to generalize too much upon or adopt without reserve results secured in other parts of the country under different climatic conditions, and emphasize the necessity of securing data based on Maine experience. Moreover, in spite of recent progress, there are numerous unsolved problems of both practical and scientific interest in connection with orchard spraying.

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*It was the writer's good fortune to visit a peach orchard in Utah in the summer of 1914 where some spraying experiments were being carried on by Dr. Geo. R. Hill which amply demonstrated this fact.

†Melander, A. L. and Beattie, R. K. The sulphur-lime wash. Pop. Bul. 28. Wash. Agl. Exp. Sta.

Extent of the experiments: As has already been indicated Ben Davis trees only have been used each year. In many respects this variety is very satisfactory for the purpose. It is quite susceptible to spray injury and would hardly be classed as particularly resistant to scab. The number of experimental trees the first season was 128 but during the last 5 years it has varied from a little less than 150 to nearly 300. The policy now followed is to use 24 trees to a plot or 4 rows of 6 trees each.

Methods used: To obtain records of results for comparison it is now the custom to reject the crop obtained on the two outside rows, or at least the outside half of these rows. This is to avoid the effects from the spray drifting across from adjoining plots which received different treatments. At harvest time the entire crop from the portion of the plot so selected, or 20 barrels of it selected at random if the crop amounts to more than this, is carefully sorted and examined. The total number of fruits, the number of scabby and russeted and the percentages of the latter, as well as the percentage of perfect apples are determined and recorded. During the summer observations are made at frequent intervals and a careful record made of the effects of the different sprays on the foliage.

As far as possible all plots receiving the same number of applications are sprayed on the same day. Very little trouble has been experienced with scale or blister mite so dormant sprays have been used only in exceptional cases and for special plots as will be described later. In other words, the present discussion is almost wholly limited to the action of sprays applied to trees in leaf for the control of apple scab. Dormant sprays are only considered in connection with their possible effects in controlling the scab fungus and in the production of spray injury.

Unless certain applications were omitted for a definite purpose on individual plots, 3 applications have been made—the first when the fruit buds were showing pink, the second just after the petals fell and the third between two and 3 weeks later. On account of seasonal conditions the date of the first application has varied considerably. The earliest was May 8, 1913, and the latest were May 23, 1914, and May 24, 1912. The second date has been more constant, the limits being from May 30 to June 7, and in 4 out of 6 seasons from June 3 to 6. The number of days which elapsed between the first and second applications were as follows: 25 in 1910, 18 in 1911, 12 in 1912, 26 in 1913, 14 in 1914, and 20 in 1915.

In all cases arsenate of lead has been added as an insecticide to the various, so-called fungicidal sprays at the rate of two pounds of paste or one pound of dry powder to each 50 gallons. This amount has always proven sufficient for the control of chewing insects. The powder has been used exclusively in the more recent experiments. At first a plot sprayed with this amount of poison in water alone was used as a check. After the marked fungicidal effects of arsenate of lead were noticed a check plot was reserved which received no spray whatever.

In Mr. Bonns first experiment in 1910 a hand-pump, barrel outfit was used, while in 1911 his applications were all made with a Niagara carbonic acid gas sprayer. Since that time a large gasolene power sprayer, carrying two leads of hose, has been used exclusively. After each plot receiving a different treatment was sprayed the entire apparatus, including tank, pump, hose, extension rods and nozzles was thoroughly washed and flushed with clean water. Throughout the work nozzles of a type which deliver a fine mist have been employed, and the sprays applied with a pressure varying from 150 to 200 pounds. The person in charge remained in the field in constant supervision of the spraying crew while the applications were being made, care being taken to see that all of the foliage on each tree was reached as nearly as possible without applying sufficient spray to cause excessive dripping.

Detailed Discussion of Combined Results.

Bordeaux mixture vs. lime-sulphur: Each season during the 6 years plots have been sprayed with bordeaux mixture and standard dilution lime-sulphur prepared from a concentrate made on the farm.* For this purpose during the last 4 years a 3-3-50 bordeaux mixture has been used exclusively. Except in the earlier work before the relative merits of the two fungi-

*Standard dilution lime-sulphur as used in this publication signifies the equivalent of a 1 to 40 dilution of a 33° B. concentrate, or 1.22 gallons of a concentrate having this test diluted to 50 gallons with water.

cides had been fully determined these plots have been introduced solely for the purpose of checks to serve, together with the unsprayed plot, as a basis of comparison with other sprays and spray combinations with respect to scab control and the production of fruit russeting and foliage injury. They have, however, given some very striking data as to the comparative value of the two materials when used on a variety of apples which is particularly susceptible to spray injury.

Lime-sulphur at the dilution mentioned has sometimes given a little leaf injury but never sufficient to be of economic importance. When compared with the unsprayed check plot this treatment has increased the number of russeted apples from 5 to 10 per cent during the past 3 seasons. Scab control has been less than with bordeaux mixture but the greatest difference has been only about 3 per cent.

Bordeaux mixture on the other hand has caused serious leaf injury nearly every year for the past 6 seasons, frequently resulting in partial defoliation of the trees. Its greater efficiency in scab control has been discounted several times over by the increased fruit russeting produced. In the past 3 years the per cents of merchantable apples on the plot sprayed with bordeaux mixture have been in round numbers, 30, 10, and 21, respectively. At the same time the unsprayed check, not even treated with an insecticide, gave 30, 87, and 91 per cent of the same grade of fruit. In other words, based on the quality of the fruit produced, nothing was gained the first year and heavy losses resulted the next two years from spraying Ben Davis trees with 3-3-50 bordeaux mixture.

The effect of different dilutions of lime-sulphur: The question of the effect of different dilutions of lime-sulphur in controlling scab and in the production of spray injury was one of the first problems to be studied. A spray containing 25 per cent less concentrate than the standard dilution was tried for two years, in but one of which was scab very prevalent. That year the plot treated with the weaker spray produced 13 per cent more scabby fruit than was obtained where the standard dilution was used. The matter was not followed farther for it was evident that this weaker dilution would prove inefficient.

A comparison between standard dilution lime-sulphur and one 20 per cent stronger was carried on for 4 consecutive seasons.

Practically no scab developed even on the check plots the first year but during the last 3 years there was an average increase of 8 per cent of merchantable apples as the result of using the stronger spray. The greatest increase in any one year was 21 per cent in 1912. That season, however, through a misunderstanding in the writer's absence, the first spray application on both plots was omitted. While the conditions of the test were equally severe in both cases it is possible that if the applications had been made when the fruit buds were showing pink the differences between the two plots would not have been so great. As will be shown later this first application was a very important one that season.

Only one season was increased foliage injury noted where the stronger spray was used and this was slight. Contrary to expectation there was, two years out of 3, more russeting of the fruit where the weaker spray was used. These differences, however, averaged less than 3 per cent.

From the work of the 3 seasons it would seem that on the Ben Davis, a variety easily injured by bordeaux mixture, a dilution of lime-sulphur at least 20 per cent stronger than the commonly recommended may be used with comparative safety. Also in some seasons, at least, the greater efficiency in scab control secured will more than cover the added cost of materials.

The importance of the blossom bud application: Certain students of the subject of apple scab control have laid much stress upon the importance of the spray application made when the fruit buds are showing pink. Present knowledge of the life history of the apple scab fungus and some experimental data obtained in Maine tend to confirm these conclusions derived from work done elsewhere. However the results secured at Highmoor during 4 consecutive seasons indicate that under Maine conditions it is not necessarily a foregone conclusion that the spraying operations for the current year are doomed to utter failure if no spray is applied till after the petals fall.

Two seasons out of the 4, omitting the blossom bud application of lime-sulphur entirely actually resulted in a higher percentage of merchantable apples. Another season the increased efficiency due to the first application was of little account. The differences for all 3 seasons were slight, however, and were doubtless within the limits of experimental error. Therefore omission of the first spray 3 years out of 4 led to no material difference in the results. On the other hand a like omission the first year the experiment was tried meant, from the standpoint of the practical orchardist, a difference between success and failure in the spraying operations of the year. Where all 3 applications were made nearly 90 per cent of the fruit was sound and perfect. Only about 50 per cent of the same grade of fruit was obtained where the first application was omitted. This was in 1912, a season particularly favorable for scab development. The date of the first application that year, May 24, was with one exception the latest since the series of experiments were begun.

Arsenate of lead as a fungicide: The apparent high fungicidal value which this well-known insecticide has shown is one of the quite unexpected results obtained.

The first suggestion of the value of arsenate of lead for controlling apple scab, as shown by these experiments, came in 1912. Then 4 pounds of the paste arsenate of lead alone in 50 gallons of water gave as good or better scab control than did a 3-3-50 bordeaux mixture or lime-sulphur plus two pounds of the paste in each 50 gallons of spray. Unfortunately no check plot was saved that season, but over 3 times as much scabby fruit was obtained on a plot sprayed with two pounds of the arsenate of lead paste in 50 gallons of water than were produced where double this amount of the insecticide was used alone. One possible explanation for the apparent fungicidal action of the larger amount of the poison that season was that the plot on which it was used was located at the corner of the orchard more exposed to air and sun. This factor was eliminated in the later experiments.

In all later work an unsprayed check plot was added and dry arsenate of lead substituted for the paste form. In 1913 one plot was sprayed at all 3 applications with two pounds and another plot with one pound of the dry, powdered insecticide in 50 gallons of water. Nearly 39 per cent of the apples on the unsprayed plot were scabby. Almost perfect scab control was obtained with bordeaux mixture, the larger amount of the arsenate of lead used alone, and lime-sulphur 20 per cent stronger than standard dilution—the efficiency being in the order named. Somewhat poorer results were obtained with standard dilution lime-sulphur. Attention is again called to the fact that one pound of the dry arsenate was added to each 50 gallons of the bordeaux mixture and lime-sulphur used. This smaller amount of the insecticide when used alone in 1913 reduced the amount of scab, as compared with the unsprayed check from 39 to less than 16 per cent.

A large amount of fruit russeting was experienced in the experimental orchards in 1913, apparently due to natural causes, but this was materially increased by the action of some of the sprays. With bordeaux mixture and lime-sulphur the per cents of russeted apples showed an increase of 38 and 11 resectively over that recorded for the unsprayed check, while russeting on the plot sprayed with the larger amount of arsenate of lead alone was even less than on the check. On account of the last mentioned fact the relative value of the arsenate of lead spray was still more apparent that season. About 12 per cent more perfect apples were obtained with it than where standard dilution lime-sulphur was used.

Neither in 1914 nor in 1915 did scab develop sufficiently to give a rigorous test of the fungicidal properties of arsenate of lead. In scab control in 1914 two pounds of dry arsenate of lead in 50 gallons of water fell about 3 per cent behind standard dilution lime-sulphur containing one-half of this amount of the insecticide, but on account of freedom from russeting with the former the per cents of merchantable apples were practically the same. In 1915 the combined lime-sulphur and arsenate of lead gave a fraction of one per cent better scab control, but on account of russeting, only about 90 per cent of the apples were merchantable. In contrast with this, because of freedom from russeting, the larger amount of arsenate of lead used alone gave over 97 per cent of the same grade of fruit.

Strong fungicides for the first application followed by arsenate of lead alone: The aparent high efficiency of arsenate in apple scab control, as indicated by the above described experiments, suggested the following possible modification of summer spraying practice. Use a strong fungicide combined with a smaller amount of arsenate of lead when the fruit buds are showing pink. For all later applications depend entirely on arsenate of lead for the control of both scab and chewing insects, using at least two pounds of the powder or 4 pounds of the paste to each 50 gallons of water. This program has been followed experimentally for two seasons. For the first application 3-3-50 bordeaux mixture and lime-sulphur 20 per cent stronger than standard dilution have been used.

The crop in each case has been very free from scab but on account of the fact that the omission of the first application of standard dilution lime-sulphur on other plots during the same seasons failed to show an increase of scab it is impossible to draw definite conclusions regarding the chief object in view. However all evidence obtained tends to confirm the results secured where arsenate of lead was used alone during these and previous years.

One important conclusion has been reached. It is evident that bordeaux mixture cannot be used at Highmoor on the Ben Davis, even for the first application when the leaves are beginning to unfold and the blossom buds are not yet open. With it, used in this way, more or less leaf injury has been obtained each season. What seems harder to explain is that a single application of bordeaux mixture, made before the fruit buds opened has led to a considerable increase in the russeting of the fruit formed considerably later. This increase in russeting amounted to nearly 15 per cent in 1914, and about 9 per cent in 1915. In 1914 this plot adjoined one sprayed 3 times with bordeaux mixture and it was thought that the increase in russeting might possibly be the result of the spray drifting across from the latter. A relocation of the plots in 1915 prevented such a possibility.

No such difficulties were experienced where lime-sulphur, 20 per cent stronger than standard dilution, was used for the first foliage spray, but as will be mentioned later an application of dormant strength lime-sulphur somewhat earlier, but after the leaf buds had begun to open did produce similar effects in a marked degree.

Dormant sprays for insects as affecting scab control: Certain observations made in another orchard in a different part of the State, during the summer of 1913, showed quite conclusively that where young McIntosh apple trees having an abundance of limb infection with apple scab from the season before were sprayed with a dormant strength lime-sulphur solution just as the leaf buds were opening, in addition to the regular summer sprays, the amount of scab appearing on the leaves the following summer was materially decreased.* Lowe and Parrott working with the control of San Jose scale by means of the lime-sulphur-salt wash in 1902 in New York recorded a reduction in the amount of scab following a single late application of this spray.† The Baldwin variety of apples was used. No mention is made of limb infection by scab, but the following significant statement is made with regard to the control of the disease on the fruit during the season following. "Of special interest in this connection also is the fact that although the trees received no treatment except with the lime-sulphur-salt wash, the fruit from the treated trees was practically free from scab, while that of the checks was badly infested." The single spray application was made late in April and was very thoroughly done. "In many cases the buds had already burst and in some cases the leaves were well out, while in others only the tips of the young leaves were beginning to appear." It may be mentioned also that many of these young leaves were badly burned by the treatment. These injurious effects were temporary, simply tending to delay the appearance of the foliage somewhat. In a short time it "was as abundant and vigorous as in any of the neighboring orchards."

No cases of limb infection with apple scab have been observed on the Ben Davis at Highmoor but the question is frequently raised by orchardists as to whether it is safe or advisable to apply a dormant spray of lime-sulphur after the leaf buds have begun to unfold and the flower buds are swelling. To secure data upon this point and upon the question of scab control, a single plot received a late application of dormant strength lime-sulphur, in addition to the regular spraying with the summer dilution of the same material combined with the usual amount of arsenate of lead.

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*Morse, W. J. and Darrow, W. H. Is apple scab on young shoots a source of spring infection? Phytopahtology 3:265-269. Oct., 1913. Morse, W. J. Spraying experiments and apple diseases in 1913. Bul. Me. Agr. Exp. Sta. 223:20-23, Jan., 1914.

†Lowe, V. H., and Parrott, P. J. San Jose scale investigations. IV. Bul. N. Y. Agr. Exp. Sta. 228:295-297. 1902. (Reprinted in 21st Annual Report of the N. Y. Agr. Exp. Sta. with the same paging, 1903).

At the time of the application of the dormant strength lime-sulphur, May 8, the blossom buds appeared well protected. The young leaves surrounding them were not over one-third inch long, frequently less, and closely imbricated. Considerable burning of the leaves was experienced and some of the flower buds were injured, in the case of a few clusters all except the central bud or buds being killed outright. These effects soon passed away, the foliage later appearing fully as vigorous and abundant as that on the trees of the surrounding plots and as far as could be determined the total yield of apples was not lessened. The amount of scab on the fruit was slightly less than that on the plot treated exactly the same with the exception that the late dormant spray was omitted, but the differences obtained were plainly within the limits of experimental error.

A much more significant result is the amount of russeting of the fruit as shown by the records obtained at harvest time. The unsprayed check plot produced approximately 3.6 per cent of russeted apples, the one sprayed with 3 applications of summer dilution lime-sulphur gave a little less than 10.5 per cent, while the amount of russeting was increased to nearly 22 per cent where the late dormant spray was used in addition. Here again, as in the case of bordeaux mixture already mentioned, the application of a strong fungicidal spray before the blossoms were open (in this case before the flower buds had enlarged materially) and long before the fruit had set was followed by a marked increase in the russeting of the latter. However, as has already been stated no such marked increases have been experienced when the strength of the standard summer dilution of lime-sulphur was increased by adding 20 per cent more of the concentrate.

Self-boiled lime-sulphur: Interest in this material in connection with apple orchard spraying is largely historical. Although experience has shown that it is too weak a fungicide to be profitably employed in Maine for the control of apple scab, the results secured with it in other parts of the country in treating diseases of the peach and the plum without injuring the more tender foliage of this class of fruit trees, and even for treating certain apple diseases, led to the immediate development of the stronger and more effective lime-sulphur made by mixing together definite quantities of lime, sulphur and water and then boiling for some time with artificial heat.

Mention has already been made of the earlier experiments of the writer with this material at Orono. There self-boiled lime-sulphur made with hot water was more effective in scab control than that made with cold water where the slaking lime provided the only source of heat to bring about chemical action between the lime and the sulphur. Much better results were secured with bordeaux mixture.

Self-boiled lime-sulphur, also made with hot water, was used at Highmoor but one season, or in the first series of experiments. With it Mr. Bonns secured a reduction in the amount of scab on the fruit from 41.75 per cent to 15.40 per cent as compared with the check. That season however it gave nearly as good scab control as did bordeaux mixture and home-cooked lime-sulphur, but was considerably less efficient than dilutions made from certain commercial brands of lime-sulphur concentrate.

Copper-lime-sulphur: Dr. Howard S. Reed and his associates in Virginia reported very satisfactory results in spraying apple trees for rust, with lime-sulphur to which two pounds of copper sulphate dissolved in water were added to each 50 gallons of dilute lime-sulphur spray. They stated that this spray was not injurious to the foliage.* In a later publication additional data is given including the following statement. "On most trees, when copper-lime-sulphur was used, it was possible to find leaves whose margins were much darker green than the normal leaves, but no evidence of scorching by this material was found."† The York Imperial is mentioned as the variety of apples used.

At Highmoor in 1914 a plot of Ben Davis was sprayed with this copper-lime-sulphur mixture to which the usual amount of dry arsenate of lead had been added. As far as scab control was concerned the results were practically identical with

*Reed, Howard S., Cooley, J. S. and Crabill, C. H. Experiments on the control of the cedar rust of apples. Bul. Va. Agr. Exp. Sta. 203. Jan., 1914.

†Reed, Howard S. and Crabill, C. H. The cedar rust disease of apples caused by *Gymnosporangium juniperi-virginianae* Schw. Tech. Bul. Va. Agr. Exp. Sta. 9:87. May, 1915.

those secured from the same dilution of lime-sulphur without the addition of copper sulphate. On the other hand where the lime-sulphur was used alone no foliage injury was observed and only about 4.5 per cent of the fruit was russeted. On the copper-lime-sulphur plot severe foliage injury occurred, closely resembling that produced by bordeaux mixture and nearly equal to the amount obtained with "Soluble sulphur." At harvest time over 57.5 per cent of the fruit was unmerchantable on account of russeting.

This experience with copper-lime-sulphur farther emphasizes the fact that in apple spraying the results secured in other parts of the country using different varieties, grown in a different climate, may or may not be applicable to local conditions.

Extra fine sulphur flour as a fungicide for scab: A suspension of finely ground sulphur in water at the rate of 10 pounds in 50 gallons was used as a spray on one plot in 1914 and again in 1915.* While scab did not develop sufficiently in the orchards either season to make the test a severe one it is evident from the results that this form of sulphur, used in the manner described, has considerable fungicidal value. As compared with the check the per cent of scabby apples was reduced from about 12.5 per cent to a little over 3 per cent in 1914. In 1915 these figures were 5 per cent and a little over one-half percent respectively.

The fungicidal properties of very finely ground sulphur have recently been well demonstrated by the pathologists of the Cornell University Agricultural Experiment Station by means of numerous and extensive experiments in dusting apple trees and various kinds of nursery stock with it mixed with powdered arsenate of lead, also in dusting hops for mildew with sulphur alone.

There seems to be no particular advantage in using the watery suspension of sulphur as employed experimentally at Highmoor. Dusting on the other hand is claimed to have decided advantages, particularly for very high trees and for rough or hilly orchards as the lighter dusting machines can be taken where it would be impossible to go with the heavier spraying

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*The method for making this suspension is described on page 180 of Bulletin 240 of this Station.

apparatus. It is also of advantage in orchards which are remote from an adequate water supply.

Proprietary spraying compounds: Under this heading only those spraying materials are considered which have been tried in comparison with lime-sulphur and bordeaux mixture—the commercial brands of lime-sulphur concentrates are not discussed.

The first material of this kind employed was what is known to the trade as "Sulfocide" and was used by Mr. Bonns in 1910. For the first two applications one-third gallon was used to 50 gallons of water with two pounds of arsenate of lead paste added. For the third and last application the amount of "Sulfocide" was decreased to three-sixteenths gallon and the amount of arsenate of lead paste increased to 3 pounds.

Very serious injury followed its use. Leaf scorching of the most severe type followed shortly after the second application. This injury was increased by the final application although the amount used was a greater dilution than the weakest strength recommended by the manufacturers. The fruit was also injured severely, particularly around the calyx. As a result nearly 45 per cent of the apples at harvest time were found to be so badly deformed and injured as to render them unsalable. "Sulfocide" proved very efficient in scab control, but on account of the injury mentioned the amount of merchantable apple secured with it was far less than where no spray at all was applied.

A dry powder to be applied after dissolving and diluting with water and known under the trade name of "Soluble sulphur" was used in 1913 and 1914. This has been much advertised and sold in Maine as a substitute for lime-sulphur. The manufacturers did not make such claims but many orchardists purchased and used the material supposing that it was identical in composition with lime-sulphur, except that the water in the liquid had been removed.

The first year at Highmoor two pounds of this powder and one pound of dry arsenate of lead was used in 50 gallons of water. Efficient scab control was secured but the effects on the foliage were disastrous. Shortly after the second application of the spray very evident leaf injury began to appear in the form of spotting and more or less browning of the margins. This injury developed slowly till after the third application on

June 24. After that it progressed quite rapidly so that by July 7 from 75 to 90 per cent of the leaves were affected, with much yellowing and leaf drop showing at this time. On July 15 the ground was nearly covered with fallen leaves, and the appearance of the trees showed a marked contrast with those on adjoining plots, sprayed with other materials, which were covered with healthy foliage.

The experiment was repeated the second year, reducing the amount of the fungicide to three-fourths pound in 50 gallons. The effects on the foliage were essentially the same as before. No injurious effects were observed on the fruit. The results of two successive trials indicate that even when used in small quantities "Soluble sulphur" is an efficient fungicide for scab, but at the dilutions tested it is unsafe for use as a summer spray for apple foliage. Reports secured from several Maine orchardists who used the material as a summer spray in 1913 fully confirmed this conclusion. No attempt was made to test its merits as a dormant spray.

Another proprietary compound used is known as "Atomic sulphur." This is sold in the form of a paste. It was used two seasons at the rate of 7 pounds, plus the usual amount of arsenate of lead, diluted with 50 gallons of water.* No injury to fruit or foliage was obtained. Scab control on the fruit and the percentage of perfect apples was very nearly the same as was secured with standard dilution lime-sulphur both seasons.

*Through error due to following the directions of a local dealer 14 pounds of "Atomic sulphur" to 50 gallons was used for the first application the first season.

BULLETIN 250.

STUDIES ON OAT BREEDING. IV. PURE LINE VARIETIES.[1]

By

FRANK M. SURFACE AND JACOB ZINN.

The agricultural importance of the oat crop in Maine led the Experiment Station to undertake some definite breeding work with this cereal at Highmoor Farm in 1910. The general outline of this work has been given in a previous paper.[2] One of the lines of work attempted, has been to develop new varieties which would be better adapted to our conditions than any of those now grown. In attempting to do this several methods have been employed. One of these has been the isolation of "pure lines" out of certain standard commercial varieties. This work has now reached such a point that a discussion of the results may be undertaken.

Before proceeding to the discussion of these "pure lines" it is important to have a clear understanding of what is meant by this term. This term was first used by the Danish botanist, Johannsen. According to Johannsen's[3] definition a "pure line" is the offspring of a single, self-fertilized, homozygous individual. The exact meaning of this can perhaps best be made clear by referring to the work of Johannsen himself.

Johannsen, in his work on beans, brought out very clearly three things which in themselves and in their implications are of fundamental importance to all practical breeders of animals or plants, as well as to students of breeding. These three things are:

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[1]Papers from the Biological Laboratory of the Maine Agricultural Experiment Station No. 96.

[2]Surface, F. M. and Barber, C. W. Studies on Oat Breeding. I. Variety Tests 1910-1913. Maine Agricultural Experiment Station, Ann. Rept. 1914, pp. 137-192. (Bulletin No. 229).

[3]Johannsen, W. Elemente der exakten Erblichkeitslehre. Jena, 1913, pp. XI + 723.

1. That the size of an individual bean was no absolute or certain criterion whatever, as to the average size of its offspring. He found that while some particular large beans always produced large offspring beans, other equally large ones always produced small offspring beans. Some individual small beans produced offspring of large average size, others produced beans of small average size like the parent, and, in general, he showed it to be quite impossible for anyone to tell merely from the size of a bean itself whether its progeny will be large or small.

The nature of Johannsen's results on this point have been clearly set forth in the accompanying diagram.

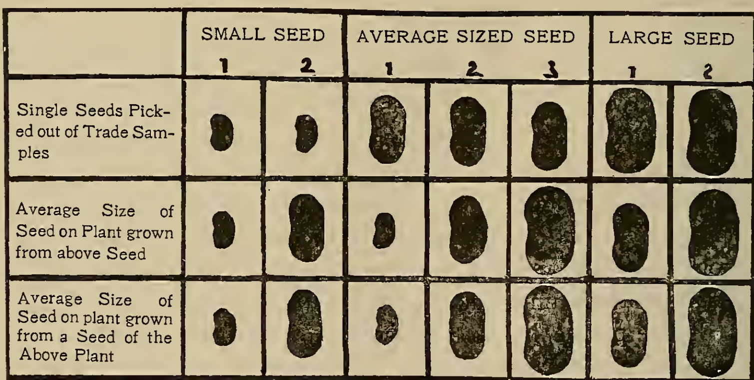

Fig. 14. Diagram to illustrate Johannsen's results with beans. (From Wood and Punnett).

2. That a population of beans, no matter from how supposedly "pure" a commercial variety it is taken, is really not a homogeneous unitary aggregation, but instead is made up of a varying number of lines or strains, each of which breeds true to itself when propagated in isolation. In other words, the population in question is a mixture of several component lines. The individuals in each line produce offspring true to the type of the line, rather than to the type of the population as a whole, except in cases where by chance the population type and the type of one or more lines happen to be the same.

3. That when mass selection alters the population type it does so by a process of isolating from the mixture certain strains whose own types are different from the original general popula-

tion type, and which differ in the direction towards which selection was made. Thus if one begins in a general mixed population of beans to select for planting the largest beans, and by so doing increases the average size of the beans in the crop, what he really does is gradually to throw away all beans except those which belong to strains having large beans as the type. Having isolated from the population one of these component strains which breeds true to a definite type no amount of further selection will modify that strain.

The idea underlying these conclusions is that, in the continued propagation of the offspring of any self-fertilized plant, every individual will possess exactly the same hereditary constitution as every other individual. Consequently except for the effect of environmental conditions such a "pure line", as it is called, should breed true and should show the same characters in every generation.

The same reasoning cannot, without some modification, be applied to open fertilized plants, such as corn for example. Here any individual kernel, in the majority of cases, has been fertilized by pollen from some neighboring plant. This latter plant, and consequently its pollen grains, may be carrying characters very different from those of the mother plant. The offspring of such a grain would split up, some showing characters similar to the pollen parent and others like the mother plant. By continued self-fertilization (hand pollination) of corn a condition approaching that of a pure line could be obtained.

The majority of our cereals, such as oats, wheat, barley, etc., are nearly always self-fertilized. Wilson[4] says that natural crossing occurs only very rarely in oats. Rimpau[5] found only five spontaneous crosses in dealing with 19 different varieties during a period of six years. In our own experience we have never observed a single natural cross although in our oat gardens different varieties including black, white and yellow oats, open and side heads, have been grown in adjacent rows. These rows are only one foot apart and at the time of blooming the heads of one row interlock with those of the next. The reason

[4]Wilson, J. H. The Hybridization of Cereals. Journ. Agric. Sc., Vol. 2. pp. 68-88, 1907.

[5]Rimpau, v. Kreuzungsproduktion Landw. Kulturpflanzen. Landw. Jahr. 1891.

that cross-pollination does not occur is that the anthers shed their pollen before the glumes open, and there is very little chance for the introduction of foreign pollen. Consequently we may assume that for many generations the ancestors of any particular oat plant growing in a field or plot have been self-fertilized and that this plant will breed true to its hereditary characters. This is the fundamental assumption upon which all pure line breeding is based. By the selection and isolation of such pure lines out of ordinary commercial varieties new strains may often be secured which are far superior to the parent variety.

The point in question can perhaps be made still clearer by considering what constitutes a commercial variety. To the casual observer a variety may appear to be breeding perfectly true and all the plants may appear to be alike. However, if the plants are examined carefully many differences will be found. Some have larger heads, or more spikelets per head, others have a larger number of culms, some have stiffer straw than others, etc. Some of these differences are due to environment, such as more space or better ground. On the other hand some of these variations are definitely inherited. If individual plants are selected and the seed of each grown in separate rows, it will be found that many of these rows differ greatly in their yield, time of maturity, strength of straw, etc. These differences are transmitted from one generation to the next. Each plant which breeds differently from the others belongs to a different pure line. A commercial variety then, consists of a mixture of a large number of pure lines which we may designate by the letters

A, B, C, D, E, F, ———— etc.

If we select a single plant it will belong to one of these pure lines, for example *C*. If we multiply the seed of this plant we may have finally a whole field, all the plants of which belong to this pure line *C*.

It further follows from this theory that if we again select individual plants from such a pure line field we have still only the same pure line. If we grow the seed of such selected plants in separate rows there is little or no difference between the rows. That is, in selecting and isolating the pure line we have made all the improvement possible in this direction. Theoretically and, as Johannsen proved in the case of beans, practically it is not possible to improve such a pure line by further selection.

The question as to whether it is possible to improve a pure line of oats by continued selection has been studied by this Station for several years. The results of three years of such selections have been published.[5] It has been shown that selection for three years both to increase and to decrease certain characters has not modified any of the characters studied.

The results of this work are of much importance to the practical oat breeder. It follows that in order to secure improved strains it is only necessary to select individual plants from the commercial fields and then to multiply the seed of each plant separately. Then each of these pure lines must be tested and only the best retained. After a desirable pure line has been isolated it is only necessary to keep it pure and unmixed with other seed. Such a pure line will not deteriorate nor can it be improved by further selection. This greatly simplifies the methods of practical oat breeding. It has been shown that it is useless to continue the expensive methods of selecting year after year within a pure line. In order to get still better yielding strains it is necessary to go back to commercial fields and make new selections with the hope of isolating still better pure lines. Once a pure line is isolated it cannot be improved by further selection.

Of course, at any time and for reasons at present unknown, germinal variations may occur within a pure line and these may breed true to their new characters. If plants showing such germinal variations should be selected it would be possible to secure strains showing characters different from the parent pure line. While there is good evidence that such germinal variations do occur in oats, they are relatively rare. Practically, there seems to be very little chance of securing such variations from a pure line. (cf. pp. 142-143.)

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[5]Surface, F. M. and Pearl, R. Studies on Oat Breeding. II. Selection within pure lines. Maine Agr. Expt. Stat. Ann Rept. 1915, pp. 1-40. (Bulletin No. 235).

Methods.

The general methods of pure line breeding in the case of cereals may be briefly outlined as follows: In the first year individual plants are selected from the fields or plots of the commercial varieties. These plants are selected because in some one or more respects they appear to be better than their neighbors growing under the same conditions. Each of these plants is harvested separately and various data recorded concerning it. On the basis of the notes made in the field and the data on the threshed plants a further selection is made.

The seed from the plants which are finally selected are sown the next spring in short rows in a cereal garden. In our work we usually plant 25 kernels in each row. The rows are one foot apart and the plants three inches apart in the row. This allows each plant sufficient room to develop and the 25 plants are enough to judge the character of each pure line. The garden rows are subjected to a severe selection. Careful notes are taken in the field and considerable data taken at the time of threshing. Out of several hundred rows usually only a few are judged good enough to be continued.

The third year the seed from the selected rows is sown in small multiplying plots. In our work these plots have been 1-2000 acre in area and usually in duplicate. In these plots the grain is planted much closer together in fact, approaching the number of grains per unit area, that are usually sown in the field. These plots are subjected to a still further selection and only the best retained.

The fourth year there is sufficient seed from each selected pure line to sow one or more field plots. According to our method of testing varieties[6] these are sown in 1-40 acre plots. Here they are tested in duplicate or quadruplicate plots for several years and subjected to still further selection until only those which are superior in some respects, at least, to already existing varieties are retained.

In the work with which this bulletin is concerned over 450 plants were selected in 1910. Of these something less than 200 were tested out in garden rows. Eighty were deemed good enough for the 1-2000 acre test, but only 34 ever reached a field

[6]Surface, F. M. and Barber, C. W. Loc. cit.

test. Of these 34 all but 12 have been discarded as not sufficiently valuable to be offered to the public. These 12 pure lines have now been tested for 3 years under field conditions and in competition with the best commercial varieties which we could obtain.

In the following pages some of the details of this work are given and the comparative yields in each year. A description of the 12 pure lines still retained is also given.

This work was begun under the general direction of Dr. Raymond Pearl. The selections in 1910 were all made by the senior writer. In 1911 the work was in charge of Dr. E. P. Humbert. In 1912 Dr. M. R. Curtis and Mr. C. W. Barber looked after the field work. Mr. Barber was also associated with the work in 1913. The present writers were associated in the work of 1914 and 1915 and in the preparation of the data for publication The writers desire to express their appreciation of the careful and efficient assistance rendered throughout this and other work by Mr. Wellington Sinclair, Superintendent of Highmoor Farm.

Work in 1910.

In 1910 25 varieties of oats were tested in 1-10 acre plots at Highmoor Farm. The location of these plots as well as other data concerning them has been given by Surface and Barber.[7]

Shortly before harvest a number of these plots were carefully gone over and plants showing points of excellence were given a tag bearing a selection number. The points which were particularly noted in this field selection were the number of culms, the size and general character of the head, the number of spikelets, the number of sterile or abortive spikelets, and the strength of the straw. In making these selections much weight was given to the position of the plant in the plot. Thus usually marginal plants were not chosen because their greater development was manifestly due to better environment. In general, the attempt was made to select plants which were noticeably better in some respects than their neighbors located under the same environmental conditions.

The number on the tag is the plant selection number by which the plant can at any time afterwards be identified in the records. No plant selection number is ever duplicated in the

[7] *Loc. cit.*

plant breeding work of the Station. For those plants which are later multiplied in plots, the plant selection number becomes the "Line Number." Thus when we speak in the latter part of this paper of Line No. 355, it refers us at once to selection number 355 and from this the entire pedigree of the line can be traced. So long as no new germ plasm is added by crossing, the line number remains the same.

Notes were taken at the time of the original selection of each plant. These notes were recorded on 5″ x 8″ loose leaf sheets similar to that shown in facsimile in Figure 15. These sheets,

MAINE AGRIC. EXPT. STATION—PLANT SELECTION RECORD

DATE HARVESTED SELECTION NO.

PLANTED BY LINE NO. CROSSED SELFED

SELECTED FROM PLOT ROW NO. PLANT NO.

CROSSED AS MOTHER PARENT WITH PLANT ROW PLOT VARIETY

PLANTED IN BREEDING PLOT NO. ROW PLANT

OATS, VARIETY: PHOTO NEG. NO.

HEIGHT	NO. OF CULMS	WEIGHT			LENGTH OF HEAD	TYPE		COLOR GRAIN					
		PLANT	GRAIN	STRAW		HEAD	GRAIN						

CORN, DENT FLINT SWEET, VARIETY:

HEIGHT OF PLANT	NO. OF EARS	WEIGHT			LENGTH OF EAR	DIAMETER		NO. OF ROWS	KERNELS PER ROW	GERMINATION %		
		EARS	COBS	CORN		MID-EAR	MID-COB					

BEANS, VARIETY:

HEIGHT OF PLANT	RUNNER OR DWARF	WEIGHT					NUMBER		COLOR PODS	COLOR BEANS	TYPE BEANS	TYPE LEAF	
		PLANT	FILLED PODS	BEANS	EMPTY PODS	STALK	PODS	BEANS					

NOTES:

Fig. 15. Facsimile of plant selection record sheet used in the plant breeding work.

it will be noted, are designed to be used with certain other plants besides oats.

This sheet provides space for data relating to the pedigree of the plant and also such characters of the plant as height, number of culms, weight of grain and straw and certain characters of the head and grain. At the time of the field selection, the date, the name of the variety and the plot from which it came are recorded. Also brief notes relative to the position of the plant in the plot and the character for which it was especially selected are noted.

When the plants were fully ripened they were pulled and brought into the laboratory. Sometime after they were thoroughly dry they were measured, weighed and threshed.

On the basis of the data thus obtained a further selection of the plants was made. The grain from the best plants was saved for planting in the breeding garden the next year.

In 1910, 460 plants were selected from the variety test plots. These represented 18 different varieties. Of these plants 188 were deemed good enough to be tested in garden rows.

Table 1 shows the plot numbers and the names of the varieties from which plants were selected. Also the number of plants selected from each plot and the number that were grown in the 1911 garden rows.

Table 1.

Showing the number of plants selected from the different varieties in 1910 and the number of these which were continued in the 1911 oat garden.

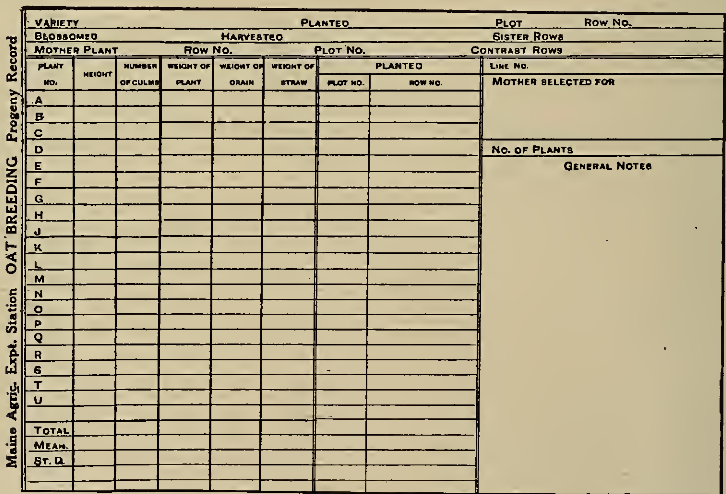
1910 plot No.*	Variety.	Number selected plants.	Number grown in 1911 garden.
2	Welcome	10	1
3	White Tartar King	11	1
5	Black Tartarian	32	5
6	Kherson	18	3
7	Kherson	6	1
8	Irish Victor	28	14
9	Early Champion	18	9
10	Prosperity	32	14
13	Regenerated Swedish Select	28	12
14	Regenerated Swedish Select	27	20
15	Regenerated Swedish Select	30	6
16	Swedish Select	18	14
17	President	30	18
18	Senator	10	6
19	Victor	14	12
20	Old Island Black	4	1
23	Imported Scotch	21	10
25	Unnamed White	28	14
26	Banner	16	6
27	Banner	16	5
28	Banner	17	1
29	Banner	25	2
31	Hamlin	21	13
	Total	460	188

* For a description of these varieties, source of seed, etc., see Surface and Barber, *Loc. cit.*

Work in 1911.

Seed from the 188 selected plants were grown in garden rows in 1911. In many instances two or more rows were grown from the same plant. Each row was planted with seed from a single culm of the plant. In this way we were certain that all the plants in a given row were the offspring of a single individual. Where plants are taken from a field plot it is not always possible to be certain that several different culms belong to a single plant.

Each row was about 6 feet long and contained 25 kernels. The plants were 3 inches apart in the row and the rows in 1911 were alternately one foot and two feet apart. This brought the rows in pairs with a one-foot space between the rows of a pair and a two-foot space between the pairs of rows. This latter space allowed ample access to the individual plants in taking notes, etc.


Maine Agric. Expt. Station OAT BREEDING Progeny Record

Variety | Planted | Plot | Row No.
Blossomed | Harvested | Sister Rows
Mother Plant | Row No. | Plot No. | Contrast Rows

Plant No.	Height	Number of culms	Weight of plant	Weight of grain	Weight of straw	Planted: Plot No.	Planted: Row No.
A							
B							
C							
D							
E							
F							
G							
H							
J							
K							
L							
M							
N							
O							
P							
Q							
R							
S							
T							
U							
Total							
Mean							
St. D.							

Line No.
Mother selected for
No. of Plants
General Notes

Fig. 17. Facsimile of progeny row record blanks used in the oat breeding work.

Careful notes were taken with regard to each row. When ripe, the plants of each row were pulled and tied together with the row number tag attached. After the plants were thoroughly dry they were weighed, measured and threshed. In some cases each individual plant was threshed separately. In other cases all the plants of a row were threshed together. In either case

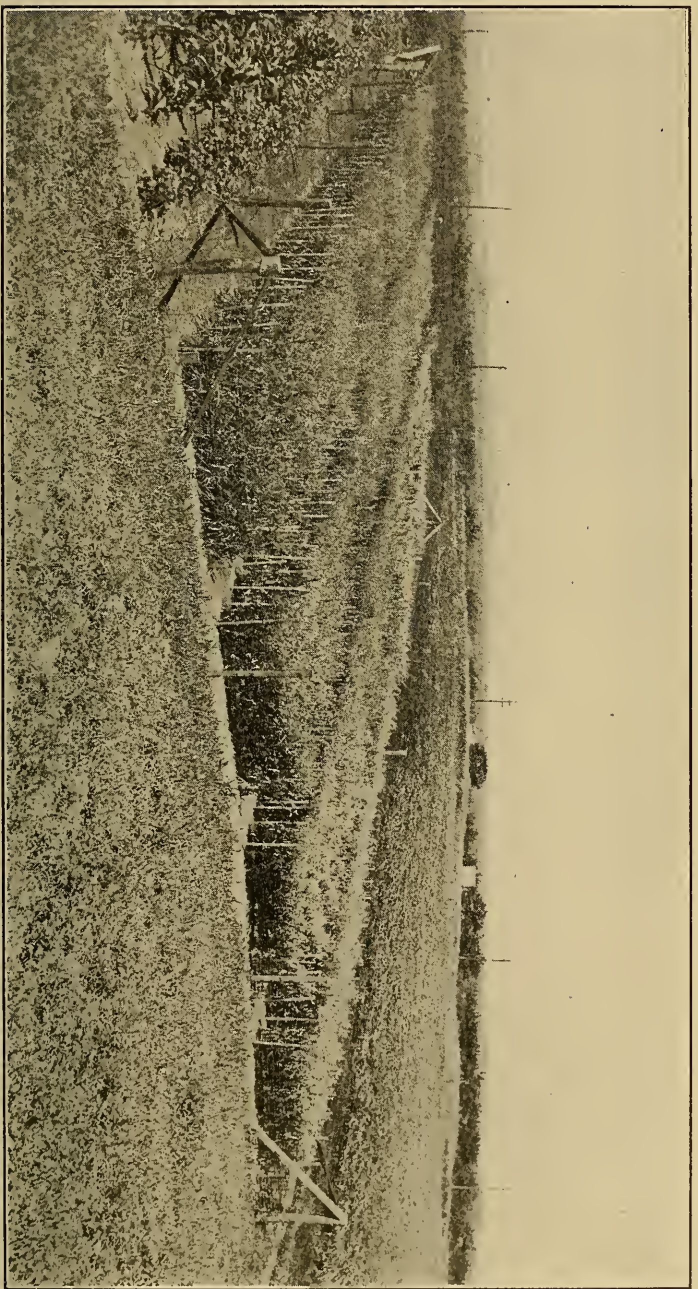


Fig. 16. Photograph of the 1911 oat garden at Highmoor.

all mutilated plants were discarded. The data were recorded on 5″ x 8″ loose leaf sheets like that shown in Fig. 17.

Since the number of threshed plants varied in different rows the average per plant of a given character was used in comparing different rows.

From the notes and the data thus obtained a further selection was made and only the very best rows were selected for propagation the next year.

WORK IN 1912.

Eighty-two rows from the 1911 garden were regarded as good enough to be tested further. In one case two of these rows belonged to the same pure line. In another case three rows were from the same line. There were then 79 pure lines tested in 1912. Seeds from these selected rows were planted by hand in small plots. These plots were four feet, six inches wide and four feet, ten inches long, giving a total area of 21.75 square feet, or 1-2000 of an acre. The grain was planted in rows three inches apart and one and one-half inches between the plants in the row. There were in each plot 18 rows with 39 plants to the row. This makes 702 plants per plot or at the rate of 1,404,000 plants per acre. This is about the average number of grains of a medium sized oat sown on an acre when seeded at the rate of two bushels. Each pure line was planted in duplicate plots of this size and the average of the two plots for each character was taken for comparison of the different pure lines.

The planting of such plots has been greatly facilitated by the use of a planting board like that shown in figure 18. This board contains rows of 3-8 inch pegs spaced at the proper distances.[9]

During the growing season detailed notes were taken regarding each plot and when ripe the plots were harvested and later threshed. On the basis of these data the pure lines were again subjected to a severe selection. Out of the 79 pure lines tested in these plots 34 were chosen for testing in larger field plots.

The threshing data from these 34 pure lines are given in Table 2. The measurements are recorded in centimeters and

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[9]The board shown is designed for marking only half a plot and varies somewhat in shape from that described above.

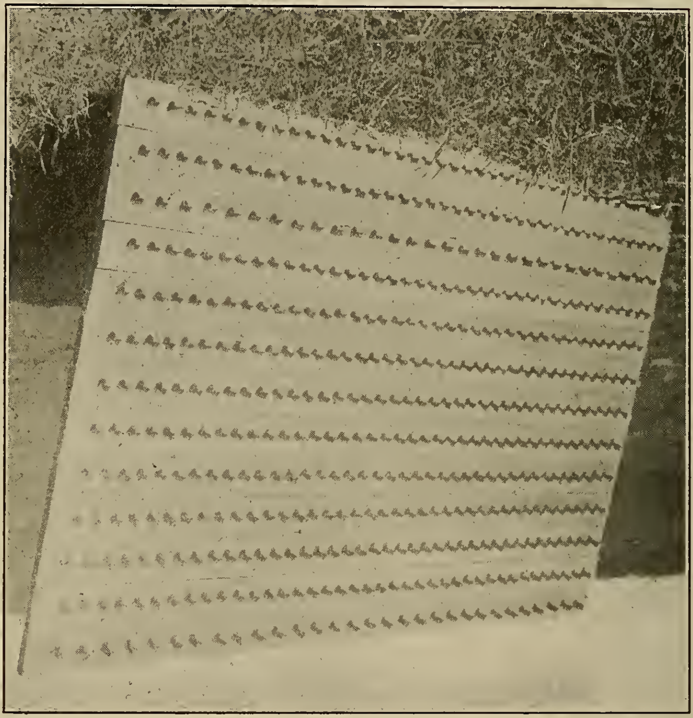

Fig. 18. Photograph of a planting board used in planting 1-2000 acre plots.

the weights of straw and grain in grams. In order to make these figures more intelligible to those unaccustomed to the metric system, the calculated yield in bushels per acre is also given. It will be understood that in calculating acre yields from small garden plots it is not assumed that in actual practice such yields would necessarily be obtained on the larger areas. However, the translation of yield in grams per 1-2000 acre plot to yield in bushels per acre merely means multiplying the former by a constant factor. So that for purposes of comparing the different pure lines one column can be used as well as the other. As a matter of fact, however, the results obtained in the variety tests in 1914 and 1915 (see tables 4 and 5) indicate that the yields calculated from these garden plots are not far above what may be expected from a properly handled crop in a favorable season.

From Table 2 it is noted that these pure lines averaged to yield at the rate of from 132.8 bushels to 81.3 bushels per acre. It will be understood that the 34 lines given in the table are selected from the 79 which were grown. As a rule the discarded lines yielded less than those given in the table. However, in instances where high yielding lines showed undesirable characters these were also discarded.

TABLE 2.

Data from the 1-2000 acre plots of the 34 selected pure lines. Grown in 1912.

Line No.	PARENT VARIETY.	Height cm.	Weight of straw gms.	Weight of grain gms.	Calculated bushels per acre.
247	Imported Scotch	104.1	1871	963.5	132.8
336	Irish Victor	113.0	1780	953.5	131.4
346	Irish Victor	108.0	1601	916.0	126.7
281	Banner	115.6	2245	915.0	126.1
74	President	115.6	2317	897.7	123.7
340	Irish Victor	105.4	1540	892.5	123.0
250	Imported Scotch	97.7	1520	884.5	121.8
286	Banner	112.5	1999	871.5	120.1
337	Irish Victor	102.9	1569	832.0	114.7
122	Prosperity	104.1	1613	807.0	111.2
82	President	116.8	2280	800.5	110.3
357	Banner	110.8	1901	796.5	109.7
334	Irish Victor	106.7	1602	790.5	108.9
238	Regenerated Swedish Select	101.6	1430	778.0	107.2
199	Prosperity	111.8	1896	775.5	106.9
78	President	100.3	1695	752.0	103.6
351	Banner	110.5	1844	745.5	102.7
355	Banner	104.8	1778	739.8	102.0
198	Prosperity	112.8	1544	737.0	101.6
79	President	111.8	1670	727.0	100.2
307	Banner	106.7	1587	721.5	99.4
230	Banner	105.4	1583	719.5	99.2
217	Hamlin	100.3	1211	718.0	98.9
75	President	109.2	1676	702.5	97.3
128	Regenerated Swedish Select	97.8	1500	701.0	96.5
201	Hamlin	94.0	1238	700.5	96.4
103	President	100.3	1390	697.0	96.0
133	Regenerated Swedish Select	96.5	1152	679.0	93.6
249	Imported Scotch	111.0	1975	656.0	90.4
261	Swedish Select	97.8	1485	630.5	86.9
104	Swedish Select	109.2	1231	619.5	85.9
243	Swedish Select	97.8	1152	606.5	83.6
239	Regenerated Swedish Select	97.8	1398	601.0	82.8
139	Regenerated Swedish Select	96.5	1271	595.0	81.3

It is of interest to note the distribution of these pure lines among the different parent varieties. From Table 1 it is noted that there were 188 pure lines grown in garden rows. These 188 pure lines represent 18 differently named varieties. The 34 lines given in Table 2 represent eight different commercial varieties. It will further be noted from Table 2 that certain varieties are represented by a large number of lines. These varieties are the Banner, President, Irish Victor and Regenerated Swedish Select. It will further be noted that the majority of the Swedish Select lines are near the bottom of the table, indicating relative low yield.

WORK IN 1913.

In 1913 each of the 34 lines given in Table 2 were grown in one or more 1-40 acre plots. These plots were located in the field with the plots of the commercial varieties for that year. For a description of the soil, methods of seeding, harvesting, etc., the reader is referred to the earlier paper by Surface and Barber.[9] In each of the three years, 1913 to 1915, in which these pure lines have been tested in field plots, they have been grown in the same field and treated in exactly the same manner as the plots of the commercial varieties. In 1913 the pure line plots were grown all together along one side of the field. In the two other years the pure line plots have alternated with the plots of the commercial varieties.[10]

In 1913 there was not enough seed from many of these lines to plant more than a single plot. Table 3 gives the detailed results for each pure line.

From this table it will be noted that individual plots yielded from 83 to 46 bushels per acre. Four plots yielded above 80 bushels and 10 plots between 70 and 80 bushels per acre. Seven lines with two or more plots gave an average yield of 70 bushels or more.

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[9]Surface, F. M. and Barber, C. W. Studies on Oat Breeding. I. Variety Tests 1910-1913. Maine Agr. Expt. Stat. Ann. Rept. 1914, pp. 137-192. (Bulletin No. 229).

[10]Owing to the fact that the field on which these plots were grown was quite irregular in shape, the method of obtaining corrected yields described on page 114 cannot readily be applied to these plots. For this reason the discussion of the 1913 results is based on the observed yields only.

TABLE 3.

Test of 34 Pure Lines in 1913.

VARIETY NUMBER.	Plot number.	STRAW YIELD.		GRAIN YIELD.		Weight per measured bushel.	Days to maturity.
		Lbs. per plot.	Lbs. per acre.	Lbs. per 1-40 acre plot.	Observed bu. per acre.		
Maine 336.........	580	93.0	3720	65.0	81.3	35.9	102
	581	70.5	2820	55.5	69.4	38.4	102
Average...........	–	*81.7*	*3270*	*60.3*	*75.3*	*37.2*	*102*
Maine 340.........	578	64.0	2560	52.0	65.0	39.0	99
	*579	100.5	4020	62.5	83.2	36.4	99
Average...........	–	*82.3*	*3290*	*57.3*	*74.1*	*37.7*	*99*
Maine 281.........	565	73.5	2940	53.5	71.2	36.5	105
	601	77.0	3080	60.0	75.0	34.1	105
Average...........	–	*75.3*	*3010*	*56.8*	*73.1*	*35.1*	*105*
Maine 346.........	584	69.0	2760	56.0	70.0	37.4	99
	585	65.0	2600	59.0	73.8	37.3	99
Average...........	–	*67.0*	*2680*	*57.5*	*71.9*	*37.4*	*99*
Maine 78..........	606	71.0	2840	57.0	71.3	39.3	103
Maine 355.........	560	90.0	3600	58.0	72.5	35.6	105
	561	86.0	3440	61.0	76.3	35.5	105
	570	59.5	2380	51.5	64.4	35.8	104
Average...........	–	*78.5*	*3140*	*56.8*	*71.0*	*35.7*	*105*
Maine 286.........	566	79.5	3180	59.5	74.4	35.2	99
	567	68.0	2720	54.0	67.5	–	105
Average...........	–	*73.8*	*2950*	*56.7*	*70.9*	–	102
Maine 357.........	558	93.5	3740	66.5	83.1	36.2	105
	559	87.0	3480	63.0	80.0	35.6	105
	562	56.0	2240	43.0	53.8	36.9	104
	563	62.5	2500	50.5	63.1	36.7	104
Average...........	–	*74.8*	*2990*	*55.7*	*70.0*	*36.4*	*102*
Maine 351.........	564	72.0	2880	56.0	70.0	36.2	105
Maine 128.........	597	75.0	3000	56.0	70.0	37.2	102
Maine 230.........	568	55.7	2228	46.3	69.4	36.7	102
Maine 133.........	602	56.5	2260	46.5	69.3	37.8	101
Maine 217.........	572	63.0	2520	55.0	68.0	37.4	102
Maine 74..........	587	71.5	2860	55.5	69.4	37.9	104
	588	63.5	2540	54.5	68.1	37.8	105
Average...........	–	*67.5*	*2700*	*55.0*	*68.8*	*37.4*	*105*
Maine 243.........	603	64.5	2580	54.5	68.1	37.8	102
Maine 103.........	591	47.7	1908	47.3	67.6	39.5	101
Maine 75..........	586	76.5	3060	54.0	67.5	39.3	104
Maine 239.........	600	64.0	2560	54.0	67.5	39.0	102
Maine 307.........	569	61.5	2460	53.5	66.9	36.8	102
Maine 82..........	589	73.0	2920	55.0	68.8	34.8	106
	590	67.0	2680	51.0	63.8	35.8	106
Average...........	–	*70.0*	*2800*	*53.0*	*66.3*	*35.3*	*106*
Maine 261.........	604	68.0	2720	52.0	65.0	36.9	103
Maine 238.........	598	75.5	3020	54.5	68.1	36.4	103
	599	57.5	2300	46.5	58.1	36.8	102
Average...........	–	*66.5*	*2660*	*50.5*	*63.1*	*36.6*	*103*

* Plots marked with (*) were not exactly 1-40 acre in area when harvested. The yields of these plots have been calculated to a 1-40 acre basis in order to be comparable with the other plots.

TABLE 3.

Test of 34 Pure Lines in 1913—Concluded.

Variety Number.	Plot number.	Straw Yield.		Grain Yield.		Weight per measured bushel.	Days to maturity.
		Lbs. per plot.	Lbs. per acre.	Lbs. per 1-40 acre plot.	Observed bu. per acre.		
Maine 247..........	573	72.0	2880	52.0	65.0	37.7	102
	574	101.0	4040	48.5	60.6	35.8	99
Average...........	–	*86.5*	*3460*	*50.3*	*62.8*	*36.8*	*101*
Maine 201..........	571	61.0	2440	50.0	62.5	37.2	104
Maine 199..........	594	62.5	2500	49.5	61.9	36.6	103
Maine 334..........	583	48.0	1920	48.0	60.0	39.2	95
Maine 139..........	596	61.0	2440	48.0	60.0	38.5	101
Maine 79...........	592	66.0	2640	47.0	58.8	36.9	102
Maine 198..........	593	56.0	2240	47.0	58.8	37.5	103
Maine 337..........	582	87.2	3488	46.8	58.4	37.5	94
Maine 250..........	*575	73.2	2928	42.8	55.7	36.4	94
	576	73.5	2940	38.5	48.1	36.8	94
Average...........	–	*73.4*	*2934*	*40.7*	*51.9*	*36.6*	*94*
Maine 122..........	595	77.5	3100	41.5	51.9	36.3	101
Maine 249..........	577	48.5	1940	34.5	50.8	36.8	94
Maine 104..........	605	63.0	2520	34.0	46.0	43.7	89
Average for all lines	–	*67.7*	*2709*	*50.9*	*65.0*	*37.4*	*101*

* Plots marked with (*) were not exactly 1-40 acre in area when harvested. The yields of these plots have been calculated to a 1-40 acre basis in order to be comparable with the other plots.

The average yields of the commercial varieties tested in 1913 have been given by Surface and Barber (*loc. cit.*). By reference to Table 6 of that paper it will be noted that only one variety, the Siberian, yielded as high as 70 bushels.

The fact that the plots of the commercial varieties and the pure lines were arranged on separate sides of the field in 1913 make it somewhat difficult to draw reliable comparisons. As a whole, the land on which the pure lines were grown was somewhat inferior to that on which the commercial varieties grew. Nevertheless, individual lines far outyielded the commercial varieties. The average yields of the two sets of plots did not show a very great difference. The 21 commercial varieties averaged to yield 62 bushels per acre, while the 34 pure lines gave 65 bushels.

Work in 1914.

In 1914, 31 of these pure lines were tested again. Three lines, viz., 139, 243 and 249, were discarded because they possessed certain undesirable characters. The data from the 1913 test were not sufficient to warrant discarding any of the other lines. By this time practically all of the lines possessing weak straw, poor head character, or poor grain had been discarded. The further selection in these pure lines would have to be largely upon the question of yield. Consequently two or three years records are necessary.

Owing to a large amount of other work in 1914, it was not possible to plant more than two plots of each pure line. Two lines were represented by only a single plot. These pure line plots alternated in the field with the plots of standard commercial varieties. They were therefore tested under exactly the same conditions so far as that was possible.

In connection with these tests a method has been devised to correct the yields of individual plots for differences in the soil. Before discussing the results of the 1914 tests it will be necessary to consider this method very briefly.

The method used by us in testing varieties is to grow several (usually 4) systematically repeated plots of the same variety. These plots are each 33 feet square, or 1-40 of an acre. Where four of these are grown it makes 1-10 acre devoted to each variety. It has been clearly proven that much more satisfactory results are obtained by growing several systematically repeated small plots of one variety than by growing a single large plot. With single plots one of these may fall on better ground and give a much better yield for that reason, although the intrinsic yielding ability of the variety may not be as good as some of the others which were on poorer soil. Where several plots are grown and scattered over the field there is much less chance of all of them falling in very good or very poor soil.

Even where several plots are grown there is some chance that one or two of these will fall in exceptionally good or exceptionally poor soil and these may unduly affect the average yield. To take account of this, a method has been devised by which the yield of each plot can be corrected for differences in soil. The details of this method have been published[11] in another place and will not be repeated here. Briefly the principle upon which this method is based is to determine first the most probable yield of each plot in the field on the assumption that there is no intrinsic difference in the yield of the different varieties. In other words, a "calculated" yield is obtained which is the probable yield of each plot on the assumption that all plots had been planted with a hypothetical variety whose mean yield is the same as the observed average of all the plots.

The differences between the "calculated" yield of any plot and the average of the field may be taken as a measure of the goodness of the soil in that plot. Thus if a certain plot has a "calculated" yield of 10 bushels above the average of the field, it means that the soil on this plot is capable of producing about 10 bushels per acre more grain than the field as a whole. Therefore, the observed yield of the variety on this plot is higher than it ought to have been for comparative purposes. In order to make the yield of this plot comparable with the field as a whole it would be necessary to deduct 10 bushels (or at least a percentage figure based on this amount) from the observed yield. In case the "calculated" yield is below the average of the field a corresponding amount must be added to the observed yield. For further details of this method with examples the reader is referred to the above mentioned paper.

This method has been tested out under a variety of conditions and appears to give very satisfactory results. We have applied this method of correction to the 1914 and 1915 plots and the discussion of the results will for the most part be based on these corrected yields. The 1913 plots were on a somewhat irregularly shaped piece of ground and it was not possible to use this method of correction satisfactorily.

There is no doubt but that small plots of oats like these give a somewhat higher absolute yield than can be expected when an entire field is planted. The reason for this is that the necessary pathways allow more air and sunlight and also afford more plant food for the marginal plants. However this may be, there is positive evidence that much better results are

[11]Surface, F. M. and Pearl, R. On a Method of Correcting for Soil Heterogeneity in Variety Tests. Jour. Agric. Research, Vol. V, pp. 1039 to 1050, 1916.

obtained in a variety test with several small plots of each variety than with a single large one. Furthermore all the plots are subjected to the same conditions and consequently the results are comparable. Some of our observations indicate that the yield of oats in 1-40 acre plots may be 10 per cent higher than in a large field. If the reader so desires he may reduce the yield reported, by 10 or even 15 per cent but that will not in the least affect the conclusions drawn from this work as to the *relative* value of these varieties. It is this relative value which we are trying to determine. The use of systematically repeated small plots helps very materially in reducing the experimental errors due to differences in soils and other environmental conditions and aids us in determining the relative intrinsic value of the different varieties.

In 1914 the test plots were located in the field to the southwest of the buildings on Highmoor Farm. They were on the west side of the farm road and extended from the house almost to Ben Davis No. 1 orchard. This field had been in potatoes in 1913. The land was apparently very uniform with the exception of a few places where a ledge came near the surface. These spots were not included in the variety test. The methods of handling the soil and the crop were the same as those given in a previous paper.[12]

The plots were arranged in six tiers, each with 28 plots. Allowing for plots not planted on account of ledges, etc., there were 148 plots in the variety test. Eighty-eight of these were sown with commercial varieties, i. e., there were 22 commercial varieties with four plots each. The remaining plots contained the pure line varieties discussed in this paper. The plots were planted May 3 to 6 with the exception of a few which on account of heavy rains could not be sown until about ten days later.

The seasonal conditions for oats in 1914 were very favorable. A sufficient supply of moisture well distributed throughout the season produced a very heavy crop. The yield in this year was much heavier than can be expected throughout a series of years.

The yield and other data for each of the pure line plots together with the average observed and corrected yield of each line is given in Table 4.

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[12]Surface and Barber. *Loc. cit.*

TABLE 4.

Test or Pure Lines in 1914.

VARIETY NUMBER.	Plot number.	STRAW. Lbs. per 1-40 a. plot.	STRAW. Lbs. per acre.	GRAIN. Lbs. per 1-40 a. plot.	GRAIN. Observed Yield. Bus. per acre.	Corrected yield. Bushels per acre.	Weight per measured bushel.	Days to maturity.
Maine 355	685	110.0	4400	79.0	98.7	116.0	37.1	97
	760	73.3	2932	69.3	86.6	94.6	39.0	96
Average	–	*91.7*	*3666*	*74.2*	*92.7*	*105.3*	*38.1*	*97*
Maine 337	712	137.7	5308	96.3	120.3	103.9	42.3	99
Maine 351	687	102.0	4080	79.0	98.8	93.3	40.3	104
	762	104.8	4192	81.3	101.6	103.1	39.4	93
Average	–	*103.4*	*4136*	*80.1*	*100.2*	*98.2*	*39.9*	*98*
Maine 201	698	106.0	4240	82.0	102.5	105.9	–	100
	773	87.3	3492	68.8	85.9	88.5	–	92
Average	–	*96.7*	*3967*	*75.4*	*94.2*	*97.2*	–	*96*
Maine 281	690	91.5	3660	74.5	93.1	93.7	41.6	102
	765	88.3	3532	74.8	93.4	99.5	39.7	94
Average	–	*89.9*	*3596*	*74.7*	*93.3*	*97.0*	*40.7*	*98*
Maine 122	736	97.3	3892	76.8	95.9	95.8	–	92
	810	93.5	3740	75.5	94.4	97.1	–	92
Average	–	*95.4*	*3816*	*75.7*	*95.2*	*96.4*	–	*92*
Maine 307	696	110.0	4400	76.0	95.0	97.8	38.1	98
	771	96.0	3840	77.5	96.9	93.8	38.1	99
Average	–	*103.0*	*4120*	*76.8*	*96.0*	*95.8*	*38.1*	*99*
Maine 340	707	121.3	4852	88.0	110.0	95.7	41.9	97
	781	117.5	4700	86.0	107.5	95.9	41.6	91
Average	–	*119.4*	*4776*	*87.0*	*108.8*	*95.8*	*41.8*	*94*
Maine 217	701	84.8	3392	68.8	85.9	99.8	–	98
	776	90.5	3620	71.5	89.4	90.0	–	99
Average	–	*87.7*	*3506*	*70.2*	*87.7*	*94.9*	–	*99*
Maine 230	694	77.0	3080	80.0	100.0	101.5	40.3	104
	769	122.8	4892	86.0	108.4	86.0	38.7	96
Average	–	*99.9*	*3986*	*83.0*	*104.2*	*93.8*	*39.5*	*100*
Maine 261	747	105.3	4212	78.5	98.1	93.5	39.4	93
	821	97.2	3888	74.8	93.7	92.9	39.7	92
Average	–	*101.3*	*4050*	*76.7*	*95.9*	*93.2*	*39.6*	*93*
Maine 238	740	68.5	2740	60.5	75.6	87.6	–	93
	814	100.8	4032	79.3	99.1	98.6	–	91
Average	–	*84.7*	*3386*	*69.9*	*87.4*	*93.1*	–	*92*
Maine 247	703	103.5	4140	83.5	104.4	98.0	39.8	100
	778	122.5	4900	82.5	103.1	86.8	40.2	91
Average	–	*113.0*	*4520*	*83.0*	*103.8*	*92.4*	*40.0*	*96*
Maine 128	738	104.3	4172	68.8	85.9	87.2	44.2	104
	812	95.0	3800	74.5	93.1	95.1	41.3	92
Average	–	*99.7*	*3986*	*71.7*	*89.5*	*91.2*	*42.8*	*98*
Maine 334	715	112.8	4512	80.3	100.3	86.7	41.1	100
	788	98.0	3920	78.0	97.5	94.3	38.4	89
Average	–	*105.4*	*4216*	*74.2*	*98.9*	*90.5*	*39.7*	*94*
Maine 346	720	107.5	4300	84 2	105.3	103.2	41.0	100
	794	99.3	3972	60.8	75.9	75.8	40.3	99
Average	–	*103.4*	*4136*	*72.5*	*90.6*	*89.5*	*40.7*	*100*

Table 4.

Test or Pure Lines in 1914—Concluded.

Variety Number.	Plot number.	Straw. Lbs. per 1-40 a. plot.	Straw. Lbs. per acre.	Grain. Lbs. per 1-40 a. plot.	Grain. Observed yield. Bus. per acre.	Corrected yield. Bushels per acre.	Weight per measured bushel.	Days to maturity.
Maine 336	709	113.0	4520	86.5	108.1	86.2	40.6	100
	783	92.8	3712	76.3	95.3	92.2	40.5	96
Average	–	*102.9*	*4116*	*81.4*	*101.7*	*89.2*	*40.5*	*98*
Maine 79	730	95.8	3832	73.3	91.6	82.0	–	102
	804	112.0	4480	78.5	98.1	95.0	–	95
Average	–	*103.9*	*4156*	*75.9*	*94.9*	*88.5*	–	*99*
Maine 82	726	102.5	4090	80.5	100.6	94.7	–	105
	800	107.3	4292	65.8	82.2	81.4	–	99
Average	–	*104.9*	*4191*	*73.2*	*91.4*	*88.1*	–	*103*
Maine 75	722	56.0	2240	54.0	67.5	81.0	39.7	95
	796	116.8	4662	78.3	97.8	93.5	39.7	93
Average	–	*86.4*	*3451*	*66.2*	*82.7*	*87.3*	*39.7*	*94*
Maine 286	692	165.5	6620	80.0	100.0	102.1	36.5	95
	767	91.2	3648	74.8	93.4	72.2	37.4	92
Average	–	*128.4*	*5134*	*77.4*	*96.7*	*87.1*	*37.0*	*94*
Maine 250	705	53.0	2220	59.0	73.7	86.8	–	93
Maine 198	732	122.3	4892	75.8	94.7	86.5	–	104
	806	112.0	4480	71.0	88.8	85.3	–	98
Average	–	*117.2*	*4686*	*73.4*	*91.8*	*85.9*	–	*101*
Maine 199	734	80.3	3212	62.8	78.4	84.0	–	97
	808	112.0	4480	71.0	88.8	87.7	–	98
Average	–	*96.2*	*3846*	*66.9*	*83.6*	*85.8*	–	*98*
Maine 103	728	64.8	2592	61.3	76.6	83.9	–	93
	802	105.5	4220	74.5	93.1	86.1	–	95
Average	–	*85.2*	*3406*	*67.9*	*84.9*	*85.0*	–	*94*
Maine 74	724	95.8	3832	69.3	86.6	80.0	–	99
	798	91.8	3672	70.3	87.8	87.6	–	91
Average	–	*93.8*	*3752*	*74.8*	*87.2*	*83.8*	–	*95*
Maine 357	683	87.5	3500	67.0	87.7	82.2	38.4	111
	758	88.3	3532	60.3	75.3	83.9	38.7	99
Average	–	*87.9*	*3516*	*63.7*	*81.5*	*83.1*	*38.6*	*105*
Maine 133	745	75.3	3012	68.8	85.9	85.5	–	93
	819	93.0	3720	56.8	70.9	78.4	–	98
Average	–	*84.2*	*3366*	*62.8*	*78.4*	*82.0*	–	*96*
Maine 78	753	70.5	2820	55.0	68.8	82.7	–	99
	827	84.0	3360	54.0	69.0	72.8	–	98
Average	–	*77.3*	*3090*	*54.5*	*68.9*	*77.8*	–	*99*
Maine 239	743	78.8	3152	61.3	80.2	81.7	–	99
	817	103.0	4120	55.0	68.8	71.4	–	98
Average	–	*90.9*	*3636*	*58.2*	*74.5*	*76.6*	–	*99*
Maine 104	751	82.0	3280	49.0	61.2	67.0	–	91
	825	81.0	3240	49.0	61.2	64.4	–	88
Average	–	*81.5*	*3220*	*49.0*	*61.2*	*65.7*	–	*90*
Average of all lines	–	97.6	3902	72.4	90.7	86.9	39.9	97

From this table (4) it will be noted first that the yields of grain are absolutely much higher than in 1913. Individual plots gave an observed yield as high as 120 bushels per acre. The reason for this is partly in the better soil in the 1914 field, but more especially in the very favorable season. While there was abundant moisture well distributed throughout the growing season, nevertheless there were no flooding rains or heavy wind storms to damage the crops. As a matter of fact, the seasonal conditions were almost ideal. The yields obtained in 1914 would seem to represent almost a maximum production.

The average observed yield for the several pure lines ranged from 108.8 bushels in No. 340 to 62.2 bushels in No. 104. Thus showing a range of over 46 bushels between the highest and the lowest yielding lines.

The corrected average yield per acre varied from 105.3 bushels in No. 355 to 65.7 bushels in No. 104. The range is about 6 bushels less than in the case of the observed yields.

The average corrected yield of all the pure lines tested was 86.9 bushels. This is nearly 22 bushels per acre better than the average of these pure lines in 1913.

The highest observed yield among the 22 commercial varieties tested in 1914 was 105 bushels for the Minnesota 26. This was the only commercial variety with an observed yield of over 100 bushels. On the other hand, six of the pure line varieties gave an average observed yield of over 100 bushels. Regarding the corrected yields, which is undoubtedly a fairer basis of comparing the varieties, the highest yield in a commercial variety was 96.1 bushels shown by the Lincoln variety. There were six pure lines which gave an average corrected yield of over 96 bushels. More detailed comparison of the yield of commercial varieties and pure lines will be given after the results of the 1915 test have been considered.

The average yield of straw per acre varied from 5308 pounds to 3090 with an average of 3902 pounds. Comparing this with the average weight of straw in 1913 (Table 3) it is seen that the straw yield in 1914 is nearly 1200 pounds per acre greater than in the preceding year.

The weight per measured bushel was not obtained for all of the lines. For the sixteen lines in which it was determined the average weight varied from 42.8 to 37.0 pounds per bushel with an average of 39.9. Comparing with Table 3, it will be seen that this average is over two pounds per bushel higher than in 1913, showing that the increased yield was accompanied by an increase in quality.

The number of days from planting to harvesting varied from 105 to 90 with an average of 97. This was an average of four days less than in 1913.

Work in 1915.

In order to test more thoroughly some of these pure lines a number of the poorer ones were discarded entirely as showing nothing essentially better than already found in commercial varieties. Certain other of these pure lines were held over to be tested more thoroughly in later years. Twelve of these lines were grown in quadruplicate plots in 1915 in connection with 11 of the best commercial varieties. The pure line plots alternated with the plots of the commercial varieties. A map of these 1915 plots has been published in connection with another paper[13].

These 1915 plots were located on the east side of the farm road leading from the buildings on Highmoor Farm to Ben Davis No. 1 orchard. They were on the end of the field next to the orchard. This land had been in grass in 1913. This field had been cropped for several years and was somewhat deficient in humus. It was plowed in the fall of 1913 and in 1914 a crop of buckwheat was grown and turned under.

The method of preparing the land, fertilizing, planting, etc., were the same as in previous years. The plots were planted on April 21 and 22, about 10 days earlier than usual at Highmoor.

The detailed results of the 1915 test of the 12 pure lines are given in Table 5. The lines are arranged in the order of their corrected yield.

From this table it is noted first that the yields, both observed and corrected, are somewhat lower than in 1914, but distinctly higher than in 1913. The season of 1915 was in many respects favorable for oats. In particular there was abundant moisture

[13]Surface, F. M. and Pearl, R. On a Method of Correcting for Heterogeneity in Variety Tests. Journ. Agr. Research, Vol. V., pp. 1039-1050, 1916.

throughout the growing season and the early part of the season was cool. Both of these things are essential to a good oat crop. The chief disturbing factor was the very heavy flooding rains often accompanied by wind. Any varieties which had a tendency to lodge were very severely affected. As a matter of fact, these varieties had all been carefully selected with reference to strength of straw and few of them lodged to any extent. Further mention will be made of this in a later paragraph.

TABLE 5.

Test of Pure Lines in 1915.

Variety.	Plot number.	Straw Yield.		Grain Yield.			Weight per measured bushel.	Days to maturity.
		Lbs. per plot.	Lbs. per acre.	Lbs. per 1-40 acre plot.	Observed. Bushels per acre.	Corrected.		
Maine 340	908	80.8	3232	66.2	82.8	82.6	39.7	114
	933	96.3	3852	67.2	84	84.1	39.4	117
	958	94.5	3780	60.3	75.3	75.6	38.4	119
	983	93.8	3752	71.2	89	91.9	40.3	112
Average	–	*91.4*	*3654*	*66.2*	*82.8*	*83.6*	*39.4*	*116*
Maine 355	915	87.8	3512	59	73.8	78.6	35.5	119
	940	106.7	4268	74.5	93.1	82.8	36.2	117
	965	98.5	3940	62.5	78.1	83.7	37.8	119
	990	101.7	4068	67	83.8	89.1	37.1	118
Average	–	*98.7*	*3947*	*65.8*	*82.2*	*83.6*	*36.6*	*119*
Maine 281	911	100.8	4032	66.7	83.4	81.4	39.0	116
	936	80.5	3220	55	68.8	71	35.8	119
	961	96	3840	65	81.3	82.9	35.8	118
	986	95	3800	73.5	91.9	89.4	37.8	117
Average	–	*93.8*	*3723*	*65.1*	*81.4*	*81.2*	*37.1*	*118*
Maine 337	906	91.5	3660	71	88.8	79.4	37.8	114
	931	82.7	3308	65	81.3	87.8	39.0	117
	956	71.5	2860	59	73.8	74.5	37.8	115
	981	80.3	3212	57.3	71.6	75	37.4	118
Average	–	*81.5*	*3260*	*63.8*	*78.9*	*79.2*	*38.0*	*116*
Maine 247	913	84.5	3380	67.5	84.4	85.2	38.4	114
	938	95.5	3820	72.5	90.6	70.2	37.1	113
	963	69.7	2788	56	70	80.1	37.1	118
	988	82.5	3300	60.5	75.6	80.8	38.4	113
Average	–	*83.1*	*3322*	*64.1*	*80.2*	*79.1*	*37.8*	*115*
Maine 357	898	100.3	4012	68.8	85.9	85.2	35.5	123
	923	79.2	3168	59	73.8	78.9	34.6	119
	948	93.8	3752	65.7	82.1	80.7	35.8	118
	973	94.2	3768	61.5	76.9	71.7	36.2	118
Average	–	*91.9*	*3675*	*63.8*	*79.7*	*79.1*	*35.5*	*120*
Maine 230	902	99.9	3996	60.2	75.3	76.4	38.4	123
	927	94.8	3792	59.7	74.6	72.6	37.8	119
	952	90.5	3620	61	76.3	76.9	36.5	119
	977	86	3440	68.5	85.6	81.4	37.1	115
Average	–	*92.8*	*3712*	*62.4*	*78.0*	*76.8*	*37.4*	*119*

TABLE 5.

Test of Pure Lines in 1915—Concluded.

Variety.	Plot number.	Straw Yield.		Grain Yield.			Weight per measured bushel.	Days to maturity.
		Lbs. per plot.	Lbs. per acre.	Lbs. per 1-40 acre plot.	Observed. Bushels per acre.	Corrected.		
Maine 346	919	95	3800	55.5	69.4	67.1	38.7	119
	944	77	3080	66	82.5	75.7	35.2	111
	969	71.5	2860	61.5	76.9	83.6	37.1	112
	994	90	3600	72.	90.	81.7	39.0	112
Average	–	*83.4*	*3335*	*63.8*	*79.7*	*77.0*	*37.5*	*114*
Maine 307	917	97.5	3900	61.5	76.9	75.7	36.5	119
	942	99.8	3992	65.7	82.1	72.6	36.5	117
	967	94.0	3760	62.	77.5	81.8	36.8	119
	992	78.0	3120	57.	71.3	77.9	36.5	113
Average	–	*92.3*	*3693*	*61.6*	*77.0*	*77.0*	*36.6*	*117*
Maine 286	921	94.	3760	68.5	85.6	85.8	38.4	117
	946	89.5	3580	68.5	85.6	75.1	37.1	112
	971	85.8	3432	62.3	77.8	79.2	37.8	119
	996	95.2	3808	49.5	61.9	62.5	37.8	117
Average	–	*91.1*	*3645*	*62.2*	*77.7*	*75.7*	*37.8*	*116*
Maine 351	900	101.8	4072	62.2	77.8	79.3	36.5	119
	925	96.8	3872	62.7	78.4	77.6	38.1	118
	950	93.	3720	58.5	73.1	71.4	38.4	117
	975	102.5	4100	64.5	80.6	73.8	38.4	118
Average	–	*98.5*	*3941*	*62.0*	*77.5*	*75.5*	*37.8*	*118*
Maine 336	904	80.	3200	59.	73.8	77.1	39.0	114
	929	91.5	3660	57.8	72.2	72.7	39.4	119
	954	89.8	3592	67.3	84.1	76.3	37.8	117
	979	93.5	3740	52.8	65.9	74.1	37.8	119
Average	–	*88.7*	*3548*	*59.2*	*74.3*	*75.1*	*38.5*	*117*
Average of all lines	–	*90.6*	*3622*	*61.7*	*79.1*	*78.6*	*37.5*	*116*

It will be noted from this table that the observed and corrected yields are very nearly parallel in the majority of these pure lines. The reason for this is that the soil in the 1915 field was much more uniform than that used in the preceding year. The following discussion unless specifically stated will be based on the corrected yield.

The corrected yield of individual plots ranged from 91.9 to 62.5 bushels. The highest average yield was for No. 340 and No. 355, viz., 83.6 bushels each. The lowest average yield was 75.1 bushels in Line No. 336. The average yield of all the lines was 78.6 bushels per acre. This was about 8 bushels per acre less than in 1914.

The average yield of straw per acre was 3622 pounds or nearly 300 pounds less than in 1914.

The average weight per measured bushel was 37.5 pounds, or 2.4 pounds less than in 1914.

The most marked variation was in the Days to Maturity. For individual plots this ranged from 123 to 112 with an average of 116. This was 19 days more than in 1914 and 15 days more than in 1913. The reason for this probably lies in the nature of the season and also in the fact that the plots were sown very much earlier than in former years. Apparently the grain ripened at about the same time of the year as usual regardless of the fact that it had been planted 10 to 12 days earlier.

More detailed discussion of these pure lines will be undertaken in later paragraphs.

VARIATION IN THE YIELD OF THE 1915 PLOTS.

Surface and Barber (*Loc. cit.*) have pointed out that other things being equal the variety which shows the least tendency to vary under different environmental conditions is the best variety. Thus what is most desired in a variety is one which will give a good substantial yield under all kinds of soil and climatic conditions to which it is likely to be subject. Only in 1915 are there sufficient data for determining the variation between different plots. For this purpose it is desirable to use the observed yields instead of the corrected. In the case of the corrected yields other factors enter which, on the whole, tend to lower the variability. The variation in the *observed* yield shows the actual amount of difference due to differences in soil and other environmental conditions.

TABLE 6.

Constants of Variation in Yield for the Four 1915 Plots of Each Pure Line. Observed Yields.

VARIETY.	Mean.	Standard deviation	Coefficient of variation.
Maine 351	77.47 ± .91	2.73 ± .65	3.52 ± .84
Maine 307	76.94 ± 1.30	3.86 ± .92	5.02 ± 1.20
Maine 230	77.94 ± 1.50	4.47 ± 1.06	5.73 ± 1.37
Maine 357	79.67 ± 1.58	4.70 ± 1.12	5.90 ± 1.41
Maine 340	82.77 ± 1.65	4.90 ± 1.16	5.92 ± 1.41
Maine 337	78.83 ± 2.27	6.76 ± 1.61	8.58 ± 2.06
Maine 336	73.99 ± 2.19	6.51 ± 1.55	8.79 ± 2.11
Maine 355	82.19 ± 2.44	7.24 ± 1.72	8.81 ± 2.11
Maine 346	79.69 ± 2.54	7.56 ± 1.80	9.49 ± 2.28
Maine 247	80.15 ± 2.66	7.92 ± 1.88	9.88 ± 2.16
Maine 281	81.31 ± 2.78	8.27 ± 1.97	10.17 ± 2.45
Maine 286	77.73 ± 3.26	9.69 ± 2.31	12.47 ± 3.01
Average	79.06	6.22	7.86

Table 6 shows the variation constants[14] for the 1915 plots based upon the observed yields. The varieties are arranged in the order of their coefficients of variation.

The following points may be noted from this table:

1. The standard deviation ranges from 2.73 bushels per acre to 9.69 bushels. This is a somewhat smaller range than has usually been observed for a similar number of commercial varieties.

2. The coefficient of variation is to be regarded as the better measure of variability in cases like this. This constant varies from 3.52 per cent to 12.47 per cent with an average of 7.86.

3. With regard to the coefficient of variation, the table falls into two parts. The first five varieties have a coefficient of less than 6 per cent and may be regarded as showing a low degree of variability. The remaining lines have a coefficient of from 8.5 to 12.5 per cent and thus have a medium variability. Two of the higher yielding lines, viz., 340 and 357, are included in the first part of the table. Insofar as the evidence goes these varieties are to be regarded as more desirable than those with an equal yield, but greater variability.

Too much reliance should not be placed upon these constants which are derived from a relatively small number of plots and for one year only. They may, however, serve to help point out the desirability of certain lines which for other reasons are believed to excell in quality.

Mean Production for the Three Years.

The 12 pure lines grown in 1915 have now been tested for three years. While the tests have not included the same number of plots each year, the number of plots and other conditions were nearly the same for each line in each year. Therefore, the yields in individual years ought to afford some expression of the *relative* merits of the different lines under the conditions of that year. Although the data are not all that could be desired, some information can be obtained by averag-

[14]The meaning and the method of determining these constants and their probable errors has been given by Surface and Barber (*Loc. cit.*)

ing the results of the three years. The most important character is of course the yield of grain. This will be considered first.

In the years 1914 and 1915 we have based the discussion mainly on the corrected yields. For reasons discussed above it is not practicable to apply the correction method to the 1913 plots. In the tables below we have used the observed yield for 1913 and the corrected yield for the other two years. This method is perfectly justifiable and after careful consideration has seemed to be the best method of dealing with these data. While some of the 1913 yields are admittedly influenced by heterogeneity in the soil, this does not seem to offer any sound reason for introducing similar errors in the later years.

Table 7 gives the 12 pure lines arranged in the order of their average yield. The yield for each of the three years is given together with the three-year average. In addition to this the name of the parent variety from which the selection was made is also given.

TABLE 7.

Yield of Grain, Pure Lines Tested for Three Years.

Line number.	Parent Variety.	Bushels per Acre.			
		1913.	1914.	1915.	Mean.
Maine 355	Banner	71.0	105.3	83.6	86.6
340	Irish Victor	74.1	95.8	83.6	84.5
281	Banner	73.1	97.0	81.2	83.8
351	Banner	70.0	98.2	75.5	81.2
337	Irish Victor	58.4	103.9	79.2	80.5
230	Banner	69.4	93.8	76.8	80.0
307	Banner	66.9	95.8	77.0	79.9
336	Irish Victor	75.3	89.2	75.1	79.9
346	Irish Victor	71.9	89.5	77.0	79.5
247	Imported Scotch	62.8	92.4	79.1	78.1
286	Banner	70.9	87.1	75.7	77.9
357	Banner	70.0	83.1	79.1	77.4
	Average	69.5	94.4	78.6	80.8

One of the most striking things about this table is the preponderance of certain parent varieties. These pure lines were selected from the 188 lines grown in the 1911 garden solely on their merits, without thought or often even without knowledge of the parent variety. Fourteen of the 188 1911 rows were from the Banner variety (cf. Table 1). Seven of these are included in the above table. Likewise there were 14 Irish Victor rows in 1911 and 4 of these have been continued. Only one other variety out of the original 18 is represented in the final selection. This is the Imported Scotch with a single line. Evidently either the Banner and Irish Victor possessed better yielding ability or else these varieties tend to throw desirable inheritable variations more frequently than the others. These points will be referred to below.

The average yield of these pure lines ranged from 86.6 bushels to 77.4. A total range of about 9 bushels. The average of the twelve lines for the three years is about 81 bushels per acre.

The highest yielding line is No. 355. Nos. 340 and 281 were only slightly below the former.

The next six lines, Nos. 351, 337, 230, 307, 336, and 346, give an average yield of approximately 80 bushels per acre. The three remaining lines are probably to be regarded as slightly inferior in yielding ability, although a consideration of the yields in individual years does not always indicate this.

On the whole these results indicate that these pure lines are remarkably uniform in yielding ability. While there are some differences in their relative yield from year to year and in the average yield, nevertheless they are all well adapted to the conditions under which they are grown at Highmoor. This is, of course, what might be expected from the fact that these are what remain after discarding the poorer strains from 460 original selections.

It is now of interest to compare the yield of these pure lines with the yield of the best obtainable commercial varieties grown in the same years and under exactly the same conditions as nearly as this is possible. There are 11 commercial varieties which have been tested for all three years. For the most part these represent the best commercial varieties which we have been able to obtain. They are selected from over 40 varieties that have been tested at Highmoor. Two or three of these varieties are retained because they represent distinct types of oats or like the Swedish Select because they are very popular in this State.

Table 8 gives the yields for these 11 commercial varieties. In order to make the tables as comparable as possible the observed, uncorrected, yield is given for 1913 and the corrected yields for 1914 and 1915.

TABLE 8.

Yield of Grain, Commercial Varieties.

Variety.	Bushels per Acre.			
	1913.	1914.	1915.	Mean.
Early Pearl	69.7	93.9	82.3	82.0
Minnesota 26	67.7	94.4	82.7	81.6
Banner	62.7	94.5	81.8	79.7
Gold Rain	65.2	90.3	77.9	77.8
Siberian	71.1	83.3	77.1	77.2
Prosperity	63.0	92.1	74.1	76.4
Irish Victory	67.0	82.4	76.2	75.2
Imported Scotch	67.7	87.1	64.8	73.2
Kherson	60.8	82.7	66.8	70.1
Swedish Select	60.9	79.9	68.3	69.7
Senator	51.7	83.6	57.9	64.4
Average	64.3	85.8	73.6	75.2

From this table and the preceding it is noted:

(1) That the average yield ranges from 82 bushels for the Early Pearl to 64.4 bushels for the Senator. This is a range of over 17 bushels or very nearly twice as much as for the 12 pure lines.

(2) The average yield is 75.2 bushels against 80.8 for the pure lines.

(3) The highest yield of the varieties is 82 bushels while three of the pure lines exceed this figure. The highest yield in the pure lines is 86.6 bushels.

(4) Only four of the 11 commercial varieties give a better yield than the *poorest* of the pure lines.

(5) The seven Banner pure lines average to yield 81 bushels per acre while the parent variety in the same years gave 79.7 bushels. This is an average increase of a little less than a bushel and a half per acre. Of course some individual lines far exceeded this.

(6) The four Irish Victor pure lines averaged to yield 81.1 bushels while the parent variety gave only 75.2 bushels an increase in the pure lines of nearly 6 bushels per acre.

While these differences may appear insignificant to some readers, such is not the case. These varieties and pure lines have been tested under conditions which are as nearly uniform for all plots as it is possible to make them. Corrections have been applied which take account of differences in the fertility of the soil of different plots. Checks upon the accuracy of the work have been applied wherever possible. Further the uniformity of the results in different years indicate clearly that in these pure lines we are dealing with strains which are innately superior to the best varieties we have been able to obtain.

The practical significance of using varieties with even a slightly increased yield is shown by a simple calculation. On the average about 140,000 acres of oats are grown in this State each year. If half of this average could be planted to varieties which would yield only two bushels per acre more than those now grown it would mean at the price of 50 cents per bushel an annual increase of $70,000.00 to the farmers of the State over and above what they are now receiving.

Yield of Straw and Other Characters.

Table 9 gives the three year average yield of straw per acre for each line also the average weight per measured bushel and the average days to maturity. In addition to this the average yield of grain as given in table 7 is repeated for comparative purposes.

Table 9.

Average Yield of Straw and Other Characters.

PURE LINES TESTED FOR THREE YEARS.

Line Number.	Grain. Bus. per acre.	Straw. Lbs. per acre.	Weight per measured bushel.	Days to maturity.
Maine 355	86.6	3584	36.8	107
Maine 340	84.5	3907	39.7	103
Maine 281	83.8	3443	37.7	107
Maine 351	81.2	3652	38.0	107
Maine 337	80.5	4019	39.3	103
Maine 230	80.0	3007	37.9	107
Maine 307	79.9	3424	37.2	106
Maine 336	79.9	3794	38.7	106
Maine 346	79.5	3384	38.6	104
Maine 247	78.1	3767	38.2	104
Maine 286	77.9	3909	36.7	106
Maine 357	77.4	3394	36.8	109
Average	80.8	3607	38.0	106

From this table it may be noted:

(1) That there is no definite relation between the yield of straw and grain.

(2) The varieties giving the largest amount of straw are 337, 286 and 340. These are pretty evenly distributed over the table in which the lines are arranged in the order of their yield of grain.

(3) The average yield of straw is 3607 pounds per acre with a range of from 3,000 to 4,000 pounds.

(4) The weight per measured bushel varies from 36.7 to 39.7 pounds with an average of 38.

(5) There is no very definite relation between the weight per bushel and the yield of grain. No. 340 which is one of the best yielding lines gave the highest weight per bushel. On the other hand No. 355 which leads the list as to yield gave one of the lowest average weights per bushel.

(6) The average number of days from planting to harvest is 106 with only slight variations. The seven lines selected from the Banner variety are later than the others. These give an average of 107 days. The Irish Victor lines average to mature in 104 days. This expresses about the average difference in the time of maturity of these two varieties so that in these respects these lines are not different from their original parents.

The actual time to maturity is probably somewhat less than the above figures in ordinary seasons for these averages are unduly affected by the extra long growing season in 1915. Further when grown in large fields these varieties will mature a few days earlier than in our plots. It is always necessary to wait a few days for the marginal plants to mature on a small plot after the center of the plot is ready to cut.

Description of the Pure Lines.

In the preceding section of this paper we have discussed the origin, development and the comparative analysis of the pure lines based upon their quantitative characters, particularly the yielding ability. From the economic point of view the productive power is the most important physiological character of every commercial crop. In this sense the success or failure of the practical breeder naturally depends upon whether he will be able to procure and maintain strains which in their high yield and quality will justify his endeavors. It is, therefore, of great importance for the breeder to have a thorough knowledge of the underlying qualitative characters which are typical of the highest yielding strains and varieties under given environmental conditions.

The importance of these qualitative, or morphological characters may be seen from the fact that they have frequently been considered as directly correlated with physiological characters.

Thus, the Swedish Experiment Station at Svalöf used these morphological characters in its breeding work as a basis for isolating different types, distinguished from each other by different qualitative features. The importance of the morphological external features of the plants, however, must not be overestimated and too much relied upon when undertaking a selection of desirable plants out of commercial varieties. The best looking plant in such a population does not always possess the best physiological qualities. The environment plays an important part and often misleads the breeder. It is not until we undertake a thorough examination of the progeny of a selected plant that we learn its true merits. Nevertheless morphological characters may be a valuable guide in breeding work.

As pointed out in the introduction of this paper, every individual in the progeny of a self-fertilized plant will have the same germinal constitution as every other individual, unless spontaneous germinal changes should occur. Experiments have shown that such changes are relatively infrequent. It has further been shown that certain pure lines can be isolated from some commercial varieties which are far superior to the parent variety in one or more characteristics. It is now of importance to determine whether these physiological characters are related to definite morphological changes in the plant or whether they have occurred independently of changes in these morphological features.

The data given in the following paragraphs are the results of an attempt to find definite morphological characters which might serve to distinguish these pure lines. No attempt has been made to determine the definite correlation between these characters. The question of correlation in oats has been studied by many writers. Tschermak[15] and others have determined the relation between many morphological and physiological characters. Waldron[16] and especially Love and Leighty[17] and

[15]Tschermak, E. v. Fruwirth's Handbuch der. landwirtschaftlichen Pflanzenzuchtung. 2 Auf. Bd. 4, 1910.

[16]Waldron, L. R. A suggestion regarding heavy and light seed grain. Amer. Nat., Vol. 44, pp. 48-56, 1910.

[17]Love, H. H. and Leighty, C. E. Variation and Correlation of Oats (Avena sativa). Part I. Studies showing the effect of seasonal changes on biometrical constants. Cornell Exper. Stat. Memoir No. 3, pp. 1-70, 1914.

Leighty[18] have studied the correlation between various characters in different varieties and different pure lines. In general these studies have shown that there is a high correlation between certain straw and head characters and the yield of grain per plant or culm. It will therefore be of interest to discuss certain of these morphological characters in our pure lines.

The characters of these pure lines may conveniently be classified into two groups, one containing the features studied in the field, the other those analyzed in the laboratory.

The first feature of the young oat plant attracting attention in the field is the *stooling*. By this we understand the ability of the cereals to produce, apart from the main culm, a smaller or larger number of adventitious culms. While a high stooling power is not looked for in dry and continental regions, it is a very desirable feature in this state owing to the abundant precipitation well distributed throughout the growing season. This is particularly true of the central part of this state where the growing season is longer than in the northern part and late maturity of the crop, usually associated with abundant stooling, is not to be feared. The stooling power is influenced by environmental factors such as climate, soil, fertilizer and stand. The stooling qualities of our lines were studied in the garden rows and under field conditions and since they grew under the same environmental conditions the conclusions concerning their stooling ability are comparable.

It has been found that the lines 230, 281, 286, 307, 351, 355 and 357, all originally selected from the Banner variety, tend to show a high stooling power approached only by the lines 340 and 336 of the Irish Victor group. With this vigorous growing tendency is associated a later maturity. The plants of the lines 307, 355, etc., devote, in their early growth, a great amount of growing energy to the production of new culms, while other lines, producing fewer culms, use that energy for the furtherance of their smaller number of heads. This compensation of growth can be clearly seen by comparing the time of heading and maturity of the respective lines.

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[18]Leighty, C. E. Variation and Correlation of Oats. Part II. Effect of differences in environment, varieties and methods on biometrical constants. Cornell Exper. Stat. Memoir No. 4, pp. 81-216, 1914.

It has been found that the difference in the time of heading of the Banner and Irish Victor lines respectively amounts to 7-10 days. This difference is marked in the time of blooming but is even more pronounced towards maturity so that the Irish Victor lines can be harvested several days earlier than the lines 307, 355, etc., of the Banner variety. Line 247, the only representative of the Imported Scotch variety, very nearly approaches the Irish Victor lines in regard to stooling power and maturity. In connection with Table 9 it was pointed out that for the three years the Banner lines averaged to mature in 107 days, while the Irish Victor and Imported Scotch lines each averaged 104 days. In some seasons the difference is much more pronounced than that shown by these averages.

Thus the Irish Victor and Imported Scotch lines may be classified as medium early and those of the Banner variety as medium late. The original parent variety of the Imported Scotch consisted of a majority of rather small, early plants with slender yellow grain and a small per cent of tall, large-grained individuals of a yellowish white color and later maturity. From this latter group line 247 was selected. In regard to stooling ability and maturity the pure lines exhibit a similar behavior to that of their parent varieties.

The *qualities of the straw* are the next characters to be considered. The character of the straw determines the degree of resistance of the plants to wind storms, rains and the influence of rich soil which tend to cause lodging. The importance of the structure and general constitution of the straw under the conditions prevailing in this state does not need to be emphasized. The most important of the straw characters is, therefore, its breaking strength. Several methods have been tried by various investigators in determining this character. One that is very frequently used is to determine the relative amount of force necessary to break a piece of the dry straw of a definite length[19]. Some attempts were made to determine this breaking strength but the results obtained with the dry straw did not agree with field observations as to lodging. Consequently the attempt was abandoned.

Various investigators have also studied the anatomical structure of the culm and the amount of mineral substance

[19]Leighty, C. E. Loc. cit.

deposited in the straw in the attempt to find a relation between those characters and the lodging of the plants. For practical purposes under conditions facing the plant breeder in his selection work, these methods can not be taken into consideration. It has seemed to us more satisfactory to rely chiefly upon experience and observations made directly in the field. The study of the actual conditions in the field, the notes taken after heavy storms and rains served in our selection work as a very valuable guide in the process of elimination of undesirable strains. Consequently under ordinary soil conditions the 12 ultimately selected lines show a very considerable resistance and strength of straw. This was shown very clearly in the season of 1915 when the very heavy flooding rains in the latter part of the season caused much damage in the central part of the state. In our plots those commercial varieties which were inclined to lodge were in very bad condition at harvest. None of these pure lines were seriously damaged. Several of the Banner lines, especially 357 and 355, lodged to some extent. The Irish Victor lines all stood up well. No. 340 was grown as a farm oat at Highmoor and on the entire 13 acres there was only one small area that lodged at all. Of the pure lines, Nos. 355 and 357 showed the greatest amount of lodging.

Some data with regard to the height and diameter of straw of the pure lines are given in Table 10. These data represent the means of measurements of a considerable number of individuals collected at random in the different field plots. It will be noted from this table that the pure lines also show only a slight variation in the height and diameter of the straw.

In regard to the *color and width of the leaves* the pure lines show again a resemblance to their respective parent varieties. The Banner lines have slightly wider and darker leaves than the Irish Victor lines.

CHARACTERS OF THE HEAD.

The panicle or head of the oat plant contains a series of very important features which determine the qualitative and quantitative merits of the plant. The type of head is therefore a most important character and a very reliable guide in selection and breeding work. The head characters serve to isolate different forms and types of oats and on that basis the Svalöf

Experiment Station has founded a system of oat varieties. In the recent classification of oat varieties proposed by Böhmer[20] the type of head has also been used as a distinguishing basis together with the grain characters, thus combining the system of the Svalöf Experiment Station based upon the head types with that of Atterberg[21] founded upon the grain characters. The type of the oat head has also been found to be correlated with quantitative characters. Thus at Svalöf the spreading type of head with drooping branches is considered as correlated with a small yield of grain.[22]

The pure lines dealt with in this paper belong to the vast group of oats with spreading heads. Here again they show a resemblance to the predominating types in their respective parent varieties. The description of the head characters of the pure lines will be aided by referring to figures 19 to 24. These photographs were taken shortly before maturity and all on the same day. The head types of the Banner lines fall within the group of the stiff-branched heads. As will be seen from figures 19, 23 and 24 the Banner head is chiefly characterized by its vigorous, stiff, ascending branches forming a very narrow angle with the main axis of the head. This is especially true of the first branches in the lower whorl. The position of the branches with respect to the main axis and the angle which they form with the latter determine the character of the head. Although with the approaching maturity the increasing weight of the spikelets tend to bend the branches away from the main axis, the characteristic upstanding habit can still be clearly seen. In the early growth and especially when allowed a wide stand this habit is considerably more pronounced. The branches of the Banner head are vigorous, medium long and well covered with spikelets. The main axis of the head is straight and well covered with spikelets at its top, which is a desirable feature since the grain develops and matures best at the top of the main axis and at the tips of the branches. The

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[20]Böhmer. Über die Systematik der Hafersorten, Berlin, 1909.

[21]Atterberg, A. Neues System der Hafervarietäten. Landwirtschaftl. Versuchstationen. Bd. XXXIX, Berlin, 1891.

[22]Cited from Fruwirth: Züchtung der landw. Kuturpflanzen, Bd. IV, p. 354, Berlin, 1910.

head of the Banner oat has a tendency to distribute its branches in such a manner as to leave a part of the circumference vacant or filled only with one or two branches. Thus the Banner head is not perfectly symmetrical. This lack of symmetry is still more intensified by the different angles which the branches in the different whorls form with the main axis.

While the Banner oat has a typical stiff-branched head, the pure lines of the Irish Victor variety show characters of a transitional type of head. A comparison of figure 19 with figure 20 clearly shows the difference between the two types. The panicle of the Irish Victor lines suggests a greater symmetry caused by the more proportionate dimensions of the branches and the more uniform angles between the branches and the main axis. It will be noted that the branches are more drooping, thus causing the head to appear shorter and more extended on its circumference. The branches of the Irish Victor head spread more symmetrically about the whole circumference and are somewhat finer than those of the Banner oat. The main axis ascends straight upwards and is rich in spikelets at the top.

The type of head of No. 247 of the Imported Scotch variety shows still more clearly the drooping habit. The general picture of this type is given in figure 22. The head is markedly smaller than that of the two former types, the branches are shorter and decidedly more drooping. The main axis is straight but with a slight tendency to bend over at the top. The branches are proportionate and symmetrically spreading.

While the figures 19 to 24 give the general appearance of the three types of head, a closer analysis of the details of these head characters is shown in Table 10.

This table does not include all the 12 lines. However it contains the best representatives of the three types. The given data represent the means of measurements of a number of individuals of each line. From this table it may be noted that there is a correlation between the length of the head and the total number of spikelets. This correlation and several others have been established by v. Tschermak[23] and by Love and Leighty. It has been shown that with an increase in the length of the head there is a corresponding increase in the number of

[23]Cf. Fruwirth, *loc. cit.*, p. 332.

whorls, the number of spikelets in the lower whorl, and the length of the longest branches in the lower whorl.[24]

Line 355 which leads the list as to yield ranks also highest with regard to all these head characters, while line 247 occupies the lowest rank of the table.

The lines 355 and 307 of the Banner variety show the highest values for the length of head and for the length of the longest branch in the lower whorl. This correlation of the longest branch in the lower whorl is also illustrated by Line 351.

TABLE 10.

Data on Certain Straw and Head Characters.

Line number.	PARENT VARIETY	Height of main culm.	Diam. of straw.	Length of head.	Length of longest branch in lower whorl.	Distance from lower to next whorl.	No. of whorls.	No. of spikelets in lower whorl.	Total number of spikelets.
		cm.	mm.	cm.	cm.	cm.			
Maine 355	Banner..........	138.6	41.3	22.0	12.4	5.9	6.0	10.8	37.3
307	Banner..........	132.9	39.4	21.2	12.6	5.6	5.7	10.3	33.6
351	Banner..........	132.5	41.7	20.5	12.0	5.7	5.4	9.8	32.4
340	Irish Victor......	133.9	40.4	20.7	11.7	6.0	5.6	10.1	32.1
336	Irish Victor......	138.6	41.3	21.0	11.3	5.7	6.0	8.3	32.8
346	Irish Victor......	133.9	42.9	20.6	11.7	5.6	5.8	10.5	33.4
247	Imported Scotch	133.7	40.4	19.7	10.9	5.3	5.0	9.9	30.4
	Average....	*134.9*	*41.1*	*20.8*	*11.6*	*5.7*	*5.6*	*10.0*	*33.2*

GRAIN CHARACTERS.

With pure lines selected chiefly for high yielding ability out of only three more or less related commercial varieties the grain will naturally not show many striking botanical characters that would serve as a basis for classification. Furthermore, the three groups of the pure lines resemble in respect to external grain characters their respective parent varieties so that the

[24]It is realized that the material from which these data have been obtained is comparatively small and that the analysis of a large number of plants would bring out these relations more clearly and smooth out the irregularities.

question of shape of kernel is reduced to the distinction of possibly three types. The grain of the Irish Victor lines is of medium size, of a pale yellow color with a slightly reddish hue. It is nearly cylindrical, well filled, and bluntly pointed. The glumes are smooth and lustrous. There is no trace of pubescence on the base or back of the grain. The awns, which are in general a very variable character, appear very infrequently on the glumes of the Irish Victor grain. On the average there are only one or two awns per culm. The spikelets contains as a rule two kernels.

The type of kernel of Line 247 very closely resembles that of the Irish Victor lines.

The Banner lines have a rather coarse kernel of lighter, almost pure white color, slightly oval and more pointed than the Irish Victor. The glumes are a little coarses than those of the Irish Victor grain and have not the glossy appearance of the former type. They show a greater tendency to develop awns.

While there are only a few distinguishing qualitative features of the grain of the pure lines, a greater difference and variation is exhibited by the quantitative characters of the kernels.

The relation between the three dimensions of the oat kernel have been recognized as a valuable distinguishing character. They were introduced by Körnicke and Werner[25] and also used for systematic purposes by Åtterberg[26], Danaiffe and Sirodot[27] and Böhmer[28]. The methods used in measuring the length, width, and thickness of the kernels of our lines differed from those followed by the above named authors. They measured the grain as a whole, i. e., enclosed in its hulls, while the data given in Table 11 refer to measurements of the hulled, naked kernel, i. e., the caryopsis itself.

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[25]Körnicke, F. and Werner, H. Handbuch des Getreidebaues, Berlin, 1885.

[26]Atterberg, A. *Loc. cit.*

[27]Denaiffe and Sirodot. L'avoine, Paris, 1901.

[28]Böhmer, —. *Loc. cit,* p. 26.

TABLE II.

Relation between the three dimensions of the hulled kernels of the pure lines.

Line Number.	Length mm.	Width mm.	Thickness mm.
Maine 340	9.11	2.38	1.96
Maine 337	9.09	2.41	1.97
Maine 336	9.13	2.37	1.93
Maine 346	9.15	2.44	1.95
Maine 230	8.99	2.31	1.99
Maine 281	8.98	2.36	1.94
Maine 355	8.87	2.25	1.87
Maine 286	8.96	2.32	1.87
Maine 351	9.14	2.29	1.90
Maine 307	9.04	2.30	1.93
Maine 357	9.02	2.35	1.96
Maine 247	8.85	2.38	1.94
Average	*9.03*	*2.35*	*1.93*

In using this method an attempt has been made to determine whether the relations between the three dimensions of the naked kernel might not furnish a reliable index that would allow a distinction between the kernels of even closely related strains. From an economical standpoint the measurement of the naked kernel would be justified, since in many cases the hulls or glumes obscure the real merits of the kernel proper, which alone determines the value of the grain. It is admitted that the measurement of the naked kernels involves the technical difficulty of hulling the grain. However, any closer study of the grain characters requires the determination of the hull percentage and the hulled kernels prepared for that purpose can be used for the measurements. It is realized that this method has some points to be determined yet and it is proposed to test further its validity by analyzing a larger material from different years and working up the data statistically.

In the present case, however, the data have been found rather interesting and have a comparable value, since they refer to kernels of plants grown in the same year and under the same environmental conditions. The measurements were carried out with the aid of a micrometer caliper. The measurements were recorded to hundredths of a millimeter. In Table II the lines are arranged according to their parental varieties. It will be noted that there is a marked distinction between the three groups of the lines. The first four lines of the Irish Victor show throughout higher values for all the three dimensions than the Banner lines and line No. 247. Their values are pretty close and indicate a fluctuation about the mean of the original type. This is true also of the majority of the Banner group. Lines No. 351, 307 and 357 show higher values for the length and thickness than the other four Banner lines and approach in this respect the Irish Victor lines but they rank decidedly lower than the latter with regard to width. The data in this table enable us to distinguish more clearly the types of kernel of the three line groups than would be possible by an inspection of the kernels enclosed in the hulls. The Irish Victor lines develop on the whole a longer, wider and thicker kernel than the majority of the Banner lines. Line 247 has the shortest kernel but the relation between width and thickness approaches that of the Irish Victor lines.

A further important quantitative character of the grain is

The weight of the kernel. The *absolute* weight of a number of kernels is the most reliable measure of the quality of the grain. The weight of a given volume of grain is generally considered as unsatisfactory, especially with regard to oats. Neither does the specific weight furnish reliable values as has been shown by Wolny.[29]

TABLE 12.

Weight of grain and hull percentage.

Line Number.	PARENT VARIETY.	Weight per 1000 kernels.	Weight of 1000 naked kernels.	Calculated weight of hulls from 1000 kernels.	Hull percentage.	Rank in order of the hull percentage.
		gms.	gms.	gms.		
Maine 340	Irish Victor	40.30	29.02	11.28	28.00	4
Maine 336	Irish Victor	39.38	28.16	11.22	28.50	8
Maine 247	Imported, Scotch	39.38	28.09	11.29	28.77	9
Maine 337	Irish Victor	39.76	27.78	10.98	28.32	5
Maine 357	Banner	38.16	27.33	10.83	28.37	6
Maine 346	Irish Victor	37.61	26.36	11.23	29.87	12
Maine 281	Banner	37.48	26.67	10.81	28.83	11
Maine 351	Banner	36.84	26.58	10.26	27.84	2
Maine 286	Banner	36.71	26.14	10.57	28.78	10
Maine 307	Banner	36.40	26.05	10.35	28.44	7
Maine 230	Banner	36.10	26.01	10.09	27.95	3
Maine 355	Banner	35.49	25.64	9.85	27.76	1
	Average	*37.72*	*26.99*	*10.73*	*28.45*	–

[29]Cited from Böhmer. *Loc. cit,* p. 24.

Table 12 gives in the third column the weight per 1,000 kernels of the respective pure lines. In determining this weight the general method of using only the lower or larger kernel of the spikelet was followed. It is obvious that it is necessary to use the same form of kernel throughout the measurements when comparative values are sought.

From Table 12 it is noted that the lines of the Irish Victor group and Lines No. 247 rank highest as to the weight per 1,000 kernels. It is interesting to note that the highest yielding line, No. 355, shows the lowest kernel weight.

Hull percentage. The economic value of the oat is determined by the naked kernel and it is, therefore, of importance to determine what part of the grain as a whole is made up by the hulls. From Table 12 it will be seen that the hull percentage does not quite parallel the weight per 1,000 kernels. Thus Line No. 346 ranks lowest as to hull percentage while it occupies the sixth place with regard to kernel weight. Similar points are noted for Lines No. 281 and No. 286. Line No. 340 has a comparatively low hull percentage considering its high weight per 1,000 kernels. Line No. 355 shows the lowest hull percentage.

Table 12 also gives the data regarding the relation between the weight of the naked kernels and the hulls. The weight of hulls of 1,000 kernels has been calculated from the hull percentage and weight per 1,000 kernels (Cf. Böhmer, *loc cit.,* p. 35). The lines 247, 340, 336 and 346 have the highest absolute weight of the hulls. While with the three first lines named the high weight of the hulls is balanced by the high weight of the naked kernels with Line No. 346, the high relative and absolute weight of the hulls is not followed by a corresponding high weight of the naked grain. Line No. 355 has the lightest hulls and Line No. 247 the heaviest.

To complete the description of the pure lines a few data may be given with regard to the germination of the grain. The germination tests were carried out in two series with 200 kernels of each line.

The results given in Table 13 do not show any great variation in the percentage of the germinated kernels of the pure lines. The total average for all the lines is 98.9 per cent which indicates a very high germination quality.

TABLE 13.

Germination Test of Pure Lines.

Line Number.	Number of Germinated Kernels.		Percentage of germinated kernels.
	Series I.	Series II.	
Maine 247	199	200	99.8
Maine 351	200	199	99.8
Maine 340	199	199	99.5
Maine 286	200	198	99.5
Maine 336	200	198	99.5
Maine 346	198	199	99.3
Maine 281	197	200	99.3
Maine 357	198	199	99.3
Maine 307	198	197	98.8
Maine 230	196	198	98.5
Maine 355	199	194	98.3
Maine 337	192	192	96.0
Average	198.0	197.4	98.9

The preceding description of these pure lines has shown very clearly that there are no marked morphological differences between these pure lines and their respective parent varieties. In the discussion of the majority of the characters, e. g., stooling, type of head and of grain, it has been necessary to deal with groups of the pure lines corresponding with their parent varieties. On the other hand, there is a large amount of evidence which indicates that in such characters as yielding ability and strength of straw these pure lines are distinctly superior to their parent varieties.

The modern view of the hereditary processes indicates that separate characters are inherited as units or as groups of units. It is, therefore, conceivable that at some time in the history of the parent varieties, spontaneous germinal changes occurred which affected the hereditary yielding ability of a certain plant. Such changes might or might not be accompanied by changes in one or more morphological characters. Further, such a spontaneous germinal change might result in either an increase or a decrease in the yielding ability. In the process of selection and elimination as outlined in this paper naturally only the variations in the direction of an increase would be preserved.

That variations do occur which tend to yield less than the parent varieties is indicated by the so-called "running out" of varieties. A variety which has been grown for many years without any attempt at improvement often shows a large number of undesirable, low yielding plants. Such a variety is said to be "run out." This condition undoubtedly results from the chance preservation and multiplication of germinal variations in the direction of low yield. With care to avoid mixing and the occasional selection of seed in the field, it is possible to avoid the undue multiplication of these undesirable types and hence to avoid the so-called "running out" of varieties.

That germinal variations similar to the above do occur in the case of morphological characters has been clearly shown by Nilsson-Ehle[30]. He was able to show that in pure breeding strains and under conditions in which there was no chance of mixing, grains appear which differed either in their color or in the character of their grain. These variations either bred true at once or after one or two generations the great majority of their progeny bred true to their new characters. The existence of these well authenticated cases of germinal variation in morphological characters makes it almost certain that similarly inherited variation may occur in respect to physiological characters such as yield.

The frequency with which such variations occur is unknown but experiments indicate that they are relatively very rare. Likewise the underlying cause of these germinal variations is unknown. The evidence indicates that they are probably not due to hybridization. They probably belong to the class of mutations as defined by de Vries.

In the case of self-fertilized plants such as oats, wheat, beans, etc., there is a large amount of evidence to indicate that when once acquired these new characters will breed true. It is these germinal variations in respect to yield and to strength of straw that we have attempted to isolate. The evidence from the three year tests indicates that we have been successful with these twelve pure lines, or with the majority of them at least. At the same time it is clear that these variations in yield have not been accompanied by any marked morphological changes in the characters studied.

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[30]Nilsson-Ehle, H. Über Fälle spontanen Wegfallens eines Hemmungsfaktors beim Hafer. Zeit. f. indukt. Abst.—u. Vererbungslehre, Bd. 5. pp. 1-37, 1911.

——————. Spontanes Wegfallen eines Farbenfaktors beim Hafer. Verh. d. naturf. Vereins in Brünn, Bd. 49, pp. 139-156.

Discussion and Conclusions.

After the discussion of the various characters and qualities of these pure lines we come to the practical question as to which is the best. It has been clearly brought out in the paper that under Highmoor conditions all of these twelve pure lines possess desirable qualities. If that had not been the case they would have been discarded. While under our conditions one or two of these lines have appeared to be especially good, it is not at all certain that under other conditions some of the other lines might not prove as good or better. It is certain that any one of these lines is capable of producing a much better yield of oats than the varieties commonly grown in the state.

In this connection, however, we desire to say that if these or any other varieties are sown on wornout land without proper fertilization, or if the seed bed is poorly prepared, good yields cannot be expected. A circular giving the exact methods used in growing oats on our two farms will be sent to any resident of the state on request. It will be seen from this circular that the methods used by us are only such as can be employed by any intelligent farmer.

Of the twelve pure lines we have chosen No. 340 as the best for Highmoor conditions. As shown in Table 7, this variety stands second in average yield for the three years. It has a very stiff straw and even under very severe tests has shown practically no lodging. In this respect it has appeared superior to No. 355 which gave a higher average yield. Further No. 340 has a very good white grain and a high weight per measured bushel. It has the highest weight per 1,000 grains of any of the pure lines. It has a relatively low hull percentage. It shows a relatively small amount of variation in the yield of its four 1915 plots (Table 6).

In 1914 this line was grown in a field test plot about three-quarters of an acre in area. It gave a yield of 86 bushels per acre. In 1915 this pure line was grown as a farm oat at Highmoor. While the area was not accurately measured, there were about 13 acres. The average yield was about 75 bushels per acre. In the variety test plots Maine 340 has averaged for the three years to yield 9.3 bushels per acre more than its parent variety, the Irish Victor, during the same time. Further, as may be seen from Tables 7 and 8, this difference in yield between this pure line and its parent variety has been very consistent in each year.

Maine 355, a Banner selection, probably stands as second choice. This pure line averaged to yield about two bushels per acre more than No. 340 for the three years. However, this higher yield is offset by certain other characters. Thus No. 355 is a little more likely to lodge on very rich soil, or in very wet seasons. It is not weak-strawed, but yet it does not have quite the same resistence as No. 340. No. 355 also showed a relatively high variation in the yield of its 1915 plots. It has a relatively low bushel weight and a low weight per 1,000 kernels. It has, however, given the highest average yield of any of the pure lines. Its average yield is seven bushels above the average of its parent variety for the same years. It also has the lowest hull percentage of any of the pure lines.

Maine 247, from the Imported Scotch variety, and Maine 286 and 357, from the Banner variety, are the least promising of these pure lines when grown under Highmoor conditions.

The remaining seven lines, Nos. 281, 351, 337, 230, 307, 336 and 346 show comparatively slight differences in yield. No. 337, an Irish Victor selection, has proved very variable in yield in the different years. In 1913 it gave a very low yield and in 1914 a very high yield. In 1915 its yield was about the average of the pure lines. While there are some differences in minor characters between the other pure lines, these differences are not of sufficient importance to warrant further discussion.

Another point which should be emphasized in connection with pure line varieties in general is the evenness with which the plants ripen. The relative time from planting to harvesting is an inherent characteristic of different varieties and different strains. In many ordinary commercial varieties there are some plants which ripen much earlier than others and likewise some that ripen very late. The casual observer is not likely to notice this difference but a closer inspection of individual plants shows that this is the case in many varieties. The plants which ripen first are likely to be too ripe when cut and will tend to shatter, thus cutting down the yield. Plants which are late in maturing will be slightly green when cut. Grain from such plants will tend to injure the appearance of the entire lot of grain. Further such immature grain will tend to lower the weight per bushel and likewise the yield.

All the plants of a pure line, since they are the descendants of a single original plant, will have the inherent tendency to ripen at the same time. This is one of the factors which leads to increased yields with pure line varieties. Of course, environmental conditions may greatly influence the time of ripening so that unless a field is reasonably uniform in the character of its soil there will always be some difference in maturity in different parts of the field. However, insofar as this matter can be remedied by seed, the pure line varieties offer a distinct advantage over the ordinary commercial varieties.

It is planned to continue the majority of these pure lines in our test plots until such time as newer and better lines shall be obtained. A large number of new selections are being tested at the present time. These will be tested along with the best of the pure lines described in this bulletin and also with a selected list of commercial varieties.

In order that these pure lines may be tested by the farmers of the state, arrangements have been made with the Extension Department of the College of Agriculture to place the limited amount of seed of each line in the hands of representative farmers. The arrangements are that the farmer shall grow one of these lines for at least two years in order to give it a satisfactory test. Seed from these lines which prove satisfactory in their respective communities is to be offered for sale at a reasonable price. It is hoped that this arrangement will secure a distribution of the seed of such of these pure lines as prove themselves worthy. Maine 340 will continue to be grown as a farm oat at Highmoor and the surplus seed offered for distribution.

Summary.

In the introduction to this bulletin the meaning of a pure line is defined and illustrated. The general methods used in the pure line breeding of cereals are also discussed.

The work with which this paper deals was begun in 1910. In that year 460 individual oat plants were selected from 18 different commercial varieties. In 1911 seed from 188 of these plants was grown in short garden rows.

On the basis of the results thus obtained 80 of these rows were thought good enough to be continued in small plots. Duplicate 1-2000 acre plots of each of these 80 pure lines were grown in 1912.

Of these pure lines 34 were sufficiently promising to be continued into field tests in 1913. Thirty-one of these were again tested in 1914.

In 1915 all of these pure lines were discarded except twelve. These twelve lines were tested in quadruplicate plots in 1915.

In each of the three years, 1913-1915, these pure lines were grown along with a number of the best commercial varieties obtainable. In 1914 and 1915 the pure line plots alternated in the field with commercial variety plots.

A method of correcting the yield of individual plots for differences in soil fertility is briefly outlined. This method of correction was applied to the 1914 and 1915 results and the major portion of the discussion is based on these corrected yields.

The detailed results of the field tests of these pure lines for each of the three years is given in tables 3, 4 and 5. The results so far as yield is concerned are summarized in table 7. In table 8 are summarized the results of tests of eleven commercial varieties tested for the three years under the same conditions as the pure lines.

From these tables it is seen that the 12 pure lines averaged to yield 80.8 bushels per acre against 75.2 bushels for the 11 commercial varieties. Only four of the commercial varieties gave a better yield than the poorest of the pure lines. In all cases the average yield of the pure lines selected from a given variety exceeded the yield of the parent variety.

While the original selections represented 18 different varieties, the pure lines finally retained came from only three different varieties. Seven of these are from the Banner variety, four from the Irish Victor and one from the Imported Scotch.

A detailed description of the 12 pure lines shows that in morphological characters, such as type of head, character of the grain, etc., these pure lines closely resemble their respective parent varieties. The changes in the physiological characters which result in higher yield are therefore not necessarily associated with morphological characters in the plant or grain.

Of the 12 pure lines, Maine 340, an Irish Victor selection is regarded as the best for Highmoor conditions. This line stood second in average yield but it possesses an especially stiff straw, a high weight per bushel and per 1,000 kernels and a relatively low hull percentage.

Maine 355, a Banner selection, is second choice. It gave the best average yield of any of the lines. It has a slight tendency to lodge on heavy soil. This variety is especially recommended for planting on lighter soils.

Maine 247, 286 and 357 appear to be slightly inferior in yield to the other pure lines. Between the remaining lines there is little to choose so far as the tests at present show.

Each of these 12 pure lines is well adapted to conditions in the southern and central part of the state. Being bred from single plants they tend to ripen much more evenly and are more uniform in all their characters than most commercial varieties. These 12 varieties represent the best out of 460 original selections.

We are satisfied that the use of any of these pure lines will result in increased yields over those obtained with most commercial varieties. Steps are being taken to secure the distribution of seed of these pure lines to the farmers of the state.

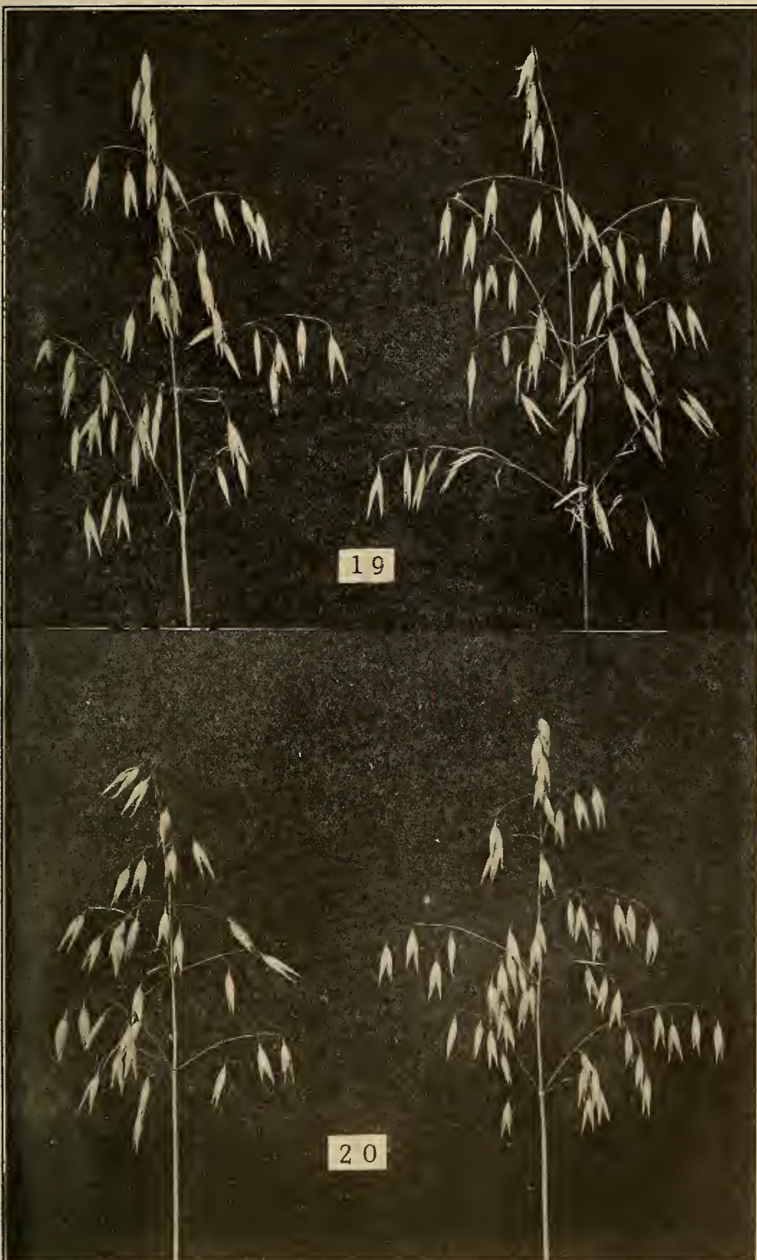

Fig. 19. Typical Heads from Maine 355
Fig. 20. Typical Heads from Maine 340

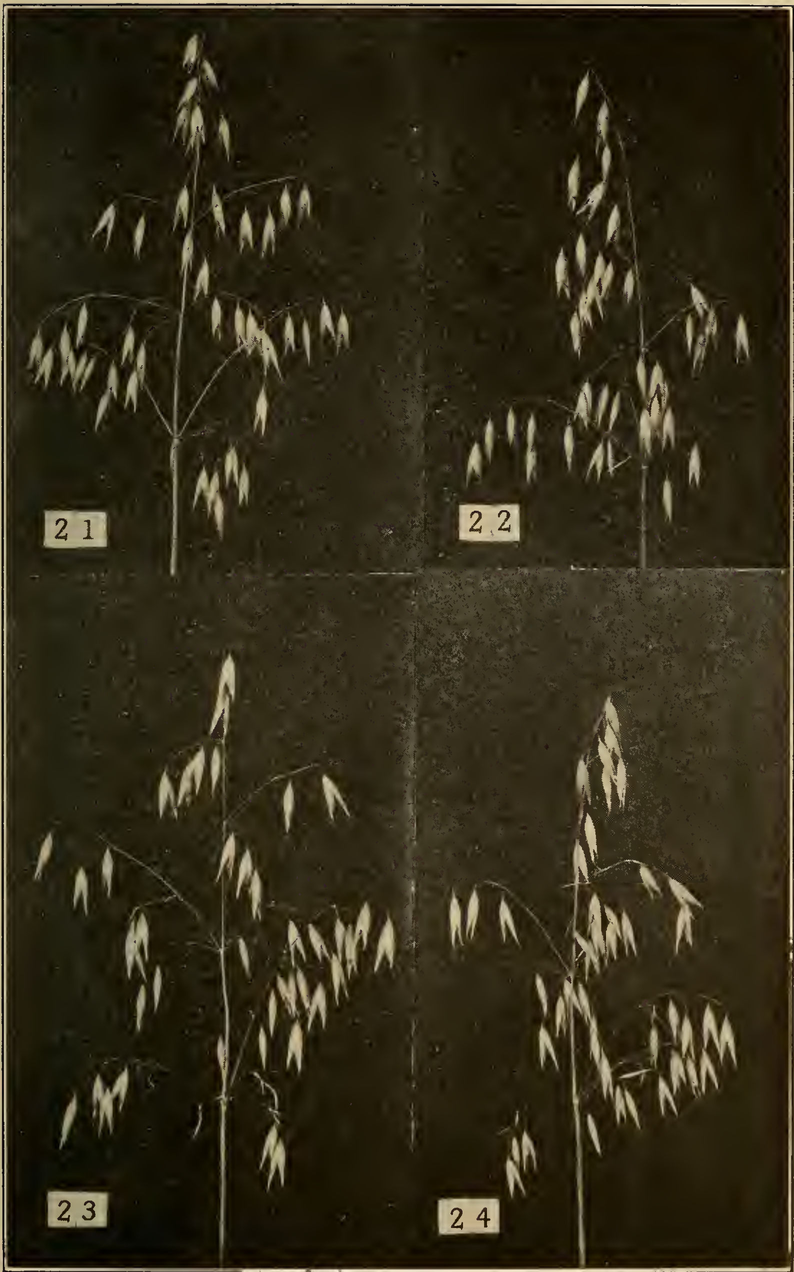

Fig. 21. Typical head from Maine 337
Fig. 22. Typical head from Maine 247
Fig. 23. Typical head from Maine 357
Fig. 24. Typical head from Maine 230

BULLETIN 251

SOLUBLE POISONS IN THE POISONED BAIT SPRAY TO CONTROL THE ADULT OF THE APPLE MAGGOT (*RHAGOLETIS POMONELLA WALSH*).*

Henry H. P. Severin.†

For a period of ten years a number of Italian entomologists have been experimenting with various methods of baiting and a large number of different formulas of poisoned baits to control the olive fruit fly (*Dacus oleae* Rossi) and at present a cheap and practical remedy is used to combat this insect. After the Italian naturalists demonstrated the effectiveness of the poisoned bait, French entomologists also tested the different methods declared a success in Italy to control the olive fruit fly. After a period of five years, French scientists gave a striking demonstration of the remarkable success of the poisoned bait spray. South African entomologists, apparently unaware of the work of the Italian naturalists started in 1903, began to spray with poisoned diluted molasses to control the Mediterranean fruit fly (*Ceratitis capitata* Wied.) in the season of 1904-5. This work was carried on for a period of five years and during this time a decisive demonstration of the success of this insecticide was given under South African conditions. The same remedial measures have been adopted in other parts of the world to control the Mediterranean fruit fly.

Poisoned Bait Studies in America.

Within recent years similar control measures have been started in the United States and Canada against the adult of

*Papers from the Maine Agricultural Experiment Station: Entomology No. 86.

†Member of the Station Summer Staff in 1914 and 1915.

the apple maggot (*Rhagoletis pomonella* Walsh), the cherry fruit flies (*Rhagoletis cingulata* Loew. and *Rhagoletis fausta* O. S.), the currant fruit fly (*Epochra canadensis* Loew.) and the imported onion fly (*Phorbia cepetorum* Meade). The methods adopted and the results obtained by the different investigators in the control of the apple maggot are given in the following paragraphs.

O'Kane* used a "mixture of arsenic, molasses and water distributed over the leaves of the tree," to control the apple fly in New Hampshire. "Through the coöperation of growers this plan of spraying was tried at several different points. In most the results were negative. It seems probable that in these instances the possible value of the treatment was obscured by the proximity of other infested trees not so treated. Also owing to the pressure of other work the grower was unable to apply the spray as often as would be needed in order to keep the poisoned sweet ready for the flies throughout their egg-laying season. In one instance, however, the treated tree stood alone, and this tree was given repeated sprayings as primarily planned. The variety was August Sweet and the fruit had been worthless for years. This tree yielded this season practically perfect fruit."

An experiment to combat the apple fruit fly with the poisoned bait spray, was conducted at the Maine Agricultural Experiment Station. Johannsen and Patch† write, "Our own experiments made this season upon two Tolman Sweet apple trees, using a spray of arsenate of lead and brown sugar in solution gave discouraging results."

During two seasons, Illingworth‡ experimented with the poisoned bait spray to control the adult of the apple maggot in New York. In the season of 1911, the larvæ were already at work in the Primate apples when he began to spray. "Sweetened arsenate of lead proved effective but was rather slow." Quick results were desired, and potassium arsenate, a soluble poison, was used together with syrup diluted with water. Illingworth (1912, p. 165) observed that the trypetids fed on the sprayed fruit shortly after the application of the spray. These

*New Hampshire Station Bul. 151, pp. 42-44.

†Maine Station Bul. 195, p. 238.

‡New York (Cornell) Station Bul. 324, pp. 126-187.

flies were collected in jelly-glasses, where they became paralyzed in about fifteen minutes and in half an hour they were dead.

An application of the bait containing the soluble poison was made on July 22 and 26, a pint being sprayed upon the lower branches of a 20-years-old Maiden Blush tree. In a table the author gives a daily record of the drops from this treated tree and the number of larvæ which bored out of the fallen fruit. All the windfalls picked up under the baited tree after August 15, were absolutely free from larvæ. From an untreated tree of the same variety in another field, 180 drops were gathered on August 23, and from these, larvae emerged during September. On the other hand, 115 drops collected on the same date from the treated tree failed to show a trace of a single maggot. "Hence it is quite evident that the flies deposited no eggs in the fruit of the sprayed tree after the application of July 26."

In the season of 1912, Illingworth used arsenate of lead and molasses diluted with water. On July 3, Red Astrachan trees received the first treatment. Five applications of the spray were made during the season. "On August 5, the Red Astrachan apples were ripening and showed no trace of the maggots."

"Slight difficulty was experienced in controlling the flies on a seedling variety of sweet apples," due to showers which came up nearly every afternoon during the period that the fruit fly remedy was being applied to the tree. "Even in this case, however, the fruit was vastly improved over former years." No mention is made of the number of trees treated and no check or control trees were used in 1912.

Ross* "tested two spray mixtures, one composed of arsenate of lead, glycerine and molasses and the other of Paris green, glycerine and molasses, but neither yielded satisfactory results," in the control of the apple fruit fly in Ontario.

For a period of three years, O'Kane† tested the poisoned bait to control the apple trypetid in New Hampshire. His records are taken for the most part from typical lots of sprayed trees, of which surrounding conditions were accurately known. Such field tests as are recorded consisted of two trees treated with the poisoned sweet in the season of 1910, three trees in 1911

*Ent. Soc. of Ontario. Report 1912, pp. 67-72.

†New Hampshire Station Bul. 171, pp. 1-120.

and ten trees in 1913. In the above spraying experiments, different proportions of arsenate of lead and molasses diluted with water were employed. The results are given in the table which follows.

Table showing the number of applications of the spray, the variety of apple trees, and the per cent of apples free from egg punctures on the sprayed trees and on such check or control trees as were used.

Applications of spray.	Varieties of Apples.	Apples free from egg punctures on sprayed tree.		Apples free from egg punctures on check tree.	
		Drops.	Picked.	Drops.	Picked.
	1910	%	%	%	%
3	Winter Sweet.............	14 (dr	ops or pick	ed?) .5	
4	President................	0	8.1		
	1911				
10	Granite Beauty...........	55.8		52.7	
7	Sops-of-Wine.............	55.8	46.1		
9	Porter...................	46.4	59.		
	1913				
5	Porter...................	39.3	74.7	22.6	32.8
7	Porter...................	....	0	*8.5	*.8
4	Williams Favorite........	....	3.7		
4	August Sweet.............	....	11.7	....	3.5
7	Fameuse..................	0	15.6		
7	Porter...................	....	11.9	0	
7	Porter...................	.4	9.	0	
10	Grimes Golden............	....	34.8	....	68.9
10	Grimes Golden............	....	27.9	....	68.9
10	Grimes Golden............	....	87.3	....	68.9

* Indicates that an "unknown sweet" was used as a check for the Porter.

The author summarized the above results as follows: "Poison bait sprays, as so far devised, have entirely failed to insure protection of the fruit of the sprayed trees from attack by the maggot. In part of the experiments there was apparently some improvement of the fruit, especially in isolated trees. This may have resulted from the death of flies because of the spray; or it may have been due to various other factors. The important point is that no such protection was forthcoming as would be essential if the treatment were to be ranked as an effective means of control."

"The above conclusions should not be taken as asserting that no flies are poisoned by such sprays. Some flies may be. Indeed it may be, as will be noted later, that with ordinary spraying of apple trees with a simple solution of arsenate of lead and water for some other insects, such adults of the apple maggot as chance to feed or drink at spots where poison has persisted may be killed. The conclusion offered is that the adults are not materially attracted to the bait, and that such sprays, or any others so far devised, are without any adequate avail as definite and sufficient protection of the fruit, in the absence of other treatment."

Investigations Here Reported.

In our work in Maine not only were the entire orchards sprayed but also apple trees in surrounding fields and dooryards. An attempt was also made to control the apple maggot under town conditions. In the season of 1914, different kinds and amounts of poisons were employed in the bait in spraying the various orchards and the apple trees in the residential section; whereas, in the season of 1915, but one formula was used in treating the same trees. Before giving the details of the work in each season, the results of a number of preliminary experiments will follow.

DATES OF EMERGENCE OF FLIES.

The dates of the first and last emergence of the pest have an important bearing on when to make the first and possibly the last applications of the poisoned bait spray. In the season of 1914, the dates of emergence of the apple fruit flies were determined under orchard conditions; whereas, in the season of 1915, similar records were obtained in the residential section of Orono. Ground cages were placed on the sod or soil below apple trees. Soil was banked and tamped around the bottom of each cage to prevent the escape of any of the flies. During the season the vegetation which sprouted beneath the cages was cut with a sickle from time to time. Spiders and predacious insects were removed from the cages as soon as they were noticed. The records of the emergence of the adults, the maximum and minimum temperature and precipitation in the season of 1915 are given in the following table:

Dates of Emergence of Flies, Temperature and Precipitation in 1915.

Date.	Number of flies.	Maximum temperature.	Minimum temperature.	Precipitation.
July 15	1	80	56	
16	0	83	58	
17	0	78	57	.11
18	9	76	60	.24
19	0	89	51	
20	1	81	59	
21	2	84	55	
22	14	83	49	
23	9	82	56	
24	11	81	49	
25	5	79	51	
26	5	79	57	
27	0	82	62	.35
28	6	85	56	
29	0	83	58	.47
30	0	73	58	
31	6	76	60	
August 1	2	83	62	
2	0	79	62	.64
3	3	75	48	.05
4	0	78	50	
5	2	72	46	.04
6	0	80	67	
7	0	78	55	.10
8	0	73	58	
9	1	77	58	
10	1	69	60	.17
11	0	85	52	
12	0	89	58	
13	0	87	62	.40
14	1	82	63	

In the season of 1914, the first fly issued on July 20, and the last on August 15, under orchard conditions and on July 17, one specimen was found dead below a baited plum tree in the residential section. In the season of 1915, the first trypetid emerged on July 15, and the last on August 14, under town conditions. From these records it is evident that the first application of the poisoned bait spray should be made on July 15, and the last treatment on August 15, providing that the adults, which probably live until the apples are harvested, do not invade the sprayed area from neglected trees.

EXPERIMENTS WITH KINDS AND AMOUNTS OF POISONS.

In view of the fact that a number of entomologists advocate the use of soluble poisons in the bait to control various species of Trypetidae, we conducted a series of experiments with different kinds and amounts of poisons to control the apple fruit fly. In Italy and France soluble poisons, such as potassium or sodium arsenite and sodium arsenate, were used in a large number of different formulas of the poisoned bait to control the olive fly (*Dacus oleae* Rossi). In 1911, Illingworth used the following "fly destroyer" as given by Merck to control the adult of the apple maggot in New York:

Syrup	4 parts or	4 pts.
Potassium arsenate ...	1 part or	1 lb.
Water	45 parts or	45 pts.

In 1912, Illingworth used the following formula:

Molasses	1 lb. or	25 lb.
Arsenate of lead	3 oz. or	5 lb.
Water	4 gal. or	100 gal.

The author states that, "If the conditions are such that the flies do not succumb readily to this treatment, the use of the soluble potassium arsenate is advisable as previously described."

To determine the effectiveness of different amounts of various kinds of soluble poisons used in the bait, and the extent of injury to the leaves and fruit, a number of preliminary experiments were performed. With each formula that was used, cheese cloth was fastened to the ground with spikes below a sprayed tree, so that the insects which succumbed to the effects of the poisoned sweet and dropped from the tree, could be detected more easily on a white background. By gathering the dead specimens daily, we endeavored to determine how long the spray was effective after different amounts of rainfall, and thus secure a clue as to the minimum number of applications necessary to insure good results.

Experiment I. In the first experiment one each of the following apple trees, Duchess, Fameuse, McIntosh Red, Tolman Sweet and three plum trees were treated with the fruit fly remedy, which was prepared according to the same formula Illingworth used in 1911. One pint to two quarts of the insecticide, depending upon the size of the tree, was applied to the foliage and fruit on July 11. The sprayed leaves on all of these trees were scorched and on July 16, some of these leaves began to drop. The fruit was examined from time to time and occasionally traces of burning was found but this was especially marked with the Duchess. A large number of dead moths, flies, ants, occasionally hymenopterous parasites, beetles, etc., were picked up daily on the cheese cloth, and then the leaves, bits of bark, twigs and wind-falls were swept off with a broom. Rain fell on July 11, 12 and 19, amounting to a total of 1.12 inches. On July 16 and 17, the fogs were so heavy that droplets of water dripped from the wet leaves and probably washed off some of the bait. On July 19, eight days after the application of the spray, no dead insects were found on the cheese cloth and the bait was now considered ineffective.

Experiment II. In the second experiment instead of one pound of potassium arsenate, one-half pound was used, the proportions of the other ingredients being the same as in Illingworth's formula of 1911. On July 11, one pint of the poisoned bait was sprayed on the foliage of the lower branches of a large Tolman Sweet. The results of the first experiment were practically the same as in this second experiment.

ORCHARD EXPERIMENTS WITH POISONED BAIT.

In order to give the various soluble poisons such as potassium arsenate, sodium arsenate and sodium arsenite a most thorough test under orchard and residential conditions, it was decided to use 3-4, 1-2 or 1-4 of an ounce of these insecticides to every three gallons of water and one pint of molasses. The different kinds and amounts of soluble poisons burned the leaves, some of which finally turned yellow and dropped from the trees. Some of the owners were considerably alarmed on account of the scorching of the leaves of their apple trees and we were compelled to discontinue the use of soluble poisons and substitute insoluble arsenicals. A remarkable peculiarity was the fact that rarely was a dead specimen collected from the cheese cloth with the use of Paris green or arsenite of lime in the bait, and we are inclined to believe that the explanation rests in the ability of some insects to strain out particles of insoluble poisons from the diluted molasses. During the two seasons cheese cloth was fastened to the ground below 29 apple trees sprayed with different quantities of soluble or insoluble poisons in diluted molasses, but not a single honey bee was found among the dead insects. As no conclusion can be drawn on the effectiveness of the poisoned bait, due to the fact that a soluble poison was used in one or more applications of the spray and an insoluble arsenical in the other treatments, only such details of the work of 1914, worthy of mention will be taken up in the following discussion of the season's work of 1915.

Experimental area. As the poisoned bait has been found to be more effective in the control of other species of Trypetidae in a well isolated orchard or in a large isolated area composed of many non-isolated orchards, a description of the location of our experimental area is necessary. A glance at the map shows that all of the apple trees indicated by dots were isolated on one side by the Penobscot river, and a bay of this river, but on the other sides apple trees were sometimes found at short distances from the margin of the experimental area. A more careful examination of the map shows that there are six orchards indicated by the following figures which represent the number of trees in each orchard: 84, 31, 40, 57, 47 and 38. The principal part of each orchard is situated above the figures. A series of dashes indicates the boundary between two orchards or separates an orchard from trees present in adjacent dooryards. The residential district contained 274 apple trees scattered in the different yards. The entire area covered about one square mile and contained a total of 571 apple trees.

Since we bred the apple fruit fly from haws gathered near Orono, Maine it was decided to spray all of the hawthorns near the orchards, and also those located on a hillside along the bay of the Penobscot river. Seedlings and crabapple trees near the orchards were also baited.

Care of orchards. The orchard which contained 84 trees was sprayed on May 4, 1914, with Scalecide to control the oyster-shell scale. Seventy-five gallons of spray containing 4 1-2 gallons of scalecide were used. On May 23-25, a combination spray consisting of dry powdered arsenate of lead and lime-sulphur was applied to control the tent-caterpillar, codling moth and fungous diseases. On July 8, the combination spray was again applied. Seventy-five gallons of the following formula were used with each application of the spray:

Dry powdered arsenate of lead..	1 1-2	lb.
Lime-sulphur	1	gal.
Water	50	gal.

In 1915, two applications of the combination spray were made as in the previous year. The orchard was plowed once during June and received no further cultivation during the entire season. The drops were allowed to remain on the ground, and an examination of this orchard in April, 1914, showed numerous rotted apples below the trees.

A general infestation of the apple maggot had occurred throughout this orchard during 1913, and all of the different varieties of apples had been attacked by the pest. The most seriously infested variety, however, was the Tolman Sweet.

None of the other orchards had been sprayed for the control of insect pests and fungous diseases. The owners stated that they had been troubled for a number of years with the railroad worm and that the drops had been allowed to decay on the grass in previous years.

Poisoned bait formula. In 1915, the following formula of the poisoned bait was used in spraying the six orchards and the apple trees in the residential section:

Potassium arsenate	3-4 oz. (dissolved in boiling water)
Molasses	1 pt.
Water	3 gal.

The solution was prepared by stirring the molasses in three gallons of water until all of the molasses on the bottom of the pail was dissolved. The potassium arsenate was first dissolved in about a quart of boiling water and was then added to the diluted molasses. The poisoned bait was thoroughly agitated by pumping the liquid back upon itself with a spray pump.

Application of Poisoned Bait. The poisoned bait was applied with a common, garden, brass spray-pump provided with a rose sprinkler nozzle, which throws a mist-like spray. A different method was employed in applying the insecticide in each season. In 1914, the man applying the spray walked rapidly around the tree, a yard or more away from the ends of the lower outermost branches, and at the same time the poisoned liquid was forced from the pump, into the air toward the top of the tree. The minute drops fell over and into the tree resulting in an even distribution of the droplets, for the most part on the upper surface of the leaves. The dose per tree varied from a half pint to a quart depending upon the size of the tree. In 1915, the fruit fly remedy was applied to the trunk, large limbs and foliage of the lower branches. The man faced the trunk of the tree and applied the bait, then he turned his back toward the trunk, walked around in a circle and at the same time forced the poisoned sweet from the pump over the large limbs and foliage of the lower branches. Those droplets which strike the foliage adhere for the most part to the lower surface of the leaves, where rains are not so apt to wash off the spray.

The following table shows the dates of the applications of the poisoned bait and the number of gallons of spray material used in the various orchards and the residential district in 1915.

Dates of Applications of Spray and Number of Gallons Used in 1915.

Dates of Applications of Spray.	Number of trees in orchards.						Residential district.	Total gallons.
	84	31	40	57	47	38	274	
July 16	......	......	......	......	......	......	12	12
19	......	4	7	7	5	......	......	......
20	14	......	......	......	......	......	......	......
21	......	......	......	......	......	4	26	67
August 3	......	3	3	6	6	3	......	......
4	12	......	......	......	......	......	27	60
16	......	3	3	6	......	......	......	......
19	......	......	......	......	......	4	26	......
20	12	......	......	......	5	......	......	59
	38	10	13	19	16	11	91	198

Spray injury from Poisoned Bait. The orchards containing 31 and 40 trees were sprayed with eleven gallons of the bait in the first application, but in the second and third treatments the amount of spray material was reduced to six gallons. Tent-caterpillars had practically stripped the leaves from some trees, while others were partially defoliated, and as the partly devoured leaves dropped very readily due to the scalding of the soluble poison in the diluted molasses, it was deemed advisable to reduce the amount of spray material in the second and third baitings.

In 1914, a number of complaints were made on account of the scorching of some of the leaves, which later turned yellow and finally dropped from the trees. In some of the dooryards we were forced to stop spraying before the end of the season due to the scalding of the leaves, while in other yards and in the orchards it was decided to discontinue the use of soluble poisons and substitute insoluble arsenicals. In visiting the owners during the next season, however, they were so delighted with the crop of sound apples obtained in the previous year, that they promptly forgot all about the alarm created by the partial defoliation, and without exception, permission was granted to spray the apple trees again. Nevertheless, during the second season the fear of some injurious effect of spray injury to the trees was voiced repeatedly. Many people, however, preferred sound fruit even if burned foliage was the necessary price. Raking the leaves from well kept lawns where apple trees were growing proved to be a troublesome task.

Effectiveness of poisoned bait. An attempt was made to determine how long the poisoned bait would remain effective after different amounts of rainfall. After each treatment, cheese cloth was fastened to the ground with spikes below a sprayed tree. The insects which succumbed to the effects of the soluble poison in the sweet were collected daily from the cheese cloth and it was reasonable to suppose that the insecticide became ineffective due to rains when no dead specimens were found. As the records on precipitation at the University of Maine were taken at a distance of about two miles from our experimental area, no accurate statement can be made as to the amount of rainfall required to wash off all the bait. It is evident, however, that an "all day rain" with heavy intermittent showers will destroy the effectiveness of the fruit fly remedy. In view of the abundance of rain in the season of 1915, the effectiveness of the poisoned diluted molasses was put to a most thorough test.

An experiment was performed in the field to determine the length of time required for the amount of poison used in the formula in 1915, to kill the adults. A tall Benoni apple tree (Map, L) received the fourth treatment on August 19, at 3.30 P. M. and on August 20, at 7.30 A. M. six female and four male apple fruit flies were collected on the cheese cloth sixteen hours after the application of the bait. Four specimens feeding on the insecticide on the upper surface of the leaves were captured, but all died in captivity within two days. On Augu·t

21, two days after spraying, one dead fly was picked up on the cheese cloth and on August 24, the last trypetid was found, but due to heavy rains during the preceding day we were unable to visit the tree. A light shower of rain fell on August 22, but heavy rains fell during the night and continued throughout the next day. The precipitation amounted to 1.58 inches on August 23, and the last baiting in the entire experimental area became ineffective after this date.

We have already called attention to two different methods of applying the spray. After the above Benoni tree received three applications of the bait, by spraying the trunk, larger limbs and foliage of the lower branches, 88 per cent* of the apples were found to be infested on August 19. On this same date, the fourth treatment was given by forcing the poisoned sweet from the spray pump into the air toward the top of the tree, so that the minute drops fell over and in the tree. On September 2, 49 per cent* of the apples were maggoty and on September 22, 15 per cent* were infested. In all probability, a general distribution of the fruit fly remedy over the foliage is more effective than spraying the trunk and large limbs due to the fact that the bark seems to absorb the poisoned diluted molasses. After the water has evaporated, a glossy layer of molasses adheres to the upper surface of the leaves, while the hairy coating of the lower epidermis prevents the formation of this film of sweet and seemingly absorbs a considerable amount of the poisoned liquid.

Attraction to poisoned bait. One observation tends to show that the apple fruit fly is attracted to the poisoned bait under field conditions. A specimen was observed at rest on an apple just at the time that the spray was about to be applied to the tree. Suddenly the fly took wing and came to rest on my hand which was spattered with the bait and here it began to feed. The distance from the apple to my hand was about a yard.

Checking up results. In checking up the effectiveness of the poisoned bait spray, the apples were picked at random from a treated tree in the various orchards or residential district and on the same day apples of a similar variety were gathered from

*This sequence of per cents is of course only possible where the infested fruit is dropping and the counts taken each time from fruit remaining upon the tree.

an untreated tree in other orchards or another section of the residential district, at a distance varying from about 1,000 feet to two miles. Some varieties of apples were kept in the insect-house for a month or more so as to give any eggs that were deposited shortly before picking an opportunity to hatch and also to bring out more conspicuously the tiny tunnels of the recently hatched larvæ in the pulp. Each apple was cut in half and if there was no evidence of an infestation, the halves were thinly sliced to determine whether there was any trace of the conspicuous brown tunnels of the larvæ in the pulp. In this way a record was taken of the infested and non-infested apples. No attention was paid to egg punctures as the apple fruit fly will sometimes make an egg puncture and not deposit an egg.

RESULTS IN ORCHARDS.

The following table shows the per cent of apples infested on the sprayed and check trees in 1914 and 1915, the dates on which the apples were picked, the location of the treated trees on the map in the orchards and the varieties of apples:

Results of Two Seasons' Spraying in Orchards.

Varieties of Apples.	Map.	Picked, 1914.	Picked, 1915.	Apples infested on sprayed tree.		Apples infested on check tree.	
				1914.	1915.	1914.	1915.
				%	%	%	%
Tolman Sweet*	T1	Sept. 19	Sept. 27	4	5	96	100
Tolman Sweet	T2	....	Sept. 27	....	3	....	100
McIntosh Red	D1	Sept. 19	Sept. 24	0	0	28	....
McIntosh Red	D2	....	Sept. 24	....	1	....	....
Fameuse	F1	Sept. 29	Sept. 27	0	6	38	52
Fameuse	F2	....	Sept. 27	....	2	....	52
Milden	M1	Sept. 12	Sept. 29	0	2	92	25
Milden	M2	....	Sept. 29	....	4	....	25
Pyrus prunifolia (Hybrid crab)	P	....	Sept. 17	....	7	....	....
Rolfe*	R	Sept. 14	Sept. 8	14	1	....	....
Hyslop crab	H	....	Sept. 17	....	24	....	1
Large Red Siberian	S	....	Sept. 17	....	0	....	....
Bells Early*	B	Sept. 26	Sept. 12	55	20	....	....
Tolman Sweet*	T3	Sept. 26	Sept. 27	40	3	100	100
Alexander	.....	Sept. 14	....	24	....	97	....
Tolman Sweet	T4	....	Sept. 27	....	34	....	100
Fameuse	.....	Sept. 19	....	4	....	....	....
Wealthy	W	....	Sept. 24	....	57	....	....
Tolman Sweet	T5	....	Sept. 27	....	32	....	100

* Indicates that the apples were picked from the same sprayed tree during 1914 and 1915, while the varieties not so marked were picked from different trees during the two seasons.

It is evident from this table that in the orchard which contained 84 trees (Map, 84) the results show practically no infestation in the season of 1914. From time to time during this season, the drops of different varieties of apples were gathered, but among the windfalls, only one infested Tolman Sweet apple was found. The Tolman Sweets in this orchard had been badly infested for a number of years. In 1913 no Tolman Sweets escaped infestation. In 1914 and in 1915 the apples were practically free from the railroad worm. In view of the fact that the pest was almost completely controlled in the season of 1914, we are hardly justified in drawing conclusions from similar results obtained in 1915; because since maggots were not present the fall of 1914 we should not expect to have flies the next summer.

No definite conclusions can be drawn from the results obtained in the two orchards containing 31 and 40 apple trees (Map, 31 and 40), due to the fact that no check or control trees of the same variety as the treated trees could be obtained. In 1914, 14 per cent of the Rolfe (Map, R) were infested; whereas, in the season of 1915, the infestation on this same tree was reduced to 1 per cent. In the season of 1914, there was a heavy crop of apples, while in the following season there was an exceedingly short crop and one would naturally expect a heavier infestation.

Definite conclusions, however, can be drawn from the results obtained in the orchard containing 57 trees (Map, 57). A Tolman Sweet tree (Map, T3) showed an infestation of 40 per cent after the first season's baiting and 3 per cent after the second season's treatment, while the check tree showed 100 per cent maggoty fruit. A Bells Early (Map, B) showed an infestation of 55 per cent and 20 per cent during the two seasons. The Tolman Sweet and Bells Early trees were by no means stripped of their fruit in the season of 1914, since only 100 apples were picked of each variety for examination in each year. It must be noted, however, that the Tolman Sweet tree was sprayed by forcing the poisoned bait into the air so that the minute drops fell over and into the tree, while in the case of the Bells Early tree the insecticide was applied to the trunk, large limbs and foliage of the lower branches.

The orchards containing 47 and 38 trees were within 100 feet of other untreated orchards and apple trees in dooryards, and the higher infestation is seemingly due to the invasion of the apple fruit flies. A Tolman Sweet tree in each orchard (Map, T4 and T5) showed that 32 per cent and 34 per cent of the apples were infested compared with 100 per cent maggoty fruit on the control or check trees. A Wealthy (Map, W) showed that 57 per cent of the apples were infested and this represents the highest infestation under orchard conditions in the season of 1915.

RESULTS IN RESIDENTIAL DISTRICT.

Lounsbury* of South Africa, demonstrated that the Mediterranean fruit fly can be controlled with the poisoned bait spray under town conditions even where summer rainfall is heavy. We, therefore, decided to test the value of the poisoned sweet as a means of combating the apple fruit fly in the residential section of Orono, Maine. The residential district in the experimental area contained 274 apple trees scattered in vacant lots and dooryards.

Some of the occupants informed us that certain varieties of apples had been seriously infested by the apple maggot for ten years. In some yards all of the infested fruit was allowed to decay on the ground, and in others, some or all of the drops had been gathered during previous years. Poultry was fenced off in some of the back yards below the apple trees and in others, the fowls were allowed to run at large.

The following table shows the results of two seasons' spraying in the residential district:

Results of Two Season's Spraying in Residential District.

Varieties of Apples.	Map.	Picked, 1914.	Picked, 1915.	Apples infested on sprayed tree.		Apples infested on check tree.	
				1914.	1915.	1914.	1915.
				%	%	%	%
McIntosh Red	D3	....	Sept. 24	....	49	....	0
Coles Quince†	C	Sept. 17	Sept. 17	34	4	....	....
Munson Sweet†	U1	Sept. 8	Sept. 2	96	91	99	100
Alexander	A	....	Sept. 22	....	64	....	4
Transcendent crab	K1	....	Sept. 17	....	97	....	100
McIntosh Red	D4	Sept. 14	Sept. 24	14	16	....	0
Bellflower	X	....	Sept. 27	....	41	....	....
Tolman Sweet	T6	....	Sept. 27	....	24	....	95
Tolman Sweet	T7	....	Sept. 27	....	50	....	95
Tolman Sweet	T8	....	Sept. 27	....	46	....	95
Tolman Sweet	T9	....	Sept. 27	....	88	....	95
Munson Sweet†	U2	Sept. 14	Sept. 2	99	98	....	100
Transcendent crab	K2	....	Sept. 9	....	80	....	100
Fameuse	.....	Sept. 14	....	84	....	....	....
Fameuse	.....	Sept. 14	....	54	....	....	....
Fameuse	.....	Sept. 14	....	11	....	....	....
Golden Russet	.....	Sept. 14	....	13	....	....	....
Duchess	.....	Sept. 14	....	13	....	....	....
Seedling	.....	Sept. 17	....	73	....	....	....

*Agr. Jour. Union of South Africa, No. 25, pp. 1-7.

† Indicates that the apples were picked from the same sprayed tree during 1914 and 1915, while the varieties not so marked were picked from different trees during the two seasons.

It is evident from the results recorded in this table that the control of the apple fruit fly with the use of the poisoned bait has been a complete failure in the residential district. Two Munson Sweet trees (Map, U1 and U2) showed an infestation of 96 per cent and 99 per cent of the fruit after the first season's spraying compared with 91 per cent and 98 per cent after the second season's treatment. In the case of a Coles Quince (Map, C), however, there was a decided improvement of the fruit, 34 per cent being attacked in 1914, and 4 per cent in 1915. A comparison of the infestation of a treated McIntosh Red and Alexander (Map, D3 and A) with the check trees shows a higher per cent of maggoty fruit on the sprayed trees. On the other hand, four Tolman Sweet trees (Map, T6, T7, T8, and T9) showed an infestation of 24, 46, 50 and 80 per cent compared with 95 per cent on the check trees.

Attention must be called to the severe infestation of fruit on treated trees situated in dooryards in close proximity to Professor Woods' orchard (Map, 84) in which there was practically no infestation during the past two seasons. Situated within 450 feet of this orchard were the following varieties of apple trees showing a high per cent of infested fruit: Tolman

Sweet (Map, T9) 88 per cent; Munson Sweet (Map, U2) 99 per cent in 1914, and 98 per cent in 1915; Transcendent crab (Map, K2) 80 per cent and Benoni (Map, L) 88 per cent on August 19.

It is reasonable to suppose that when badly infested early varieties are harvested, such as the Transcendent crab and Munson Sweet, that the absence of apples on the trees will cause the female flies to seek other fruit in which to oviposit. The Transcendent crabs and the Munson Sweets were harvested by the middle of September. It must be noted that the last application of the spray in the orchards and residential district were made between August 12 and 22, during the two seasons. The bait was washed off by rains before the early varieties had been harvested, leaving the fruit trees unprotected, at the time when the dispersal of the flies probably occurs.

CONCLUSIONS.

In 1914, no conclusions could be drawn on the effectiveness of the poisoned bait spray from any of the experiments that we performed, due to the fact that the different soluble poisons scorched the leaves and therefore insoluble arsenicals were substituted in the later treatments. A series of experiments with different amounts of soluble poisons, such as potassium and sodium arsenate and sodium arsenite, show that as small a quantity as one-quarter of an ounce of these insecticides dissolved in boiling water and then added to three gallons of water with one pint of molasses will burn the foliage of the apple trees.

In 1915, during a very rainy season, the results obtained with three applications of the poisoned bait spray containing a soluble poison dissolved in diluted molasses, showed that the infestation varied from 0 to 20 per cent in orchards situated away from the margin of the experimental area, and from 32 to 57 per cent in orchards near untreated trees. An even distribution of the droplets over the foliage is more effective than spraying the trunk, large limbs and foliage of the lower branches. The number of applications necessary to insure good results can not be stated with this work still in its experimental stage. In orchards where tent-caterpillars have practically stripped or partially defoliated the trees the poisoned bait with the use of a soluble poison can not be advocated. In orchards where tent-caterpillars are controlled, defoliation caused by spray injury is far less than the damage caused by these pests in neglected orchards. Our experience shows that after fruit growers have been convinced of the results obtained by the use of the poisoned bait spray, many prefer sound fruit even if burned foliage is the necessary price.

The fruit fly remedy has been a complete failure in the control of the pest under town conditions. With four applications of the spray the infestation varied from 4 to 98 per cent.

Explanation of Map.

Map showing the location of the experimental area in which an attempt was made to control the adult of the apple maggot by means of the poisoned bait spray under orchard and town conditions. The apple trees indicated by dots on the map were isolated on one side by the Penobscot river and a bay of this river. The location of six orchards are shown by the following figures which represent the number of trees in each: 84, 31, 40, 57, 47 and 38. The principal part of each orchard is situated above the figures. A series of dashes represents the boundary between two orchards or separates an orchard from trees present in adjacent dooryards. The residential district contained 274 apple trees scattered in the different yards. The entire area covered about one square mile and contained a total of 571 apple trees.

A circle surrounding a dot shows the location of a sprayed tree which was checked up with an untreated or control tree situated on the outside of the experimental area. The following is a list of varieties of apples that were used in checking up the results:

A = Alexander.
B = Bells Early.
C = Coles Quince.
D1-D4 = McIntosh Red.
F1-F2 = Fameuse.
H = Hyslop Crab.
K1-K2 = Transcendent Crab.
L = Benoni.
M1-M2 = Milden.
P = Pyrus prunifolia (Hybrid Crab).
R = Rolfe.
S = Large Red Siberian Crab.
T1-T9 = Tolman Sweet.
U1-U2 = Munson Sweet.
W = Wealthy.
X = Bellflower.

For Explanation of Map see Preceding Page

BULLETIN 252

APPLE SPRAYING EXPERIMENTS IN 1915.*

W. J. Morse.

The 1915 apple spraying experiments at Highmoor Farm, as in the past, were conducted with the Ben Davis variety. The number of trees involved was 216, or 9 plots of 24 trees each. Each plot consisted of 4 parallel rows of 6 trees to the row. The trees are now between 25 and 30 years old and those used for experimental purposes are in a fairly uniform and vigorous condition.

Treatment of the Plots.

The following is the spraying treatment outlined for each separate plot. The dates of application are given on p. 171.

Plot 1. Standard dilution lime-sulphur, plus one pound of dry arsenate of lead in 50 gallons.†

Plot 2. Blossom bud application omitted, otherwise like Plot 1.

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*The present publication constitutes the sixth annual report of results obtained from a series of apple spraying experiments at Highmoor Farm. Previous reports may be found in Bulletins 189 (1911), 198 (1912), 212 (1913), 223 (1914), and 240 (1915) of this Station. For the first two years these experiments were conducted by Mr. W. W. Bonns, then Station Horticulturist, but since then they have been under the general supervision of. the writer. They are planned to cover an indefinite series of years, the object being to secure data regarding sprays and their effects upon the apple as influenced by Maine conditions. A summary of the results obtained during the six successive seasons will be found in Bulletin 249 of this Station.

†By standard dilution is meant the equivalent of 1 gallon of a 33° B. lime-sulphur concentrate diluted with 40 gallons of water. For a 20 per cent stronger dilution, one-fifth more of the concentrate was used for making a given amount of spray than was used for making the standard dilution.

Plot 3. Blossom bud application lime-sulphur 20 per cent stronger than standard, plus one pound of dry arsenate of lead to 50 gallons; later applications two pounds of dry arsenate of lead alone in 50 gallons of water.

Plot 4. Blossom bud application 3-3-50 bordeaux mixture, plus one pound of dry arsenate of lead in 50 gallons; later applications like those on Plot 3.

Plot 5. All applications dry arsenate of lead alone, two pounds in 50 gallons of water.

Plot 6. All applications extra fine sulphur 10 pounds, dry arsenate of lead 1 pound, water 50 gallons.*

Plot 7. All applications 3-3-50 bordeaux mixture plus 1 pound of dry arsenate of lead in 50 gallons.

Plot 8. Treatment like plot 1, plus a previous application of dormant strength lime-sulphur *after the leaf buds began to open*, but the buds still small and the young leaves closely imbricated.

Plot 9. Unsprayed check.

Plots 1, 7 and 9, sprayed with standard dilution lime-sulphur, bordeaux mixture, and unsprayed respectively, were introduced as checks upon which to make comparisons in judging the results obtained upon the other plots.

Plot 2 was used to test, in comparison with plot 1, the efficiency of the spray application made when the blossom buds are showing pink. Omitting this application in previous experiments had by no means always resulted in a material increase in the amount of scab on the leaves and fruit. This part of the experiment has now been carried on for four successive seasons.

Plots 3 and 4 represent a modified spraying practice which previous work in connection with this series of experiments suggested as applicable to Maine conditions. The idea is to use a strong fungicide combined with a moderate amount of arsenate of lead when the blossom buds are showing pink, but for later protection both against apple scab and chewing insects to depend entirely on arsenate of lead,—using a larger quantity for subsequent applications.

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*For method of preparation see page 180 of Bulletin 240 of this Station.

Plot 5 was a continuation of previous work, the object being to test the fungicidal properties of arsenate of lead in controlling apple scab.

Plot 6 was a repetition of an experiment conducted the previous year.

Plot 8 was introduced largely to determine how much injury might be expected from the application of dormant strength lime-sulphur after the leaf buds had begun to open, or at a later period than it is customary to use this material. It has been demonstrated previously at this station, where young McIntosh trees showed an abundance of limb infection from the season before, that a dormant strength lime-sulphur applied just as the leaf buds were swelling, but before they opened, materially reduced the amount of scab on the leaves the following summer.* While, as far as the writer is aware, so long a delay in applying the dormant strength lime-sulphur has been advised or recommended by no one, even for limb infection for apple scab, the Station receives numerous inquiries each year as to whether or not it may be done with safety. These usually come from orchard owners who have purchased materials in order to spray for blister mite, scale insects, etc., but who, for one reason or another, have failed to do so at the proper time.

Time and Manner of Spray Applications.

All the sprays were applied with a gasoline power sprayer at a pressure of from 150 to 200 pounds per square inch, using a nozzle which delivered a fine mist. Especial care was taken to see that each tree was thoroughly covered with the spray at each application, but not enough material was applied to cause excessive dripping. After each plot was sprayed the spray tank, pump, hose and extension rods were thoroughly rinsed in clean water.

The dormant spray on plot 8 was applied on May 3. At this time the blossom buds appeared well protected. The young leaves surrounding them were not over one-third of an inch long, frequently less, and closely imbricated.

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*Morse, W. J., and Darrow, W. H. Is apple scab on young shoots a source of spring infection? Phytopathology 3:265-269, Oct., 1913.

Morse, W. J. Spraying experiments and apple diseases in 1913. Bul. Me. Agr. Exp. Sta. 223:20-23, Jan., 1914.

All the other applications were made to all of the plots on the same day. The first was made on May 14 just as the blossom buds were showing pink, the second on June 3, immediately after the petals fell, and the third on June 21.

The dormant strength lime-sulphur was prepared on the basis of a 1 to 8 dilution of a 33° B. concentrate, the summer strength on the basis of a 1 to 40 dilution of the same material.

Effect of the Different Sprays on the Foliage and Fruit During the Summer.

The development of scab. As will be shown later in the tabulated results obtained from sorting the fruit, scab was not severe even on the unsprayed trees. Undoubtedly early cultivation of the orchards last season materially assisted in reducing the amount of early spring infection. On May 3, the date of the late application of the dormant spray, a considerable number of scab infested leaves of the season before were gathered from under the trees and were taken to Orono for examination. At this time only immature asci or spore sacs could be found. These leaves were moistened, and then placed in covered, porous flower pot saucers, the latter being partly sunk in the soil out of doors to prevent drying out and to keep the leaves as near under natural conditions as possible. Under these conditions the spores in the asci were still immature at the time of the first application of the fungicidal spray on May 14, and did not reach maturity till 4 or 5 days thereafter. The orchards had been quite thoroughly plowed, and the fallen leaves of the season before turned under before May 14, so that it was impossible to secure fresh material at that time to determine what the actual conditions were in the field. However, since the temperatures at Orono during this time averaged higher than at the farm, it is not probable that the spores developed any more rapidly there. Hence it would seem that the early plowing whereby the leaves were turned under the soil before the ascospores of the scab fungus were mature and were able to bring about the first spring infection may partly account for the small amount of scab on the unsprayed plot.

Although frequent examinations were made, usually once a week, up to about August 1, no scab was observed on the leaves till July 28 when a small amount was found on both leaves and fruit on the unsprayed check plot and an occasional affected leaf was seen on the trees sprayed with the extra fine sulphur. No scab was observed on the leaves of any of the trees on the remaining plots then or later in the season.

Records were kept during the season as to the appearance of scab on the fruit on the different plots, but these contain nothing of value which is not given in the tabulated results of the condition of the fruit at harvest time.

Spray injury during the summer. On a few nights about May 15 the minimum temperature recorded at the farm was only slightly above freezing. These low temperatures at one time at least were accompanied by strong winds, and resulted in considerable foliage injury, more particularly on the northwest sides of the trees. This made it difficult in some instances to determine just how much of the injury should be attributed to the spray. Also late in the season a certain amount of scorching and browning of the leaves, resembling injury due to weather conditions, was observed all through the orchards. This was less, however, on the unsprayed trees than on the other experimental plots and the remainder of the orchards.

Plot 8, sprayed on May 3, with dormant strength lime-sulphur, after the leaves surrounding the bud clusters had begun to show, did not give any evidence of spray injury for at least 3 days. On May 7 very slight traces of burning of the buds began to appear. The leaves of the latter had grown but slightly in the meantime but on this date the margins of some of them had begun to turn brown, particularly at the tips. One bud was found where the entire outer leaves were browned. On May 10, one week after the spray was applied it was apparent that the young leaves on fully 50 per cent of the smaller and more tender buds had been injured. When compared with those on unsprayed trees, they showed a decided checking in growth. The buds at this time were fully double the size that they were on May 7, the cluster leaves being from one-half to three-fourths inch long and the enclosed blossom buds being in some instances one-eighth inch or more in diameter. As far as could be determined then the injury was confined to the outer leaves and did not effect the blossom buds within.

On May 14 the evidences of injury were rapidly disappearing. In some instances it was quite evident that the flower bud clusters were injured more or less and occasionally the flower buds were killed except the central one or two in the cluster. On May 25, or about three weeks after the dormant spray was applied, the evidence of injury had so largely disappeared that a person not knowing about it would not notice it in passing through the orchards. However, on some trees where the worst injury was noted quite a number of bud clusters could be found where all but the central bud had been destroyed. From the early part of June and following, the trees on this plot appeared as healthy as any of the others, although the leaves were a little smaller at first. The amount of fruit which finally set was apparently fully as much on the average as on other trees which did not receive the late dormant spray. It was noticed early in the season that the fruit on this plot showed considerable russeting.

As usual the plot sprayed 3 times with bordeaux mixture showed a large amount of spray injury. By June 15 numerous leaves showed spotting and quite a percentage were turning yellow and falling. Russeting of the fruit was apparent when the latter was quite small.

Spray injury was also later recorded on the leaves of the trees on plot 4 where a single early application of bordeaux mixture was applied, followed by double strength arsenate of lead for later applications. On July 1 it was noted that some of the leaves were turning yellow and falling. A careful examination on July 8 indicated that spray injury, though common on the leaves, was not severe. *It was, however, by no means confined to those leaves which had been formed before the single application of bordeaux mixture was made.* No such injury could be found on the adjoining plot where the double strength arsenate of lead alone was used for all applications.

Throughout the season no differences with regard to spray injury could be detected on the remainder of the plots, including plot 3 which received a blossom bud application of lime-sulphur, 20 per cent stronger than standard. A very slight amount of injury undoubtedly occurred but this was complicated with the frost injury of the early spring and the leaf scorch of late summer which made it difficult to decide how much of the trouble should be ascribed to each factor.

The Effect of the Different Sprays on the Fruit.

It has been the custom in the past to harvest the apples on the experimental plots some time during the first 10 days of October and then immediately sort them into three classes—the smooth or perfect apples; those which are scabby; and those which are russeted or show spray injury. In 1915 a heavy wind took over half the crop from the experimental trees on the night of September 26. These apples were immediately picked up and sorted, but the remainder were not harvested and sorted till October 6 and following.

As has already been mentioned the plots in each case consisted of four rows of 6 trees each. For sorting for the purpose of record it is the custom to take only the fruit from the 12 trees which constitute the two inner rows, limiting the sample to 20 barrels for each plot in case the crop on the two central rows exceeds this amount. In this way the effects of spray blowing from one plot onto another, receiving a different treatment, is largely eliminated.

In the instance under consideration it also eliminated the danger of mixing the samples from the different plots in the case of the apples blown off by the wind.

The following, Table 1, (page 176) is a summary of the results obtained from sorting and counting the number of fruits on each of the different plots.

Discussion of Results.

The fact that scab developed in such a slight degree on the experimental plots in 1915, even where no spray whatever was applied, makes the results regarding its control less valuable than those obtained in certain previous years.

Efficiency of the First Spray Application.

In this discussion the spray application made just before the blossom buds open is the one under consideration. In the case of lime-sulphur it refers to the first application made with the material diluted to summer strength. This phase of the experiment in which a comparison of two plots, numbers 1 and 2 in 1915, sprayed exactly alike except that on one of them the first application when the blossom buds were showing pink was omitted, has been going on for four years. In 1913 and 1914 the differences in the amount of scab resulting from such

TABLE I.

Summary of Results Obtained from Sorting Fruits.

Plot.	TREATMENT.	Total number of apples.	Number smooth.	Number scabby.	Number russeted.	Per cent of perfect apples.	Per cent of scabby apples.	Per cent of russeted apples.	Difference in per cent of russeting as compared with check.
1	Standard dilution lime-sulphur plus 1 pound of dry arsenate of lead to 50 gallons	9,164	8,197	12	955	89.45	.13	10.42	6.84
2	Blossom bud application omitted, otherwise like plot 1	7,794	7,089	11	694	90.96	.14	8.90	5.32
3	Blossom bud application, lime-sulphur 20 per cent. stronger than standard, plus 1 lb. of dry arsenate of lead in 50 gallons. Calyx and one later application, 2 lbs. of dry arsenate of lead in 50 gallons of water	4,742	4,606	13	123	97.13	.27	2.59	.99
4	Blossom bud application 3-3-50 bordeaux mixture plus 1 lb. of dry arsenate of lead in 50 gallons. Calyx and one later application like plot 3	7,406	6,434	36	936	86.87	.49	12.64	9.06
5	Dry arsenate of lead alone, 2 lbs. to 50 gallons of water	8,748	8,530	37	181	97.50	.42	2.07	1.51
6	Extra fine sulphur alone, 10 lbs., plus 1 lb. of dry arsenate of lead to 50 gallons of water	8,190	7,837	54	299	95.69	.66	3.65	.07
7	Bordeaux mixture 3-3-50 plus 1 lb. of dry arsenate of lead to 50 gallons	4,987	1,068	4	3,915	21.42	.08	78.50	74.92
8	Treatment like plot 1, plus a previous application of dormant lime-sulphur *after the leaf buds* had begun to open	9,659	7,536	2	2,121	78.02	.02	21.96	18.38
9	Unsprayed check	4,798	4,386	240	172	91.41	5.00	3.58	-

omission of the first spray were only slight and probably within the limits of experimental error. In one case there was slightly more and in another slightly less. In 1912, or the first season in which the experiment was carried out, quite striking results were obtained showing the value of the first application.

In 1915 scab was controlled equally well on both plots, it being reduced in each instance, when compared with the check plot from 5 per cent to a little over one-tenth per cent. As has already been mentioned it was not possible to determine just when the ascospores of the scab fungus reached maturity in the orchard on the fallen leaves of the season before, but it was plainly some days after the application of the first fungicidal spray, or the one omitted on plot 2, as shown by laboratory studies of the material collected and taken to Orono.

The evidence secured on this point in the past plainly indicates that the omission of the application when the blossom buds are showing pink may result in a large increase of scab. On the other hand the results of the past season again show that no orchardist should fail to carry out the remainder of the season's spraying program, if for any reason the first application was omitted.

Lime-sulphur vs. Bordeaux Mixture.

As has already been stated plots 1 and 7, sprayed with these two materials, in connection with the unsprayed check, form the basis for determining the relative merits of the other spray combinations used. It is of interest to note, however, that upon a variety of apples like the Ben Davis where both the foliage and fruit are particularly susceptible to spray injury lime-sulphur continues to show marked superiority. Scab control in each case was nearly perfect, but on account of russeting of the fruit less than 22 per cent of perfect apples were obtained from the use of bordeaux mixture, while over 89 per cent of the same grade of fruit was secured where lime-sulphur was used.

Another fact worthy of comment is that in this season where only a small amount of scab developed on the unsprayed check the amount of russeting produced by the lime-sulphur itself more than offset its beneficial results in scab control, for over 91 per cent of perfect apples were obtained on the check plot.

It is only fair to state in this connection that this is the first time such a result has been secured in these series of experiments since an unsprayed plot has been introduced as a check.

Arsenate of Lead as a Fungicide.

While the conditions for the past season were not such as to make the test of the fungicidal properties of the various sprays in any way a severe one the results obtained with arsenate of lead in controlling apple scab were in general confirmatory of those previously obtained. Where this material was used alone on plot 5 the amount of scab on the fruit, as compared with the check plot was reduced from 5 per cent to less than half of one per cent. This is the fourth consecutive season in this orchard in which the use of arsenate of lead on experimental plots at the rate of 4 pounds of paste or two pounds of the dry powder alone in 50 gallons of water has been followed by a material reduction of the amount of scab on the crop. One of the striking results obtained from the use of arsenate of lead alone on the Ben Davis, as shown by these experiments, is the relatively small amount of russeting of the fruit. Consequently, as will be seen on reference to the table, the plot sprayed in this way gave the largest percentage of perfect apples of any in 1915, or 97.50 per cent. In this connection attention is called to the fact that practically the same record was made on plot 3 which received lime-sulphur 20 per cent stronger than standard dilution combined with one pound of dry arsenate of lead in 50 gallons for the first application, and for the last two sprayings two pounds of dry arsenate of lead alone in 50 gallons of water.

While the evidence of apple scab control in the field by means of arsenate of lead appears quite conclusive some unpublished results secured by the writer's associate, Mr. M. Shapovalov, indicate that, while it is much retarded, the growth of the apple scab fungus in artificial culture media is by no means prevented when arsenate of lead is added to the culture medium at the same rate at which it was used in water for spraying. Similar results were obtained in germinating the spores of the fungus in pure, distilled water and carbonated water in comparison with other spore germination tests where arsenate of lead was added to the same liquids.

Arsenate of Lead Alone for Calyx and Later Applications.

The use of a strong fungicide for the first foliage spray followed by double strength arsenate of lead alone, as applied to plots 3 and 4 in 1915, has been tried for two successive seasons. Again, as in 1914, conditions were such that it is impossible to draw conclusions relative to the advantages derived from the use of the strong fungicidal spray instead of arsenate of lead alone for the first application. This is due to the fact that omitting the first application of standard dilution lime-sulphur entirely on plot 2 was not followed by any increase in scab as compared with plot 1 which was sprayed three times with the same material. Apparently scab control in 1915 came largely from the two later applications. Also the differences in amounts of scab recorded on plots 3 and 4 when compared with plot 5, sprayed with arsenate of lead alone, are within the limits of experimental error. However, the results obtained on plots 3 and 4 tend to conform those secured on 5 and similar plots of previous years relative to the fungicidal action of arsenate of lead. They also add to the evidence that, under the climatic conditions which existed in 1915 as well as in 1914, the first fungicidal spray application had little to do in the prevention of apple scab.

Again, as in 1914, an application of 3-3-50 bordeaux mixture on plot 4 before the flower buds opened resulted in leaf injury and increased fruit russeting. It is difficult to explain why some of this injury should occur. As has already been pointed out the injury was not confined to those leaves already formed when the bordeaux mixture was applied, and the amount of russeted fruit, as compared with the check, was increased about 9 per cent. Since the apple fruit is morphologically an enlarged and thickened calyx tube it is evident that a strong spray applied before the blossom buds open may and does reach tissues which later develop into the the skin of the fruit. Hence, there is a possibility that it might cause injury then which would appear as russeting later. Attention is called to the fact, however, that as is shown below an application of winter strength lime-sulphur to plot 8 at an earlier date when the blossom buds were still all surrounded and protected by young leaves led to somewhat more russeting of the fruit than was recorded upon plot 4. It hardly seems possible that the calyx tubes could have been injured sufficiently at the time of spraying with the strong lime-sulphur to account for all of the russeting experienced.

From a practical standpoint it is evident that bordeaux mixture cannot be safely used on the Ben Davis, even for the first spray application before the blossom buds open. On the other hand it is equally evident from the experience of several seasons that the amount of lime-sulphur concentrate in a given amount of spray used for this first application may be increased 20 per cent without fear of appreciable leaf injury or of increasing russeting. It will be noted that there was less russeted fruit on plot 3, sprayed in this manner, than there was on the unsprayed check. In this respect it agreed with plot 5 which had arsenate of lead alone for all 3 applications.

Late Application of Dormant Strength Lime-sulphur.

It seems improbable that an application of dormant strength lime-sulphur would be of material benefit in controlling apple scab except in cases of the over-wintering of the fungus on young twigs. This, however, in Maine according to the writer's observations is confined to the McIntosh and a few other varieties which are particularly susceptible to scab. Therefore, especially since no scab has ever been observed on the limbs of the Ben Davis at Highmoor it was not surprising that the difference in the amount of scab obtained in sorting the fruits on plots 1 and 8 was only about one-tenth of one per cent, or plainly within the limits of experimental error.

As has already been stated the use of the strong lime-sulphur on plot 8, after the buds had enlarged sufficiently so that the young leaves were beginning to show, caused very apparent injury at the time, but no permanent ill effects were observed on the foliage or in the reduction of the amount of fruit set. On the other hand reference to Table 1 shows that only about 78 per cent of merchantable fruit was obtained on plot 8 as compared with over 89 per cent on plot 1 which was sprayed exactly the same, except it received no dormant spray application, this difference being entirely due to the increase in russeting on the former.

Plot 8 consisted of trees 7 to 12, rows 11 to 14. The record given in Table 1 is for the fruit harvested on the two central rows, 12 and 13. Row 11 adjoined plot 7 on the south, sprayed throughout the season with bordeaux mixture. Row 14 came next to the unsprayed check on the north. The question arose with reference to plot 8 whether the increased russeting might result from spray drifting across from the plot sprayed entirely with bordeaux mixture. A like situation occurred in 1914 with the plot sprayed with bordeaux mixture for the first application, which was similarly located with reference to another plot sprayed throughout the season with the same material. That season, however, the increase in russeting on the plot receiving only one application of bordeaux mixture was not discovered till all the fruit was harvested and the sorting had been begun.

No differences could be observed, before harvesting, in the amount of russeting of the fruit on the different rows of trees on plot 8 in 1915. If any such differences did exist, due to the spray drifting across from the adjoining plot, it would seem that row 11, the nearest, should show more and row 14, the farthest removed from plot 7, should show less russeting than the two central rows. Accordingly the fruit on these two outside rows was harvested and sorted separately. The results obtained as far as they apply to russeting are given in Table 2 along with similar data with reference to rows 12 and 13.

TABLE 2.

Russeting of Fruit on Plot 8.

	Total number of apples.	Number russeted.	Per cent. russeted.
Row 11, nearest plot 7	2,786	516	18.52
Row 14, nearest plot 9	2,713	610	22.48
Rows 11 and 14, combined	5,499	1,126	20.48
Rows 12 and 13 (Plot 8, Table 1)	9,659	2,121	21.96

It is evident from the above figures that the bordeaux mixture applied to plot 7 was in no way responsible for the increased amount of russeting on plot 8. It will be seen that the fruit on the row nearest the bordeaux sprayed plot showed less russeting than that farthest removed or nearest the unsprayed check plot, also that the amount of russeting on it is less than on the fruit on rows 12 and 13 which were used for making the record given for plot 8 in Table 1. Other factors apparently being eliminated it would seem that the application of the dormant strength lime-sulphur, after the leaf-buds had begun to open, but at a time when the flower-buds were still quite thoroughly protected was in some way responsible for the increased amount of fruit russeting observed later. Regardless of the cause of the russeting there appears to be no advantage from the standpoint of scab prevention in applying the dormant spray later than is usually recommended for scale and similar insects.

Extra Fine Sulphur.

How efficient this material would be for scab control, when applied to apple trees in the manner described in this publication, during a season in which the disease is particularly severe, cannot be predicted from the experience with it during the past two seasons. That it possesses very evident fungicidal properties is shown by the fact that scab on the fruit produced on plot 6, when compared with the check was reduced from 5 per cent to a little more than one-half of one per cent.

WINTER INJURY OF YOUNG APPLE TREES FOLLOWING SETTING IN DYNAMITED HOLES.

W. J. Morse.

Of the two original Baldwin orchards on the farm, one was so far gone through a combination of neglect, and the direct and indirect effects following the severe winter of 1906-7 that it was removed soon after the Station took control in 1909. The other, though very unpromising, was retained, largely for the purpose of determining what might be expected from reclamation work upon other orchards similarly injured and neglected. A certain proportion of the trees in the last named orchard failed to recover and were removed from time to time. In the early spring of 1913 the places formerly occupied by 150 of these were filled by setting young Baldwin trees.

In the case of 126 of these trees, they were set where holes had been blasted with dynamite the fall before. With these 52 other trees, similar in every respect, were set in the same orchard in the usual manner by digging a hole with a shovel. In both cases, whether dynamited or not, a large hole was dug and filled in with top soil to where the tree was to be set. This was necessary in both instances for the primary object of the dynamiting was to shatter the subsoil rather than simply to make a hole. As far as the location of the trees in the orchard was concerned, conditions were ideal from an experimental standpoint. Since they were to replace trees which had been removed from different parts of the orchard for one cause or another, chance rather than design determined where the young trees should be placed. Consequently they were scattered indiscriminately through the orchard, those in dynamited and shovel dug holes mixed in with no particular order.

As first outlined this experiment was in no way concerned with pathology and the writer had no part in planning or carrying it out and knew nothing of the former treatment of the individual trees previous to collecting the records with regard to the winter injury upon them. The work was undertaken at the instance of one of the large firms which manufacture explosives and the dynamited holes were made by one of their experts. The primary object of the experiment was to determine whether or not the trees would make a better or more vigorous growth where the subsoil had been shattered with dynamite. As far as could be judged no difference in this respect occurred for good growth was made both seasons and in the fall of the second year, 1914, all of the trees appeared uniformly vigorous and healthy.

Before taking up the discussion of the injury which occurred during the winter of 1914-15 a brief statement should be made with regard to the character of the soil in the orchards and the method followed in dynamiting.

The soil on the farm is a moderately heavy, reddish loam, underlain by a very compact subsoil. In the orchard in question the surface soil contains rather more sand and is consequently somewhat lighter than most of the remainder of the farm which is devoted to similar purposes. Regardless of the presence of the sand the subsoil is quite impervious to moisture, and according to the farm superintendent, runs only from 7 to 15 inches below the surface. The topography of the orchard is such that for the most part a gentle slope to the west provides good surface drainage. The only soil pockets where water was likely to stand or where the surface drainage was poor have been underlaid with tile.

In blowing holes for setting the young apple trees the charge of dynamite was inserted at a depth of from 30 to 36 inches. The material encountered toward the bottom of the holes consisted of a resistant hardpan which was very difficult to break and required one stick of extra 20 per cent dynamite. The expert reported as follows regarding a test hole put down to a depth of 36 inches and loaded with one cartridge. "This blew but a small amount of dirt out of the hole. A man was put to work digging out the loose material, and we found there was very satisfactory loosening to a depth of 36 inches with lines of breakage extending in all directions from the point of the shot." In writing of digging into another hole on similar soil on another part of the farm he said: "This shattering seemed to dip slightly upward in all directions."

In the spring of 1915 it was evident that a considerable number of the young apple trees had suffered severely from winter injury. Many were killed back to within 12 to 18 inches of the ground while some appeared dead, nearly or quite to the soil line. In the latter part of June, when it was felt that the full extent of the injury was apparent, the writer made a careful examination of each tree and recorded its condition at that time.

In taking this record it was evident that there was no relation between the location of individual trees in the orchard and the amount of winter injury observed, but some quite striking results were obtained when these observations were tabulated in comparison with the method used in setting the trees. Out of 126 trees set in holes previously dynamited, 49 or nearly 39 per cent were either winter killed or badly injured. Of the 52 trees set in shovel dug holes, only 4 or less than 8 per cent suffered in like manner.

No attempt is made to draw general conclusions from these figures obtained in a single orchard. What happened here might not, and probably would not occur under different soil conditions. Nevertheless it would seem evident that the method of setting trees in dynamited holes is not adapted to soil conditions like those on this farm. Based on the results where the trees were set in shovel dug holes the probable loss from winter injury among the entire 178, had they all been so set, would be approximately 14 trees. Similarly had all the trees been set in dynamited holes, the expected loss would be about 69.

TWO APPLE-LEAF TROUBLES NEW TO MAINE.

W. J. Morse.

In the summer of 1915 two foliage troubles of the apple were observed, of which there appears to have been no previous record in this state. One of these, which the writer has called chlorosis, was widespread and common in a single orchard and occurred to a certain extent on individual, scattered trees in the same locality. No definite cause could be assigned to the condition. The other, a disease previously reported in Europe, Canada, South Africa and New Zealand, is known as silver-leaf and was found to be fairly common in various parts of the orchard growing section of the State.

Chlorosis.

In September, 1914 some diseased apple leaves were received through the college of agriculture from their extension representative in Franklin county, Mr. W. M. Morse. At that time the trouble was known to exist on a single tree, growing by the roadside in Livermore Falls. Further observations by Mr. Morse in the spring and early summer of 1915 showed that this condition of apple foliage had a wider distribution than was first indicated, and led to a visit to the locality by the writer under his guidance.

As far as observed this chlorotic effect on the leaves was limited to apple trees in a rather restricted area of adjoining portions of the towns of Jay and Livermore. Although several more or less isolated affected trees, including Baldwin, Northern Spy and Harvey varieties were seen which were growing on high, well-drained land under good conditions, observations in Jay were confined principally to a single orchard of Baldwins of two or three acres in extent. This orchard was on rather low land, naturally moist, but was fairly well drained with open ditches. The leaf trouble was restricted to no particular part of the orchard but was apparently not quite so severe on the higher portion. However, the trees here were somewhat younger than the rest. The majority of those affected were probably 25 to 30 years old and may have been older. While they had apparently been neglected up to a few years ago their treatment in this respect did not differ from that given to the trees in many other orchards in which no such trouble occurred. For the past few years they have been cultivated, fertilized and pruned.

The trouble appeared on the younger as well as the older branches and is in no way connected with the normal yellowing and falling of the inner and more shaded leaves which is of common occurrence. Neither is it associated with any form of spray injury for it occurs on sprayed and unsprayed trees alike. However, leaves so affected are easily and sometimes severely injured by lime-sulphur, used at a dilution which gave absolutely no injurious effects on the healthy foliage of the same tree.

The leaves showing the chlorosis here described are, as a rule, variously spotted or mottled with irregular splashes of yellow, giving a variegated appearance. No opportunity was afforded to follow the course of the disease through the season, but it is thought that the yellowing is progressive, eventually involving a large part if not the whole of the leaf, for some were collected which showed but little of the original green remaining.

Figures 26 and 27 illustrate the appearance of the affected leaves much better than any written description. The portion of the young branch represented in Figure 26 gives an idea of the characteristic appearance of the diseased foliage on the tree. The leaves shown in Figure 27 were selected to show individual variations. The two on the extreme left of this illustration are far from typical of the great majority and represent about the only specimens of this character found, out of probably more than one hundred collected. While the yellowing appears to start frequently along the line of the larger leaf-veins it is just as likely to appear first in the tissues midway between them.

In the preliminary studies made in the field no definite clue could be obtained as to the cause of the trouble. Conditions in this part of the state during the growing season of 1915 were decidedly abnormal, being characterized by excessive rainfall, associated with a large amount of cool, cloudy weather. The following facts are against the unreserved acceptance of the theory that weather conditions and the location of the orchard were the prime contributing factors in bringing about the condition observed. The disease was present the previous season; it occurred in the same locality on several varieties represented by scattered trees on high, well-drained soil, and was not found elsewhere under similar conditions.

Dried specimens showing the more common characteristics of the affected leaves were sent to three recognized experts in plant pathology in other states, asking if they had previously seen the trouble and if they could give any information as to its cause.

Dr. G. P. Clinton of Connecticut replied as follows: "On page 360 of my 1914 report on chlorosis of plants, I mentioned a chlorosis trouble of apples that I have occasionally seen. This trouble is not quite like the one sent in that I have only rarely seen it attacking the leaves of small branches, and the chlorosis areas on the leaves are more elongated and whiter than those you sent."

Had Doctor Clinton seen the two leaves shown at the left of Figure 27 it is possible that he might have wished to qualify this statement. However, the writer is convinced that he is correct in this opinion that the trouble found in Maine is distinct from the one observed by him in Connecticut.

Prof. F. C. Stewart of New York made these comments: "In our bulletin 328, page 318 you wil find a brief account of the apple mosaic or variegation which you mention. From your description and the specimen sent I am confident that the two ar identical. I kno nothing about the cause of the trouble and hav made no other observations on the effect of spraying such leaves."

In the publication mentioned* Professor Stewart records under the heading of "Variegated Foliage" the occurrence of this trouble on apple trees in four different parts of the state of New York at various times from 1896 to 1910. In the earliest observed case one tree had practically all the foliage affected for two successive seasons. An adjacent tree which showed the variegation the first year on one of its branches was entirely free from it the second. One apple tree is mentioned on which certain branches show variegated leaves year after year.

The third lot of diseased leaves was sent to Dr. L. R. Jones of Wisconsin. The reply came from Dr. G. W. Keitt who

*Stewart, F. C. Notes on New York Plant Diseases I. Bul. N. Y. Agr. Exp. Sta. 328:318, 1910.

stated that neither he nor Dr. Jones had seen any apple injury in that state which closely resembled this.

Silver Leaf.

As far as the writer has been able to learn the only references to this disease in American literature are contained in the writings of Güssow. In 1910 he recorded its presence in Nova Scotia.* In giving the characters of the disease he mentioned that the leaves on the affected branches have a silvery appearance or a milky-white gloss, particularly on the upper surfaces. The epidermis on the upper surfaces of the leaves is also very brittle. In this paper he states that when a branch is attacked it dies, as a rule, after one or two years and that a tree once attacked by silver leaf will eventually succumb. In this paper he mentions that some European writers consider the disease to be physiological but says that it is remarkable that *Stereum purpureum* Pers. is constantly associated with it.

In a second paper‡ he states that it is known by him to exist from Nova Scotia to Vancouver Island and expresses his surprise that none of it should be recorded across the border when it is evident that so many cases exist in Canada. At this time he reported that he had only observed the disease on apples and plums in Canada, but mentions the fact that pears, peaches, cherries, currants and gooseberries are also attacked by silver leaf. He cites experimental evidence of his own and others, particularly in England, tending to connect the cause of the disease with *S. purpureum*.

In still a third paper† he reports more fully on the disease, giving the results of inoculation experiments which lead him to conclude that it is caused by *S. purpureum*. Therefore, as a control measure he would advise the destruction by burning of all diseased branches and fully diseased trees. Any dead apple wood including stumps in the orchard which might serve as a breeding place for the fungus, which he looks upon as a wound parasite, should be burned.

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*Güssow, H. T. Silver leaf. Report Dominion Botanist, Dept. of Agric. Canada, 1910. p. 268.

‡Güssow, H. T. A preliminary note on silver leaf disease of fruit trees. Phytopathology 1:177-179. Dec. 1911.

†Güssow, H. T. Der milchglanz der obstbäume. Ztschr. Pflanzenkrank. 22:385-401. 1912.

Observations made last summer indicate that in all probability silver leaf is as common on apple trees in Maine as it is in the adjoining portions of Canada. On account of its frequently inconspicuous appearance, and partially from a lack of familiarity with the characteristic symptoms of the disease, on the part of those who are interested in matters of this kind, it has not been recognized previously.

The writer's attention was first called to this abnormal condition of apple foliage by Dr. L. R. Jones of Wisconsin during a visit of the latter to Maine in the summer of 1915. Doctor Jones stated that he had previously had opportunity to observe the trouble in company with Professor Güssow. It was at once evident that the true "silver leaf," as it occurs in Maine, is a much less conspicuous trouble than certain cases reported from Canada. Nothing has yet been seen which would conform to the following sentence. "Some of the trees are so silvery in appearance that their abnormal condition is apparent from a great distance."

Instead of being silvery the diseased foliage had a distinct, dull, leaden, metallic luster. The name "plomb" used to designate the disease by the French seems more applicable to the cases observed in Maine. While trees showing this condition may be overlooked by the average individual, the abnormal appearance of the affected leaves is sufficiently marked so that they are readily detected a short distance away by anyone who has become familiar with the characteristic symptoms. When the diseased and healthy leaves are placed side by side the differences are apparent to any observer.

The writer was unable to collect any confirmatory evidence last season relative to *S. purpureum* being the cause of the disease. It was observed that every tree or branch which showed silver leaf also presented some slight evidence of winter injury resulting from the season immediately preceding. This fact was quite evident at Highmoor Farm where practically all of the cases were confined to one or more limbs on an affected tree, but never involving the whole tree. *S. purpureum* was not observed on any of these trees, but it follows winter injury of apple trees in Maine with great regularity.

Fig. 26. A small apple branch bearing leaves affected with chlorosis.

Fig. 27. Individual apple leaves showing variations in chlorotic effect. The type represented by the two at the extreme left was rare.

FURTHER OBSERVATIONS RELATIVE TO THE ABILITY OF THE APPLE SCAB FUNGUS TO LIVE OVER WINTER ON YOUNG TWIGS.

W. J. Morse.

Mention has already been made on p. 171 to observations made at this Station which indicated that the scab fungus *Venturia pomi* (Fr.) Wint. was able to remain alive over winter in infected young apple twigs and that viable conidia found in the pustules produced by the fungus on these twigs are at times a source of spring infection on the leaves.

In the spring of 1913 when these observations were made a large number of specimens were received from various parts of the State. In a number of instances where the conidia of the fungus were still present, germination tests made in prune decoction and prune agar indicated that they were still living. Practically all of these tests were with material obtained from diseased limbs collected in March and April. Pure cultures made from the spores thus obtained, agreed in every respect with those of *V. pomi*. Inoculations of young apple trees growing in the greenhouse with spores produced in these cultures resulted in the production of typical cases of apple scab on the leaves.

While references to the over-wintering of apple scab on the twigs are by no means lacking in European literature the writer was unable to find any previous record of similar observations in America. In fact the general consensus of opinion among pathologists in this country as expressed by their writings appeared to be quite the contrary. Therefore, it seemed worth while to continue these observations as opportunity offered. While no such an abundance of material has been obtained since the spring of 1913 additional data has been secured each year.

In 1914 one specimen was received in January and two in February. In each case a few spores were found but not in sufficient abundance to make germination tests. Specimens received from one of the coast towns in the eastern part of the State on April 15 carried sufficient spores so that positive germination tests were made in prune decoction.

A few specimens of diseases twigs bearing spores were received during March and April, 1915, but no germination tests were made.

On March 31, 1916, a few affected twigs were received from another town on the coast. These also carried an abundance of spores which readily germinated in distilled water. Another supply of material from the same source, obtained a week later, likewise gave similar results. Under the climatic conditions which exist in Maine this was about one month before the leaf buds on the apple trees would begin to enlarge and growth to start. Moreover up to within about three days before the specimens were collected the ground was covered with over a foot of snow. While it is of little practical importance whether these spores, since they are found to be viable in the spring, were produced the fall before or were formed in the spring or late winter from living mycelium growing in the bark on the limbs, it hardly seems possible that the latter should be the case in the present instance.

The first opportunity to extend these observations to scab infections on pear limbs came in May, 1916. Some specimens were received which were collected just before the leaves started in which the young twigs were bardly affected with scab and carried an abundance of the conidia of the fungus. These spores also readily germinated in distilled water.

It may be of interest to state that while other varieties of apples have been found affected and specimens have been obtained from the interior of the State a great proportion of the affected twigs came from McIntosh trees, and from towns on or near the coast.

BULLETIN 253

SYRPHIDAE* OF MAINE.**

C. L. Metcalf.†

SUMMARY.

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*Pronounced Surf'-i-dee.

**Papers from the Maine Agricultural Experiment Station: Entomology 87.

†Member of the Station summer staff.

Introduction.*

Entomologists are realizing more clearly every year the tremendous importance to agriculture and human economy of the groups of insects having the predaceous or the parasitic habit. There has long been a strong suspicion that without these natural enemies of insects man would be helpless in combating destructive crop-pests. The recent great destructiveness of certain insects introduced from foreign countries, followed by the successful repression of these pests in certain instances with their natural insect enemies (likewise introduced from foreign lands), has emphatically confirmed this opinion.

There seems to be not the slightest doubt that predaceous and parasitic insects are man's greatest ally in keeping destructive insects in control. They work without the necessity of any attention on the part of man and for the most part so unobtrusively, that most of us are unaware of their existence. It is only when some combination of conditions checks their numbers that we experience for a year or two a serious outbreak of the pests which these beneficial insects have been holding in submission and which would otherwise be seriously destructive every year.

It therefore seems desirable that we learn as much as possible about the life-histories, habits and biological relationships of such of these insects as occur in our own country. Not only because of the scientific interest which such facts may have, or so that we may learn to appreciate their value, but also in the hope that we may be able to conserve these natural resources, and possibly artificially foster, encourage, increase and transport, or extend the distribution of, the most useful ones.

One of the most universally distributed and destructive of insect groups is the Homopterous family Aphididae, or as they are commonly called, plant-lice or aphids. This group owes

*The numbers in parentheses in the text refer to papers in the bibliography, which are serially numbered.

its success not to the hardiness or resistance of the individuals but to their remarkable fecundity, for the individual aphid is conspicuously frail, defenseless and exposed throughout its life.

Because of this frailty aphids are attacked by large numbers of predators and parasites. The best known of the groups of aphid enemies are: (1) the parasitic Hymenoptera; (2) the Ladybird Beetles or Coccinellidae; (3) the Lace-winged Flies, Aphis-lions or Chrysopidae; and (4) the Flower-flies or Syrphidae. The parasitic Hymenoptera complete their transformations from eggs to minute wasps inside the body of a single aphid. The latter three groups are predaceous and grow, not at the expense of a single aphid, but by catching and eating dozens or hundreds of them. The Coccinellidae have achieved a good deal of popular interest so that there is hardly a school boy but knows that the Lady-birds eat plant-lice and are the farmers' friends. The Syrphidae, on the other hand, seem to be little known and much misunderstood by the farmer. This deplorable lack of a better popular knowledge of this group is a little hard to explain. Perhaps the principal reason is that they have been so little discussed in entomological and popular literature; and the lack of a good common name may have had its influence. Although it gives little or no intimation of the economic importance of the group, and may even be misinterpreted as indicating a habit injurious to flowers, the name "Flower-flies" seems to be the most satisfactory of the names in use; because it is based on the most characteristic habit which is uniformly true for the adults of the family: *viz,* that of visiting flowers for the purpose of getting food.

As contrasted with the Lady-birds, the movements of the Syrphid larvæ are slow, their colors subdued and their general appearance quite inconspicuous,—even repulsive. Their elongate flattened bodies are often nearly or quite covered from view by the aphids or their secretions. They are consequently usually overlooked or ignored; or the adults persecuted as "sweat-bees," under the wholly erroneous idea that they can sting; or, worse still, the flies may be accused of being responsible for the presence of the lice on the plants, or the larvæ for the damage resulting from the plant-lice.

In spite of their lack of popular recognition, I have become convinced during several years' study of this group, that, in the sections observed, the Flower-flies are a more important enemy of aphids than are the Lady-bird Beetles, and that probably they are the most important of the natural enemies of aphids. I have been gratified to find this opinion confirmed by Dr. Edith M. Patch after many years' extensive observations of the aphids of Maine.

The present bulletin deals with only one of the groups of insect enemies of aphids,—the Syrphidae. Its aim has been to elucidate the life-economy of these little-understood Flower-flies, so that the agriculturist may come to look upon them as his friends and give them his well deserved protection. And that as a basis for fostering and increasing their numbers we may have an intimate knowledge of their structure, habits and transformations. And since the larval habits are very diverse, not all being enemies of aphids and a few quite injurious, it has been deemed important to study all the species of whatever larval habit so that we may learn to distinguish the injurious and the beneficial ones.

What Flower-Flies Are.

The family Syrphidae is one of a number of families comprising the great order of insects known as the Diptera, or two-winged flies, (characterized especially by the possession of a pair of knobbed threads, *halteres,* on the thorax in lieu of the second pair of wings) and to the sub-order Cyclorrhapha, section Aschiza.

They are medium to large flies, sometimes uniformly black but usually very brightly-colored; being characteristically striped, spotted or banded with bright yellow on a blue, black or metallic ground-color. The yellow occurs especially commonly as transverse bands or fasciae on the abdomen, but also on thorax and head. This black and yellow coloring gives them a general, and often a particular and very striking resemblance to wasps and hornets for which they are commonly mistaken. Other species are covered with long black and yellow hairs and resemble bumblebees. This resemblance to Hymenoptera is further heightened by their habit of visiting flowers for nectar and pollen.

The Syrphidae may be distinguished readily from all the other Diptera by the so-called *false* or *spurious vein,* which is a vein-like thickening of the wing-membrane between the third and fourth longitudinal veins (radius 4+5 and media 1+ 2) and running through the anterior (radio-medial) cross-vein. It can be distinguished from the true veins by the fact that it is not so clear-cut nor so deep in color and that it ends freely without joining other veins. This false vein is present in all but a very few Syrphidae and not found in the flies of any other family. In the few cases where it is wanting the fourth vein (media 1+2) terminates in the third (radius 4+5) a considerable distance from the margin of the wing. The following combination of characters will always distinguish them.*

Head at least as broad as thorax. Front never excavated, often swollen. Face excavated under the antennæ and projecting below, or with a distinct tubercle near the middle. The antennæ are three-jointed with a dorsal arista or tapering into a terminal style. Ocelli present, three. Tegulæ of moderate size. Empodia not pulvilliform. Bristles (macrochaetae) almost always wanting, never on the head. Second (radius 2+3) and third (radius 4+5) longitudinal veins never forked; fourth longitudinal vein (media 1+2) joins the third before the margin of the wing. Three posterior cells; the anal (cubital) cell long, acutely closed before the border of the wing; basal cells (radial and medial) large; *between the third* (radius 4+5) *and fourth* (media 1+2) *veins and nearly parallel with them there is a false or spurious vein* nearly always present and characteristic of the family. The post alar membranes or squamae with peculiarly-formed, forked and fan-like ciliatión, and an elongate fringed filament-like projection, the *plumula,* from the upper margin of the pteropleura beneath the squamae (Verrall).

How Flower-Flies Live.

Any one of these flies during its entire existence passes through four quite different and distinct conditions or life-stages: The egg; the larva; the pupa; and the adult.

(1) *The Egg.* The eggs of Syrphidae are placed by the parent fly in many different kinds of places, depending on the species, but generally in such a situation that the young when they hatch may easily find at hand an abundance of the par-

*Williston (62, p. xxvi).

ticular kind of food on which they may thrive. Certain kinds, to take an example, glue their eggs to the surface of parts of plants which are infested with plant-lice or aphids. In this case they may be actually placed among the aphids or, more often, on a part of the leaf or stem within easy crawling distance of the aphids. The eggs of other species are laid upon moist filth, in the nests of other insects, in decaying wood, etc., depending on the feeding habits of the forthcoming young.

In whatever situation found, the eggs of Syrphidae have a somewhat characteristic appearance as indicated by Figs. 30-*1, 2, 3;* 31-*61, 62, 63;* 32-*41, 42, 4*_ ; 36-*1, 2, 3;* and 37-*1, 2, 3.* They are chalk-white, shiny, elongate-ovate or subcylindrical with rounded ends. The micropylar end more truncate. Flattened slightly to the surface on which they are deposited, slightly humped above. Commonly about 1 mm. (1-25 inch) long by a third of a millimeter in diameter,—so small that they are seldom noticed yet they can easily be seen by the unaided eye. However, when viewed under a microscope the characteristic thing appears; *viz.,* a delicate and beautiful sculpturing of the shell (chorion) consisting typically of elevated oval areas (*bodies*) separated by depressed areas, but each elevation surrounded by radiating and interlacing, sometimes branched *arms,* also elevated, which they give off into the depressed areas and which often completely cover the latter with a fine elevated network.

(2). *The Larva.* Upon hatching there appears from the egg, not a miniature fly as some might expect, but a very small, slender, headless, footless, blind, creeping maggot, known technically as a *larva.* The exertions of splitting the shell and escaping from the egg may require a brief rest; but very soon the larva seeks out the food-supply. There follows a period of almost constant feeding, covering from one to several weeks, during which the maggot increases many hundreds of times in size and deposits within its body a great excess of fatty material of use in the third stage.

The larvae of the different species are by no means all similar in appearance. In fact they differ so much that no one would suspect some of them of being the young of closely-related flies. All of them agree in being eruciform, slug-like, without true legs and only the most rudimentary of pro-legs or none. They also agree in lacking a specialized head, the anterior segments being usually bluntly accuminate, and in no way constricted or marked off from the rest of the body. A few filth-inhabiting larvæ have the anterior segments globose and slightly constricted from the succeeding ones making a feebly-differentiated false-head. All the larvæ of Syrphidae carry on aerial respiration through stigmata or spiracles near the anterior and posterior ends of the body,* and lack them on the intermediate segments. *The posterior spiracles are always situated on the ends of two elongate or very short tubes which are fused mesad throughout their length, never forked or divergent,* except very slightly at the tip or in very young larvæ; and consist of three pairs of slit-like spiracles and a pair of circular plates or "buttons." The anterior larval spiracles (Fig. 33-*12;* 34-*2;* 36-*4*) are small, situated dorso-lateral near the anterior end and may be somewhat elevated on cornua or quite sessile. The head-segments bear a pair of short, fleshy, sensory structures corresponding to antennæ and certain chitinized external mouthparts. The oesophagus has also a chitinized cephalo-pharyngeal framework or skeleton. The mouth and anus are terminal or slightly ventrad at the two extremities.

The somites are not clearly differentiated and in some genera, notably *Microdon,* are indistinguishable. Usually they are indicated externally by groups of transverse wrinkles between which groups the body is slightly constricted. But more especially by the presence of a transverse row of specialized vestiture consisting typically of twelve hairs or spines either with or without subtending, conical, wart-like papillæ, called the *segmental spines or elevations* (35, p. 18). Sometimes these spines are very inconspicuous, sometimes instead of the single spine we have a clump of several soft hairs; but in all the larvæ I have examined, except the species of *Microdon,* the segmental vestiture is specialized or differentiated in some way from the other vestiture of the body, the *integumental vestiture.*

Although the segmentation is obscure in this family, for convenience of description I have assumed (35, pp. 18 and 20) that there are twelve somites represented in the larva. I have

*I have so far failed to find anterior spiracles on the larvæ of *Microdon* which I have examined.

considered that there are two head segments cephalad of the anterior spiracles; and that these spiracles are borne on the third or prothoracic segment. On the basis of the segmental spines there are usually eight similar and sub-equal segments caudad of the one bearing the anterior spiracles, and one terminal segment which bears the posterior respiratory process, making twelve in all.

(3) *The Pupa.* When the larva is fully grown, commonly about a half inch in length, it comes to rest in some suitable place in or near the larval habitat and prepares for the transformation to the winged fly. It fastens its caudal segments to a leaf or twig or other support with glue from anal glands, or buries in the ground. Its skin inflates dorsally and laterally, nearly obscuring the wrinkles characteristic of the larva, shortens on the ventral line and becomes much indurated by the deposition of chitin, thus forming the pupa-case or *puparium*. Within this case certain complicated changes take place during which legs and wings and hair and eyes and mouth parts and the other features of a winged fly, like the one that laid the eggs, gradually make their appearance.

Since the pupa is concealed in the puparium throughout this stage, the characteristics readily observable are those of the larval skin which are, except for shape, mostly the same as during the larval period. The tracheæ leading from both anterior and posterior larval spiracles are atrophied during this stage and respiration is provided for by a pair of stigmata which pierce the puparium in the region of the fourth or fifth larval segment. From each of these stigmata a large tracheal trunk leads downward to the prothorax of the developing imago. In some species the pupal respiratory stigmata are much elevated on cylindrical cornua (Figs. 36-*8A*; 37-*6A*); in others they are sessile, exceedingly small and often indistinguishable or apparently wanting (Fig. 30-*7A*). The characteristics of the larval skin, such as anterior and posterior larval spiracles, prolegs and vestiture, usually remain practically unchanged throughout this period.

The coarctate pupa (Fig. 32-*53*, *54*) is protected by the hard puparium and, within this, a thin, delicate, transparent membrane (Fig. 32-*54a*) encases the developing wings, legs, and other parts of the body. The segmentation and appendages of the fly are produced very gradually. The legs, mouth-parts and wing-pads differentiate first while the dorsal part of the body and especially the abdomen is still eruciform as in the larva. Antennæ and eyes next take form followed by the segmentation of the abdomen the appearance of the vestiture and the differentiation of the thorax. The hind leg during this stage is bent at the middle of the tibia at an angle of about 150 degrees. The coloration of the adult is well developed sometimes several days before emergence; and in species where the puparium is quite transparent it is often possible to identify the species through the puparium.

(4) *The Adult.* When fully formed the adult pushes off a lid-like portion of the anterior end of the puparium by the dilation of its face and crawls out of the opening so formed. Emergence often requires several hours' time and not infrequently a specimen dies in the attempt to disentangle itself from the puparium. By the time emergence is accomplished the insect has practically assumed the adult form. The principal difference is that the wings are thick, crumpled and folded (Fig. 32-54) and must expand to a much greater area, become flattened instead of bag-like and hardened to form an effective organ of flight. The coloration of the fly is pale and the whole body somewhat soft and worm-like. But within an hour, sometimes, indeed, within a few minutes, the body has become perfectly indurated, the wings completely expanded, and the color-markings fixed to that of the imago.

After emergence the life of the fly is dominated by two impulses, the instinct to feed and the instinct to reproduce its kind. The food of the adult is practically always secured from flowers and consists of nectar and pollen. The flies seem to be strongly influenced by heliotropism or sunlight. They are almost always active in the sunshine and the brighter and warmer the day the more active they become. These facts may be taken advantage of by the person who wishes to collect Flower-flies. The most fruitful collecting is to be found about melliferous flowers and in the sunshine, particularly in very early spring.

Mating may take place on the wing with both sexes actively flying (hovering) and oriented in the same direction, the male uppermost (*Sphaerophoria, Sphegina,* etc.); or the pair may come to rest on foliage, in which case the two are usually facing in opposite directions, either resting or the male being passively dragged about from leaf to leaf by the female (*Temnostoma*). The process of copulation has been observed to continue for many hours at a time.

The next and final step in the completion of the life-round or life-cycle is oviposition for the next generation. The female, no longer closely attended by the male, hovers about the medium on which the larvæ are to feed settling down at intervals to place the eggs. The terminal segments of the abdomen with the ovipositor are greatly extended and the egg passes between the vulva to its position on leaf, filth, or other medium, according to the habits of the particular species. The eggs may be placed singly and greatly scattered, as in most of the predaceous species; or several may be placed closely side by side (*Melanostoma mellinum,* q. v.); or they may be deposited in great numbers in a mass, as in most of the filth-inhabiting species. In the latter case some of the species seem to rank the eggs in quite regular order; in others they appear to be simply extruded in a pile with little regard to their orientation. Often a gluey substance is passed with the egg which fastens it securely to some surface. Eggs succeed each other commonly at intervals of about a minute.

Habits of the Larvæ.

The habits of the larvæ of Syrphidae, which are remarkably varied, have formed an interesting subject of study for a number of years. Perris in 1870 (41) gave a brief resumé of the modes of life of these larvæ as known to him. Williston, 1886, (62, p. 271), Verrall, 1901, (55, p. 674) and the writer, 1913, (35, pp. 38-42) have amplified and extended this table to include additional habits and species as determined.

I have attempted to outline our present knowledge of the habits of these insects in a logical way in Figure 28. In the first column of this plate is a systematic analysis of the known larval habits. In the second are listed the North American species or genera known to follow any particular habit. And in the third the structure of these larvæ, so far as the writer has personally studied them, is indicated.

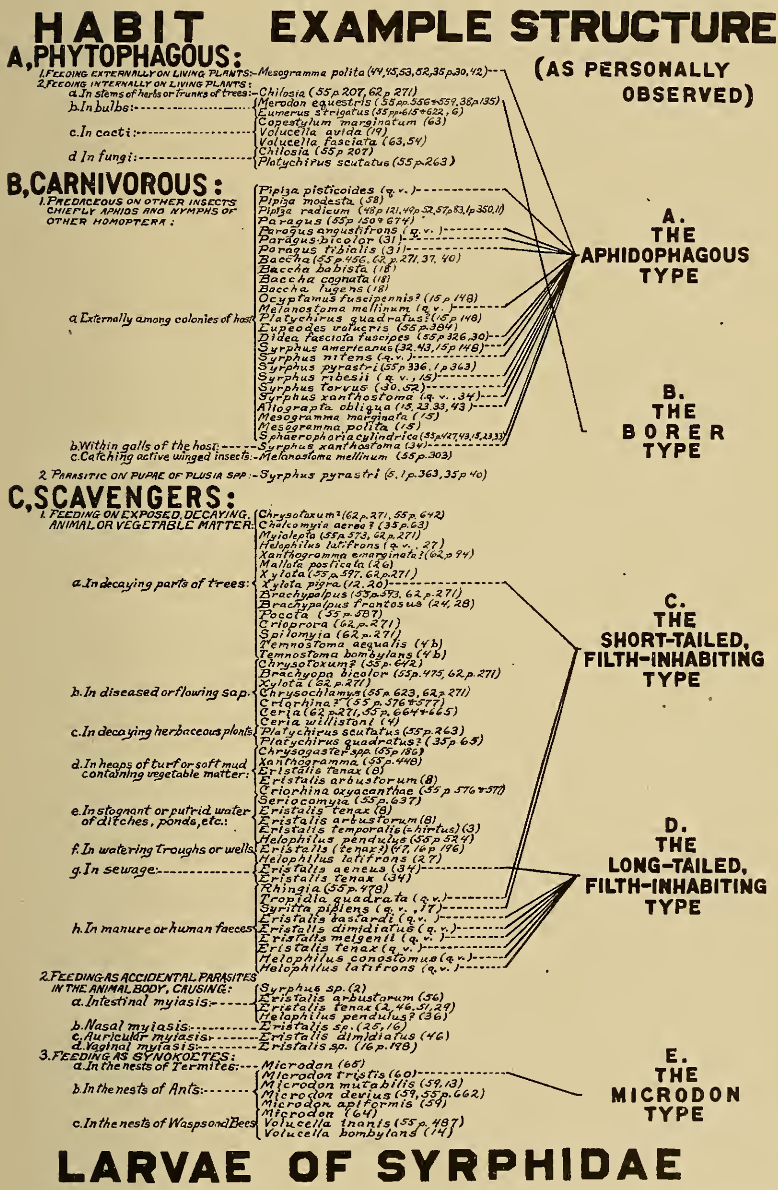

Fig. 28. An outline of the known habits and structure of the larvae of Flower-flies. The numbers following the names of species refer to papers in the bibliography.

Although the larva of each species will doubtless be found to vary in a measurable degree or perceptible way from every other species, it appears that these various larvæ can be assembled into five groups, collectively distinct from each other, while the larvæ in the group have many important points in common. I have, therefore, separately described them and shall, for convenience, speak of them as *types* of larvæ.

Structure of the Larvæ.

I. THE APHIDOPHAGOUS TYPE OF LARVA.

Body sub-cylindrical, flattened ventrally and much attenuated anteriorly. Posterior respiratory process short, the spiracles either straight or convoluted, never denticulated. Inter-spiracular ornamentation consisting of bare hairs, nodules, ridges or lamellæ, never of plumose hairs. Mouthparts of two Λ-shaped jaws. Segmental hairs single. If prolegs present, without specialized vestiture. Anterior pupal respiratory cornua apparently wanting.

This type of larva, named from the most characteristic habit, has the posterior larval spiracles at the apex of two very short, rigid, heavily chitinized, cylindrical breathing tubes which are fused mesad throughout their length (except in very young larvæ) never bifurcated except very slightly at the extreme tip; situated terminally or on the dorsum of the depressed twelfth segment. This short double tube bears on its tip three pairs of slit-like *spiracles* elevated on radiating carinæ, usually nearly straight, never branched or denticulate; and a more or less prominent *circular plate* or "button." The interspiracular ornamentation (between the spiracles) may consist of hairs, spines, nodules, ridges or perpendicular plates,—never of plumose hairs. The anterior spiracles are sessile or nearly so, rounded or lunate, very small. The body is elongate, slender, tapering to a point at the anterior end, somewhat flattened ventrally.

The body is wrinkled transversely and the wrinkles or folds grouped in such a way as to imperfectly mark the body segments, which are further indicated by the *segmental spines,* a transverse row of twelve hairs, spines, or bristles on each segment, sometimes obscure, sometimes very prominent, but always present and differentiated from the remaining *integumental* vestiture.

The mouth-parts consist of two V-shaped, jaw-like pieces working vertically and associated spines or hooklets; which, with the terminal anterior segments, are strongly retractile.

The integument is tough but thin and more or less transparent, either glabrous and papillose or closely set with minute stiff hairs (the integumental vestiture). The colors are various but commonly some shade of green, brown or pink, striped or blotched with white or black. Usually the dorsal blood-vessel (heart-line) shows as an interrupted black mid-dorsal line throughout most of the length.

In the pupa stage this type has a somewhat characteristic shape,—subovate, bulbous in front and tapering to the posterior respiratory process (which retains its larval characteristics) behind.

It is separated from the other types I have examined in lacking a conspicuous pair of anterior (prothoracic) stigmata developed and pushed through the puparium for pupal respiration. These pupal respiratory cornua appear to have been heretofore overlooked. They are so minute that even when one knows they are present it is only with the greatest difficulty that they can be demonstrated. In *Melanostoma mellinum* (q. v.), a species with unusually transparent integument, they can be located readily because the tracheæ leading from them are easily visible.

II. THE BORING TYPE OF LARVA.

Body nearly cylindrical, less attenuated anteriorly. Posterior respiratory process short, the spiracles convoluted, inconspicuous; circular plate sunken. Inter-spiracular ornamentation of short, palmately-branched, plumose hairs. Mouth-parts fitted for rasping, of two ventrally directed hooks uniting basally into a mouth-hood. Segmental hairs single.

This type is represented in my collection only by the larvæ of *Merodon equestris,* collected from Narcissus bulbs in British Columbia, for which I am indebted to Dr. C. Gordon Hewitt, Dominion Entomologist. These larvæ are superficially much like the first type but the body is more nearly cylindrical, less flattened ventrally, and less attenuated anteriorly. Segmental hairs single, prominent. The posterior respiratory process has lost nearly all trace of its double nature and appears as a truncated cone. The circular plates are deeply sunken and occupy a central rather than a dorsal position. The spiracular slits are very inconspicuous and are irregularly and much convoluted. The inter-spiracular ornamentation consists of short, palmately-branched, plumose hairs.

The anterior three body segments are directed ventrad and terminate in the mouth-parts. The latter entirely different from aphidophagous species, consisting of two black, heavily-chitinized, rasping, recurved hooks, each with a small, inner, basal spur, fused basad to form a heavy, black, ventrally-concave hood beneath which is the mouth opening.

I have not seen the pupa of this type.

III. THE SHORT-TAILED FILTH-INHABITING TYPE OF LARVA.

Body cylindrical with the anterior segments modified into a "false-head." Posterior respiratory process short, the spiracles convoluted and denticulated. Inter-spiracular ornamentation of short, palmately-branched, plumose hairs. No external mouth-parts but a chitinized mouth-hood. Three pairs of lateral, fleshy, conical protuberances on segment twelve. Segmental hairs triple or quadruple, flexible, inconspicuous. Rudimentary prolegs. Pupal respiratory cornua prominent, morel-shaped.

This type of larva is superficially like the Boring Type, but the anterior three or four segments instead of being accuminate are rounded out, globose, as broad as, or broader than, the succeeding segments, and somewhat separated from them by a slight neck-like constriction to make a kind of *false head.* There are no external, chitinized mouth-parts, the mouth opening being covered by a moderately-chitinized, striated mouth-hood, the termination of the cephalopharyngeal skeleton; and guarded on each side by a poorly defined, piliferous fold of skin.

The posterior respiratory process shows its origin from two tubes; the circular plate is on a level with the apex of the tube; and the slit-like spiracles which are more prominent are convoluted and also ornamented with more or less numerous lateral projections or denticles. The inter-spiracular ornamentation consists of plumose, palmately-branched hairs. The segmental vestiture consists of clumps of about three or four fine, flexible hairs, a little longer than the integumental vestiture, and all arising together. The larvæ have seven pairs of prolegs along the ventral side of the body, which consist of elevated folds of the body-wall over which the integumental vestiture is specialized into heavier, rigid and retrorse hooks of varying size.

This and the following types of larvæ differ strikingly from the first in producing for the pupa stage a pair of very conspicuous tubular, anterior respiratory cornua, studded with minute nodules and connected with the nymphal prothorax, as in the first type, by large tracheal trunks. These cornua in the three species examined are more or less mushroom- (morel-) shaped.

IV. THE LONG-TAILED (RAT-TAILED) FILTH-INHABITING TYPE.

Body cylindrical with a false head, and long tail. This posterior respiratory process elongate, telescoping, flexible, at least half as long as the body. The spiracles on its end entirely inconspicuous. Inter-spiracular ornamentation of single, long, plumose hairs. No external mouth-parts except the mouth-hood. Segmental hairs double or triple, flexible, inconspicuous.

Rudimentary prolegs present. Anterior pupal respiratory cornua elongate, cylindrical, very prominent.

This type is most closely allied to the third type but differs from it and from all the others in the remarkable elongation of the posterior respiratory organ, which, in these species, is tube-like, three-jointed and telescopic; and may be extended to several times the length of the body although commonly contracted to about body-length. This remarkable and highly specialized organ enables the larva to carry on aerial respiration while feeding at various depths beneath the water level. It is of two tubes fused mesad and enclosing two tracheæ which open at the tip. The inter-spiracular ornaments consist each of a single, unbranched, but plumose, long hair instead of a palmate group of short plumose hairs as in the two previous types. The prolegs are similar to type III. The anterior larval spiracles are unusually conspicuous, borne on a pair of cornua which are capable of considerable elevation although usually rather closely retracted.

The shape of the body is sub-cylindrical with the anterior segments forming a false head, and the mouth-hood as in type III. The terminal segment tapers strongly into the respiratory process. The integument is very flexible and transparent; segmental hairs double, similar to type III. The anterior pupal cornua are longer than in type III and nearly cylindrical, the enlarged distal part much longer than the basal stalk, hence the whole less mushroom-shaped.

V. THE MICRODON TYPE OF LARVA.

Body hemi-spherical; the flat surface ventrad, with a row of spines around its margin; dorsum reticulated. Posterior respiratory process short, the three spiracles on each half together making nine loops, convex outwardly and denticulated on their outer margin. Inter-spiracular ornamentation of non-plumose fine hairs. Mouthparts consisting of a ventral Λ-shaped jaw and two dorsal pieces placed Λ-shaped, but not fused at the apex. Segmental hairs and prolegs wanting. Anterior larval spiracles apparently wanting. Pupal respiratory cornua morel-shaped.

The larvæ of this genus are very aberrant and superficially show no relationship with the other larvæ of Syrphidæ, differing strikingly from all the others in shape. Instead of the elongate, sub-cylindrical body we have a nearly hemi-spherical body. The outline is short elliptical, the ventrum very much flattened forming a ventral sole around the margin of which is a circlet of ornamental spines. Dorsum almost uniformly rounded up. Mouthparts open in a longitudinal slit on the cephalic part of the ventral sole. Posterior respiratory process dorso-caudad, short, tubular, but with some indication of its double nature; circular plate medio-dorsad. The spiracular slits each of three, outwardly directed loops, denticulated only on the outer side, almost arborescent in appearance but still divisible into three pairs. The interspiracular ornamentation of small, delicate, non-plumose hairs. No anterior larval spiracles have been demonstrated.

In place of the transverse folds or wrinkles on the dorsal surface, it is evenly convex and beautifully reticulated with lines of papillæ. I find no evidence of the segmental hairs.

The pupal respiratory cornua are similar to those of type III being much shorter than in type IV.

Economic Importance of the Larvæ.

The principal economic importance of the larvæ is four-fold, two of these relationships being beneficial and two of them detrimental to human interests.

A. Beneficial Habits.

1. *As predators.* By far the most important economic bearing of Syrphidae arises from the predaceous habit of many common species. Of the prey affected, aphids compose probably ninety-nine per cent. *Coccidae* and the young of *Aleyrodidae, Jassidae, Psyllidae and Membracidae* are also attacked, and occasionally even active winged insects such as Diptera may be caught (55, p. 311) or the larvæ of other Syrphidae devoured.

With the vast majority of species there is no close restriction to particular species of prey; although a few species such as *Didea fasciata* and *Pipiza pisticoides* have been found among only one or a few species of aphids.

For the most part the service of these insects is in preventing the abnormal increase of the various injurious species of aphids rather than in exterminating the colonies in any particular place; although the latter result is by no means uncommon. Their value is ordinarily due to their very uniform distribution and constant occurrence, rather than to tremendous numbers at any time or place. Nevertheless, instances of the occurrence of enormous numbers of them are not lacking. Perhaps the most notable of such records is that by W. G. Johnson (23, p. 97) regarding the abundance of larvæ during an outbreak of the pea-louse (*Macrosiphum pisi* Kalt.) in southern Maryland in 1899. I quote from Mr. Johnson as follows:

"The real importance of the Syrphus-fly larvæ in the reduction of the species [the pea-louse] was shown beautifully in southern Maryland, where they were so abundant the first and second weeks in June as to almost completely destroy the lice." And quoting further from his correspondent: "'The insects (lice) started to disappear last week and are now about all gone . . . The last few days I packed, the separators sieved out about 25 bushels of green worms [larvæ of Syrphidæ, chiefly *Allograpta obliqua*] which no doubt proves that they destroyed the lice.'"

Mr. Johnson states further that the Syrphid-flies did not save the crop that year but calls attention to their probable value in relation to future ravages of the pest. A conservative estimate shows that twenty-five bushels of the larvæ of *Allograpta obliqua* could scarcely represent less than 3,000,000 individuals. Presuming that the larvæ lived ten days and ate on the average twenty aphids a day (which I believe also to be a conservative estimate) such a multitude of larvæ would be responsible for the destruction of over half a billion aphids.

Another example of the extermination of aphid colonies by these predaceous larvæ is afforded by the attacks of *Pipiza pisticoides* on the Woolly Apple Aphis. These aphids became evident as above-ground colonies on apple, at Orono, about the first of August. At the same time several species of Syrphid larvæ also made their appearance among them, chiefly the larvæ of *Pipiza*. Shortly the Woolly Apple Aphis began to disappear, the aphids becoming scarcer and scarcer and the predaceous larvæ more and more evident, until by early September I found myself with many larvæ on hand and almost no aphids anywhere to be found as food for them. Doctor Patch tells me she has found this a rather common experience; and that year after year, the colonies of Woolly Apple Aphis on apple have practically disappeared in the presence of these predaceous larvæ, by mid-September. See also page 224.

The relentlessness of these enemies of aphids is illustrated in a peculiar way by the experience of the Station Entomologist, who for a number of years has been studying the aphids of the State. It is an altogether too common experience that aphid material mailed to her for study has been absolutely consumed *en route* by Syrphid larvæ, inadvertently introduced into the package by the correspondent.

Hardly a colony of aphids can be found that is not being preyed upon by from one to half a dozen species and from one to dozens of individuals. They kill the individual aphids outright but on account of the rapid rate of reproduction of the latter the colony usually exists for some time at least.

I have been interested in getting some definite data as to the capacity of these larvæ for devouring their prey.

Specimens of *Aphis brassicae* proffered to a four-day old unfasted larva of *Syrphus americanus* were devoured at the following rate: Four minutes and 30 seconds, 2 minutes, 1 minute, 1 minute, 30 seconds, 3 minutes and 15 seconds, 2 minutes, 1 minute and 45 seconds, and 1 minute and 30 seconds; a total of nine aphids in seventeen and a half minutes (32, p. 481). In this test the aphids were touched to the mouth-parts of the larva as rapidly as the previous skin was discarded. It was thought that this represented an abnormal rate of feeding. Last summer the larva of *Syrphus nitens* was observed while feeding *normally* on the large aphids *Pterocomma flocculosa*. During a period of twenty minutes, twenty-one aphids were caught and destroyed. The larva had not been kept away from food nor were the aphids supplied for it or the process in any way hurried or artificial.

How much longer feeding at this rate may continue or how frequently such periods of rapid feeding may succeed each other, observations have not yet shown. However, it seems certain that the number of aphids destroyed by a single specimen during its larval existence of one or two weeks or longer must be very considerable.

Particularly when we consider the enormous numbers of progeny which may be prevented from developing by the destruction of even a single agamic female, the value of these agricultural benefactors may be more correctly judged. A point of great importance in this respect is that the Flower-flies infest the aphid colonies very early in the establishment of the latter; indeed, sometimes the Syrphid eggs are deposited on a plant in advance of its infestation by the aphids; so that numerous voracious larvæ may be awaiting the first appearance of the stem-mother and her progeny.

Another important point which enhances the destructive powers of the Syrphid larvæ, is that they eat—not the entire aphid—but only the soft and rapidly digestible body-contents.

"These aphidophagous larvæ, although frequently found entirely surrounded by an abundance of prey, are very often obliged to search about for food. Their characteristic, looping movements are very familiar to many people. When used for progression alone, these movements may be very rapid. Their progress is very similar to that of a 'measuring-worm' though the body is not so long. When the larva is searching for food, the anterior half or two-thirds of the body is raised in the air, very much extended, and lashed from side to side. It is then attached and the posterior parts pulled up, when the movement is repeated. Thigmotropism, and not chemotropism, seems to be involved in locating food. Hungry larvæ frequently pass by aphids so closely as almost to touch them, and go on in search of others. When a suitable aphid is found the larva frequently grasps it first by the leg or antenna and clings to this appendage until the thorax or abdomen can be reached. The mouth-parts are firmly attached to the body, the body-wall is punctured, and the aphid usually lifted high in the air. Then begins a process of slowly picking and sucking out all the body contents, which may continue from a fraction of a minute to more than an hour (in the case of very young larvæ). The action of the mouth-parts is very characteristic and very well adapted to the needs of the case. Many different muscles, which have their origin on the body-wall in the region of the head, are inserted upon the cephalo-pharyngeal skeleton, the jaws, and the mouth-hooklets. Some of them operate the framework in and out like a battering ram. Others at the same time open and close the jaws. The anterior two or three segments are inserted completely within the body wall of the aphid. The jaws are directed into every corner of the body and even into the bases of the appendages as they pick and suck out the soft contents. The skins, absolutely empty, are then discarded by retraction of the segments, the hairs or spines on those outside serving readily to dislodge the skin. These dead skins usually drop down or blow away but may sometimes be seen in numbers on the host-plant." (The Author, 35, pp. 26, 27).

2. *As Scavengers.* The other important way in which the larvæ of Syrphidae are beneficial to human interests is by their activities as scavengers. Considerable quantities of dead animal and vegetable matter are in this way reduced to simpler compounds, more readily assimilated by plants; and certain materials which are obnoxious, and may be a menace to health, are transformed to innoxious forms.

To quote from Comstock (10, p. 415):

"Although the habits of these creatures, which revel in all kinds of filth are very disgusting, we cannot help admiring that arrangement by which a mass of filth, instead of being left to poison the atmosphere, is transformed into myriads of living beings whose swift flight and delicate forms lend life and beauty to the landscape."

Happily, the breeding of these flies in excrement ordinarily causes no menace to human health; because (unlike the house-fly) they do not commonly visit human habitations and human foods, but confine their explorations as adults almost exclusively to flowers out-of-doors.

B. INJURIOUS HABITS.

Few large families of insects are on the whole less detrimental to human interests than the Syrphidae. Yet it is incorrect to state, as some of our text-books do, that none of the species are injurious; for although the family includes no well-known pests in this country, there are two important ways in which the Flower-flies are injurious in the larval stage.

1. *As Crop-Pests.* The few species which are phytophagous are occasionally seriously destructive to crops. The most notable of them in America is *Toxomerus* politus* which has come to be known as the Corn-feeding Syrphid-fly. This species has been reported as feeding on corn in abundance as follows: New Jersey, 1885 (44), 1899 (53) and 1913 (42); Florida, 1886 (44); Missouri, 1889 (45); Delaware, 1900 (50); and North Carolina, 1913 (35). I found them (pupæ) abundant on field corn (in the axils of the leaves) at the Ohio State University farm, September, 1915; and Professor Z. P. Metcalf sent me larvæ and pupæ (attached among the glumes on the tassels) from West Raleigh, North Carolina, in late August, 1915 with the statement that they were again plentiful there.

The species is evidently widespread and common on corn, but only a few cases are known where its attacks were considered serious; notably in Florida and Missiouri (*loc. cit.*). They feed on pollen grains and on the saccharine cells at the axils of the leaves. The former habit might seriously interfere with fertilization and the consequent yield of grain, if the larvæ were abundant; while the latter attack was stated to produce a wilting and browning of the lower leaves similar to the injury from chinch-bugs. This species is not yet recorded from Maine but will probably be found to occur within the State. The puparia are often heavily parasitized which may explain why they are not oftener seriously destructive.

**Mesogramma.*

In Europe the larvæ of *Merodon equestris* (55, p. 556) and *Eumerus strigatus* (55, p. 615) are pests of flowers such as Narcissus and Amaryllis, and of the onion among vegetables. The larvæ burrow into, and promote the decay of, the bulbs of these plants; in certain instances having destroyed thousands of plants. They have been introduced into North America and are transferred from place to place in infested bulbs, and there is reason to fear that their range will continue to be extended and that they may become serious pests in this country.

On July 25, 1916, a number of the adults of each of these two species was taken about blossoms in a nursery at Bar Harbor. No damage by the larvæ had been recognized by the nurserymen, but the number of adults present indicates that the species are established in the State or are quite likely to become so.

2. *As Transitory Animal Parasites.* The fourth important way in which larvæ of Flower-flies affect us is by their occasional occurrence in the living human or animal body and the accompanying disturbances or destruction of tissues. Myiasis is known to be produced by Syrphidae in four ways: First, by their presence in the alimentary canal (intestinal or gastric myiasis); secondly, by their introduction to the nasal cavities (nasal myiasis); thirdly, by their introduction to the auditory cavities (auricular myiasis); and fourthly, by their introduction into the vagina (vaginal myiasis).

The first of these is the more common. Probably it not infrequently occurs and is not recorded. On the other hand, many reported cases of larvæ having been passed from the bowel are doubtless erroneous due to the stools having become infected after passage. Hall and Muir, 1913, (16) have summarized the published data relative to myiasis due to Syrphidae and described an additional case. It appears that there are certain authentic cases on record where such larvæ have been passed alive, sometimes as many as twenty or thirty at a time. The presence of the larvæ in the intestine caused some of the following symptoms: Intestinal pains, vertigo, nausea, vomiting, constipation, headache, nervousness, weakness and emaciation.

The species known to be concerned in such infestation are *Eristalis tenax* (2, 46, 51, 29), *Eristalis dimidiatus* (46), *Eristalis arbustorum* (56) and possibly *Helophilus* (*Musca*) *pen-*

dulus (36). These are all larvæ of the long-tailed, filth-inhabiting type which live normally in sewage, putrid or stagnant water, in ditches or even in watering troughs (27), and wells (47; 16, p. 5).

The source of infection in certain cases has been explained as follows: By ingestion of eggs laid on cream, sour milk or cheese; by ingestion of eggs or larvæ in drinking water from springs, contaminated by the drainage from compost heaps or from stagnant pools or ditches; by eating water-cress or over-ripe fruit in which larvæ may be present; or by deliberate ingestion on the part of children. Any of these methods seems possible and all, except the first and the last, quite probable.

It is not difficult, as pointed out by Wagner (56), to see how these larvæ are able to exist in the alimentary canal, where the conditions would not differ greatly from their normal habitat in fæces. The food is similar, plenty of air is supplied by swallowing, and the mephitic gases are not greatly different. It is not quite clear how the larvæ manage to resist passage for many weeks, as certain cases indicate. They have no hooks which would enable them to attach to the intestinal wall unless, indeed, it be the minute ones on the prolegs, which seem inadequate.

Austen (2) reports two cases of intestinal myiasis due to the larvæ of *Syrphus,* which are not so easy of explanation; because what is known of the larval habits of this genus does not indicate a ready source of infestation, nor a likelihood that these larvæ would readily adapt themselves to the conditions of the alimentary canal.

The other kinds of myiasis due to Syrphidae are exceedingly rare. Leidy (25) has recorded a case of a rat-tailed larva stated to have been removed from the nasal cavity; Austen (2) a case of the invasion of the external auditory meatus by a *Syrphus* larva, resulting in pain and deafness; and Hall and Muir (16) record a case, reported to the Bureau of Animal Industry, U. S. Department of Agriculture, from Maryland in 1909, where eight larvæ of *Eristalis* were stated to have been passed in a jelly-like substance from the vagina of a cow. The source of infestation in such cases as these is doubtless oviposition by the fly directly in these natural cavities of the body; especially if the latter were in a diseased or uncleanly condition.

In this connection, I wish to emphasize the practical impossibility, at our present state of published knowledge, of referring larvæ found in such circumstances to a definite species, or even to the genus, unless specimens are reared to the adult. It seems to be the custom to refer any rat-tailed larva to *Eristalis tenax*, or at least to the genus *Eristalis*. Such records, unless based on adults reared from the larvæ, must, it seems to me, be discarded as of no specific importance. I am working on the problem of separating these different species in the larval stage, and have examined a dozen species of rat-tailed larvæ belonging to several genera, the separation of which is exceedingly puzzling and difficult, and any one of which might easily be mistaken for the larva of *Eristalis tenax*.

Other biological relations of the larvæ, of more or less economic importance, may arise from their association with other insects, in aphid colonies, or in the nests of colonial insects; and with their predaceous and parasitic enemies.

Economic Importance of the Adults.

While the principal economic importance of Syrphidæ arises from the habits of the larvæ, the adults are by no means devoid of importance in this respect. The adults, so far as known, feed almost exclusively on the nectar and pollen of flowers or the honey-dew of insects. Anyone who has observed the tremendous numbers of these flies which mingle with Hymenoptera about all sorts of melliferous flowers, will be able to appreciate their importance in the cross-fertilization of entomophilous plants. All sorts of fruit and shade trees, wild and cultivated flowers, and certain field and garden crops, are regularly visited by these flies. Some of the flies, which possess an abundant vestiture, often of spurred and branched hairs, are very admirably adapted for the carrying of pollen. This is a subject deserving of careful observation. But in the absence of much definite data it seems safe to ascribe to this family a very large share of credit for this beneficient work, which is usually attributed to Hymenoptera alone.

Practical Measures.

Since the above analysis shows that the economic importance of the Syrphidæ is overwhelmingly beneficial, one is naturally desirous of knowing what could be done to favor, or foster them and increase their numbers.

1. The first thing to be done it seems to me is to educate people and especially agriculturists to discriminate between these Flower-flies and stinging Hymenoptera. The writer knows from personal observation that many of these beneficial insects are constantly being killed as "sweat-bees" under the impression that they can sting. Whereas, *they are absolutely unable to harm the person in any way; and furthermore, are, both as larvæ and adults, (with the exception of a very few species) among the farmer's most valuable animal friends.*

There are several simple ways in which these two groups can easily be distinguished in spite of the great resemblance in color, form and habit. *If the insect is flying,* the Flower-fly can be recognized by its distinct manner of flight, which has given the group the name of "Hover-flies." They constantly poise in the sunlight, or about flowers, remaining suspended in one place for a considerable time without any apparent movement of the body, the wings beating so rapidly as to be practically invisible; then dart away and quickly return, the body always in a tense horizontal position. Bees, when flying, habitually weave back and forth or bob up and down. On closer inspection most of the species can be distinguished by the shorter antennæ ("feelers") which are not easily seen in flight; while the antennæ of the bee are usually visible in front of the head. *If the insect comes to rest,* the Flower-fly is apt to keep its wings partly spread, the bee or wasp to fold them closely or cross them at the tips. *If you have the insect in your hand,* see if the wings on one side can be separated into two readily. The bees have two pairs of wings hooked together, but easily separable; the Flower-flies of course have only one wing on a side. Back of the base of the wing in the Flower-flies is a small knobbed thread (Fig. 29-4) visible to the naked eye on very careful examination, wanting in the Hymenoptera. And, finally, if a hand lens is available look for the false vein (Fig. 34-7) on the wing, which is the most distinctive characteristic of the Syrphidæ.

2. Not only should the adults be spared but the larvæ (Figs. 29-*1*; 30-*6*; 34-*1*) on plants, among aphids, should be given careful protection. Too often they are killed under the supposition that they are damaging the plant. The figures and descriptions should enable one to distinguish these larvæ; but, if there is any doubt, careful observation will usually be rewarded by seeing one of them attack and devour an aphid.

3. The writer, with the assistance of Mrs. Cleo Fouch Metcalf, is investigating the effect of contact insecticides, such as are used for plant-lice, on these predaceous larvæ, in the hope that an effective spray for the aphids may be found which will not destroy the larvæ. In this way the latter might be left on the plants to seek out and destroy any aphids which escaped the spray, and thus tend to make the control measures perfect. The investigation has not gone far enough to justify conclusions, but it may be said that in laboratory tests a solution of Black Leaf 40*, 1 to 1000 of water with soap added, killed every aphid and only a small percentage of the larvæ. The effect of this insecticide on the larvæ under field conditions will be further observed.

4. During late summer and autumn, especially, a large percentage of the puparia of Flower-flies are parasitized by a small wasp which kills them. Such puparia can be easily told, after a little experience, by the fact that they do not completely inflate dorsally and soon become darker in color than normal. Much good could be done by careful observers in destroying such parasitized puparia wherever found.

Species Reared in the State.

During the summer of 1915 at this Station, I succeeded in rearing from eggs or larvæ twenty species of Syrphidæ, nine of which have apparently not previously been described in the immature stages. These species fall into three of the structural types of larvæ already described, as follows:

*Made by the Kentucky Tobacco Product Co., Louisville, Kentucky.

I. *Aphidophagous Species.*

Paragus angustifrons Loew.
Pipiza pisticoides Willist.
Melanostoma mellinum Linné.
Sphaerophoria cylindrica Say.
Sphaerophoria sp.
Syrphus sp.
Syrphus americanus Wied.
Syrphus ribesii Linné.
Syrphus torvus O. S.
Syrphus xanthostomus Willist.
Syrphus nitens Zett.
Didea fasciata Macq. var. fuscipes Loew.

II. *Short-tailed, Filth-inhabiting Species.*

Tropidia quadrata Say.
Syritta pipiens Linné.

III. *Long-tailed, Filth-inhabiting Species.*

Eristalis bastardii Macq.
Eristalis dimidiata Wied.
Eristalis arbustorum Linné.
Eristalis tenax Linné.
Tubifera lineata Fabr. (Helophilus conostoma Willist.)
Tubifera trivittata Fabr. (Helophilus latifrons Loew.)

The Short-tailed and Long-tailed Filth-inhabiting species were, all except the last species, reared from decomposing human fæces at the mouth of a sewer. *Tubifera trivittata* (*Helophilus latifrons*) was breeding in old and dried, but recently water-soaked, droppings of cattle, and soft black mould about stumps in an old stumpy pasture where heavy rains had left numerous pools of shallow water.

The aphidophagous species named above and others not determined were found preying on 33 species of Aphididae and two species of Psyllidæ as follows:

List of Homoptera* Attacked by Syrphidae in Maine as Observed in 1915.

APHID.	HOST PLANT.	SYRPHID.
Aphis viburnicola	Viburnum opulus	*Syrphus ribesii*
		Sphaerophoria cylindrica
Aphis viburniphila Patch mss.	Viburnum opulus	
Aphis cardui	Plum	*Syrphus* sp.
		Sphaerophoria sp.
Aphis cerasifolii	Prunus virginiana	*Sphaerophoria cylindrica*
		Syrphus sp.
Aphis pomi	Apple	*Syrphus americanus*
Aphis spiraecola	Spiraea	*Syrphus torvus*
		Sphaerophoria sp.
Aphis spiraephila	Wild Spiraea	*Paragus angustifrons*
Aphis sanborni	Flowering Currant	*Paragus angustifrons*
		Sphaerophoria sp.
Aphis rumicis	Syringa	*Sphaerophoria cylindrica*
Aphis rumicis	Evonymus alatus	
Aphis rumicis	Broad-leaf Dock	
Aphis helianthi	Cornus	*Sphaerophoria cylindrica*
Aphis cornifoliae	Cornus	*Sphaerophoria* sp.
Macrosiphum rosae	Rose	
Macrosiphum solanifolii	Rose	*Sphaerophoria cylindrica*
Macrosiphum rudbeckiae	Goldenrod	
Macrosiphum sp.	Anaphalis margaritacea	
Myzus cerasi	Plum	
Myzus cerasi	Wild Cherry	*Syrphus* sp.
		Sphaerophoria cylindrica
		Sphaerophoria sp.
Myzus cerasi	Prunus sp.	*Sphaerophoria cylindrica*
Myzus persicae	Rape	*Melanostoma mellinum*
		Sphaerophoria cylindrica
		Sphaerophoria sp.
Myzus sp.	Currant	
Rhopalosiphum nymphaeae	Plum	*Syrphus ribesii*
		Syrphus sp.
		Sphaerophoria cylindrica
Rhopalosiphum nabali	Prenanthes sp.	
Phorodon humuli	Plum	*Syrphus ribesii*
		Syrphus torvus
		Syrphus sp.
		Sphaerophoria cylindrica
Pterocomma flocculosa	Willow	*Syrphus nitens*
		Syrphus americanus
		Didea fasciata fuscipes
Siphocoryne xylostii	Snowberry	
Symdobius oblongus	White Birch	*Syrphus americanus*
Chaitophorus populifoliae	Poplar	*Syrphus ribesii*
Chaitophorus sp.	Willow	
Schizoneura americana	Elm (Curl)	
Schizoneura lanigera	Apple	*Pipiza pisticoides*
Tetraneura graminis	Elm (Cock's Comb Gall)	
Prociphilus corrugatans	Amelanchier canadensis	
Prociphilus fraxinifolii	Ash	*Syrphus* sp.
Thecabius patchii	Populus balsaminifera	
Hamamelistes spinosus	Birch	*Syrphus ribesii*
PSYLLID.		
Psylla striata Patch	Birch	
Psylla cerasi Patch	Prunus Pennsylvanica	

* Identifications by Dr. Edith M. Patch, Entomologist.

Descriptions of Life-Stages and Life-Histories of Maine Species.

Pipiza pisticoides Williston.

This species is one of the most important if not *the* most important natural enemy of the Woolly Apple Aphis (*Schizoneura lanigera*) about Orono. The larvæ were plentiful among the above-ground colonies of this aphid, especially during August. The eggs are laid by adults, doubtless of a spring generation (developing among one of the elm Schizoneura?), as soon as the aerial colonies of the aphis are established on the apple.

Good-sized larvæ were collected August 3, 16 and September 1. Pupæ were formed August 14, 21 and 24, the adults emerging from 11 to 13 days later.

So rapacious are these larvæ that they practically exterminated the Woolly Apple Aphis about Orono by the first half of September. Dr. Edith M. Patch tells me this is the usual experience year after year.

Walsh and Riley (48, 49, 57) have described and figured a species of this genus, which was found feeding on *Schizoneura lanigera* and *Phylloxera vastatrix,* under the name of "The Root-louse Syrphus-fly (*Pipiza radicum* n. sp.)." Osten Sacken (38, p. 120) listed this species as a synonym of *femoralis* as did also Williston (62, p. 26) with a query. The type specimen appears to be lost but Coquillet (11) concludes from a comparison of the original description with the type of *Pipiza pistica* Williston that they are the same, hence the latter a synonym of *radicum,* and consequently that "the root-louse Syrphus-fly" should be known as *Pipiza radicum* Walsh and Riley, being distinct from *femoralis* Loew.

Williston (62, p. 29) at the same time that he described *Pipiza pistica* described another species, *P. pisticoides,* from a single female from Mount Washington, as follows:

"Resembles *P. pistica* very much but seems evidently different. The third joint of the antennæ is orbicular, as broad as long; the pile throughout is shorter on the abdomen scarcely discernible; the size is also distinctly smaller."

Certain specimens collected in Ohio and one specimen, reared from an overwintering puparium among *Schizoneura americana* on Elm agree with Williston's description of (*pistica*=) *radicum*. In these species the third joint measures, — maximum width, .32 mm. by maximum length about .5 mm., the ratio being roughly 1 :1.6.

However, the specimens reared in Maine are much less evidently pilose, and have the third antennal joint noticeably smaller and more elongate; measuring, maximum width, .25 mm., maximum length .42 mm., the ratio being roughly 1 :1.7.

Another difference between the above groups of specimens (which may or may not hold true for a larger series) is in the length of the posterior, or medio-cubital, cross-vein at the outer end of the discal cell. In the Maine specimens (*pisticoides*) this vein is about .45 mm. long, one-fourth shorter than in the Ohio specimens (*radicum*) where it measures nearly .6 mm.

The above specimens are therefore referred to *Pipiza pisticoides*.

Larva. (Fig 29-*1*) Dimensions, average of eight, length, 6.75 mm., maximum width, 2.3 mm., height 1.8 mm. A wrinkly, moderately spiny, pale-yellowish or flesh-colored larva, usually much obscured by the woolly excrescence of the aphids among which it is found. Segments 5 to 11 inclusive of nearly equal width, the fourth and twelfth a little more than half as wide. The remaining anterior segments retracted except when the larva is active, then strongly accuminate to the terminal mouth-parts. Mouth-parts of the aphidophagous type with slender accessory thorns and a pair of prominent, short and heavy lateral mouth-hooks. The anterior larval spiracles slender, inconspicuous.

Each segment with one prominent, and two less prominent, transverse wrinkles, the latter sometimes sub-divided. The produced edges of the segments form two, zig-zag, lateral carinæ one above the other, composed chiefly of the fleshy, conical elevations which bear the dorso-lateral and lateral segmental spines. The entire dorsum covered with minute, close-set pale integumental spines, .015 to .03 mm. long, with broad bases and acute tips. The segmental spines likewise pale. about .1 to .15 mm. long, of two sub-equal parts, the terminal part slender, accuminate, the basal part more than twice as broad.

The posterior respiratory process with a moderate constriction about mid-length; the basal half sub-conical fleshy and papillose, the distal half polished sub-cylindrical, a little flattened dorso-ventrad, at the tip evidently of two tubes fused mesad. The entire process is elevated to a length of about .5 or .6 mm.. the polished distal part measuring about .25 mm. in length; maximum width about .25 mm., maximum heigth about .15 mm. The spiracular slits prominent, usually raised on radiating carinæ. Length of median spiracle about .065 mm., its width about .015 mm. The two stigmal plates separated by a median incision. The circular plates or "buttons" prominent, situated a little dorsad, .035 to .04 mm. in diameter, their inner margins separated by about half their diameter. The inter-spiracular ornamentation consists of four pairs of prominent slender bristles or hairs (Fig. 29-*2*) about .04 to .05 mm. long, a pair dorsad and ventrad of the circular plate, respectively, and one in each of the other interspiracular spaces.

Puparium. (Fig. 29-*3*). Length about 4.75 mm., height about 2 mm., width 2.25 mm. to 2.4 mm. Ventral line strongly concave, the dorsal line moderately elevated, producing almost a semi-circular curve from mouth-parts dorsally around to the posterior respiratory process. Greatest depth and width about the anterior third, tapering moderately on each side to within one millimeter of the posterior respiratory process, thence rapidly to that organ, which occupies a terminal position. Nearly circular in outline as seen from in front, slightly flattened ventrally. Color testaceous brown. Segmental and integumental spines not visible to the naked eye, but giving the puparium a spinulose appearance when somewhat magnified. Other characteristics as in the larva.

Adult. (Fig. 29-*4*). Uniformly black, about 6 mm. long. Antennæ black above, lower half of first and second joints and third joint on basal half of lower side yellow; the distal half and upper side all black. Arista as long as second and third joints together. Front black pilose, a few white hairs across the middle. At each side midway between ocelli and base of antennæ a white pollinose spot. A similar, narrow, elongate stripe of the same pollen on upper part of facial orbits. Face with rather sparse white pile, the eyes and posterior orbits short, white pilose. Thorax and abdomen shining metallic black, finely ruguloso-punctate, with very fine short white pile. Legs black with white pile, the following parts yellow; tips of all the femora, the broad base and narrow tip of the four front tibiæ, the narrow base of hind tibiæ and basal joints of the four front tarsi.

Melanostoma mellinum Linné.

One of the most common species throughout North America and in Europe. Of their abundance Schiner (Fauna Austr. i. 291) says (translating freely):

"I have brought in thousands from all possible situations. They are found on every trip and finally tire the poor dipterologist because, while always apparently new, they nevertheless prove, upon closer examination to be nothing but varieties of the same variable species."

Verrall (55, p. 311) writes: "The larvæ of this species are believed to be aphidophagous as they have been bred from *Aphides* on *Chrysanthemum leucanthemum,* but M. A. Giard in Bul. Soc. Ent. France, 1896, p. 234, traced and bred many larvæ which occurred on the umbels of *Daucus carota* (on plants which bore no *aphides*) and which lived on the bodies of *Musca domestica* and *Chortophila pusilla;* the larvæ attacked these flies at the junction of the neck with the thorax and held on for one or two days before pupating."

On July 24, 1915, I found in a field of oats and wild mustard on the Station farm, many females of this species, their abdomens greatly distended with eggs. They seemed to be feeding on the blossoms of the mustard and no signs of oviposition were found. No aphids could be found on these plants. The ova of the flies were plainly visible through the thin, distended and transparent abdominal sterna and pleura, especially of the posterior half of the abdomen. Only a single male was taken and no others seen. Whether this indicates a relative scarcity of males or simply that the gravid females were more easily taken I am unable to say,—propably the former.

Twelve females were placed in jars with the single (available) male. Two days later July 26, 7 A. M., a large number of eggs had been deposited on the sides of the jar and on grass enclosed; probably having been laid during the night. July 28 by 8 A. M., the eggs were hatching, the duration in the egg stage having been between two and two and a half days. Not being certain of the larval habits, I placed the young in a variety of situations and offered them a variety of substances for food. The only noticeable result was the decided preference shown by the larvæ for very moist situations. From the variety of aphids offered them they seemed to show a preference for *Aphis cornifoliae* from *Cornus* although no larvæ were found among this species in the field.

The larvæ fed in captivity developed rapidly and began pupating August 14.

The following are the dates of pupation and subsequent emergence of adults from the eggs laid July 26.

Pupated	August	14	Parasite	emerged	August	26
"	"	16	♂	"	"	26
"	"	17	♀	"	"	23
"	"	20	♀	"	"	27
"	"	20	♀	"	"	30
"	"	23	♀	"	Sept.	3
"	"	26		"	"	4

Again on August 12 a female in captivity deposited a number of eggs. They were placed quite rapidly at intervals of about a minute. The following is the rate at which ten successive eggs were laid: 48 sec., 3 min., 2 min., 3 min., 4 min., 1 min. and 20 sec., 1 min., 1 min., 1 min., 1 min.

The above eggs had practically all hatched over night previous to 8 A. M., August 16; the duration in the egg stage having been about 4 days.

On August 7 a number of females were found hovering about among a very dense growth of rape on the Station farm. Careful examination revealed an abundance of eggs, which later proved to be this species, deposited on the under side of the lower leaves near the ground where it was constantly wet or damp. The eggs were ranked quite closely side by side in groups of from 2 to 8, more commonly 4 or 5 (the sides of the eggs touching each other). These eggs hatched August 11. The larvæ were apparently half-grown by August 23, and began pupating August 31 to September 4.

At the same time (August 7) a large number of larvæ of all sizes, and pupæ in all stages of development, were found on the under side of the leaves among the rape. The larvæ apparently sought out the moist places near the ground. These plants were infested with *Myzus persicae* but the aphids present at this time were fewer in numbers than the predaceous larvæ. It seems to me likely that here is a case where an infestation of aphids, which must have been severe to mature so many hundreds of larvæ, had been all but exterminated by the predaceous larvæ. This opinion gains confirmation from the fact that many of the pupæ present were undersized and somewhat misshapen, such as often results from starving larvæ. The larvæ collected were placed in all conceivable situations to see if possibly they might feed on some other food; but all foods were refused except aphids. They showed a preference for *Myzus persicae* and *Aphis cornifoliae* from *Cornus*. Fed on these aphids in captivity the larvæ pupated between August 7 and 11, and adults or parasites emerged August 14 to 18.

Of larvæ collected August 16 two pupated August 24, one emerging as adult August 28 the other August 31; another pupated September 4 and emerged as adult September 9.

Egg. (Fig. 30-*1*, *2*, *3*). Of the usual Syrphid shape, sub-cylindrical, a little broader and more rounded at one end, narrower and truncated at the micropylar end. The dimensions of 56 eggs from several different females were as follows: The length ranged from .8 mm. to 1.057 mm., with an average of .96 mm.; the maximum width ranged from .315 mm. to .4 mm. with an average of .36 mm. Figure 30-*1* and *2* is from camera-lucida drawings of three masses of eggs as found in nature. The sculpturing on the egg-shell (Fig. 30-*3*) consists of irregularly-shaped elevations 5 to 10 times as long as broad and separated by depressed areas several times their width. Each elevation has around its border a varying number (commonly about a dozen) of short, irregularly-sized and unsymmetrically-placed, lateral extensions. Forty-five to fifty of these elevations occur end to end the length of the egg, and eighty to ninety side by side around its circumference. Color: chalk white.

Larva. (Fig. 30-*4*, *5*, *6*). Length when well extended 8 to 9 mm., width about 2.5 mm. Color saturate lettuce-green, a little more yellowish mediad. One of the most characteristic things about this species is the unusual transparency of the integument and the unusual plainness with which much of the viscera shows through the body wall. Integument finely papillose but without vestiture. The segmental spines consist of a fleshy, sub-conical base surmounted by a slender blunt peg of about equal height, the whole small, light-colored, entirely inconspicuous. The greenish color is usually entirely obscured mediad, from a little in front of the middle, backward, by a black mass of visceral matter. This mass extends nearly half the total width but is overlaid on each side by several longitudinal chains of whitish, adipose cells, which extend throughout about the posterior two-thirds of the body. Between the latter is a longitudinal, pulsating heart-line,—entirely dull black except where it is crossed by folds of the intestine. Laterad of the several whitish chains of cells, and to some extent among them, the black again appears. Near the mid-dorsal line in the second fourth of the body on each side is a single chain of black polygonal cells. The lateral third of the body and all of the anterior end entirely greenish, except for a slender white line on each side formed by the longitudinal tracheal trunks, which run from anterior to posterior spiracles. These trunks give off fine superficial branches mediad at each segment.

The transverse folds of the integument and the division into somites are inconspicuous, as are also the antennæ and anterior spiracles. The latter are a little more than usually elongate and conical. The double Λ-shaped mouth-parts may be seen through the segments at the anterior end or terminally when extended. There is a pair of heavy, black, lateral mouth-hooks. Just in front of the posterior respiratory organ, between the two tracheal trunks, is a mass of very finely-divided white filaments (tracheæ?) especially noticeable when the larval skin is moist.

The posterior respiratory process is about .3 mm. broad at the end, about .17 mm. in depth, and elevated above the surface of the last segment only to a length of about .1 mm. or .12 mm. Circular plate evident; the three pairs of spiracles unusually short, less than twice as long as broad,—.05 mm. long by about .03 mm. wide. The interspiracular ornamentation consists only of four pairs of short, rounded nodules. A moderate emargination between the two stigmal plates.

Superficially the larva resembles most closely those of *Sphaerophoria cylindrica* or *Allograpta obliqua* (*q. v.*) being about the same size and similar in color and structure. However, besides the greater transparency of the integument in this species, *Melanostoma mellinum* can be very certainly separated from the other two species; *first,* by the shorter, more nearly sessile, posterior respiratory organ which is less than half as long as broad, whereas in *Sphaerophoria cylindrica* and *Allograpta obliqua* it is considerably longer than broad; *secondly,* by the greater length of the individual spiracles on the posterior respiratory process in *S. cylindrica* and *A. obliqua.* In *M. mellinum* the slit-like spiracles are less than twice as long as broad, while in the other two species they are each at least three times as long as broad.

Puparium. (Fig. 30-*7, 8, 9*). Length 6 to 7 mm., width about 2 mm. to 2.25 mm., height about 1.7 mm. to 2 mm. Usually broadest and highest about the anterior fourth. Very moderately elevated, the posterior half of the body being especially attenuated, the dorsal line descending very gradually to the posterior respiratory process. Color dilutely greenish or yellowish. The larval skin retains its great transparency in the puparium so that the developing imago is quite plainly discernible. On this account this is one of the very few puparia of the aphidophagous type on which anterior pupal spiracles or cornua can be detected. These (Fig. 30-*7 A*) are located near the cephalo-dorsal corner of the puparium and appear as mere specks even at moderate magnification, being about .025 mm. across. Hence they would be entirely obscure (as they are in most related species) if it were not that the relatively large tracheal trunks leading from them to the prothorax of the nymph can be discerned through the puparium.

When highly magnified (Fig. 30-*8, 9*) the pupal respiratory cornuum is seen to be a nearly cylindrical elevation, a half longer than broad and the end differentiated into eight denticles, evenly distributed and not contiguous, around the circumference of the apex and extending a short distance down the sides. Each denticle oval in outline, several times as long as broad.

Adult. (Fig. 30-*10, 11, 12, 13*). Length 6 to 7 mm. *A brilliantly shining, metallic black species with bright yellow spots on the abdomen; facial tubercle small; hind metatarsi not thickened*

In the male the frontal triangle a little prominent with a pit in the middle; in the female the frons with a broad shallow transverse depression. Frons and face shining, whitish-dusted on the sides. Antennæ yellow to black, usually brownish on upper half, yellowish below except at tip of third segment, arista very briefly and short pubescent, nearly bare, yellow at the base. Abdomen *in the male* (Fig. 30-*13*) about four times as long as broad, dull black with three pairs of yellow spots; the first pair on the middle of the second segment, inner ends rounded; the others at the basal corners of the third and fourth segments, subquadrate, a little longer on the median side extending broadly over the margins. *In the female* the abdomen (Fig. 30-*12*) is shorter and oval, shining, with four pairs of orange spots the first pair small, isolated, near the middle of the segment; the third and fourth pairs subtriangular, touching the anterior margins, the posterior point rounded, the spots (either isolated or) narrowly reaching the side margins at the extreme base of the segment; the fifth segment with a pair of small slender basal spots. Legs variable, yellow to black.

Sphaerophoria cylindrica Say.

(See also 33, p. 538 and 35, p. 59).

This is an exceedingly common, and one of the most valuable aphidophagous species about Orono, and probably throughout North America. It has a variety of species of prey and may be expected in almost any colony of aphids.

Partly grown larvæ were taken June 17 from among *Aphis viburnicola* on *Viburnum opulus;* were full grown by June 28, in puparium June 30 and emerged as adults July 7. Other larvæ collected from the same source June 25, pupated July 2 and emerged July 9.

On July 7 four larvæ and one pupa were collected on Rose among *Macrosiphum solanifolii,* but all were parasitized.

A small larva collected July 14 among *Aphis rumicis* on *Evonymus alatus* was full grown and pupated July 24, emerging July 30. On the same date larvæ were collected from *Myzus cerasi* on wild cherry and a pupa from *Phorodon humuli* on plum. The former pupated July 17 and all emerged July 22.

On July 16 a pair were taken *in coitu* about blossoming turnip at 10 A. M. By 3 P. M. of the same day the female was ovipositing which continued until the death of the female on July 19. By the latter date many of the eggs were hatching.

July 26 two parasitized larvæ were taken from *Aphis cerasifolii* on *Prunus virginiana* and July 28 two puparia from the same host, the flies emerging August 3 and 6. July 31 a puparium was taken from flowering currant, the adult emerging August 7. And on the latter date larvæ and pupæ were found in all stages of development on rape, sparingly infested with *Myzus persicae.* Adults from these puparia emerged August 14.

Egg. Of the usual shape, less pointed anteriorly than that of *Allograpta obliqua* (Fig. 31-*61*, *62*). Length of twelve eggs measured, ranged from .91 mm. to 1.015 mm., with an average of .958 mm.; the maximum diameter from .32 mm. to .37 mm., the average .34 mm. Color, chalk white, sculpturing similar to that of *A. obliqua* (Fig. 31-*63*) but the elevated bodies a little shorter and broader than in that species, about two or three times as long as broad; distance between bodies about half their width; number of arms around each, 12 to 20; rather short, not much branched, many ending at half the distance across the intervening space. Number of bodies around the egg at the middle about 50; number the length of it about 30.

Duration in the egg stage about two or three days. The eggs are laid singly at short, varying intervals of time. In captivity the female always moved about after each egg was laid before depositing another. The actual process of placing the egg is speedily accomplished, the egg slipping out of the much extended ovipositor very quickly. The end is touched to a leaf where the "glue" fastens it and the ovipositor is then quickly drawn away from it, retracted, and the fly crawls away some little distance when the process is repeated. In the field the insect *flies* about from place to place, occasionally resting briefly on the under side of a leaf for the deposition of an egg. This habit of scattering the eggs of aphidophagous species is of value in preventing the too great congregation of larvæ and consequent scarcity of food. In captivity the insect frequently rested and manipulated the extended ovipositor with her hind legs, rubbing the metatarsi over it. Whether this is a natural habit or induced by some artificial condition (as, possibly, contact with the sugar solution supplied as food) I do not know. The female laid eggs at the following rate: 4 minutes, 7½ minutes, ½ minute, ¾ minute, 2¼ minutes. About 60 eggs were laid by a female taken *in coitu* and kept confined.

Larva. (Fig. 31-*76*). Length 9 to 10 mm., height 1.25 mm., width 2.25 mm. Elongate oval, tapering at anterior end, somewhat truncate except for respiratory appendage at posterior end, depressed. Outline irregular, dorsal integument much wrinkled transversely, and with lateral, longitudinal carinæ. Color pea-green with two, narrow, longitudinal, white stripes, laterad of and paralleling the rather conspicuous dark heart-line. The stripes attenuated and confluent a little before the anterior end, not reaching the respiratory appendage posteriorly. Respiratory appendage brownish black at the tip. The skin papillose, bare except for the usual segmental bristles which are here short, light-colored and inconspicuous. There are a number of poorly defined proleg-like projections of the body on the ventral side. The mouth-parts

(Fig. 31-*77*) consist of three pairs of hooklets in addition to the pair of jaws. One pair of hooklets is short and heavy, triangular, lateral in position (Fig. 31-*77 d*), the other two pairs, situated close beside the jaws (*c*), are slender, elongate, slightly curved. The jaws (*b*) are of the usual type but U-shaped rather than V-shaped, the shoulders rather prominent, with a median, terminal, pointed projection.

The antennæ (Fig. 31-*77*, *a*), and anterior spiracles are rather well elevated. The latter on a fleshy base with a prominent constriction beyond the middle showing at the apex a small number of rounded teeth or lobes about three larger and three smaller ones, (Figs. 31-*74*, *75*).

The shape, color and general appearance is very similar to the larva of *Allograpta obliqua*.

The two species can, however, be very certainly and definitely separated on the basis of the posterior respiratory appendages. These are about the same length and other dimensions; the difference lies in the distal end. As described in *Allograpta obliqua* the two tubes are slightly divergent at the tip making them broader here than at mid-length, and bear between each two spiracles a short, but readily visible, spur-like elevation continued as a slight ridge down the side of the tube. In *Sphaerophoria cylindrica* the end of the tube is very nicely and evenly rounded off; the spiracles very slightly elevated; the two tubes slightly emarginate but not at all divergent, and all trace of inter-spiracular spines or projections lacking. The posterior respiratory appendage .35 to .415 mm. long, .31 to .335 mm. wide, .15 to .175 mm. high. The median spiracle about .065 mm. long. The circular plates .035 to .04 mm. in diameter, their inner margins about .065 mm. apart. With the aid of a good hand-lens one can always separate these two species at a glance when the characters have once been fixed in mind. (See Figs. 31-*72* and *73* and compare Fig. 31-*66* and *68*).

Larvæ were taken almost continuously from mid-June to mid-August and probably occurred before and after these dates. The duration in the larval stage appears to be about two weeks.

Puparium (Fig. 31-*78*). Length, exclusive of respiratory process, about 5.3 mm., height about 2 mm., width about 2 mm. In general shape, color and appearance so similar to *A. obliqua* as scarcely to permit of separate description. The puparium is generally less strongly elevated on the posterior part. The characters of the posterior respiratory appendage, however, remain as in the larva and will always serve to distinguish these two species.

Puparia were taken from June 30 to August 7. In all cases these were found glued by the posterior part of the venter to the leaves of the host plant. The duration in the pupa stage ranged from 5 to 9 days.

Adult (Fig. 31-*71*). The following description adopted from Williston (62, p. 105) applies to the adults reared from the above described larvæ and pupæ. Length 6 to 8 mm. ♂. Face and front light yellow, shining; tubercle somewhat fuscous. Antennæ reddish yellow. Dorsum of thorax dark greenish olivaceous with a yellow lateral stripe, indistinct or wanting back of the suture. Pleuræ with light yellow spots as shown in Figure 31-*71*. Scutellum sulphur yellow. Abdomen slender, second segment with a broad yellow cross-band in the middle, and a brown or black band in front and behind, not reaching the lateral margin. Remaining abdominal segments variable, third with a broader yellow band and more narrowly brown or blackish in front and behind. Hypopygium wholly reddish-yellow, globose, with a tuft of pile below in front. Legs yellow including the coxæ.

♀. Front shining black, yellow on the sides below; yellow lateral stripes of thorax extending only to the suture. Abdomen moderately broad, shining black, with the extreme lateral margins continuously yellow and a moderately arcuate, entire, yellow band, reaching the yellow on the sides, on each of the segments from two to four inclusive. These bands cover about one-third the length of the segment. Fifth segment with a similar but slenderer yellow band interrupted in the middle. Sixth segment yellow with some black on the disk. In other respects as in the male.

Allograpta obliqua Say.

(See also 33, p. 533 and 35, p. 58.)

This species which ranges throughout much of this country and is often common, was very rare about Orono during 1915, being represented in the collections by a single male taken about blossoming cabbage, July 29. The immature stages were not encountered. However, on account of its close resemblance to *Sphaerophoria cylindrica* and *Melanostoma mellinum*, and the certainty that it does occur here, the following brief descriptions are included from the author's Ohio report (33).

Egg. (Fig 31-*61*, *62*, *63*). Elongate oval in outline, narrowing to the roundly-pointed anterior end and the truncate micropylar end. Length about .8 mm., diameter about .3 mm. Color chalk white, with the usual microscopic sculpturing (Fig. 31-*63*). The main bodies of the elevations are broader than in *Syrphus americanus*, three or four times as long as broad; sub-oval, the arms thicker and shorter than in *S. americanus*, usually about fifteen around each body. The depressed space between the bodies about two-thirds as wide as the body. About 28 of these elevated bodies the length of the egg; about 55 around it at the middle.

Larva. (Fig. 31-*65*, *66*, *67*, *68*). When just hatched (Fig. 31-*65*) the larvæ have a length of 1.2 mm., width .25 mm. They are irregular in outline, nearly cylindrical, broadest near the middle; feeble and inactive. Color whitish, with a yellowish or greenish tinge. The usual small, fleshy, conical, segmental elevations are present, twelve to each segment, but no bristles were discernible on them. The posterior breathing appendages are rather prominent, longer than in a young larva of *S. americanus,* and light in color like the rest of the body. Their tips are, at first, rather remote from each other though with subsequent growth and their greater elevation above the general body surface they become contiguous. The two longitudinal fat bodies are discernible as a white line on each side of the dorsal blood-vessel which is more prominent in the posterior half of the body. The skin is faintly wrinkled transversely.

From this condition there seems to be a gradual growth until the larva, when full-grown has reached a length of about 8 mm., width 2 mm., height 1.25 mm. It may then be described as follows: Shape elongate oval, but much more pointed at the anterior end when extended The outline is somewhat irregular due to folding and wrinkling of the skin. The posterior end is rounding, truncate except for the projections of the posterior breathing organ; (Fig. 31-*66*).

Color green, with two longitudinal white stripes. This color is due to colored visceral bodies which show through the transparent skin. Along the mid-dorsal line for two-thirds the length can be seen the narrow, dark, pulsating blood-vessel. It is irregularly limited at the sides by a narrow mass of greenish, fatty globules changing gradually to whitish. This whitish adipose matter forms the two prominent longitudinal white stripes, .2 or .3 mm. wide and extending to within a few millimeters of either end where they become much attenuated. The rest of the body, except the appendages is green, darker on the sides. The breathing tubes are light brown, black at the tips where the spiracles are located.

The skin is finely papillose when magnified, bare except for the segmental bristles which are light in color, not elongate and not conspicuous. The outer pair of mouth-hooks (Fig. 31-*67, c*) is present. The posterior respiratory appendage is prominent, elongate, about .5 mm. in length, .33 to .4 mm. in breadth and a little less than .2 mm. in height; the two fused tubes diverging slightly at the extreme tip (Fig. 31-*66, c; 68*). The median spiracle .08 to .09 mm. long, about .015 mm. broad, the carina bearing the spiracle about three times as long as broad. The circular plates about .05 mm. in diameter, their inner margins about .08 mm. apart. There is a short, but distinct, spur-like nodule on each interspiracular space, which is continued down the side of the tube as a more or less evident ridge.

Puparium (Fig. 31-*69, 70*). Dimensions, average of eight: Length about 5.25 mm., maximum breadth 2.5 mm., maximum height 2.3 mm. This neglects the breathing tubes at the posterior end of the body which may project .5 mm. farther posteriorly or be directed more dorsally.

The puparium is broadest and deepest in front of the middle, the anterior end bulbous; strongly and evenly depressed and compressed to the posterior end, the posterior elevation very gradual. (See Fig. 31-*69* and *70*).

The color in this stage changes very decidedly during the development of the nymph within the translucent puparium. The color being due almost entirely to the inclosed matter is consequently at first the color of the larva—light pea-green with a brownish remnant of the dorsal blood vessel and, at the sides of this, the two whitish lines. The flattened posterior end of the puparium, including the breathing tubes, however, is light testaceous brown, the tips about the spiracles black. Midway on the length of the breathing appendages is a dark brown ring.

As the pupa develops within, the color changes, gradually losing all trace of the green and assuming more and more the colors of the adult. The first thing to be noticed is the reddish brown color of the eyes replacing the green in the anterior third of the pupa. Later the black and yellow abdominal markings become apparent.

The puparium is smooth, bare; the segmental spines inconspicuous. The breathing tubes as in the larva, prominent sub-cylindrical. The wrinkles of the skin often remain rather prominent.

Adult. (Fig. 31-*64*). Description after Williston (62, p. 96). "♂. ♀. Length, 6 to 7 mm. Face yellow, often with a bluish reflection, slightly brownish on the tubercle. Frontal triangle yellow; front in the female shining black on the vertex, continued as a broad stripe (broadest below) to the antennæ; on the sides the yellow of the face continues up along the eyes nearly to the ocelli. Antennæ reddish-brown, blackish on the upper part of the third joint. Thorax deep shining green, on the sides with a yellow stripe reaching from the humeri to the suture, where it is sharply truncate; post-alar callosity also yellow. Scutellum wholly light yellow, faintly reddish on the disk; pile black. Abdomen black or brown; first segment, except a slender transverse spot on each side behind, yellow; second segment with a slender yellow anterior fascia, and a broader one in the middle, about a third of the width of the segment; straight and but slightly widened at the sides; third segment with a broad arcuate band, not quite touching the posterior angles on the sides; fourth segment with two slender parallel stripes, leaving a slender black stripe between them, on each side a broader, oblique, oval spot, touching, or narrowly separated from the anterior end of the yellow longitudinal stripe, and reaching to the posterior angles; fifth segment similar, but the side spots less oblique. Legs light yellow; last three joints of all the tarsi, the hind tibiæ, except the base and a middle ring, and a ring on outer part of hind femora, brownish. Wings hyaline, veins black."

Syrphus americanus Wiedemann.

(See also 32, p. 477 and 35, p. 55.)

This American Syrphus-fly apparently ranges throughout North America and ranks along with *Sphaerophoria cylindrica* as one of our most valuable predaceous forms. The larvæ have been found preying on the following aphids in this State: *Aphis pomi* on apple; *Pterocomma flocculosa* on willow; *Symdobius oblongus* on white birch; *Aphis spiraecola* on spiraea; *Schizoneura lanigera* on apple and *Microparsus variabilis* and *Chaitophorus viminalis*. The larvæ were common during late July and early August. Pupæ were noted July 29 to August 2, the adults emerging ten to eleven days later. The office records show that larvæ, pupæ and adults occur in the State almost continuously from mid-June to mid-September at least.

Egg. (Fig. 32-*41*, *42*, *43*). Elongate-ovate in outline, sub-cylindrical, narrower and truncate at micropylar end, nicely rounded off at the opposite end, broadest in front of the middle (Fig. 32-*42*); somewhat flattened to the surface to which it is attached, slightly humped or rounded up above (Fig. 32-*41*). Length about 0.9 mm., diameter at middle about 0.3 mm. Color chalk white.

The sculpturing of the chorion consists of microscopic projections of the surface arranged in lines running longitudinally-obliquely around the egg. Each projection consists of a long, slender, irregular body (seven or eight times as long as broad) sometimes bent, with about twelve to twenty slender arms reaching out in all directions from it. The space between these bodies is roughly a half wider than the body itself. Into these spaces the arms project, most of them meeting similar projections from the same or another body, many branching so as to form a delicate network of slender white arms between the larger bodies. Figure 32-*43* is a fair representation of a small part of the surface of the egg-shell, highly magnified. The projections are chalk white, the depressions between them shaded, appearing grayish or yellowish. The bodies are of such a size that one may count about 25 the length of the egg and about 50 around it, transversely.

Larva. (Fig 32-*45*, *46*, *47*, *48*, *49*, *50*). Just after hatching (Fig. 32-*45*), length 1.2 mm., width .2 mm. to .3 mm. Shape sub-cylindrical, broadest at the posterior end, narrowing evenly to the anterior end, not enlarged in the middle. Color light yellow or with a greenish tinge. Body surface wrinkled, the sides irregular. *Segmental spines on the fourth to eleventh segments, inclusive, and the dorso-lateral ones on the third segment, very long, slender, black; giving the young larva a very hairy appearance, so far as I know characteristic of this species.* The posterior breathing appendages short, slightly divergent (Fig. 32-*45*, *a*). No integumental vestiture. Dorsal blood-vessel faintly discernible in the posterior half of the body. During subsequent growth these slender segmental hairs are replaced by shorter, stouter, more spine-like bristles; the posterior breathing appendages are slightly elevated becoming united on the median line; and minute black spines appear all over the dorsal surface of the body.

Mature larva: Length about 11 mm., width about 2.5 mm., height about 2 mm. (Fig. 32-*46*). Compared with many other aphidophagous larvæ this species is noticeably elongate, slender, with more nearly parallel sides. Segments 6 to 11 of nearly equal width, the twelfth narrower and much depressed. Anterior to segment six the body tapers evenly to the mouth-parts when extended, or rounds off at segment four when at rest, with the head segments retracted. Body-wall prominently wrinkled and with the usual two longitudinal carinæ at each side. General color yellowish, or salmon-brown, marked with black and white. The whitish markings consist of a transverse, rectangular bar on each segment, from six to eleven, and a narrow line along each side of the larva in the dorsal lateral carina. Interrupted by the transverse white bars at each segment, is the mid-dorsal heart-line, consisting of six elongate, wedge-shaped, black marks, broadly margined with brown. Laterad of the brown are other prominent black blotches extending obliquely outward and back to the whitish lateral carinæ. The anterior two or three segments unmarked with black or brown, light greenish-yellow in color. The amount of brown color variable, frequently covering the entire dorsum except the heart-line in segments ten to twelve.

The entire dorsum of the larva covered with short, close-set, black, integumental spines. The segmental hairs larger but light in color and not conspicuous, situated on slight elevations.

The posterior breathing appendages on the dorsum of the last segment, (Fig. 32-*46*, *c*; *49*; and *50*) are short (0.2 to 0.25 mm. long) and nearly twice as broad (0.4 to 0.5 mm.); divergent for half their length; the dorsal spiracular spines (Fig. 32-*49* and *50*, *a*) moderately long, sharply conical, with a very small lateral sub-basal spur. The six elongate spiracles (*b*) are irregularly and considerably curved, about 0.2 to 0.25 mm. long, the median one on each side nearer to the ventral than to the dorsal one.

The anterior prothoracic spiracles on the third segment (Fig. 32-*46*, *b*; *47*, *a*) are small,, subcrescent shaped, the lip of the spiracle marked by nine rounded, tooth-like lobes, (Fig. 32-*48*).

The mouth-parts (Fig. 32-*47*, *c*, *d*, *e*) consist of the usual pair of beak-like jaws (*c*, *d*) and three pairs of mouth-hooks (*e*). The jaws are Λ-shaped, sharp, slightly hooked at the tip, somewhat shorter than usual, the dorsal extending slightly beyond the ventral when apposed. The latter has a ventrally projecting basal spur on each side. The mouth hooklets are unequal in size the outer pair largest; the other two pairs are situated close beside the jaws, the dorsal ones heavier, the ventral pair small, slender.

Puparium. (Fig. 32-*51*, *52*, *53*, *54*, *55*, *56*). Dimensions, average of 15: Length 6.5 mm., height 2.5 mm., width 2.6 mm. The head segments of the larva are retracted ventrally so that segments 3 to 5 lie at the anterior pole and the tip of the mouth-parts (terminal in the larva) are about 0.5 mm., back on the ventral side. The wrinkling of the skin, characteristic of the larva is largely lost, due to the inflation. The vestiture remains as in the larva, the segmental spines inconspicuous, but the exposed parts of the wrinkles of the larva, densely covered with very small, short, sharp, black spines. Sometimes this gives a rather prominent transverse banding of black where the spines are thickest.

The posterior three segments are proportionately less inflated than the middle ones. Shape from dorsal aspect ovate with the last segment and its respiratory appendage projecting; very slightly broadest in front of the middle, nicely rounded out in front. From the side (Fig. 32-56) the anterior and dorsal inflation is evident; the puparium is not strongly elevated posteriorly, being convexly depressed gradually from about the middle. From in front the puparium appears nearly circular in outline, very slightly flattened ventrally.

Color of the puparium, empty: pale brown, transparent; with pupa enclosed: variable, darker brown, strongly tinted with salmon. A day or two before emergence the prominent colors of the adult become plainly visible.

Adult. (Fig. 32-44). Description after Wiedemann (61) and Osten Sacken (39, p. 145).

♂. ♀. Length 8 to 10 mm. Female. Face yellow, in certain positions with a pearly luster, *with a brown stripe* in the middle, which begins at the oral margin but does not reach the antennæ; the latter brownish-black, reddish on the underside of the third joint. Cheeks blackish, *but separated from the mouth by a narrow yellow border,* which on the underside of the mouth completely cuts off connection between the black color on both sides. Front brownish bronze color, powdered with yellow on each side. Immediately above each antenna there is a brownish spot sometimes continued above into an indefinite black stripe, vertex metallic bronze or black, eyes bare. Thorax metallic greenish black, unstriped; with scattered luteous pile; on the sides, in front of the base of the wing, yellowish; elsewhere metallic green; scutellum metallic yellow, with a bluish reflection and sparse yellow pile. First abdominal segment metallic blue; the rest of the abdomen black with bright yellow cross-bands. The first abdominal cross-band is not interrupted but co-arctate in the middle; its ends do not touch the margin of the abdomen, but are separated from it by a narrow black border; sometimes a brownish mark in the middle of this band gives it the appearance of being sub-interrupted. The second cross-band is nearly as broad as the black cross-band between it and the next yellow band; it is usually perfectly straight (in some specimens the hind margin is gently sinuate); its ends do not touch the lateral margin of the abdomen; they are cut obliquely, forming a sharp angle anteriorly, and a rounded one posteriorly; the former almost touches the margin of the abdomen. The third band is similar to the second, only its hind margin is more perceptibly arcuated. The posterior margin of the fourth segment has as usual, a narrow yellow border; the fifth likewise, and two yellow spots at the base besides. Femora yellow; the four anterior ones in some specimens brownish at the extreme base only; the hind pair with a more or less distinct brown ring on the distal half; four anterior tibiæ and tarsi yellow; the hind tibiæ sometimes with a brownish ring, the hind tarsi brownish.

Male (Fig. 32-*44*). Front yellow, with a more or less distinct brown spot above each antenna; cross-bands on the abdomen broader than in the female, and distinctly broader than the black interval between them; posteriorly, they are often nearly straight, sometimes distinctly arcuate, especially the third band. The yellow spots on the second segment are not coalescent, but separated by a narrow black interval (in some specimens sub-coalescent); the fifth segment is yellow, with a black spot in the middle. The four anterior femora are black at the base; the hind femora are usually black, with a yellow tip; sometimes there is a trace of yellow at the base; hind tibiæ usually with a brown ring in the middle.

Syrphus torvus Osten Sacken.

(See also 30, p. 341 and 35 p. 57.)

Common to abundant throughout June and first half of July; rare during late July and throughout August. Reared from among *Aphis spiraecola* on spiraea and *Phorodon humuli* on plum seedlings. Hundreds of adults were noted about these colonies, feeding on the honey-dew secreted by the aphids. One male in the collection bears the label: "Hibernating puparium under leaves, Houlton, Maine, May 7, '07."

Larva (Fig. 33-*10, 11, 12, 13*). Length, 10 to 12 mm., width 3 to 4 mm., height about 2 mm. Shape sub-cylindrical, tapering rapidly in front to the mouth-parts, slightly narrowed but blunt and emarginate at posterior end; integument raised into numerous transverse folds continued laterally into a distinct longitudinal keel on each side (Fig. 33-*10*). First three body segments small, retractile, gradually thicker; next eight sub-equal; terminal segment flattened, bearing on its dorsal surface the posterior respiratory process (Fig. 33-*10, b; 13*). The spiracles narrow, elongate, nearly straight. The interspiracular ornamentation of slightly elevated, inconspicuous ridges. Circular plate dorso-mediad. Mouth-parts (Fig. 33-*11*) with a prominent pair of lateral mouth-hooks (*c*). Between the second and third segments dorsally is a pair of small brownish anterior spiracles (Fig. 33-*10 a, 11 g*); conical, the semicircular slit guarded by seven rounded teeth (Fig. 33-*12*).

The general color of the larvæ is brown pink. The integument is tough but transparent; naked but very finely papillose. The black mid-dorsal blood-vessel is prominent and in the living active larvæ the blood may be seen pulsating regularly from posterior to anterior end. Laterad of this blood-vessel are two long yellowish bundles of fat, irregularly outlined, extending practically the full length and varying in width. At the approach to metamorphosis these adipose masses increase in extent sometimes covering nearly the entire dorsum except the blood-vessel. At times also the body fluid invades more or less the fatty bodies appearing as outlying pulsating pockets.

Puparium (Fig. 33-*14*, *15*). Length 8 to 8.25 mm., width 3.5 to 4.3 mm., height 3.75 to 4 mm. Testaceous brown, naked, smooth except for slight remains of the transverse wrinkling of the larva. Broadest in front of the middle, nicely rounded in front, descending rapidly at the posterior end to the projecting respiratory process.

Adult (Fig. 33-*9*, *16*). Length ♂, ♀, 10 to 12.5 mm. Description, slightly modified after Osten Sacken (39, p. 139).

Female (Fig. 33-*9*): Face and cheeks yellow, a faint grayish spot on the cheeks under the eyes. Front and vertex shining black with black pile; the front on both sides along the eyes with a broad border of yellowish pollen sometimes meeting the similar border of the opposite side. This pollen continues in dilute form down the sides of the face crossing narrowly beneath the antennæ. Eyes pubescent (in many specimens the pubescence is very much rubbed off and very difficult to perceive). Antennæ inserted beneath a double arched ledge of front. The dark color of the front begins immediately above their root forming a blackish brown arch with a projecting angle in the middle. Antennæ dark brown; third antennal joint below and the bare arista sometimes more or less reddish. Face in profile perpendicular beneath the antennæ produced but little below the eyes, slightly concave beneath the antennæ to oblique tubercle, receding below (Fig. 33-*16*). Thorax dull greenish with but little luster; in well preserved specimens with three faint dorsal longitudinal darker stripes, divergent posteriorly; scutellum dull yellowish with a slight bluish reflection. The black pile of scutellum and dorsum of thorax changes to yellow on the sides of the latter where it is also much thicker and longer. Third longitudinal vein nearly straight; anterior cross-vein a third of the way from base to apex of the discal cell; anterior outer angle of first posterior cell acute. Entire sub-costal cell brown; root of wings as far as humeral cross-vein and the costal cell slightly tinged with brown. Legs slender; coxæ and basal third of femora black; on the hind pair the black reaches beyond the middle of the femora; hind tibiæ often with a brownish ring; four anterior tarsi brown the root of the first joint often reddish; hind tarsi dark brown.

Abdomen oval slightly broader than thorax; about twice as long; with three prominent yellow cross-bands, the first interrupted in the middle, all attaining the lateral margins. First segment entirely black; second segment with a yellow elliptical spot about the middle on each side prolonged usually as a narrow neck which reaches forward and touches the margin. Third and fourth segments each with a yellow cross-band on its anterior half, the hind margins of these bands very gently biconvex with a very shallow sinus at the middle; on each side the cross-bands are attenuated and curved forward so as to reach the anterior margin of the segment. The band on the fourth segment also touches its anterior margin in the middle, while that on the third is more remote from the anterior margin; the black interval between the bands is twice as broad as the bands. The fourth and fifth segments have yellow posterior margins, the fifth usually with two yellow spots on each side at the anterior margin.

Male. "Similar to the female but abdominal cross-bands broader, the biconvexity on their hind side stronger, and the sinus in the middle deeper; the gray spot on the cheeks under the eye often larger, sometimes occupying a considerable portion of the cheek; the brown ring on the hind tibiæ usually expanded so as to reach the tip of the tibiæ. The eyes (contiguous) are more distinctly pubescent, the front is beset with yellow pollen except a narrow black space above the antennæ."

Syrphus nitens Zetterstedt.

Syrphus nitens Ztt. D. Scand. ii. 712 ♀, viii 3137 (Scaeva). Verr. Ent. M. Mag. v. 193; Brit. Fl. Syrph. 377, figs. 295, 296.

Larvæ of this European species, hitherto not recorded for North America, were found on the campus of the University of Maine, July 23 to August 11. Some of them were full grown on the former date, others only about half-grown on the latter date. They were taken among colonies of the Willow Grove Plant-louse (*Pterocomma flocculosa* Weed) on the branches of a willow tree. The aphids were very ravenously devoured. One larva under normal conditions was observed to destroy twenty-one of these large aphids in twenty minutes. Six empty, and one inhabited puparia were found glued to the small branches of the willow on July 26. The adult from this puparium emerged July 31. One of the larvæ collected July 26 pupated July 27 and emerged as adult (♀) August 6. Another pupated August 1 and emerged (♂) August 12. The duration in the pupa stage is therefore about 10 to 12 days.

Besides extending the known distribution of this species, this record is of particular interest because the larvæ are the only ones of the aphidophagous type I have seen in which the spiracles on the posterior respiratory process are not straight but remarkably convoluted (See Fig. 34-*3* and *4*).

Larva (Fig. 34-*1, 2, 3, 4, 5*). Length about 15 mm., width about 3 mm., height about 2.5 mm. An unusually slender, elongate species broadest about the eighth segment, but of nearly equal width from segment seven to eleven. The twelfth is nearly a third narrower and somewhat depressed, the posterior end squarish. Anterior to segment seven the body tapers evenly almost to a point at the mouth-parts, when extended; when at rest the anterior three segments retracted and rounded off at segment four.

In their natural habitat the larvæ were so covered with threads of flocculence from the aphid host as to appear light grayish in color. When this matter is removed the color is yellowish brown, considerably mottled with black. The most conspicuous black markings are due to masses of body fluids showing through the integument; but others are formed by particularly thick areas of the black integumental spines which cover the entire dorsum, but are so minute on the venter that the latter appears bare. The largest of these spines about .04 mm. long. The arrangement of these spots is shown in figure 34-*1*, where only the ones due to integumental spines are shown. There are nine such areas on each somite, three on the middle line and three at each side. The integument is folded transversely, there being about five folds to each somite on the dorsal side. On the ventral side in segments five to eleven, inclusive, are nude elevations suggesting prolegs. The segmental spines are situated on moderate, conical elevations and are about .10 to .15 mm. in length, but light in color. The head segments bear the antennæ and mouth-parts of the kind usual in aphidophagous larvæ. There is a pair of very heavy, black, lateral mouth-hooks. The anterior larval spiracles on the third segment (Fig. 34-*1*) are barely visible to the naked eye. When magnified (Fig. 34-*2*) the surface is found to bear about a dozen, elongate nodules arranged in a semi-circle.

The posterior larval spiracles are unique among aphidophagous larvæ so far observed. They are borne on a very short, double process rather more than usually emarginate distally, about half a millimeter broad, .25 to .33 mm. long and about .33 mm. high. *The slit-like spiracles instead of being nearly straight are remarkably and irregularly sinuate, convoluted or undulated in a very ornamental manner as shown in figure* 34-*3* and *4*. This extensive convolution makes the length unusually great for the spiracles in this type of larva. Between the spiracles the surface of the tube is deeply constricted so that each is situated along the summit of a broadly rounded carina, the most dorsal one the most prominent. The circular plate is only moderately conspicuous, about .055 to .075 mm. in diameter, their inner margins .08 to .1 mm. apart. The inter-spiracular ornamentation consists of small, blunt, rounded knobs sometimes double, entirely inconspicuous.

On several occasions larvæ of this species were noted extruding from the anus on the ventral side of the caudal segment, four finger-like flabellæ similar to those previously described for *Eristalis aeneus* (34, p. 86) but not heretofore noted among aphidophagous larvæ. Buckton (8) considers that these organs have a renal function.

Puparium (Fig. 34-6). The dimensions of ten specimens were as follows: The length ranged from 7.25 to 8 mm., with an average of 7.6 mm.; the width 3.5 to 4 mm., the average 3.75 mm.; the height 3.6 to 4 mm., the average 3.85 mm. The puparium bulbous in front, a little broader than high. The ventral line usually quite concave; the dorsal line well elevated, attaining its greatest height about mid-length. The greatest width about the anterior third, but diminishing very little either in height or width until within about 2 mm. of the posterior end; thence quite rapidly to the last segment which is commonly about one millimeter wide, half a millimeter high, and a millimeter long, uninflated. A prominent mid-dorsal carina, widening out anteriorly extends forward from the posterior respiratory process. The latter structure retains its larval characteristics. The color of the puparium is grayish-brown, with a mid-dorsal, broken, blackish line and an oblique lateral black stripe on the side of each segment due to the integumental spines. The segmental spines are easily detected, but remain inconspicuous because of their fineness and pale color.

Adult (Fig. 34-7). I reproduce Verrall's description of this species in full (55, p. 377), and append some brief notes on the Maine specimens.

"Eyes bare; abdomen ovate, with undulated entire yellow bands which scarcely reach the side-margins; thorax shining; antennæ considerably luteous but darkened above; anterior tarsi mainly yellowish."

"♂. Resembling *S. nitidicollis* but quite distinct; it is broader and flatter both on the thorax and abdomen. Face more blackish about the mouth-edge, until in dark specimens the whole mouth-edge, the jowls, and a middle facial line extending above the central knob are black; on the other hand the black may be restricted in a very pale specimen to a narrow mouth-edge and all the jowls; the pubescence on the face is usually more black, and the pubescence behind the eyes is deep orange instead of whitish as in *S. nitidicollis*. Frons almost always with blackish spots or lunules above the antennæ, but otherwise all yellow or orange, as is the face even up to the extreme top angle instead of being, as in *S. nitidicollis,* blackish grey on the upper part. Antennæ much darker than in *S. nitidicollis,* as they are at least darkened above the third joint, and usually have the whole of the upper part and end of third joint blackish or brownish as well as the upper part of the second joint, or occasionally the antennæ are altogether brownish with only obscure orange spaces beneath the joints; the third joint is distinctly longer than in *S. nitidicollis,* being on the inside much longer than deep after the end of the second joint; arista shorter and inserted farther from the base, with its basal joints more distinct, and after the basal joints more luteous and with a rather shorter thickened portion."

"Thorax brightly shining blue-black with deep orange pubescence. Scutellum with mostly black pubescence."

"Abdomen with more isolated and much more undulating bands, especially as regards the fore-margins of the bands on the third and fourth segments; the spots on the second segment are either isolated or only reach the side-margins at the upper corners, while the bands on the third and fourth segments do not quite reach the side margins and are beautifully undulated especially on the fore-margin; the hind margins of the fourth and fifth segments are less broadly orange; apparently the belly also gives a good distinction as *S. nitens* has isolated central black spots on the second, third, and fourth segments, while *S. nitidicollis* has only the hind margins of the third and fourth segments black; a very important character occurs in the marginal pubescence, which is all black after the basal corners, proving that normally the abdominal yellow bands do not reach the side margins and thereby thoroughly distinguishing it from *S. nitidicollis*."

"Legs quite distinct, as the basal two-fifths of the anterior femora and the basal four-fifths of the hind femora are black; the anterior tarsi have the three middle joints darkened, while the hind tarsi are usually more blackish. Pubescence behind the anterior femora almost all black."

"Wings less orange hued, the whole wing and especially the front part being more smoky."

"♀. Similar to the male, but also differing from *S. nitidicollis* by the undulating abdominal bands, darker antennæ, and flatter more ovate shape. Vertex brilliant purple, which is extended forwards down the middle of the frons for a short distance, which is more obvious when viewed from in front but which leaves the front half of the frons much more yellowish than in *S. nitidicollis;* the dark spots or streaks above the antennæ are small and sometimes inconspicuous; the mouth-edge is usually black, but there is only a trace of the middle facial line."

"Thorax brilliantly shining."

"Abdomen more ovate than in *S. nitidicollis,* with the basal pair of spots less sharply triangular, while the undulating bands are broader and may just indistinctly touch the side-margins at their upper corners, though not enough to cause pale marginal pubescence; the peculiar ventral spots seem very much as in the male."

"Legs paler than in the male, as in the original specimen upon which the species was introduced as British they are entirely orange down to the base of the femora, but usually the basal fifth of the anterior, and the basal two-fifths of the hind, femora are black; tarsi as in the male."

"Wings rather more orange than in the male................. Length about 10.5 mm............Rare."

In the Maine males the face across the knob with a black stripe, abbreviated much short of the base of the antennæ, prominent in all except one specimen. This stripe is continuous with the narrow black margin of the anterior mouth-edge. The latter black stripes turned obliquely outward toward the eye, cutting off a small, triangular, yellowish spot next the mouth edge before the jowls which are again all black and across behind the mouth. Pubescence behind the eyes whitish below, orange above.

Spots on the second abdominal segment in most specimens quadrangular rather than triangular. All the yellow bands distinctly separated from the side margins. The bands on the third and fourth abdominal segments, in both male and female, on the middle line, with a small anteriorly and posteriorly directed pointed projection, not shown in Verrall's figure 296.

The anterior femora are black on the basal fourth, the hind femora on a little more than the basal half.

In the females the lunate, black spots above the base of the antennæ are rather prominent and, in one specimen, almost continuous with the widened black extension from the vertex. The black stripe over the facial knob is present but the stripes across the cheeks not developed, the latter yellow to the jowls.

Hind femora entirely yellow the anterior ones black on about the basal sixth. The third joint of the antennæ in both sexes only a little longer than deep after the end of the second joint.

Didea fasciata Macq. var. fuscipes Loew.

(See also 30, p. 337, 34, p. 90 and 35, p. 58.)

This species which in Ohio I have found breeding only on *Longistigma caryae* infesting sycamore and basswood, was found among the Willow Grove Plant-louse (*Pterocomma flocculosa*) on the University of Maine campus the last of July and first of August, at which time most of the larvæ were full grown. Pupation took place about August 10. Adults were captured July 15 about infested twigs of green apple aphis (*Aphis pomi*).

The following descriptions are abbreviated from my previous publications on this species (30; 34, p. 90; 35, p. 58).

Egg. (Fig. 29-5). Of about the usual shape; broadest about the middle. Length 1.3 to 1.7 mm., diameter 0.4 to 0.6 mm. Color chalk white. The chorion is sculptured in a characteristic manner. The projecting bodies are close together, not highly elevated, each one two to four times as long as broad. There are 55 to 60 of these bodies lengthwise of the egg and 80 to 100 around it at the middle. The egg of *Didea* differs from all the others I have seen in that the projecting bodies are not smooth on the top but each one has a small number (6-10) of more or less angular, irregular-shaped, pit-like depressions hollowed out of it. These are so arranged as to leave between them an elevated part of the body with more or less parallel sides. The whole effect is to give the arm-like network appearance over the elevated body somewhat like that between these bodies, without the outlines of the bodies being obscured. The arms between these bodies are irregular, slightly branched, for the most part rather short, sometimes long, from 10 to 15 radiating from each body.

Larva (Fig. 35-*2, 3, 4, 5*). Length, 12 to 15 mm., width 5 to 6 mm., height 3 to 4 mm.; testaceous brown; flattened, sub-cylindrical, blunt at the posterior end, tapering and obtusely pointed in front when extended (Fig. 35-*2*). The head segments usually much retracted giving to the anterior end a bluntly rounded appearance. Each of the body segments, except the first two and the last, with several transverse folds of the integument and a transverse row of twelve segmental bristles each about .15 mm. long. The median and dorsal ones crown the summits of conspicuous, conical elevations which, like the rest of the dorsum, are close-set with short, radiating, black, integumental bristles about .065 mm. long. The transverse body wrinkles are continued laterally into distinct V-shaped prominences bearing the dorso-lateral segmental bristles and forming a zig-zag longitudinal carina along each side of the body. The lateral segmental bristle is situated at the apex of a similar cone or V underlying the dorso-lateral; and in front of it a small ventrally-directed fold bears the two ventro-lateral segmental bristles on smaller spiny prominences. The lateral border has thus a very irregular outline of sharp angular projections.

Mouth-parts with three pairs of small thorns close beside the V-shaped jaws. The prominent lateral mouth-hooks, found in so many aphidophagous species, wanting.

In the middle of the third segment is a pair of anterior spiracles. These are light brown, conical, with a semi-circular slit near the apex (Fig. 35-*4*).

On the dorsum of the last segment is situated the posterior breathing organ (Fig. 35-*2, b; 5*). This consists of two closely apposed, short, cylindrical breathing-tubes, united along the middle line, slightly divergent at the tip. They are hard, black, firmly chitinized structures, each with three slit-like spiracles raised on radiating carinæ. Dorsad near the middle line each is marked by a smooth circular plate about .09 mm. in diameter, their inner margins about .175 mm. distant from each other. The surface of the stigmal plates between the spiracles is very much roughened the inter-spiracular ornamentation consisting of thin laminate ridges, about as high as the carinæ, on which the spiracles are located; only the summits of these ridges are indicated in figure 35-*5;* about two such ridges on each interspiracular space and continued down the sides of the short tube. The median spiracle at least .25 mm. in length and slender.

The integument of these larvæ is exceedingly tough but transparent. The entire dorsal and lateral surfaces are beset with numerous, minute, short black bristles. The ventrum is bare. Along the mid-dorsal line for the greater part of its length the dorsal blood-vessel is visible through the body-wall. It is a poorly-defined, dark line with five or six lateral expansions.

As the larva approaches metamorphosis the anterior segments are retracted, the skin becomes inflated filling out the wrinkles characteristic of the larva. It rounds out anteriorly and dorsally, the point midway between the fourth and fifth segments coming to lie at the anterior pole, the mouth being shunted backward on the ventral side. The pupa is concealed in this indurated, inflated, sub-ovate, larval skin or puparium.

Puparium (Fig. 35-*6*, *7*). Length 9.5 to 10 mm., width 4.5 to 5 mm., height about 4.5 mm. Color, Roman sepia, a little darker than the larva. Broadest a little back of the sixth larval segment, nicely rounded in front, tapering gradually to the last segment which remains somewhat flattened, especially at the sides. The covering of small black bristles is retained and the black conical prominences become even more conspicuous owing to the inflation (Fig. 35-*6*, *7*). The posterior breathing appendages retain the larval condition.

Adult (Fig. 35-*1*). Description slightly modified from Williston (62, p. 89). ♀ ♂ Length 11-15 mm. Face yellow, with a small elongate brownish spot on the tubercle. Front yellow, with two brownish spots above the antennæ, or, in the female, with an inverted V-shaped brown stripe connected with the black of the upper part of the front. Eyes bare. Orbits thickly yellowish pollinose, posteriorly with a fringe of yellowish-whitish pile. Antennæ black, the third joint at the base sometimes reddish, elongate oval, obtusely pointed at the tip; arista reddish. Thorax shining greenish black, on the meso-, ptero-, and sterno-pleuræ yellow, thickly covered with similar colored pollen and pile. Scutellum light yellow, translucent. Wings grayish hyaline, the base before the humeral cross-vein and the stigma brown; the remainder of the subcostal cell and the costal cell may be brownish; third vein rather deeply curved near the middle of the first posterior cell. Legs brown, the posterior tibiæ and all the tarsi blackish; sometimes the legs are luteous, the base of femora, distal portion of tibiæ, and the tarsi brown. Abdomen black, with four yellow cross bands, the first consisting of two large ovate spots, narrowly separated and reaching the lateral margins in nearly their full width; second and third cross-bands broad separated from the lateral margins by a black narrow keeled border; they are much narrower in the middle of the segments, the front margin straight, touching the anterior edge of the segments; fourth band similar, but much smaller and attaining the margin; all the black is velvety opaque except the narrow posterior margin of the segments which is shining, dilated in the middle.

Tropidia quadrata Say.

This common, widely distributed species has been well known for many years, but no record has been made of the larval habits of this or any other species of the genus. No record had been made of its immature stages previous to the description by Mr. J. R. Malloch in December, 1915 (28, p. 343), of the *puparium* which was found floating on the water of a lake. The larval habit was not determined.

On July 7, 1915, at Orono a larva of this species was collected in partially decomposed human excrement near the mouth of a sewer. It was apparently full grown by July 19, pupated between the 21st and 27th and emerged from the puparium August 6.

On July 10 a gravid female was captured at the same spot and enclosed with a male over a small mass of the moist excrement. By one o'clock of the same day a mass of several hundred eggs had been deposited by this female. By July 14, 7 A. M., nearly all of the eggs had hatched and the young larvæ were submerged except for the posterior respiratory appendage in the moisture at the bottom of the jar. The larvæ were kept in cages and were about full grown on September 9. Three hundred and eighty-seven eggs were dissected from the ovaries of a female taken about human excrement on July 21. On July 27 seven puparia were taken from the drier parts of the mass of excrement. One of them which had apparently just pupated emerged August 8; others from July 28 to August 1.

Egg. (Fig. 36-*1*, *2* *3*). Sub-cylindrical, elongate-ovate in outline, a little smaller and more truncate at the micropylar end, slightly curved on its long axis. The length of specimens measured varied from .82 to .86 mm., with an average of .84 mm; the maximum diameter was very uniformly .255 mm. Color white, glistening. The markings or sculpturing of the chorion (Fig. 36-*2*) are characteristic, although approached closely by *Syritta pipiens* (See p. 253). It consists of small, irregular, polygonal areas, which are slightly raised, leaving between them narrow, parallel-sided and rather smooth-sided channels; the latter connecting with each other to make a fine dark network over the surface of the egg. Each of the areas thus marked off is further ornamented on its surface with about 20 to 40 circular areoles by the slight depression of the surface between them. When viewed under very high power (oil-immersion objective and 3-4 inch ocular) the minute circular areoles are seen to be formed by the arrangement of very fine finger-like elvations, (Fig. 36-*1*).

The polygonal areas are of such a size that about thirty occur end to end the length of the egg and about fifty or sixty side by side around it.

Egg-laying was observed from July 10 to July 21; but, since a good-sized larva was found as early as July 7 and since adults continued to emerge at least until August, the egg-laying period is doubtless much more extended. In the case observed (laboratory) the egg-stage lasted between 72 and 90 hours.

Larva (Fig. 36-*4*, *5 6*, *7*). At a very early stage (2 or 3 mm. long) the young larva shows the characteristics of the full grown one, seemingly differing only in size. Full grown larva about 16 mm. long; maximum width 3.75 mm., maximum height 3.5 mm. Nearly cylindrical, broadest in the middle; the anterior segments forming a globose, false head; the posterior segments tapering rather rapidly throughout the caudal eight (about 2 mm.) of the length to the posterior respiratory appendage. The latter structure terminal; about .75 mm. long, .66 mm. broad at its base, .5 mm. broad at its apex, and about .4 mm. high. The double nature of the appendage indicated by moderate impressions on the mid-dorsal and mid-ventral lines.

The distal end is truncated, and the stigmal plates ornamented with a pair of circular plates, three pairs of spiracles and four pairs of palmately-divided, plumose, interspiracular hairs. The circular plates occupy nearly a median position, dorso-ventrad, and are situated near the median line. Each has a diameter of .085 to .095 mm. and their inner margins are less than .02 mm. apart. The spiracles are roughly S-shaped, each ornamented with about twenty short, rounded, lateral denticles, irregular in size and irregularly distributed. The right median spiracle forms an S, the left one a reversed S. In other words the dorsal free end of the S on either stigmal plate is directed laterad, the ventral free end, mesad. The interspiracular ornaments consist each of about five plumose or feathered hairs arranged palmately. Some of the hairs are further divided; all are united at the extreme base; and occasionally two are united for some distance from the base.

Immediately cephalad of the posterior respiratory appendage at each side of the twelfth segment are three fleshy, conical lateral protuberances, the posterior one about .75 mm. long, the others about half that length, each pair connected by a prominent wrinkle across the dorsum of the segment. The first four body-segments composing about the anterior sixth of the body (2 or 3 mm.) is head-like globular, and separated by a slight neck-like constriction from the succeeding segments; with several faint longitudinal furrows on its sides. At the anterior end this false-head bears a pair of small antennæ, each of a fleshy base, surmounted by two, minute, sub-equal, rounded nodules side by side at its apex. Just ventrad of the antennæ is a rounded, somewhat-chitinized mouth-hood, concave ventrally, within which is the buccal cavity. The mouth opening further guarded by a fleshy fold at each side, covered with long flexuous hairs, of service in straining the food. The dorsal part of the bulbous false-head is ornamented with a characteristic group of black, chitinous hooks or thorns. There are two large hooks about .25 mm. long on each side, situated about one millimeter dorso-laterad of the mouth-hood, their bases about .35 mm. apart. Extending between, and dorsad, of them are three irregular, transverse rows of smaller and various-sized thorns, most of them barely visible to the naked eye. The most posterior of these rows (Fig. 36-*7A*) consists of a large thorn at each side and six to ten smaller ones between them. In the middle row near each side, and looking much like a thorn, is located the sessile, anterior larval spiracle (Fig. 36-*7B*). There is a small hook or thorn laterad of each spiracle, a large one mesad and, between the latter, about three smaller ones. The anterior row consists of six to ten thorns of moderate size. Cephalad of these three rows and above the mouth-hood is a semi-circular band of numerous microscopic hooklets. The surface of the anterior larval spiracle bears four rounded nodules.

The entire surface of the body is covered with microscopic, close-set, pale brown, short, soft hairs. The segmental hairs are longer flexible and about three in a clump. Eight transverse rows of them can be made out posterior to the anterior spiracles. The body segments are further indicated each by a group of about four transverse wrinkles. About seven pairs of prolegs, consisting of ventral fleshy projections, each bearing a clump of recurved hooklets; five pairs on segments five to nine, inclusive, about equally developed and with a dozen or more hooklets, the anterior ones largest; one pair on the venter of the third segment which usually has fewer hooklets, and a smaller pair on segment ten. The anus is a prominent transverse slit about 2 mm. cephalad from the base of the posterior respiratory organ, on the venter of the eleventh segment.

Color dirty white or clay yellow.

Under laboratory conditions the larval period extended over about two months from July to September. Although the larva has been found only in human excrement, there is no reason to believe it would not develop in other kinds of filth or decaying material.* The larvæ were found in the moist, but not watery, portions of the mass and several inches beneath the surface.

Puparium (Fig. 36-*8*, *9*, *10*). Pale brown. Length 8 to 9 mm; maximum width 3.25 to 3.75 mm.; maximum height 2.75 to 3.25 mm. Broadest a little in front of the middle where it is nearly circular in cross-section. Only a little narrowed and globose in front, but evenly tapering caudad to about one-third the width just in front of the posterior respiratory process. As viewed from the side, ventral line nearly straight to within about two millimeters of the posterior end, thence elevated; the dorsal line a little more strongly and abruptly elevated anteriorly than posteriorly.

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*Since writing this, I have found the larvæ and puparia at Presque Isle and Houlton, July 8 and 9, in masses of rotting potatoes which had beep swept out of store-houses and allowed to lie on the ground until well-decayed. Adults emerged from the puparia, July 19 and 20.

Many adults were noted hovering—apparently for the purpose of ovipositing—about the above masses and also about decaying masses of "sprouts" from potatoes used in planting.

The anterior end bears, in addition to the characteristics remaining from the larval stage, a pair of pupal respiratory cornua situated well dorsad, their bases about .75 mm. apart (Fig. 36-*8A, 10A*). Each cornuum strikingly like a common species of morel mushroom in appearance; about .4 mm. broad and .5 mm. long, the basal third or fourth slenderer. Its surface bears a hundred or more of minute papillæ each when very highly magnified (Fig. 36-*9*) showing a further ornamentation of its surface with five to eight nodules.

The buccal hood of the larva occupies a position at the anterior extremity of the ventral line (Fig. 36-*10C*), and although they are much less conspicuous, the arrangement of thorns and hooklets remains essentially as in the larval stage. For the emergence of the adult the anterior end splits into a two-piece operculum; one transversely elongate piece surrounding the pupal respiratory cornua; the other an ovate piece, cephalad of this and including the anterior larval spiracles, but not the two pairs of largest hooks. The posterior end of the puparium much as in the larva; the respiratory process terminal and, at each side of it, the three pairs of lateral processes of the body-wall, somewhat shrunken and indurated. Slight traces of the transverse wrinkling remain and on careful examination the larger hooklets of the prolegs can be distinguished.

The duration in the pupa stage was between 9 and 15 days, this stage being noted during late July and early August. The pupæ were found a few inches under the surface in the moderately-dry parts of the excrement in which the larvæ had fed. Pupation is accompanied by the induration of the larval skin with chitin and the great inflation especially of larval segments five to eleven.

Adult (Fig. 36-*12, 13, 14*). *Eyes bare, face with a median keel-like ridge, marginal cell open, third vein curved, anterior cross-vein beyond the middle of the discal cell; hind femora extraordinarily thickened with an angular projection below near outer end; abdomen of nearly equal width.*

Length 9 to 12 mm. Front in female narrow above; face gently convex in profile in the male, a little concave near the middle in the female; densely covered with yellowish gray pollen, leaving a slender median stripe and a spot on the cheeks black. Antennæ yellow, third joint nearly square. Dorsum of thorax shining, greenish black, with two rather distinct median pollinose stripes in front, two spots of the same colored pollen in front of the scutellum, another in front of each postalar callus, on the humeri, and a spot along the dorso-pleural suture immediately behind the humeri. Scutellum yellow along the border. First abdominal segment black, yellow on the sides; second segment in front (but not reaching the sides) and a narrow median stripe black, behind extending narrowly to the sides, more brownish, forming an inverted T; third segment with a similar T but more brownish, less distinct. In the female the black on the second segment is broader, the third segment black except a quadrangular spot in front on each side. Front and middle legs yellow, except on the basal half or more of the femora, black; hind legs black, the knees only yellow. Description adapted from Williston (62, p. 207) and Verrall (55, p. 571).

SYRITTA PIPIENS Linné.

This is one of our most abundant and wide spread species, apparently occurring throughout most of Europe and North America and common from spring to autumn. It has been recorded breeding in horse-dung and cow-dung in Europe (17), and Dr. L. O. Howard has noted the capture (but not the rearing) of an adult about human fæces.

The larvæ were found breeding in large numbers in moist masses of guinea-pig manure in the animal room at Ohio State University during the winter and spring of 1915. On July 7 at Orono, two puparia were taken from a drying mass of human excrement at the opening of a sewer. Adults emerged from them August 2 and 3. On July 7 and 12 a number of females were found hovering about the above-mentioned mass of filth. Two of them were enclosed in a vial and had soon deposited a mass of several hundred eggs. They began hatching on July 16, the duration in the egg-stage having been almost exactly four days.

This species in all its stages shows a close resemblance to *Tropidia quadrata* and it will be described in comparison with that species.

Egg. (Fig. 37-*1*, *2*, *3*). Sub-cylindrical, tapering toward the ends; the micropylar end somewhat truncate, the opposite end rounded out; nearly straight on the ventral side, somewhat rounded up dorsally. Dimensions (ten specimens): Length .6325 to .6875 mm., average .665 mm.; maximum diameter .213 to .24 mm., average .23 mm.

The sculpturing of the chorion consists of polygonal elevated areas, separated by narrow depressed lines which form a darker network over the entire surface. About thirty such elevations the length of the egg, fifty to sixty around it. With higher magnification (1-4 in. objective) these elevated areas are seen to be finely papillose, and on closer examination the papillæ are seen to be grouped into areoles of greater elevation, with depressions between them. As contrasted with *T. quadrata*, it is evident that the grouping of the papillæ into definite rounded areoles is much less pronounced and that the areoles are much more irregular in shape (Fig. 37-*2*; cf. fig. 36-*1*). For example on the egg of *T. quadrata* the areoles are quite easily seen with a 2-3 in.

objective; while in *Syritta pipiens* they are hardly made out with less than a 1-4 in. objective and are not as definite at any magnification. Color white.

Larva (Figs. 37-*4*, *5*, *9*). Superficially resembling the larva of *T. quadrata*, especially in the differentiation of the anterior segments into a false-head and in the possession of three pairs of lateral fleshy projections just anterior to the short, posterior respiratory process. It differs from *T. quadrata* in its much smaller size, in being less nearly cylindrical, broader in the median segments, and somewhat flatter; the posterior respiratory organ is relatively longer and slenderer and the constriction between segments three and four (at the side of the false head) more marked.

Length about 10 mm., maximum width about 2.75 mm., maximum height about 2 mm. Broadest in the region of segments seven to nine. Tapering moderately backward to less than half the width at the base of segment twelve; much more moderately toward the head. The false head 1.75 to 2 mm. broad, not as well developed as in *T. quadrata*. Color dirty yellowish. The entire integument covered with pale and delicate, close-set microscopic hairs, longer on the more exposed portions. The false head lacks the conspicuous hooks or thorns of *T. quadrata*, the vestiture being specialized only into the transverse band of microscopic hooklets above the mouth. Antennæ, mouth-hood and lateral mouth-folds not differing noticeably from *T. quadrata*. The false-head with about a dozen longitudinal furrows, one on the mid-dorsal line. The anterior larval spiracles located between the first and second furrow from the mid-dorsal line, sessile; each apparently with three rounded nodules on its summit. There are seven pairs of prolegs on segments 3 and 5 to 10, inclusive, the first pair situated more widely apart than the others, the last pair smaller, each with about two dozen hooklets of varying size.

The posterior respiratory organ is a brown, chitinized, polished tube, projecting about .75 mm. (.5 to 1 mm.) its width ranging from .25 to .35 mm., its depth from .2 to .25 mm. A little broader at base than at apex, the latter truncated. The tube is semi-transparent and the two large tracheal trunks can be seen throughout its length. The stigmal plates similar to those of *T. quadrata* but with distinct differences. The most important difference is that the three pairs of spiracles are less distinctly S-shaped and each is ornamented with from nine to fourteen (compared with about twenty for *T. quadrata*) of rounded lateral projections or denticles irregular in size and irregularly distributed.

Puparium (Fig. 37-*6*, *7*, *8*). Dimensions (15 specimens): Length, inclusive of the posterior respiratory appendage which retains the same dimensions as in the larva, 5.9 to 7.9 mm., average 6.8 mm.; maximum width 2.75 to 3.4 mm., average 2.95 mm.; maximum height 2.65 to 2.95 mm., average 2.68 mm. In outline elongate ovate, a little more attenuated posteriorly, this attenuation more pronounced than in *T. quadrata*. Nearly circular as seen from in front a little flattened on the venter. The ventral line as seen from the side, straight from mouth-parts almost to the posterior respiratory process before which it becomes a little elevated. The dorsal line begins with a very sharp, nearly rectangular elevation in front, followed by a gentle flexure reaching its greatest height a little in front of the middle. The descent is gradual throughout the third quarter of the length, thence more abruptly to the posterior respiratory organ.

The pupal respiratory processes (Fig. 37-*6A*, *8*) penetrate the puparium near the antero-dorsal flexure, about 2 mm. from the ventral line and half a millimeter caudad. Each measures .35 to .5 mm. in length, maximum diameter about .2 mm. Morel-shaped, the proximal half being somewhat more slender, the distal half dilated and studded with about seventy-five minute nodules. Each of these nodules when very highly magnified (Fig. 37-*7*) is seen to consist of four, five or six oval elevations each with a median slit. The anterior face of the expanded part traversed by a branching shallow groove. The clumps of hooklets on larval prolegs are conspicuous along the mid-ventral line and the posterior respiratory process retains its larval characteristics.

Adult (Fig. 37-*10*, *11*). *A small slender, nearly bare, fly, black with yellow markings and very thick hind femora; marginal cell open, third vein gently curved, anterior cross-vein near the middle of the discal cell.* Description adapted from Williston (62, p. 240) and Verrall (55, p. 612).

Length, 7 to 8 mm. Face and front satiny yellowish white. Front of female narrow above, shining black, with two small pollinose spots; vertical triangle of male elongate. Antennæ reddish yellow. Dorsum of thorax black, nearly bare, in front with two approximate pollinose spots. The humeri and to the suture and all the pleuræ yellowish or whitish pollinose. Abdomen: opaque black in front, shining behind; narrow sides of first segment and a broad spot at each side of the second, yellow, somewhat whitish pollinose. "At the extreme produced base of the second segment a remarkable fringe of whitish hairs, ... the only obvious pubescence on the abdomen" (55, p. 613); third abdominal segment with a smaller yellow spot at each basal corner and the fourth with a narrow, interrupted yellowish-white pollinose cross-band, the hind margin narrowly yellow. In the female the spots smaller, the sides of the third segment in front metallic, scarcely at all yellow, but with a light pollinose spot. Legs yellowish-red with obscure brownish markings; hind femora black, with the base and a usually incomplete ring near the middle, reddish yellow; hind tibiæ at the middle and tip brown or black.

Artificial Keys to the Known Larvae and Pupae of Syrphidae

KEY TO TYPES OF LARVAE

1. Body terminating in a long, flexible and extensile, rat-tail-like respiratory appendage (often longer than the body). Larvae aquatic, semi-aquatic, or living in moist decaying materials. The puparium with a pair of prominent, anterior, respiratory cornua (See also p. 210) ....
   IV. THE LONG-TAILED FILTH-INHABITING TYPE (Genera *Eristalis, Helophilus, Chilosia, Chalcomyia, Sericomyia, Mallota,* etc.)
   Posterior respiratory appendage considerably shorter than one-fourth the length of the body, rigid. Habits various, but not aquatic larvae 2
2. Larvae short-oval or rounded in outline, convex above, and with a very flat, creeping-sole, ventrally, around which is a fringe of spines. The shape constant and sub-hemispherical; no evident transverse wrinkling of the body-wall, but the dorsum often nicely reticulated. Larvae living in ant-nests. The puparium sub-hemispherical, and with prominent anterior cornua. (See also p. 211) ....
   ....V. THE MICRODON TYPE (Genus *Microdon*)
   Shape of larva elongate-oval with the venter flattened, or sub-cylindrical; the outline not constant, but the body especially the anterior end, capable of considerable extension when active 3
3. Body nearly cylindrical, the anterior end not attenuated, but rounded out, forming a false-head. Three fleshy, finger-like processes at each side of the last body-segment. No external mouth-parts. Puparium with prominent anterior cornua. (See also p. 210) ....
   III. THE SHORT-TAILED FILTH-INHABITING TYPE (See key below)
   The anterior end of the body considerably attenuated, when active; no false-head. Black, chitinized mouth-parts present..........4
4. Body nearly circular in cross-section. Mouth-parts of two recurved hooks, uniting basally into a mouth-hood. Stigmal plates with groups of minute, palmately-arranged, plumose hairs. (See also p. 209) ....
   ....II. THE BORING TYPE (*Merodon equestris* Fabr.)
   Body always noticeably, often much, flattened. Mouth-parts of two, Λ-shaped jaws. Stigmal plates with various ornamentation but not with plumose hairs. Puparium rounded in front, attenuated behind, and apparently without pupal respiratory cornua (See also p. 208) ....
   ....I. THE APHIDOPHAGOUS TYPE (See key below)

I. THE APHIDOPHAGOUS TYPE

Key to Species

1. Dorsal pair of slit-like spiracles much shorter than the other pairs, its carina rounded. Larvae phytophagous .... *Toxomerus politus,* p. 216.
All the slit-like spiracles elongate, at least several times as long as broad, or at least the dorsal pair not conspicuously shorter. Larvae aphidophagous 2
2. Posterior slit-like spiracles greatly elongate and extensively sinuate or undulate. (Fig. 34-*3*) ....*Syrphus nitens,* p. 242.
Posterior slit-like spiracles straight or somewhat curved, never much sinuate 3
3. General color greenish, with white longitudinal stripes. Rather smooth-bodied larvae with no integumental vestiture and the segmental spines not prominent 4
General color yellowish, reddish or brownish 6
4. Posterior respiratory organ less than half as long as broad. Slit-like spiracles less than twice as long as broad. Viscera usually plainly visible thru the skin. (Fig. 30-*5* and *6*) .... *Melanostoma mellinum,* p. 226.
Posterior respiratory organ considerably longer than broad. Slit-like spiracles each at least three times as long as broad.......5
5. Stigmal plates roughened, the spiracles well elevated and separated by spur-like elevations. The two tubes very slightly divergent at the tip. (Fig. 31-*66* and *68*) .... *Allograpta obliqua,* p. 234.
End of posterior respiratory appendage nicely rounded off, smooth, the spiracles not elevated, and not separated by perceptible spurs. The two tubes not at all divergent. (Fig. 31-*72* and *73*). ....*Sphaerophoria cylindrica,* p. 231.
6. Integument of the larva bare except for the segmental spines.....7
The entire dorsal surface of the larva covered with short, microscopic spines, black, or sometimes light in color and then not prominent 8
7. Posterior respiratory appendage longer than broad; inter-spiracular nodules rather prominent...*Syrphus xanthostomus* (34, p. 81).
Posterior respiratory appendage broader than long; inter-spiracular nodules not prominent. (Fig 33-*13*) ....*Syrphus torvus,* p. 240.
8. Segmental spines conspicuous or raised on prominent, fleshy or spiny, conical elevations easily seen by the naked eye 9
Segmental spines not prominent and not raised on conspicuous, conical projections; sometimes hard to distinguish from the integumental spines 11

9\. All of the segmental elevations and segmental spines, on the dorsal surface of the body, of nearly equal size. The inter-spiracular spaces on the stigmal plates with lamellate, upright ridges. (Fig. 35-*2* and *5*) ....*Didea fasciata fuscipes*, p. 246.

The dorsal, segmental elevations (ones next the median pair) in the principal body-segments much reduced in size. The dorsal spiracular nodule long and prominent; the other inter-spiracular spaces with small nodules or delicate hairs........10

10\. Posterior respiratory appendage broader than long ....*Paragus bicolor* (31, p. 397).

Posterior respiratory appendage considerably longer than broad. ....*Paragus tibialis* (31, p. 402).

11\. Integumental spines black. Inter-spiracular spaces with short, stout, black spurs. (Fig. 32-*46*, *49* and *50*) ....*Syrphus americanus*, p. 236.

Integumental spines light yellow. Inter-spiracular spaces with long slender hairs. (Fig. 29-*2*) ....*Pipiza pisticoides*, p. 224.

III. THE SHORT-TAILED FILTH-INHABITING TYPE

Key to Species

1\. False-head of larva without any conspicuous, black, anterior thorns or chitinized hooklets. Posterior respiratory appendage about three times as long as broad. The spiracles on stigmal plates with about ten lateral denticles. (Fig. 37-*5* and *9*)....... ....*Syritta pipiens*, p. 253.

Antero-dorsal part of false-head ornamented with black hooks or thorns, visible to the naked eye. Posterior respiratory appendage less than twice as long as broad. The posterior spiracles with more than fifteen lateral denticles 2

2\. Two prominent hooks on each side of the false-head, their bases united into one chitinous plate. The posterior spiracles with forty to eighty lateral denticles.........*Zelima* (*Xylota*) *pigra*.

Two prominent hooks on each side of the false-head, their bases separated by a little more than their length; also several transverse rows of slightly smaller thorns between these pairs. The posterior spiracles with fifteen to thirty lateral denticles. (Fig. 36-*5*, *6*, *7* and *8* ....*Tropidia quadrata*, p. 248.

Glossary of New or Unusual Terms.

Anterior larval spiracle: The breathing pore, or opening to the trachea, situated at the side of the third body segment of the larva (Figs. 34-*2*; 32-*46b*; and 36-*5B*).

Anterior stigmata: See anterior larval spiracle or pupal respiratory cornua.

Areoles: As applied to the sculpturing of the chorion or egg-shell, a minute differentiated spot on the surface of a *body* (q. v.).

Arm: As applied to the sculpturing of the chorion or egg-shell, a slender, root-like, elevated process from a *body* (q. v.), extending into the depression between the bodies.

Aschiza: (Brauer) a section of the dipterous sub-order Cyclorrhapha in which the frontal lunule and suture above the root of the antennæ are wanting. It includes the families Syrphidae, Pipunculidae, Platypezidae and Phoridae.

Body: As applied to the sculpturing of the chorion or egg-shell, a microscopic elevated area surrounded by a depression.

Carina: An elevated ridge; see dorso-lateral carina, ventro-lateral carina; and also under slit-like spiracle.

Circular plate: "Button" of authors: a usually smooth, or roughened, circular or oval area of the stigmal plate situated, typically, dorso-mediad on the latter; and usually distinct in color or texture from the rest of the stigmal surface; sometimes partially or completely surrounded by a ridge (Figs, 30-*5B;* 34-*3A* and 36-*6B*).

Cyclorrhapha: (Brauer) a sub-order of the Diptera in which the larvæ lack a differentiated head; the pupæ are always enclosed in the hardened larval skin or puparium, from which the fly escapes through a circular orifice or operculum at the anterior end.

Dorsal line: The upper margin of the puparium, when viewed from the side, extending from the position of the larval mouth-parts in front, dorsally around to the base of the posterior respiratory process behind.

Dorsal spiracular spine, ridge or nodule: A chitinous elevation of the stigmal plate mesad from the circular plate (q. v.) (Fig. 32-*50a*).

Dorso-lateral carina: An irregular, longitudinal, zig-zag ridge along the side of the body of the larva (formed by the fusion of the ends of transverse folds of the integument) above the ventro-lateral carina, and bearing the dorso-lateral segmental bristles of successive segments.

False-head: A globose grouping of the anterior segments of certain larvæ, partially constricted from the succeeding segment.

Integumental vestiture: Minute, close-set, short, microscopic hairs or bristles covering the integument of the larva at least on the dorsal surface; contrasted with the segmental vestiture (q. v.).

Interspiracular ornamentation, hairs, spines, spurs, nodules, ridges, or lamellae: Armature of various kinds occurring in the interspiracular spaces (q. v.). See also, dorsal spiracular spine.

Interspiracular spaces: The areas between and around the slit-like spiracles on the apex of the posterior respiratory process. These are four in number on each stigmal plate; one between the dorsal slit-like spiracle and the circular plate; one between dorsal and median spiracles; one between median and ventral spiracles; and one mesad from the ventral spiracle.

Jaws: Of aphidophagous larvæ, a pair of chitinized, Λ-shaped lips above and below the mouth-opening (Fig. 30-*4C*).

Jowls: The part of the head below the cheeks and the eyes (Wingate); also known as the cheeks or genæ.

Lateral mouth-hooks: Heavy, black, chitinized, curved hooks or thorns on the head segments but separated from the jaws by an intervening space, in which respect they differ from the mouth-hooklets (q. v.), as also in being usually shorter and broader at the base (Figs. 30-*4A*; 31-*67c*; and 33-*11c*).

Mouth-hood: A dorsally convex, ventrally concave, chitinous termination of the cephalo-pharyngeal skeleton of the larvæ of certain types, which covers the anterior opening of the alimentary canal. (Fig. 34-*7F*).

Mouth-hooklets: Chitinized, black, microscopic thorns, elongate and slender or short and thick, situated closely at the sides of the jaws and evidently of assistance in prehension (Figs. 33-*11d*; and 35-*3c* and *d*).

Posterior larval spiracles: See posterior respiratory organ.

Posterior respiratory or breathing organ, appendage, tube or process: An appendage borne terminally or dorsally on the twelfth (last) larval segment, consisting of two tubes more or less completely fused mesad throughout their length, enclosing two large tracheæ and bearing on their ends the posterior larval spiracles (q. v.) through which the tracheæ open. This tube is considered for descriptive purposes to have been originally a terminal appendage; consequently its *length* is the distance from its base (where the tube becomes differentiated from the last segment) to its apex; its *width* is the maximum transverse diameter across both stigmal plates (q. v.); and its *depth* or *height* is the maximum dorso-ventral distance at the tip when oriented as described above; (when the tube is very short and directed dorsad, what appears to be the cephalo-caudad distance).

Pupal respiratory cornua: A pair of chitinous terminations of the tracheæ leading to the prothorax of the developing fly, which are pushed through the puparium, dorso-cephalad, for respiration during the pupa stage. Their surface bears a few or many denticles or papillæ about which the air enters. Sometimes very conspicuous, sometimes (especially on the puparia of aphidophagous larvæ) exceedingly minute and indistinguishable (Fig. 30-*7A*).

Segmental bristles, hairs, spines or vestiture: A transverse row of more or less prominent hairs or other armature, specialized from the integumental vestiture (q. v.) across the dorsum and sides of each larval segment. These hairs are twelve in number, and for convenience in description, I have named them in order, beginning with the pair nearest the mid-dorsal line and proceeding laterad and ventrad: a, *median;* b, *dorsal;* c, *dorso-lateral;* d, *lateral;* e, *posterior ventro-lateral;* and f, *anterior ventro-lateral.*

Segmental elevation or cone: A more or less prominent conical fleshy elevation subtending a segmental bristle (q. v.).

Slit-like spiracle: One of the three pairs of openings of the tracheæ at the posterior end of the body of the larva, on the stigmal plate (q. v.); usually straight or slightly curved but often sinuate, convoluted or undulated, and may bear lateral projections or denticles. They usually radiate and are usually elevated on carinæ. They are named dorsal, median and ventral pairs the former usually nearest the circular plate.

Spiracle: An opening to a trachea, or breathing pore. See anterior larval spiracle, slit-like spiracle, stigmata.

Stigmal plate: Either half of the truncated apex of the posterior respiratory process, usually separated from the other lateral half by a distinct median dorso-ventral incision. It bears three slit-like spiracles (q. v.), the circular plate, and the interspiracular ornamentation.

Stigmata: See spiracle, pupal respiratory cornua.

Ventral line: The margin of the puparium, when viewed from the side, extending from the position of the larval mouth-parts in front, along the venter to the base of the posterior respiratory process at the posterior end.

Ventro-lateral carina: An irregular, longitudinal, fleshy ridge along the side of the body of the larva underneath the dorso-lateral carina and bearing the lateral segmental bristles.

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FIGURES AND EXPLANATIONS

EXPLANATION OF FIGURE 29.

Pipiza pisticoides Willist.

1 Side view of larva x12; A, lateral mouth-hook, immediately in front of which is the antenna; B, anterior larval spiracle; C, posterior respiratory process.

2 End view of posterior respiratory process x185; showing the two stigmal plates, each with a circular plate, interspiracular hairs and slit-like spiracles.

3 Side view of puparium x12.

4 Dorsal view of adult female x18.

Didea fasciata Macq. var. *fuscipes* Loew.

5 Sculpturing on egg-shell of *Didea fasciata fuscipes* (q. v.)

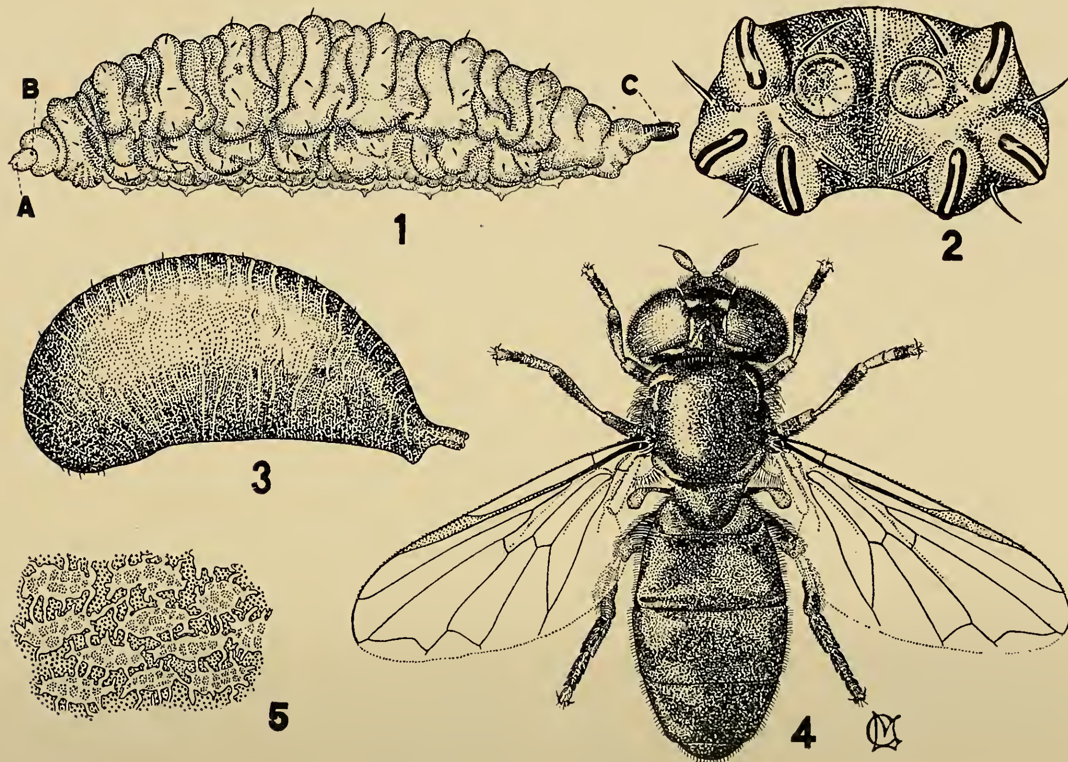

Fig. 29. Life-stages of *Pipiza pisticoides* Willist.

EXPLANATION OF FIGURE 30.

Melanostoma mellinum Linné.

1 Masses of eggs as deposited by female on leaf of rape x12.

2 Egg-mass from another female, showing the characteristic ranking of eggs side by side, x12.

3 A small area of the egg-shell highly magnified, showing nature of sculpturing.

4 Ventral view of head-segments of larva much enlarged; A, lateral mouth-hook; B, antenna; C, upper jaw; D, anterior larval spiracle.

5 End view of posterior respiratory organ x 175, showing the two stigmal plates; A, the carina bearing left, dorsal, slit-like spiracle; B, right circular plate; C, one of the inter-spiracular nodules.

6 Dorsal view of larva x 10; A, left longitudinal tracheal trunk; B, antenna; C, termination of the right tracheal trunk in the anterior spiracle; D, posterior respiratory organ.

7 Dorsal view of puparium x 10; A, right pupal respiratory cornua with trachea leading from it; B, posterior larval respiratory organ. The outline of head, thorax with wing-pads, and abdomen of the developing fly show thru the puparium.

8 Side view of pupal respiratory cornua, highly magnified.

9 End view of pupal respiratory cornua with afferent trachea, highly magnified.

10 Side view of head of adult ♀.

11 Wing.

12 Abdomen of ♀.

13 Posterior part of thorax and abdomen of ♂.

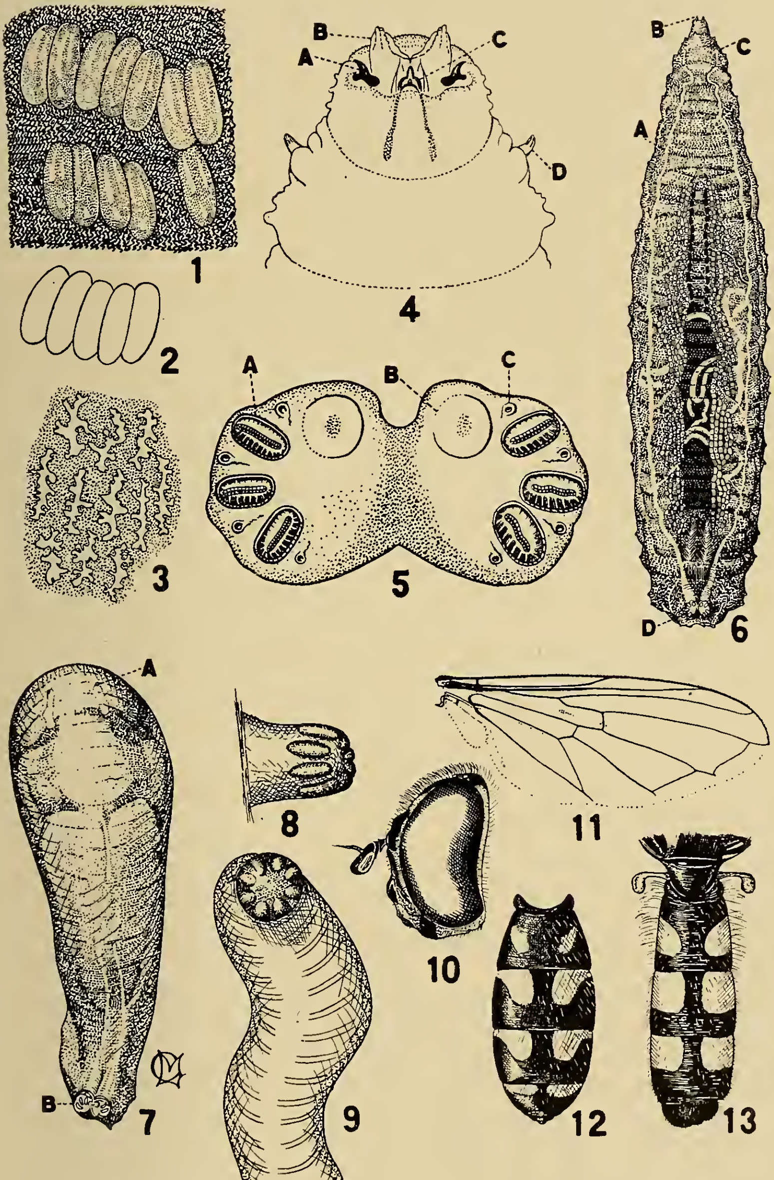

Fig. 30. Life stages of *Melanostoma mellinum* Linné.

EXPLANATION OF FIGURE 31.

61-70 *Allograpta obliqua* Say.

61 Egg x 20, from the side.
62 Dorsal view of egg x 20.
63 The sculpturing of the egg-shell, highly magnified.
64 Adult female x 7.
65 Young larva just hatched, x 50; a, antennæ; b, internal esophageal frame-work; c, the posterior respiratory tubes.
66 Mature larva x 9; a, antennæ; b, position of anterior spiracles; c, posterior respiratory tubes.
67 Antero-ventral view of head of larva much enlarged; a, antenna; b, upper jaw; c, outer pair of mouth-hooks; d, lateral mouth-hooklets; e, internal esophageal framework; f, lower jaw.
68 End view of posterior respiratory appendage, much enlarged; a, one of the spiracles; b, the circular plate; c, the interspiracular spines.
69 Dorsal view of puparium x 5; a, posterior respiratory appendage.
70 Lateral view of puparium x 3; a, posterior respiratory appendage.

71-78 *Sphaerophoria cylindrica* Say.

71 Adult male from the side x 7.
72 Dorsal view of posterior respiratory appendage, much enlarged; a, spiracles; b, circular plate.
73 End view of posterior respiratory appendage, much enlarged; a, circular plate; b, one of the three pairs of spiracles.
74 Anterior larval respiratory cornua with spiracles from the side, highly magnified.
75 End view of the same.
76 Mature larva from the side x 6; a, posterior respiratory appendage.
77 Ventral view of head of larva much enlarged; a, antennæ; b, upper jaw; c, lateral mouth-hooklets; d, the outer pair of mouth-hooks; e, esophageal framework; f, lower jaw.
78 Lateral view of puparium x 7; a, the posterior respiratory appendage; the dotted lines represent other shapes in which the pupal envelope may indurate.

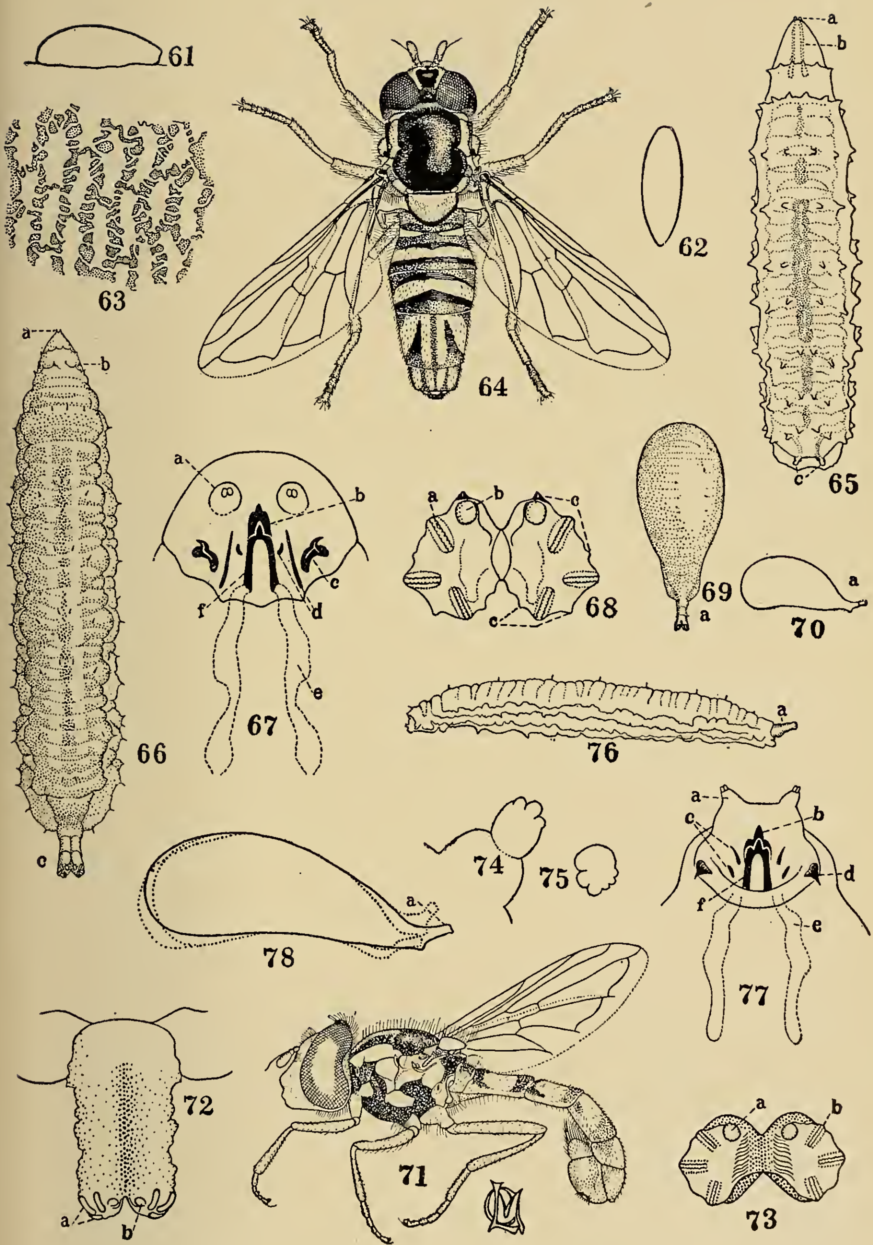

Fig. 31. Life-stages of *Allograpta obliqua* and *Sphaerophoria cylindrica* (After Metcalf, from The Ohio Naturalist.)

EXPLANATION OF FIGURE 32.

Syrphus americanus Wied.

41 Egg from the side x 17.

42 Dorsal view of egg x 17.

43 A small part of the surface of egg-shell showing sculpturing, highly magnified.

44 Adult male about 5 times natural size.

45 Larva just hatched x 59; a, posterior respiratory appendage.

46 Full-grown larva x 7; a, antennæ; b, anterior spiracle; c, posterior respiratory appendage.

47 Anterior view of larva, much enlarged, showing mouth-parts, antennæ, etc.; a, right anterior spiracle; b, antenna; c, upper jaw; d, lower jaw; e, the three pairs of mouth-hooks.

48 Dorsal view of right anterior spiracle, highly magnified.

49 End or posterior view of posterior respiratory organ x 55; a, dorsal spiracular spine; b, one of the three pairs of slit-like spiracles.

50 Side or dorsal view of posterior respiratory organ x 55; lettering as in Fig. 49.

51 Appearance of a part of the puparium externally in the region of the mouth-parts much enlarged; a, right anterior spiracle with short piece of trachea attached; b, lower jaw of larva; c, upper jaw of larva; d, chitinous esophageal framework; e, mouth-hooks of larva.

52 Hind leg of pupa showing flexure of tibiæ at a.

53 An early pupal stage from the side; a, b, and c, developing legs; d, wing-pad; e, mouth-parts.

54 A much later pupal stage, ventral view; a, the delicate investing membrane.

55 Dorsal view of puparium x 5; a, posterior respiratory organ.

56 Outline of puparium from the side. The dotted outline is given to show the typical shape of a parasitized puparium.

57 Lateral view of head of female x 7.

58 Larva of parasite, *Bassus lactatorius;* mouth-parts at a, ventral view.

59 Pupa of *B. lactatorius,* ventral view.

Figs. 53, 54, 58, and 59 each about 5 times natural size.

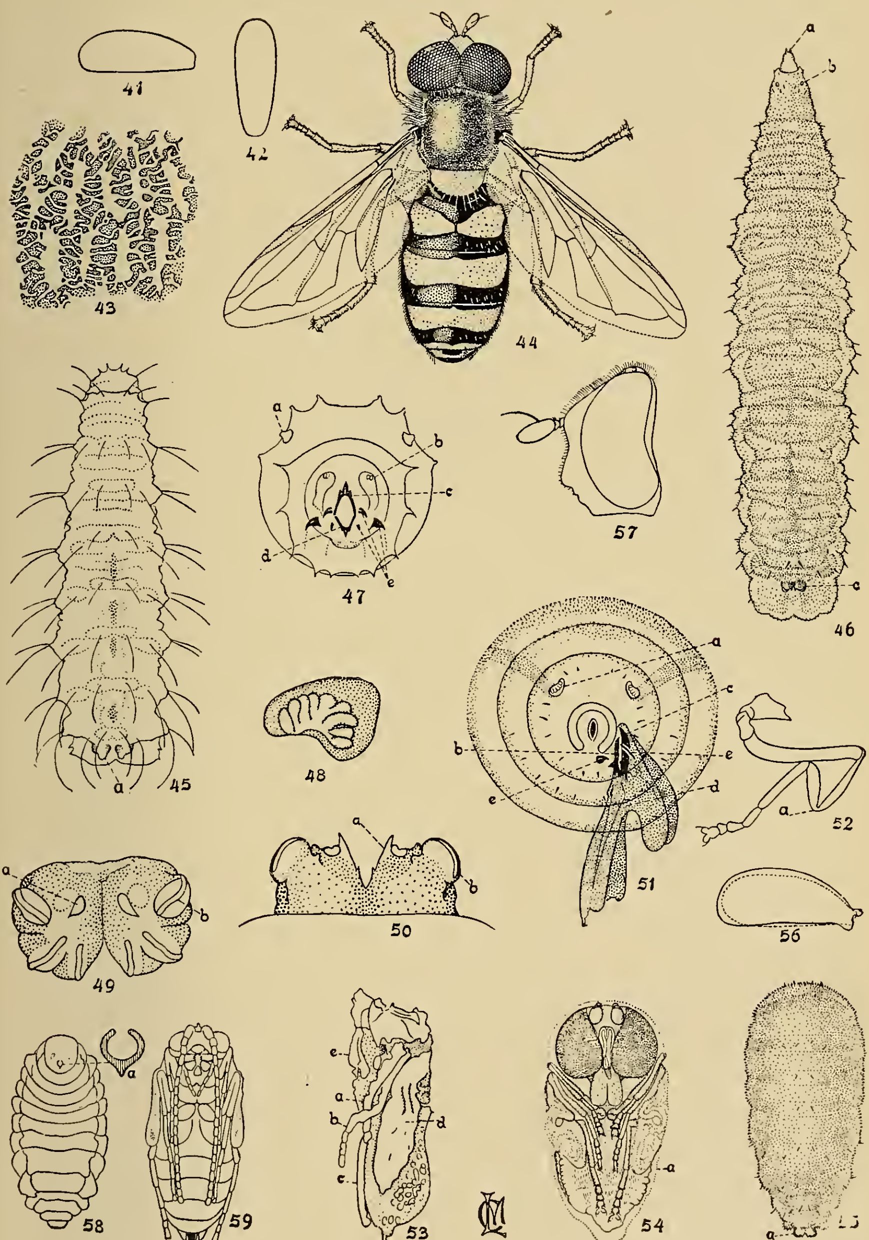

Fig. 32. Life stages of *Syrphus americanus* Wied. (After Metcalf, from The Ohio Naturalist.)

EXPLANATION OF FIGURE 33.

Syrphus torvus Loew.

9 Adult male, natural size and enlarged.

10 Larva, natural size and enlarged; a, anterior spiracle; b, posterior spiracle.

11 Antero-ventral view of head and mouth-parts much enlarged; a and b, upper and lower jaws partially separated; c, outer pair of mouth hooks; d and e, two inner pairs of mouth-hooklets; f, antenna; g, anterior spiracle; h, sense papillæ.

12 Anterior spiracle of larva highly magnified.

13 Posterior breathing appendages much enlarged; a, one of the six caudal spiracles.

14 Puparium from above, natural size and enlarged; a, posterior spiracles.

15 Puparium from side showing line of cleavage for escape of adult.

16 Head of female in profile.

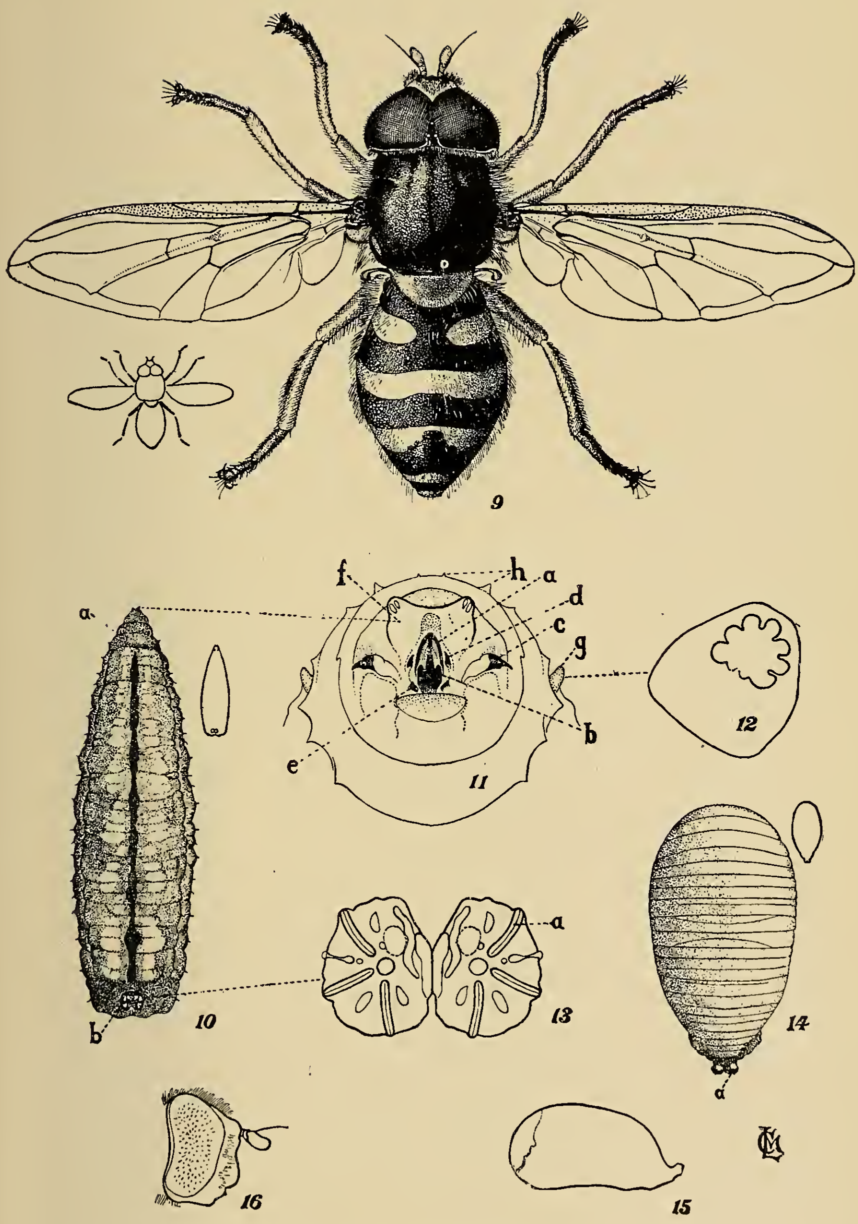

Fig. 33. Life-stages of *Syrphus torvus* Loew. (After Metcalf, from The Ohio Naturalist.)

EXPLANATION OF FIGURE 34.

Syrphus nitens Ztt.

1 Dorsal view of larva x 7.5; A, antenna; B, posterior respiratory organ.

2 Anterior larval spiracle, highly magnified.

3 End view of posterior respiratory organ x 75, showing the two stigmal plates; A, circular plate; B, one of the inter-spiracular nodules; C, median slit-like spiracle.

4 Postero-ventral view of posterior respiratory organ x 75, showing the position of the three pairs of extensively-convoluted, slit-like spiracles; the carinæ on which they are elevated; and the ridges median to the circular plates.

5 The retractile, renal? flabellæ, as protracted from the anal opening.

6 Dorsal view of puparium x 7.5; showing shape, markings, and at A, the posterior, larval, respiratory organ.

7 Dorsal view of adult ♂, x 7.5.

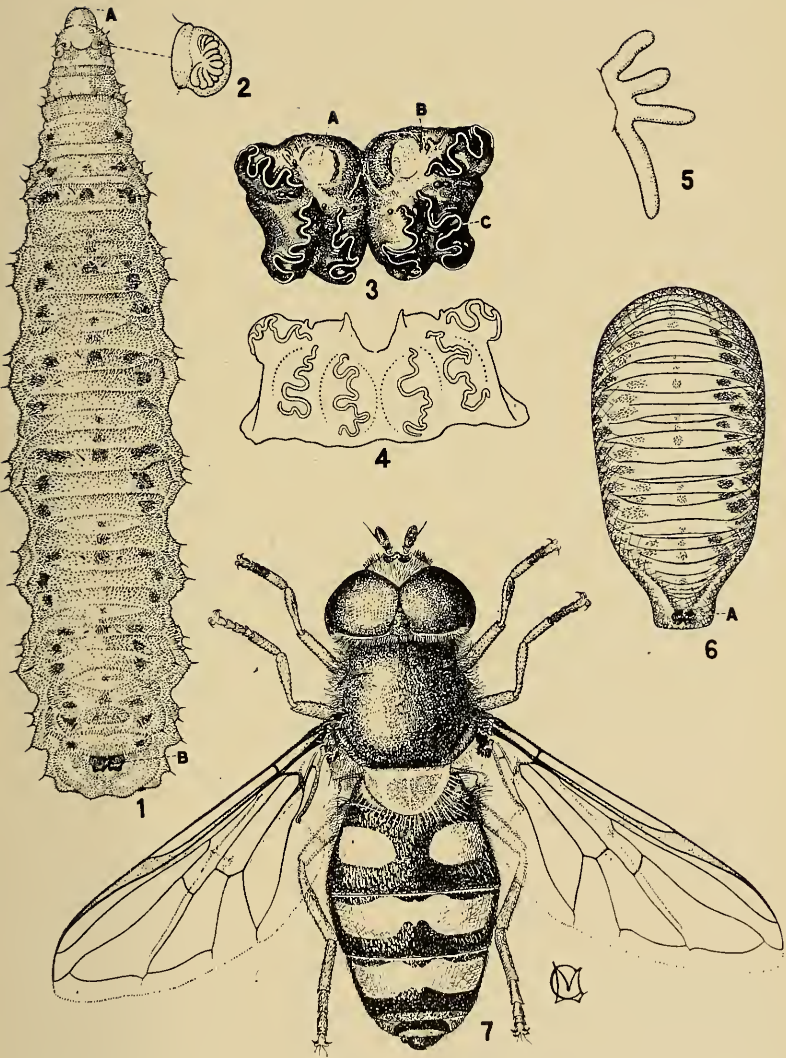

Fig. 34. Life-stages of *Syrphus nitens* Ztt..

EXPLANATION OF FIGURE 35.

Didea fasciata Macq. var *fuscipes* Loew.

1 Adult female x 6.

2 Larva about six times natural size; a, anterior spiracle; b, caudal spiracles.

3 Antero-ventral view of head and mouth-parts of larva, enlarged; a, upper jaw with a small pair of hooklets at the side; b, lower jaw; c and d, lateral hooklets; e, antenna; f, sense papillæ.

4 Right anterior spiracle much magnified.

5 Posterior breathing organs enlarged; a, one of the radiating spiracles.

6 Dorsal view of puparium a little more than five times natural size: a, caudal spiracles.

7 Puparium from the side showing arrangement of spines and line of cleavage for escape of adult.

8 Head of male in profile.

See also Figure 29-5.

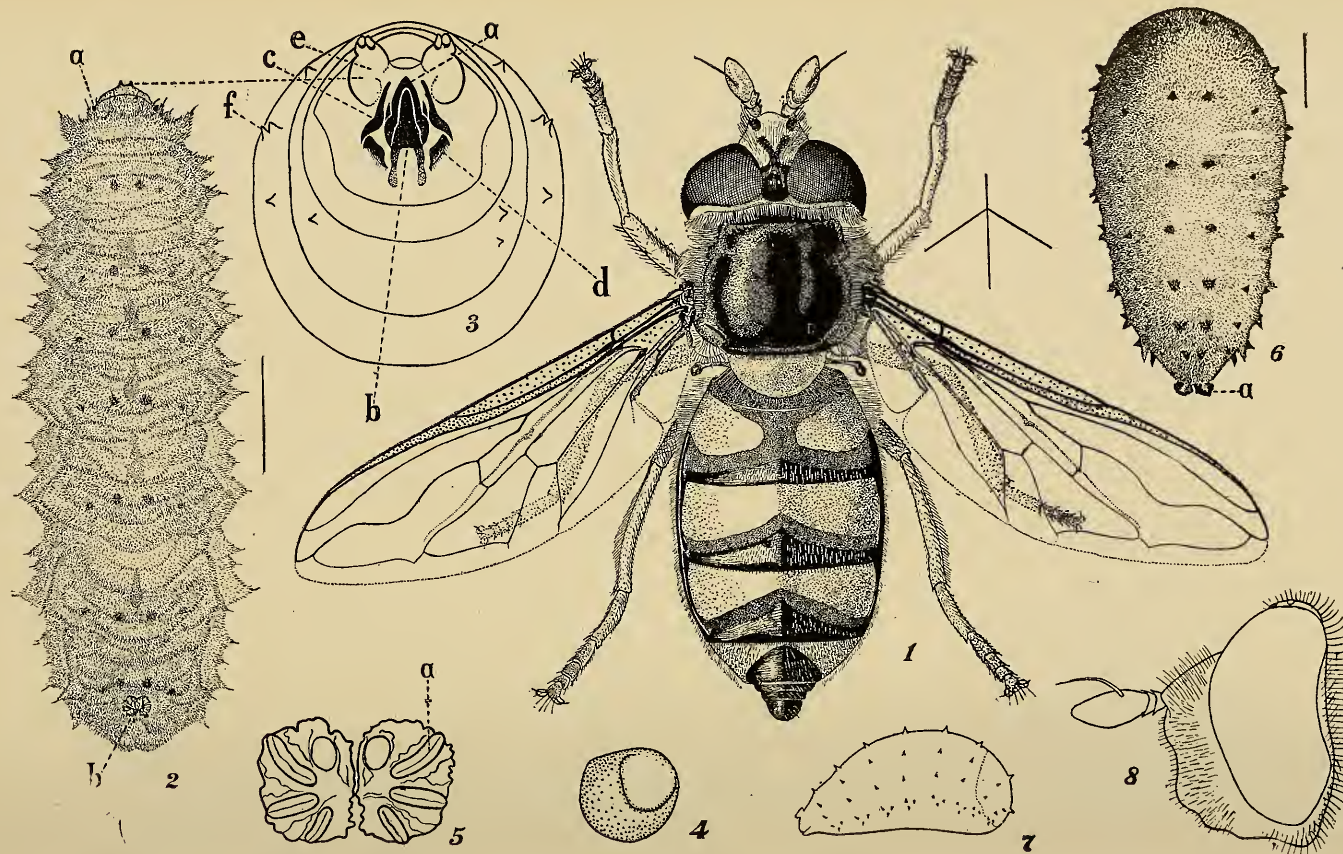

Fig. 35. Life-stages of *Didea fasciata* Macq. var. *fuscipes* Loew. (After Metcalf, from The Ohio Naturalist.)

EXPLANATION OF FIGURE 36.

Tropidia quadrata Say.

1 A few areoles from one of the bodies on the surface of the egg-shell, very highly magnified.

2 A small area of the chorion or egg-shell, highly magnified, showing the elevated bodies each of which is further ornamented with a number of rounded areoles.

3 Dorsal view of an egg x 22.

4 Anterior larval spiracle highly magnified.

5 Dorsal view of larva x 6; A, antenna; B, anterior larval spiracle, just laterad of which are the two large lateral hooks; C, posterior respiratory organ, at each side of which are the three lateral fleshy processes from the body-wall.

6 End-view of posterior respiratory organ, showing the two stigmal plates; A, one of the palmately-arranged groups of plumose, inter-spiracular hairs; B, circular plate; C, dorsal slit-like spiracle showing characteristic shape and dentations; much magnified.

7 Anterior view of head-segments of larva, much enlarged, showing arrangement of spines or thorns; A, the posterior row of thorns; B, anterior larval spiracle, situated in the middle row of thorns; C, the two pairs of large, lateral thorns, between which is the anterior row of thorns; D, left antenna; E, the first pair of pro-legs; F, the mouth-hood.

8 Lateral view of puparium x 6; A, left pupal respiratory cornua; B, posterior larval respiratory organ, at the side of which are the three lateral processes from the body-wall. Note also in the cephalo-ventral region the thorns of the larval head.

9 A group of papillæ from the pupal respiratory cornua, very highly magnified, each showing a number of nodules arranged in a circle.

10 Anterior view of puparium x 12; A, left pupal respiratory cornua; B, anterior larval spiracle; C, remnant of the larval mouth-hood; D, the two large lateral thorns or hooks of the larval head. The heavy dotted lines enclose the two pieces of the operculum which split off for the emergence of the adult.

11 Side view of head of male, showing characteristic facial carina.

12 Dorsal view of scutellum and abdomen of male, showing characteristic markings.

13 Wing.

14 Hind leg showing angular projection at outer end of femur.

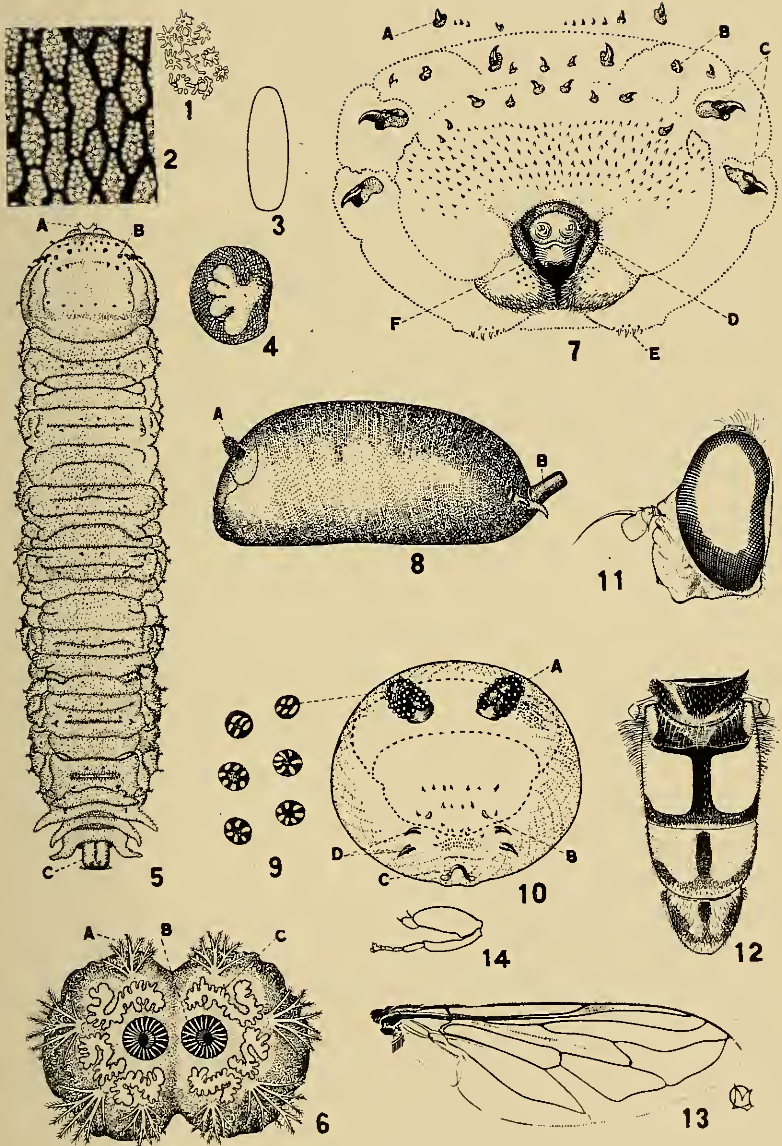

Fig. 36. Life-stages of *Tropidia quadrata* Say.

EXPLANATION OF FIGURE 37.

Syritta pipiens Linné.

1 A mass of eggs as deposited by a female on filth x 20.
2 A few areoles from one of the bodies on the surface of the egg-shell, very highly magnified.
3 A small area of the chorion or egg-shell highly magnified, showing the elevated bodies each of which is further indistinctly marked with rounded areoles.
4 Anterior larval spiracle, highly magnified.
5 Larva, dorsal view x 6; A, antenna; B, posterior respiratory organ.
6 Dorsal view of puparium x 6; A, pupal respiratory cornua; B, posterior larval respiratory organ.
7 A group of papillæ from the pupal respiratory cornua each composed of four to six nodules circularly arranged; very highly magnified.
8 One of the pupal respiratory cornua much enlarged.
9 End view of posterior respiratory organ, showing the two stigmal plates each with a circular plate, three slit-like, sinuate and denticulated spiracles (A), and four groups of palmately-arranged, plumose, inter-spiracular hairs.
10 Wing.
11 Hind leg, showing color-pattern and spines on femur.

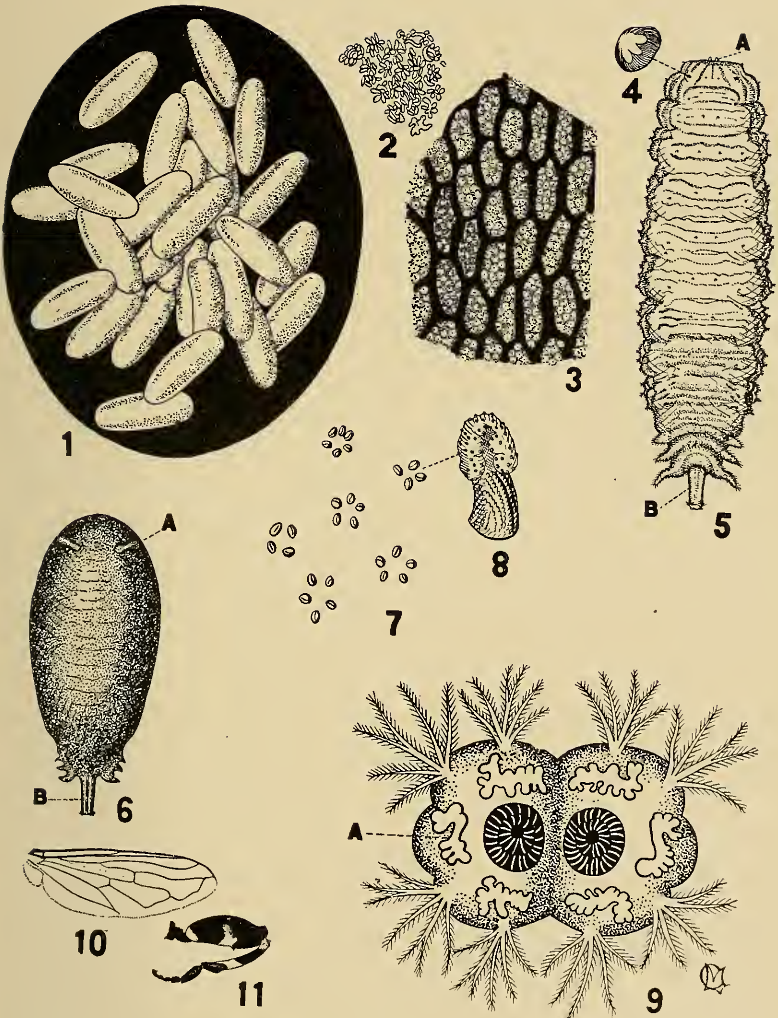

Fig. 37. Life-stages of *Syritta pipiens* Linné.

BULLETIN 254

STUDIES OF LIFE HISTORIES OF FROGHOPPERS OF MAINE.*

Herbert Osborn.†

MEADOW FROGHOPPERS.

The species of froghoppers common in meadows belong to two species, *Philaenus lineatus* and *P. spumarius,* which will be discussed in detail separately. Certain features are common to the two species but in certain respects they are very different. Both produce large quantities of frothy matter "spittle," and this is formed by liberating air beneath the fluid discharged from the anal opening. See figs. 48 and 49. This fluid evidently contains sufficient albuminous or gelatinous material to form a slightly viscid mixture so that the air liberated within it forms little bubbles that persist for a long time, some remnant of the frothy mass adhering to the plants for some time after the insects have emerged as adults and taken their departure. I am not aware of any study of the composition of the froth and it seems to have been assumed that the frothy condition was due to air in the fluid just as it is discharged from the alimentary canal. I have noticed however that there is a distinct secretion from the sides of the seventh and eighth abdominal segments, apparently a glairy or viscid substance, quite evident when the living insect is submerged in weak alcohol It seems to be slightly coagulated but not dissolved in the alcohol and it appears probable that the addition of this substance to the discharge from the alimentary canal furnishes the viscid quality to the mass that is necessary to maintain its frothy con-

*Papers from the Maine Agricultural Experiment Station; Entomology 89.

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dition. This condition persists even during rather heavy rains, showing a certain insolubility in water as well as in alcohol. The glands from which the secretion comes are located laterally in the abdominal segments (the 7th and 8th) and in a specimen of one of the intermediate instars, probably the third, they appear as black spots. In other instars, so far as observed, they are not specially colored but show in mounted specimens as a more opaque area while the surface is roughened over a triangular area though no gland openings have been observed in the material studied. The pores may be too minute for ready observation. A similar secretion has been observed for *Clastoptera.*

The purpose of the frothy masses is generally assumed to be for the protection of the nymph and it is easy to see that they are pretty well guarded against many of the smaller kinds of enemies such as spiders and other arthropods. Some distinct adaptations associated with the habit are to be noted as for instance, the loss in large degree by the nymphs of the leaping habit and also the nearly complete loss of color.

That these two species have a distinct preference, if not a positive restriction to particular food plants is indicated by the fact that *spumarius* is taken almost entirely from plants other than grasses while *lineatus* is taken almost exclusively from grasses, especially timothy and redtop.

As a test of their choice in this matter on July 9th ten individuals of *lineatus* were transferred from timothy to clover and of these none lived, though two had succeeded in changing to adult stage probably being very near maturity. In the reverse test ten specimens of *spumarius* were transferred from clover to timothy and only two lived to become adults, none made froth on the timothy and all showed restlessness and attempts to move. They evidently failed to secure sap and it is possible that there is some distinct difference in the mouth parts correlated with the different food plants as well as a difference in selection.

The economic importance of these species has been variously estimated though I think too generally overlooked. I find in an early record in the *Maine Farmer* for July 26, 1866, the following note by G. E. Brackett under the head of "Practical Entomology:"

"About 'Hoppers.' There is a class of insects including three families, the leafhopper, treehopper and froghopper, which present some peculiar characteristics, the species most common here is the froghopper (Cercopida) so called. Every farmer will have noticed upon plants, particularly on grass, a mass of foam or spittle-like substance, adhering to the stalk, and containing an insect, which, from the fact that it leaps when disturbed, may have been called a young grasshopper. This is the froghopper, of the order Homoptera, and entirely distinct from the grasshopper, in having a tube to suck juices instead of jaws to bite leaves, as do grasshoppers and all other orthopterous insects. These froghoppers hatch from eggs laid in the previous autumn, and immediately puncture the tender bark of the plant with their beak and suck out the sap. They take in such large quantities that it oozes out of their bodies in the form of minute bubbles which soon form a covering of foam or spittle-like substance, which gives it its name. This substance shelters it from the sun and also from insect enemies. When they become full grown in autumn they are not thus protected, but are found moving about on the plants where they lay their eggs. A description of this insect will be unnecessary, as every reader has seen them. There is general resemblance among the different families of hoppers. They are not considered particularly destructive to the plants on which they are found."

In speaking of the injuries of the spittle insects Dr. Lintner (Fifth Report on the Injurious and Other Insects of the State of New York, p. 246, 1889) remarks as follows:

"Report has been made in Vermont of one or more of the grass infesting species causing considerable damage to the hay crop. It was estimated that in consequence of the depredations, the quantity of hay grown on some fields was one-third less than the natural yield, not including the depreciation in the quality of the crop. It is but seldom however, that these insects increase to such an unusual extent as to become of serious injury, and it is therefore unnecessary to indicate any means for their destruction. A gentleman, who asks for information regarding them, states that, in passing through his mowing fields, in Auburn, Mass., they are so numerous as to wet his shoes. An abundance such as this would of course, be harmful to the crop but, fortunately it is of rare occurrence."

Occurrences such as these are perhaps less rare than is generally supposed since these insects are easily overlooked and the tendency has been to give little heed to the attacks of insects unless they are severe enough to cause a very complete destruction of a crop. I am informed by Dr. Patch that occurrences where the insects are abundant enough to wet ones shoes in walking through grass are not infrequent and in my collecting the present season I have found them plentiful enough for this purpose and often plentiful enough so that my net would become wet while sweeping the grass for specimens. As shown elsewhere by actual counts and estimates the drain on certain fields is such that it well deserves attention and the determination of measures for control.

If old fields showed uniformly small plants there would be some reason to attribute the reduction in growth to the soil or to "running out" but when scattered stems stand at good height and produce excellent heads it seems that this explanation is insufficient.

It is a peculiar sight in some fields to note a considerable number of tall well developed stalks with large heads in full bloom and along with them in exactly the same soil and exposure to sun, rain and other conditions, numerous dwarfed plants with short, blasted heads or no heads at all.

While some mention of the species has been made by these earlier writers there has been scarcely any reference to the species or their possible economic importance by later writers and there is evidently opportunity for some careful observations and experiment to determine their habits and possible measures for control. The observations recorded here it is hoped will furnish a basis for any more detailed studies that may be possible in the future, but they will serve, it is believed an immediate purpose in suggesting some measures which should help in the reduction of the losses from this source.

Meadow Froghopper.

(*Philaenus spumarius* L.)

This extremely abundant species is widely distributed in the eastern United States as well as in Europe. It is probably the species most commonly referred to in mention of froghoppers although the nearly related species *P. lineatus* has been doubtless often the basis of comment. In general works the two species are seldom distinguished but since they have a different food plant range and other differences in habit, a more exact reference seems desirable. In common usage froghopper covers both these and certain other species. To make a more precise distinction I would propose this species be called the

Meadow Froghopper and the *Philaenus lineatus* Grass-feeding Froghopper.

The distribution of the species covers the northern United States west to the plains region at least and in Maine its occurrence may be expected throughout the entire state. In fact it is one of the most abundant species encountered in meadows and pastures and it is found occasionally in cultivated fields of oats.

There is a quite wide range of food plants including many of the compositae as well as several cultivated crops. Among the food plants specially noted were buttercup, yarrow, thistle, helianthus, orange dock, daisy, clover, primrose, chokecherry and plum.

Its economic importance is of course considerably affected by the fact that many of its foodplants are noxious weeds and if it would confine its attacks to such plants it might be counted very useful but since it feeds abundantly on clover its presence in meadows must be counted detrimental.

In life history the species agrees very closely with *P. lineatus* so much so that one statement will almost answer for the two.

Nature of the Injury.

The effects of the attacks of this species are most apparent on the blossoms or the seed formation and in many cases are very evident. This is especially evident in the case of the buttercup which seems to be one of the favorite foodplants. Buttercup heads were marked to indicate those blossoms that were on stems attacked by the hoppers and four marked heads on a plant that bore eight other heads. The four attacked all withered and failed to produce seed while six of the others formed good seed heads and the other two were still in blossom at time the observation closed. See figs. 44 and 45.

Clover blossoms also show the same effect and there is no doubt that the hoppers must be a distinct factor in the reduction of the formation of the perfect clover heads.

Where buttercup is present *spumarius* seems to gather on it in preference to other plants though clover is apparently nearly as much affected.

Life History.

As already indicated the eggs of this species are believed to pass the winter in the meadows where the nymphs are observed in summer and probably they are found in the stems of their various food plants or possibly in dead stems or leaves at the surface of the ground.

The larvæ hatch in early summer, the earliest record which we have for the season of 1916, being June 13. The nymphs were mostly well along at the time of my first field observations in June and I conclude that the rate of growth is rather rapid for the latter part of June as during this time and early July but few less mature than the final instar were to be found. On July 10th these last instar individuals were still plenty on buttercup and a recently emerged adult was observed on dandelion. From the middle of July only adults were observed but these were evidently still feeding and it is certain that mating and egg development are carried along slowly. Mating was observed July 28th, and at this time adults of both sexes were abundant in clover in a meadow. One mated individual, dissected showed no evidence of egg development beyond the most immature formation and no indication of shell. By the middle of August egg development has proceeded so that occasional eggs are found with well formed shells but usually only a few mature eggs along with many imperfect and undeveloped ova in the oviducts. Figure 46 shows this condition as noted in a specimen dissected in August. The large black bodies are the eggs with shells and the faint ones those still unformed. The large spermatheca may also be observed above the ovipositor. No spermatozoa could be detected in the spermatheca but from its size it would seem quite certain that they must be retained for some time and the eggs are fertilized as they mature through a long period possibly several weeks during late summer and early autumn.

No egg deposition was observed before my leaving Maine the last of August and the only eggs seen were those dissected from the females during August.

Description of Early Stages.

Egg: The egg is moderately elongate, irregularly elliptic, about three times as long as broad, narrowing to one end, slightly flattened, one side straight or slightly incurved the other convexly curved, giving the egg a slightly curved appearance. The shell is tough and hard and developed while the eggs are still in the ovariole ducts.

The first instar observed is from two to three millimeters long, the head before the eyes strongly inflated semiglobose or bulbous, polished, with faint arcs on the front. Antennæ short, 8- or 9-jointed, first joint short, 2nd large, 3rd cylindric, 4th to 9th tapering, eyes dark, a distinct transverse furrow or suture across vertex between bases of antennæ. Beak reaching to third pair of legs.

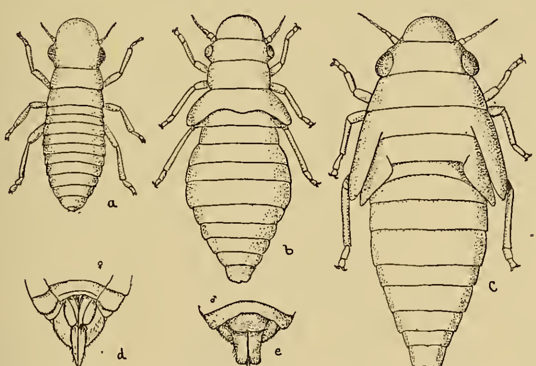

Fig. 38. *Philaenus spumarius, a,* young nymph; *b,* intermediate; *c,* last instar, all enlarged; *d,* female; *e,* male, genitalia. (Original.)

The second instar observed (possibly the 3rd in full series) has the head cordate, front bulbous, a depressed suture from antennal bases, forming a distinct transverse furrow, antennæ 9-jointed; 1st short, 2nd large, short cylindrical, 3rd longest cylindrical, 4th to 9th tapering gradually to tip. Eyes dark brown, reddish on the margins. Prothorax cylindrical; mesothorax expanded at sides to form beginning of wing pads, wider than metathorax slightly produced posteriorly, tips reaching nearly to hind border of the metathorax, hind border slightly curved, metathorax slightly expanded at sides, hind border nearly straight, transverse; legs not distinctly spined, a few weak points at tip of hind tibiæ. Abdomen widening to 3rd segment, tapering to tip, valves distinct. Length, 4 mm.

In the final instar observed the head is distinctly more pointed though the front is decidedly bulbous, ocelli are evident, the wing pads have developed backward so as to include the first two abdominal segments, those of the mesothorax being appressed to those of the metathorax and reaching almost if not quite to their tips. Head with vertex produced, subangulate, a depressed furrow crossing between the bases of the antennæ, ocelli slightly nearer the hind border and about equally distant from each other and from the eye. Antennæ 9-jointed, those following the third becoming more slender and setaceous. Eyes narrower, the larger part visible from below, red-brown appearing transversely barred, front tumid, clypeus strongly convex, beak reaching to behind 2nd coxæ. Two rows of black spines at tip of hind tibiæ. Length 5 to 6 mm.

This species is quite easily distinguished from *lineatus* in the final instar by the difference in the shape of the head. In *spumarius* this is distinctly wider than long so as to appear bluntly pointed and the transverse furrow is longer than the distance from its center to either the front of vertex or to rear margin. The body as a whole appears broader and the color is usually fairly distinct, *spumarius* having a yellowish tint while *lineatus* is green with dusky or smoky tint.

The adults present many varieties and most of these have been found in Maine. Several are figured in the accompanying plate (fig. 47) which shows also at bottom one of the nymphs.

There is apparently no relation in these varieties to the food plants as different varieties have been found to mature from nymphs feeding on the same plant. Furthermore individuals of different color varieties are found mating together, apparently without any reference to color pattern.

The typical form of the adult is easily seen from the figures, the head bluntly angular, the body elongate oval, widest about the middle, the elytra extending well beyond the end of the abdomen and the length from five to six millimeters. The color varies from pale gray to black and the markings in the form of irregular spots, broken cross bands, or longitudinal stripes.

Grass-feeding Froghopper.

(*Philaenus lineatus L.*)

This species appears to be a distinctly grass-feeding species and as noted in the preceding section seems unable to maintain itself on plants outside the grass family.

The species has a wide range in the northern hemisphere occurring over a wide territory in Europe and North America, but in the United States appears to be distributed especially through the northern portion, occurring from Maine to the Rocky Mountains. It seems to occur in greatest abundance in the New England States and, in meadows which are kept in grass for a number of years in succession, it undoubtedly must be ranked as a distinct pest. While seldom if ever alone in its attacks, being associated with various jassids and other sucking insects, it is one of the abundant forms and during the two seasons in which I have had opportunity to observe it there has been no question as to its numbers being sufficient to occasion distinct loss. The records of injury to certain fields apply with special emphasis to this species as it was so plentiful that the frothy masses were a conspicuous feature of the meadows in June and early July. Timothy and redtop were apparently about equally sought and the froth masses occurred from the level of the ground to several inches above.

The withering of the upper part of the stems and probably a considerable part of the blasting of the heads, some of which is doubtless due to thrips (*A. striatus* Osb.) or to Jassids may be attributed to this attack.

At the time of my arrival in Orono, the last of June, the nymphs had largely reached the final stage of growth so that I do not have observations on the earliest appearance. Judging by their maturity however and also by the stages of growth shown in the related *P. spumarius* it is probable that the eggs hatch and larval life begins in late May or early June.

On June 27th, 1914, at my first opportunity for personal observation the species was found plentifully on timothy and redtop, all found being in the nymphal stages and included in the froth masses, sometimes as many as two or three of the froth masses and included larvæ on a single grass stem. The most mature at this time was one with the wing pads developed evidently in the final nymphal instar. The final instar occupies a period of two or three weeks and corresponds closely with the time of rapid growth and formation of heads in the grass, the nymphal stage being passed and adults beginning to appear at about the time of hay cutting July 3rd to 10th.

The mature nymphs are easily distinguished from those of *spumarius* by the more slender body, the narrower front portion or inflated part of the head and by a more dusky coloration, especially as they approach moulting.

The process of emergence is interesting and apparently varies slightly in different individuals, but in cases observed the emergence occurred within the froth masses. The nymphal case is included within the remnant of the froth mass that remains attached and clings to the grass stem for some time. The head is closely appressed to the stem and directed toward the upper part of the stem, the abdomen is elevated and this and the thorax are both split along the dorsal line. The front legs clasp the stem, but the middle and hind legs are free.

The remnant of froth mass retains closely the original form and shows the form of individual bubbles, a condition which certainly points to the presence of some content that gives a gelatinous consistency to an otherwise watery mass.

The full life cycle of this species has not been followed and there are several points in the cycle which it will be especially interesting to determine. Nevertheless, enough is known concerning certain of the most critical periods of development to furnish a basis for the application of certain measures of control.

That the winter is passed in the egg stage as has been generally stated and is evidenced by the occurrence of larvæ in our cages, placed in early spring over timothy grass in meadows. Adults certainly could not have entered there to deposit eggs in spring and if adults had hibernated in the grass we should have found some at least of the dead bodies present within our cages.

The date of egg hatching cannot be given precisely, but the earliest appearance of the froth masses in June would indicate a rather late hatching, at least for this latitude.

During June only young are to be found and during this period they pass through three or four moults. Three instars at least are represented in material collected June 19th, 26th and 27th.

In rearings from nymphs collected on grass the latter part of June adults were secured during the first week in July. In one case a nymph enclosed June 29th moulted July 1st and emerged as adult on July 5th and in another case a nymph probably recently moulted caged July 9th, developed to maturity and adult emerged July 11th. These all indicate a short nymphal period and rapid growth.

The adults continue to feed and up to July 29th no signs of egg maturity or egg deposition had been noted. Egg development is evidently slow and mating and egg deposition must occur irregularly, probably extended over a period of some weeks in autumn.

Ovaries from females, collected in the field, were dissected and four well developed eggs were found with definite shell, but no evidence of segmentation. A number of apparently undeveloped eggs were in the ovarioles.

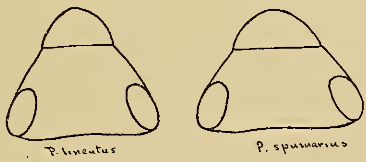

Fig. 39. Relative form of head in *Ph. lineatus* and *spumarius* nymphs of final instar.

Comparing the final instar especialy with *spumarius* the head is longer and the front more distinctly produced. In *spumarius* the part in front of the suture is in the ratio of 10 to 24 while in *lineatus* it is as 11 to 20 and the head entire in *spumarius* is in ratio of 44 wide to 31 long in *lineatus* as 40 wide to 34 long as taken in average for several specimens.

Lineatus is further distinguished by the dusky coloration especially toward the posterior end of the body as the nymph approaches maturity.

Some very small specimens of this species were taken at Saddleback Lake in the summer of 1916, the smaller ones only

4 mm. long, and many froth masses were noticed on the small dwarfed plants of Canadian bluegrass growing on rocky ledges. It seems possible that the depauperate condition of the grass and of the froghoppers living on it may be a mutual adaptation to a deficient food supply.

Adults of *lineatus* are distinguished from *spumarius* by the narrow, more parallel sided form and the longer head. The head is rounded angular in front and as wide as the thorax.

The color is gray with a whitish margin to the costa, bordered by a blackish line which fades out toward the end of the elytron. The length is from four to five millimeters.

Remedies or Control.

It seems very evident that the most effective control for this species lies in a frequent rotation from grass to some other crop and the general freedom from infestation in timothy meadows not older than two or three years as compared with the great abundance in old meadows, emphasizes this point.

This applies of course to many other of the grass insects, but on account of the restrictions of this species and the fact that the time during which eggs must be present is extended over a long period, it should be particularly effective. To be of greatest advantage plowing should be done in spring or late in fall.

It is recognized that there are many situations especially in wooded pastures and rougher meadow land where it is desirable to maintain a grass crop for a long succession of years and it is hoped that measures for reducing or eliminating these pests will make this possible without sacrificing such a large percentage of the crop.

Of the measures available for permanent meadows three seem worthy of mention and thorough trial.

While egg deposition has not been actually observed it is almost certain that the eggs are placed in grass stems and that they remain during fall, winter and early spring in this condition. It will be evident that burning of the surface dead grass, when this is allowable, will furnish a means of destroying the eggs of these and many other species.

Hopper dozer treatment immediately after haying to catch recently developed adults, would probably be the best time for use of this measure.

The hopper dozer method consists in the use of a strip of sheet iron, ten or fifteen feet in length, coated with coal tar or tanglefoot, and drawn over the surface of the grass land with about the rate of a rapid walk. Its success depends upon the fact that the hoppers when disturbed jump up a few inches from the grass and this means that they will usually fall back upon the sticky surface and be caught. The tar or tanglefoot must be replaced as often as it becomes so loaded with insects as to permit them to escape.

Early mowing would probably reduce the number materially and where the insects are abundant the gain in later growth would probably compensate for loss in quantity of crop. A trial of this was attempted, but circumstances delayed the first mowing till the bulk of insects were ready to become adult, so no conclusive results were secured.

That such mowing would be of service is indicated by the entire absence of these insects on lawns where early and frequent mowing is the practice.

Angulated Froghopper.

(*Lepyronia quadrangularis* Say.)

This species is not an abundant one in Maine, and apparently has no particular economic importance, but since it resembles the common meadow froghoppers it is desirable to show its distinctive characters.

It has not been observed, except in the latter part of the season, and so far as present evidence shows, there is a much belated single brood in the latitude of Orono, the larvæ of which develop during August, the adults being present during late August and through Sept.

Nymphs were first collected Aug 14th and included three well marked stages, representing evidently different instars and probably the second, third and fifth if the full series includes five instars. Adults appeared in the fields on the 18th, and a reared specimen was secured on the 17th from the nymphs collected on the 14th.

The nymphs are included in froth masses similar to those of the other froghoppers and are smooth and highly polished light green in color, becoming slightly more yellowish in later stages, the head distinctly blunt, almost truncate in front and the front somewhat flattened as compared with the bulbous form of the species of *Philaenus*.

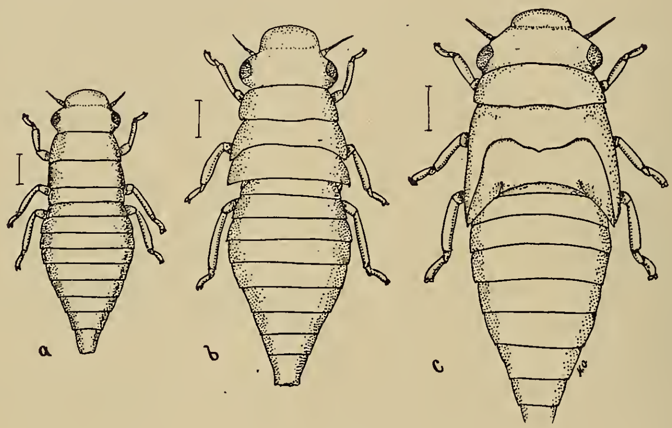

Fig. 40.

The smallest individuals taken (2nd instar?) *a*, Fig. 40, are 4 mm. long, tylus broad and distinctly truncate, beak reaching base of abdomen, the meso- and metathorax with no distinct development of wing pads, the color light green. The abdomen is pyriform, a little wider on third segment than thorax, the legs nearly uniform in size, the third pair slightly larger.

The next larger individuals (3rd instar?) *b*, Fig. 40, are 5-6 mm. long, similar in shape and color to the preceding stage, but with the wing pads clearly indicated, those of the mesothorax extending only slightly over the hinder ones, the beak reaching to the third coxæ.

The final nymphal instar (5th?) *c*, Fig. 40, is 6 to 7 mm. long, based on measurement of three individuals, light green in color with slightly more of yellowish and with the wing pads which extend to base of third abdominal segment of yellowish or whitish color. The beak extends to base of third coxæ, the legs nearly uniform in size, the hinder pair only slightly larger than the middle and the middle a trifle larger than the front pair, the head is broadly cordate, the eyes prominent, and the front similar to the preceding stage with a slight production of the anterior border.

In all stages the pleural lobes of the abdominal segment are very large and occur on all segments to last, enclosing a broad, deep channel which, as in related species, doubtless serves especially in the enclosing of air to form the froth mass.

This species is often taken in autumn in sweeping in grass lands and probably has a variety of food plants, though so far the nymphs have been found only on the *Impatiens biflora*. The adults have been taken only in autumn and while it would be unsafe to say that no spring generation occurs, the facts at hand would indicate that there is a late deposition of eggs in fall and that these eggs remain unhatched until midsummer of the following year, then producing nymphs during August, or possibly in late July, which mature very rapidly and give rise to adults by the middle of this month.

While the nymphs of this species very closely resemble those of *Philaenus* they may be at once distinguished by the blunt form of the front part of the head, appearing from above as if the head had been pushed against some object and a circular form made broadly truncate.

Adults of this species have a quite characteristic appearance with strongly sloping elytra which bear a blackish marking, the angle of which touches the costal border. The general color is gray with often a dull suffusion of purplish or brownish tint. Length 6 mm. to 7 mm.

BUSH AND TREE FROGHOPPERS.

Parallel Spittle Insect.

Aphrophora parallela Say.

Although this insect is a very abundant one and has been known to American entomologists for nearly a century, there has been very little written about it nor any careful study of its life cycle and habits.

About the only account of its habits worthy of mention is the original description by Fitch published in the Transactions of the New York State Agricultural Society for 1857.

This account is brief and while it has been reproduced in Packard's Forest Insects neither of these works is so generally available at present as to be accessible to all who might wish to see it, and it seems desirable therefore to quote it here.

"In June, a spot of white froth, resembling spittle, appearing upon the bark near the ends of the branches, hiding within it a small white wingless insect having six legs, which punctures and sucks the fluids of the bark, and grows to about a quarter of an inch in length by the last of that month, and then becomes a pupa of a similar appearance, but varied more or less with dusky or black, and with rudimentary wings resembling a vest drawn closely around the middle of the body; the latter part of July changing to its perfect form with wings fully grown, and then no longer covering itself with foam, but continuing to the end of the season, puncturing and drawing its nourishment from the bark as before. The perfect insect, a flattened oval treehopper, 0.40 in. long, with its wing covers held in form of a roof, its color brown from numberless blackish punctures upon a pale ground, a smooth whitish line along the middle of its back, and a small smooth whitish spot in the center of each wing cover, its abdomen beneath rusty brown."

This short account while giving the main points in the life cycle of the insect leaves many points to be desired and it was in hopes of supplying some of these wanting details that observations were begun upon the species in the summer of 1914.

At this time the nymphs in their frothy masses were quite plentiful on the Scotch Pines on the University Campus and it was hoped that by watching their development to verify the connection between these nymphs and the adult form. As stated by Fitch the nymphs were attached near the tips of the twigs and their presence was made very manifest, not only by the frothy masses, but by the sappy exudations running down on the branches so that there was a distinct discoloration. Usually only one nymph was observed on a twig and these were scattered over the tree. A number were enclosed in cheese cloth coverings to secure adults, but most of these were removed by some one who evidently counted them unsightly. However the rearing of some individuals and the securing of others either in process of emergence or in close proximity to the cast off skins leaves no question as to the larvæ observed being the young of this species.

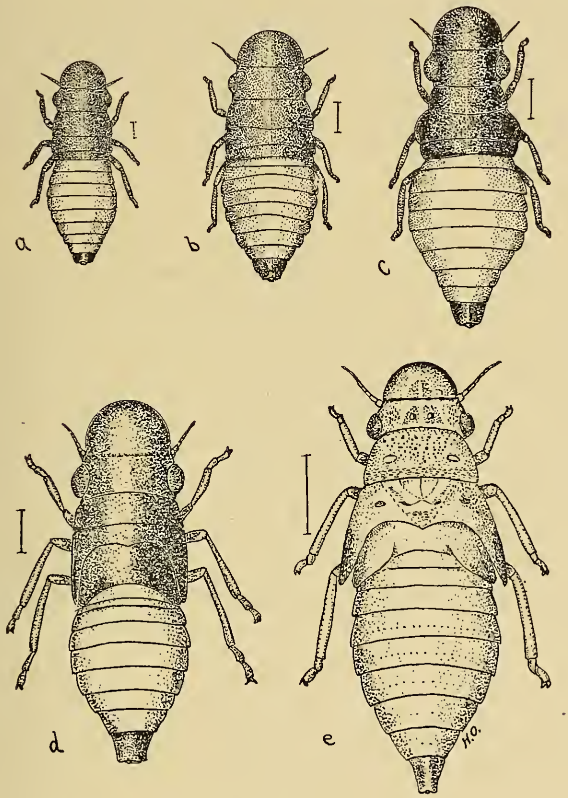

Fig. 41. *Aphrophora parallela a, b, c, d, e,* 1st, 2nd, 3rd, 4th, 5th instars. All enlarged. (Original.)

The earliest nymph collected in 1914 was a partly grown one secured by Mr. Newman June 19th, evidently representing the next to the last instar as all the later and larger nymphs showed a different color pattern. The date of egg hatching is therefore uncertain, but is probably during the last of May or early in June. The nymphal growth must be fairly rapid as individuals of the last instar occurred in early July and the first adults were observed on the morning of July 15th, one male being caught and another observed. At the same time one of the earlier instar forms was observed but at this time nearly all were in the preimago stage.

For the summer of 1916 which was late and the insects probably delayed in development, specimens were secured June 14th, that represent still earlier stages and the smallest an individual but three and one-half millimeters long is probably the first, while a larger one, four and one-half millimeters long, may represent the second instar. These complete a fairly regular series from which we may present a brief statement of distinctive characters.

Description of Early Stages.

First instar. Smallest individual seen, length 3.5 mm. Body slender, abdomen scarcely wider than thorax. Head and thorax with antennæ and legs and the last segment of the abdomen black polished. Abdomen except last segment yellow. Antennæ short, first joint thicker, about as long as thick, second scarcely longer than first, enlarging to tip, third short and with the following joints forming an obscurely segmented terminal part, tapering slightly to a blunt tip.

The second instar as indicated by size and maturity is 4.25 mm. long with the color as in the first instar, but with a very slight indication of beginning of the wing pads of the mesothorax.

The third instar 5 mm. long has the coloration of the preceding stage, but there is a distinct enlargement of the mesothorax into developing wing pads, but scarcely any for the metathorax.

Fourth instar. Length 6 mm. Head strongly produced semicircular from the base of the antennæ. A transverse suture across head, touching bases of antennæ. Mesothoracic wing pads extending back and enclosing metathorax and nearly touching base of abdomen, metathorax strongly concave behind the wing pads, not specially developed.

Color: Head and thorax including wing pads fuscous or nearly black, shining. Segments of the abdomen except the terminal one yellow-white, terminal segment black, tubular, legs black, tips of femora paler. Beneath; front black, lower part of face, legs and central stripe of abdomen brown, sides of abdomen, segments 1 to 5 orange red. (See fig. 41 *d*.)

Final instar. Length 11 mm., width 4 mm. Yellowish white with brown spots, brown eyes, ocelli in brown spots. A pair of spots on the prothorax, median and lateral spot on scutellum, part of mesothorax, the border and a pair of spots near center and the hind borders of the wing pads dusky; terminal segment black. Antennæ, eyes, tip of beak, and tarsi blackish. Ventral expansion of the pleurites giving a broad channel beneath, narrowing to tip where they form the leaf-like plates used in enclosing air to form the bubbles. (See fig. 41 *e*.)

Alder Spittle Insect.

(*Clastoptera obtusa* Say.)

This common species abundant over a large part of the northern United States has been known for a long period and while described and credited to alder it is found on a variety of plants mostly shrubs. Considerable confusion has occurred in its classification and Fitch described certain forms as *pini* and *testacea* from rather marked forms occurring on different plants, but Ball in his review of the group referred all these to *obtusa*. No distinct varieties have been clearly demonstrated as restricted to any host plant.

Linter Fifth Report of the State Entomologist of New York gives an account of the species based on larvæ occurring on alder. He describes the larvæ as nearly white with long

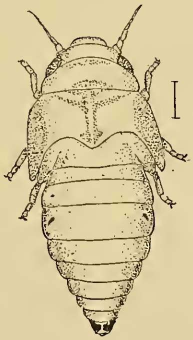

Fig. 42. *Clastoptera obtusa* Say. Nymph of last instar. Enlarged. (Original.)

legs which were moved rapidly in walking. The pupæ (last nymphal instar,) which had but recently undergone their transformation, show but little coloring, especially on their wing pads. With increased age they become more deeply colored, and they are olive-green on their thorax, wing cases and legs."

While the observations of this season add little to the past records, the fact that specimens were bred from white birch and hazel seems to make a record worth while.

Our specimens were taken as last instar nymphs on July 25th at which time they were beginning to change to adults and adults have been common on various plants since to early August. See fig. 50, *e* and *f*.

Records carry the species as adult as late as Sept. 5th, so it may be considered certain that there is a single generation in this latitude and that the winter is passed in the egg form, the eggs hatching in spring or early summer, probably in June or early July, and the larval stages are passed rapidly.

Dog-wood Spittle Insect.

(*Clastoptera proteus* Fitch.)

As the specific name implies this species is extremely variable and occurs in several forms, the more common ones being black in color with bright yellow cross bands on the thorax, in some cases with bright yellow spots on the base of the elytra and in others without these spots. See fig. 50, *g, h,* and *i*.

The species is supposed to occur on a variety of plants, but at Orono it has been taken for the larval stages, especially on the dogwood. Nymphs of apparently the final stage were taken during the summer of 1914 and adults were reared from these of both the color varieties. In 1916 still younger nymphs, the smallest found about two millimeters in length, were taken on dogwood and these are the smallest that have been secured. These were taken July 2nd, 7th and 10th and represent evidently individuals that have hatched from eggs that have survived the winter as no trace of earlier generation or of hibernating females has been found. These earlier nymphs agree closely with the older nymphs observed in 1914 except that the head and thorax are nearly black or solid dark olive green, while the abdomen is clear white or a very light greenish white. The beak extends to the hind coxæ and is dusky greenish olive, as are also the legs which are of about uniform size, or the hind ones possibly a trifle the larger.

Five fairly distinct sizes or forms representing probably as many stages are included in the series, but there is very little difference in them except in size, the greater amount of the dark color and the appearance of the wing pads.

Evidently they pass by easy gradations from one instar to another. Probably the moults take place within the froth masses as occasionally moulted skins may be found in the froth masses, but the nymphs appear to move readily from the froth if disturbed and start a new mass at another point. This habit of froth forming is so strong that they will begin the liberation of air bubbles in the balsam solution if placed in it alive for mounting.

The difficulty of securing newly hatched individuals is obvious since the only indication of occurrence is from the masses of froth and these do not appear until the young have fed and presumably have attained some increase in size.

The smallest individuals represent, therefore, probably advanced individuals of the first instar or possibly newly moulted individuals of the second instar. They are about two millimeters long, the head, prothorax, and mesothorax, with legs, antennæ, and last segment of the abdomen dark olive green, the metathorax and abdomen except last segment, greenish white or nearly pure white. There is no trace of enlargement for the wing pads and the metathorax is very short and inconspicuous.

The second size of individuals, probably second instar, show dark color on the metathorax and the angles of meso- and metathorax appear scarcely swollen.

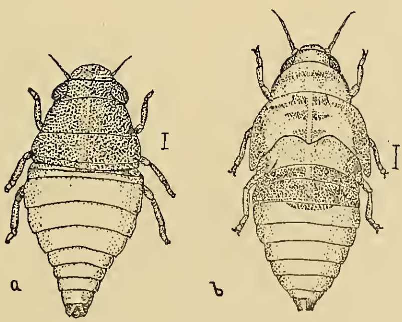

Fig. 43. *Clastoptera proteus* Fitch. Nymphs of 2nd or 3rd and final instar. Enlarged. (Original.)

The next in size, the third instar (?) show extension of mesothorax into the beginning of wingpads, but no perceptible pads on the metathorax. The dark color extends on to the first, second, and middle of the third abdominal segments, but is uniformly dusky on pro- meso- and metathorax.

No distinct separation of fourth and fifth instars has been made, but individuals referred to these differ in having less solid dark marking on the thorax and more extension of color on the abdomen. The wing pads are much more developed, and in the more mature forms extend on to the base of the abdomen. These mature forms, which are about three and a half millimeters in length, give rise to the adults, the appearance of adults coming the latter part of July.

Putting the various records together, it appears that the eggs remain over winter, the nymphs appear in late June, mature by the latter part of July and the adults presumably lay eggs during the latter part of the summer. There seems very little probability of a second brood in the latitude of Orono.

While these insects sometimes occur in considerable abundance and their food plants are often utilized as ornamental shrubs there is little danger of their becoming so serious a pest as to require any particular treatment. Indeed so far as observations go they seem pretty generally confined to the bushes, growing in their natural habitats and have not been taken upon bushes growing under cultivation.

Clastoptera xanthocephala Germ.

This small species while more southern in distribution occurs in some parts of New England, and may at times be found in Maine. It is a very small species, about three mm. long, and black or dark brown, resembling the black varieties of *proteus,* but differing in having slender lines across the upper part of the face and the lower part including the clypeus is black.

According to Mr. Heidemann it has been found during the nymphal stages on Chrysanthemums, although he surmises that the original food plant may have been Ragweed. In either case it can hardly be counted as of any particular economic importance in Maine.

Philaronia bilineata Say.

Another species which may be mentioned as belonging to the Maine fauna, although it has not been found in any abundance in the State, is the two-lined spittle insect *Philaronia bilineata* which is a common species through the northern part of the country from the White Mountains to the Rocky Mountain region. It is a little larger and more robust than *Philaenus lineatus* but much like it in general appearance. It has been taken at Fryeburg in the western part of the State by Mr. C. P. Alexander. The species has never been treated as of special economic importance and it is evidently too rare in Maine to need economic attention, but it often occurs in large numbers on the vegetation of the plains in the Dakotas and Montana.

Cercopidae Occurring in Maine.

A list of the species of this family known to occur in the state may be of service in connection with the study of the leaf-hoppers (Jassoidea) and the studies of the life histories of some of the more important species from an economic standpoint.

The froghoppers are recognized by the conspicuous circle of spines at the tip of the hind tibiæ and the species occurring in this region are mostly rather small insects of modest colors, and the young are well known on account of the masses of froth in which they are enclosed.

The tree living or shrub living species are included in the genera *Aphrophora* and *Clastoptera* while the species occurring on grasses or low herbage are included in the genera *Philaenus* and *Lepyronia.*

Aphrophora parallela Say. Occurs on pine, often abundant.

Aphrophora saratogensis Fitch. Also a pine species is less frequent.

Aphrophora quadrinotata Say. Not abundant in collections so far.

Philaenus spumarius L. A very abundant species in meadows and mixed vegetation, living on other plants than grasses.

Philaenus lineatus L. Very common in meadows and grass land living on various species of grass.

Lepyronia quadrangularis Say. Much less common here than the preceding species but evidently not a grass feeding species.

Philaronia bilineata Say, Fryeburg. (C. P. Alexander)

Clastoptera obtusa Say. A common species on alder, etc.

Clastoptera proteus Fitch. Common on dogwood.

Clastoptera xanthocephala Germ.

Of these species only the *Philaenus lineatus* and *Aphrophora quadrinotata* have been given a record for Maine in Ball's Monograph of the North American species, but *spumarius* is recorded for Nova Scotia and "New England States."

Fig. 44. Buttercup affected by *Philaenus spumarius.* The shriveled blasted heads are indicated by the x. (Original photograph.)

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Fig. 45. Buttercup heads enlarged showing the blasting due to attacks of the Froghopper *Philaenus spumarius*. Fig. 46. Female reproductive organs of *Philaenus spumarius* showing ovary with undeveloped, partially developed and mature eggs, the latter appearing very black, with shell. Below these and connected with the oviduct is the circular spermatheca and at bottom the ovipositor. (Original photographs.)

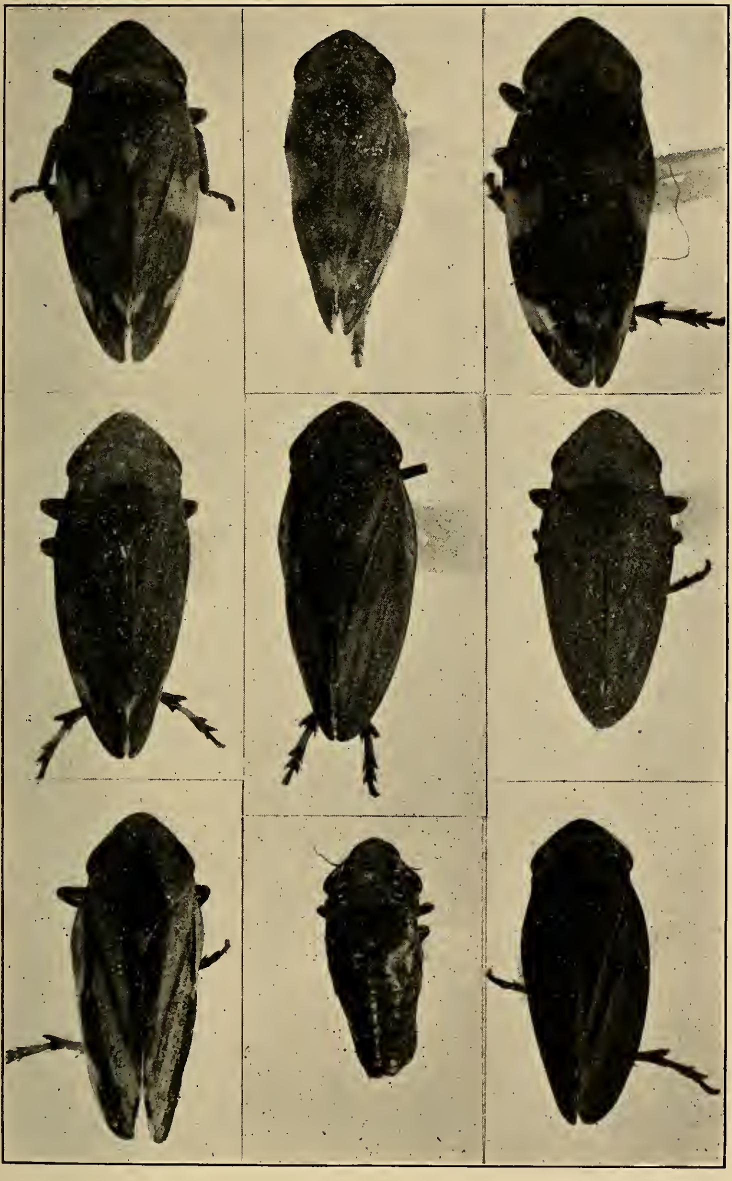

Fig. 47. Varieties of *Philaenus spumarius.* 1, 2, 3, var. *fasciatus;* 4, 6, *leucocephalus;* 5, *pallidus;* 7, *lineatus;* 8, nymph in final (fifth?) instar; 9, dark form of *leucocephalus.* (Original photograph.)

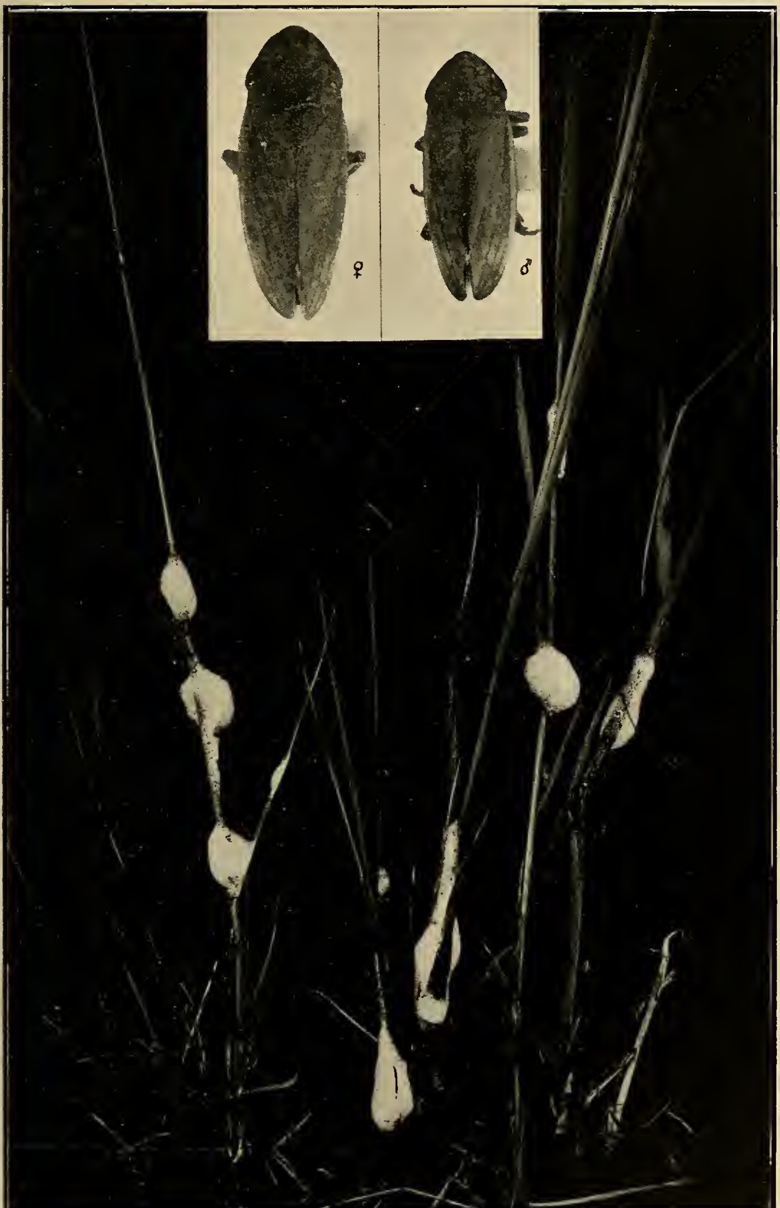

Fig. 48. *Philaenus lineatus.* Male and female above. Grass stems showing froth masses attached about natural size. (Original from photographs.)

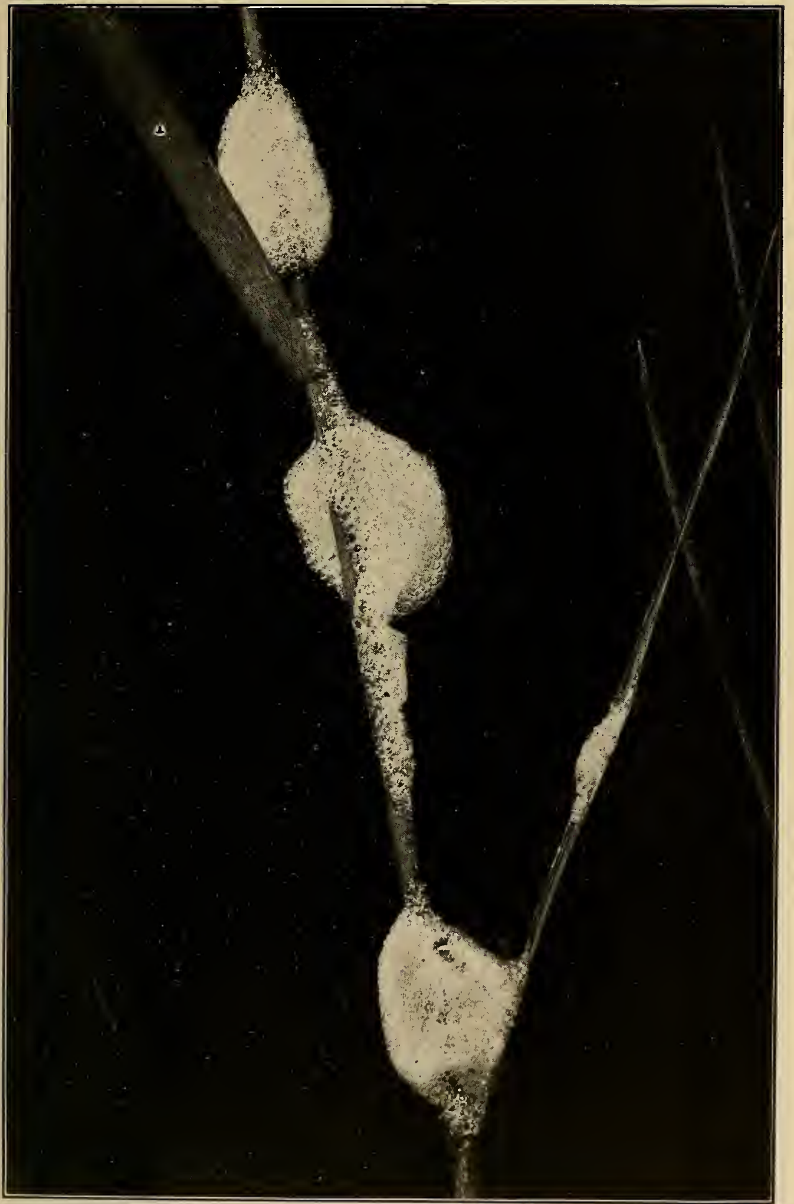

Fig. 49. Froth masses of *Philaenus lineatus* enlarged about three diameters. (Original from photograph.)

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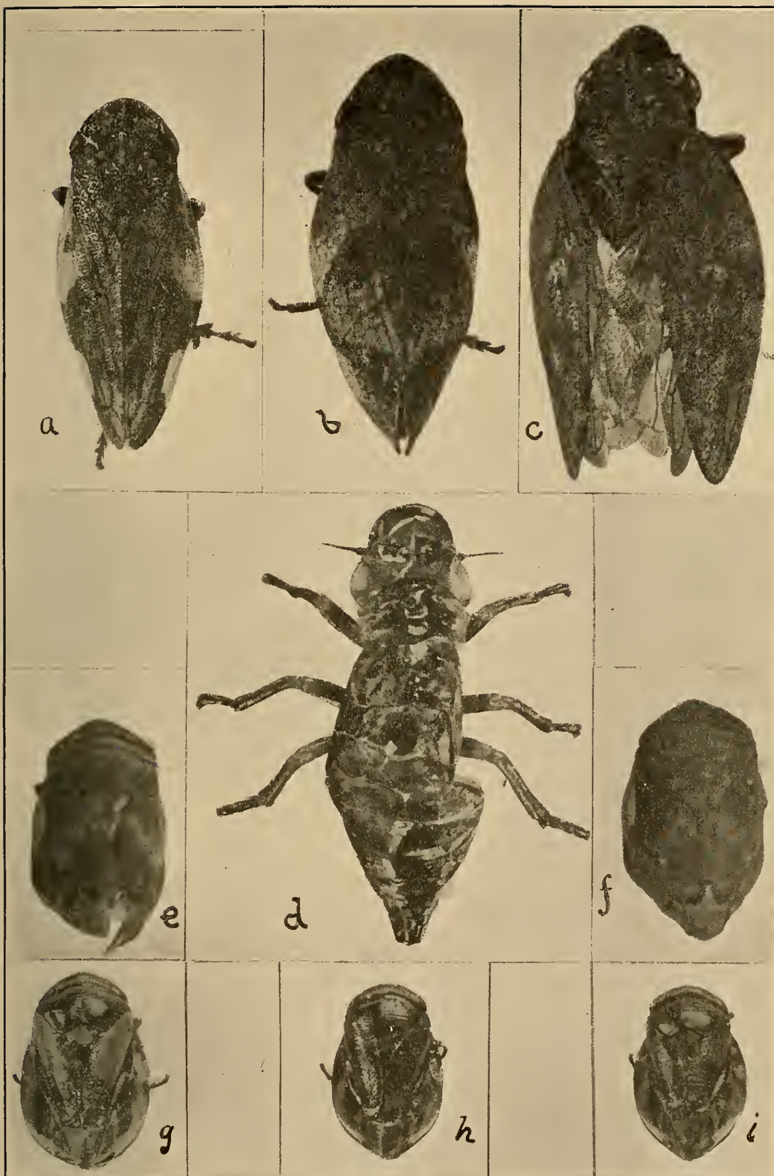

Fig. 50. *a, Aphrophora quadrinotata; b, Lepyronia quadrangularis; c, Aphrophora parallela; d A. parallela.* Nymphal molt from last instar; *Clastoptera obtusa* Say; *e*, male; *f*, female; *Clastoptera proteus* Fitch, *g*, female; *h*, *i*, two varieties of male. (Original.)

BULLETIN 255.

DWARF EGGS OF THE DOMESTIC FOWL.[1]

By Raymond Pearl and Maynie R. Curtis.

In any breed of domestic fowls there are occasional individuals which produce one or more small eggs which are from one-tenth to one-half the size of normal eggs. Various superstitions have been associated with these small eggs and in many parts of the world the eggs are still called by names derived from the superstitions formerly common to the region. A common superstition which persisted nearly to our own time was that old cocks produced these eggs. Hence they are still often called "cock eggs." At an early period it was believed that if a cock egg was incubated it would hatch into a serpent, the basalisk, whose breath or look was fatal. Other less definite superstitions considered these eggs as good or bad omens. In some places they were used as charms to bring misfortune to one's enemies and were called "witch eggs." In other places they were called "luck eggs" for it was believed that if one was thrown over a building any wish made by the thrower while the egg was in the air was sure to come true. Since no one of these names is generally accepted we have decided to use the modern descriptive term "dwarf eggs."

The dwarf egg is more common than any other type of abnormal egg except the double-yolked egg. It has emerged from the age of superstition with the cause for its production inadequately explained. It is the purpose of the present paper to discuss (1) the different types of dwarf eggs in respect to shape and also in respect to contents; (2) the variability in respect to size and shape; (3) the interrelations of the varia-

[1]This bulletin is an abstract of a more detailed paper by the same authors published under the title "Studies on the Physiology of Reproduction in the Domestic Fowl. XV. Dwarf Eggs." Journal of Agricultural Research, Vol. VI, pp. 977-1042, 1916.

tions in dimensions, shape and size; (4) the frequency of the occurrence of dwarf eggs compared to normal eggs and of dwarf egg producers compared to birds which do not lay dwarf eggs; (5) the seasonal distribution of dwarf eggs; (6) dwarf egg production by birds with normal and with abnormal oviducts; (7) the relation of dwarf egg production by normal birds to the age of the bird and to the position of the egg in the clutch and litter; (8) physiological conditions which lead to dwarf egg production; (9) the relation of the production of dwarf eggs to other abnormal phenomena of reproduction which either occur in nature or have been experimentally produced; and (10) the contribution which the study of the physiology of dwarf egg production makes to our knowledge of the normal physiology of egg production.

In the eight years from February 1, 1908, to February 1, 1916, 298 dwarf eggs are known to have been produced at this plant. The weight of 275 of these was taken and in 261 of these cases the length and breadth was also measured and the length-breadth index calculated. Of the 298 eggs recorded 274 were opened and their contents were examined. Several of the dwarf eggs were floor eggs and a few were laid by birds on which no egg record was kept. In 251 cases, however, the egg record of the bird laying the dwarf egg is available. Further several of these birds were autopsied and the condition of their sex organs observed.

I. Different Types of Dwarf Eggs Classified, First, in Respect to Shape and, Second, in Respect to Presence or Absence of Yolk.

The dwarf eggs of the fowl vary greatly in size and shape. Fig. 51 shows fourteen of these eggs with a normal egg laid

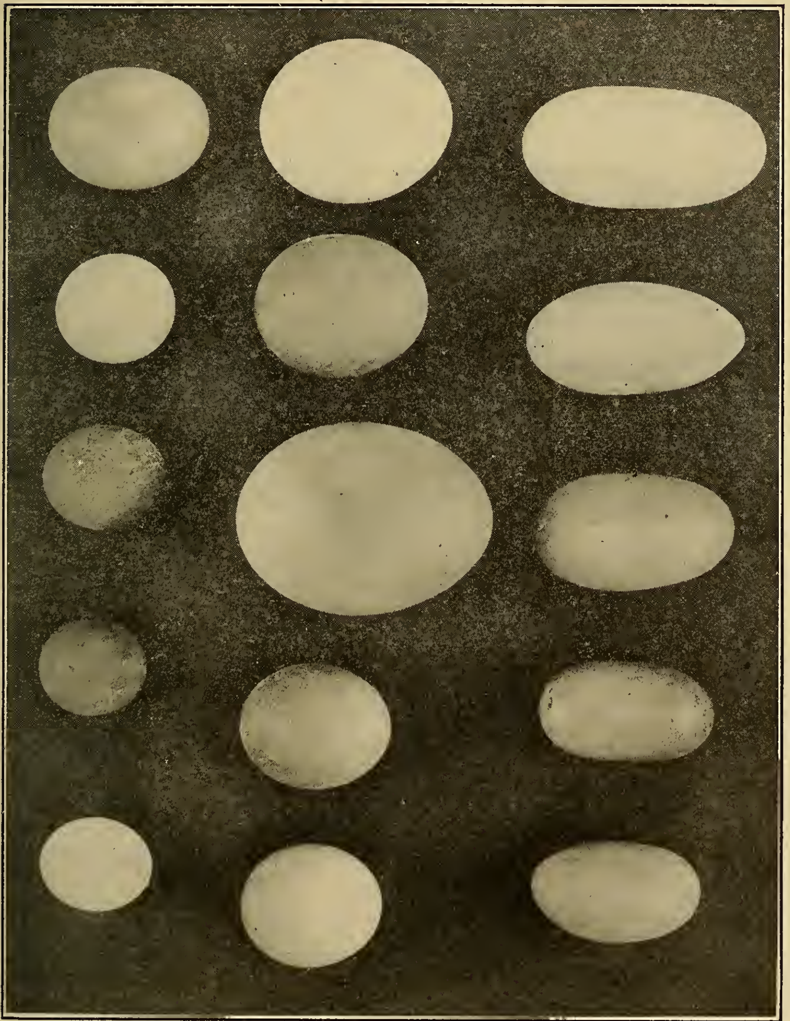

Fig. 51. A collection of dwarf eggs with a normal egg in the center of the group. X 2/3.

by a nine months old pullet for comparison. From this photograph it may be seen that there are two distinct types of dwarf eggs in respect to their shape. The prolate-spheroidal type similar in shape to a normal egg and the cylindrical type which is much longer in proportion to the breadth. The cylindrical eggs are shown in the first column of Fig. 1. These cylindrical eggs occur much less frequently than do the dwarf eggs of the prolate spheroidal type.

Not only do the dwarf eggs differ in respect to size and shape, but there is a difference in internal structure. Some of these eggs contain no yolk but appear to be formed around a nucleus which consists of a few strings of coagulated albumen, apparently untwisted chalazal threads, and there are also sometimes small lumps of hardened albumen or small blood clots associated with these chalazal threads. Some dwarf eggs contain small yolks in yolk membranes. More than half of all the eggs opened, however, contained some yolk which was not enclosed in a yolk membrane. Dwarf eggs may then be classified according to the non-occurrence of yolk and the condition of the yolk when present as, first, yolkless, second, with some yolk not in a membrane and, third with one small yolk. In Table 1 the dwarf eggs are classified both according to form and yolk content.

TABLE 1.

Showing the Classification of Dwarf Eggs both as to Shape and as to Yolk Content.

SHAPE.	Number yolkless.	Per cent. yolkless.	Number with some yolk not in a membrane.	Per cent. with some yolk.	Number with one small yolk.	Per cent. with one small yolk.	Total.
Shape not known[2]	5	38.46	8	61.54	0	0	13
Prolate spheroidal shape	83	33.33	139	55.82	27	10.84	249
Cylindrical shape	8	66.67	4	33.33	0	0	12
Total	96	35.03	151	55.11	27	9.85	274

[2]Dimensions not recorded.

From the last line of Table 1 it is seen that 96, or 35.03 per cent. of the dwarf eggs opened were yolkless. The other

178, or *64.96* per cent. contained yolk. Of these, 151, or *55.11* per cent. of all the dwarf eggs opened contained yolk not enclosed in a yolk membrane. A small yolk was present in *27*, or *9.85* per cent. of the dwarf eggs. From these figures it is seen that nearly two-thirds of the dwarf eggs contain yolk.

II. The Albumen and Shell of Dwarf Eggs.

We have seen that dwarf eggs differ in respect to the nucleus around which the albumen is formed. Bonnet[3] states that the nature of the albumen is also generally altered. The dwarf eggs observed differed greatly in respect to the density of the albumen. In many it was very condensed, being a thick clear mass which nearly maintained its shape when removed from the shell and egg membranes. It appeared very much like the albumen in a normal egg while it is in the albumen secreting region, or the isthmus of the oviduct.[4] In many other cases it appeared exactly like the albumen of a normal laid egg, that is, there was a somewhat firm inner mass surrounded by a thin fluid albumen. All gradations between these also occurred. In a very few cases the albumen was more fluid than in the average normal egg. There, however, was an undoubted general tendency for the albumen to be more than normally firm. In connection with another investigation in progress at this laboratory the specific gravity of the albumen of many normal and a few dwarf eggs was determined. The specific gravities of the dwarf eggs ranged widely, with the upper end of the range decidedly above the range for normal eggs. In fact the mean for the dwarf eggs is higher than the maximum for normal eggs, while the minimum for dwarf eggs is only slightly below the mean for normal eggs.

The egg membranes of dwarf eggs so far as superficial appearance indicates are comparable to those of normal eggs. The shell is sometimes entirely or almost entirely absent as in the case of membrane covered or soft shelled eggs which

[3]Bonnet. 1883. Das Vogelei. Deutsche Zeitschrift für Thiermedicin. Vol. 9, pp. 239-252.

[4]Pearl, R. and Curtis, M. R. 1912. Studies on the Physiology ot Reproduction in the Domestic Fowl. V. Data Regarding the Physiology of the Oviduct. Jour. Expt. Zool., Vol. 12, pp. 99-132.

are normal in all other particulars. The thickness of shell varies from very thin to very thick as in normal eggs.

III. The Size and Shape Relations of the Several Classes of Dwarf Eggs Compared to each Other and to Normal Eggs and the Relative Variability of Normal and of the Different Classes of Dwarf Eggs.

There is a considerable amount of variation within each class of dwarf eggs in respect to every measurable character. For each class of prolate spheroidal dwarf eggs the mean, standard deviation and coefficient of variation for each dimension and for weight was determined by the use of frequency distributions. In the same way the means and standard deviations were determined for shape index. Since this is a percentage character the coefficient of variation has no physical significance. However, the relative variation of the shape in the several groups may be roughly estimated by comparing directly the standard deviations. The number of cylindrical eggs was so small that the variation constants were not determined. The arithmetic means, however, were determined directly from the data. The size and variation of the different egg parts in dwarf eggs is an interesting but difficult question. It was found possible to separate accurately the parts in a dwarf egg with a small yolk enclosed in a yolk membrane. The weights of the parts were determined for sixteen small yolked dwarf eggs. The number is so small that the means, standard deviations and coefficients of variation were determined directly from the data.

The means, standard deviations and coefficients of variation for each character in each class of dwarf eggs and in two groups of normal eggs previously studied[5] are given in table 2.

[5]Pearl, R. and Surface, F. M. 1914. A Biometrical Study of Egg Production in the Domestic Fowl. III. Variation and Correlation in the Physical Character of the Egg. U. S. Dept. Agr. Bur. Anim. Indus. Bul. 110, Pt. III, pp. 171-241.

Curtis, M. R. 1914, b. A Biometrical Study of Egg Production in the Domestic Fowl. IV. Factors Influencing the Size, Shape and Physical Constitution of Eggs. Archiv f. Entw. Mech., Bd. 39, pp. 217-327.

TABLE 2.

Constants of Variation in Size and Shape in the Several Types of Dwarf Eggs and in Normal Eggs.

Character.	Prolate Spherodal Shape.			Cylindrical Shape.		All normal first year eggs from 22-bird flock.	All eggs laid by 850 birds on Feb. 13, 1908.
	Yolkless.	Some free yolk.	A small yolk.	Yolkless.	Some free yolk.		
Number of eggs	83	138	26	8	4	3,180	450
Length.							
Mean	35.27 ± .37	35.84 ± .34	41.35 ± .50	41.68	31.3	55.70 ± .03	56.32 ± .08
Standard deviation	5.03 ± .26	5.88 ± .24	3.81 ± .36	–	–	2.41 ± .02	2.39 ± .05
Coefficient of variation	14.26 ± .76	16.40 ± .68	9.22 ± .87	–	–	4.33 ± .04	4.24 ± .09
Breadth.							
Mean	28.23 ± .24	28.94 ± .21	32.38 ± .38	23.59	15.73	41.14 ± .02	41.92 ± .04
Standard deviation	3.20 ± .17	3.61 ± .15	2.87 ± .27	–	–	1.41 ± .01	1.38 ± .03
Coefficient of variation	11,34 ± .60	12.48 ± .51	8.85 ± .83	–	–	3.44 ± .03	3.29 ± .07
Index.							
Mean	80.75 ± .44	81.54 ± .36	78.88 ± .59	57.57	48.67	73.95 ± .04	74.52 ± .12
Standard deviation	5.96 ± .31	6.31 ± .26	4.41 ± .42	–	–	3.30 ± .03	3.79 ± .09
Weight.							
Mean	17.11 ± .43	18.35 ± .41	24.81 ± .81	15.24	10.63	52.92 ± .06	55.26 ± .15
Standard deviation	5.86 ± .31	7.14 ± .29	6.31 ± .57	–	–	5.01 ± .04	4.62 ± .10
Coefficient of variation	34.24 ±1.99	38.90 ±1.80	24.70 ±2.45	–	–	9.46 ± .08	8.36 ± .19
Weight.							
Mean	–	–	26.24 ± .82	–	–	–	–
Standard deviation	–	–	5.29 ± .63	–	–	–	–
Coefficient of variation	–	–	20.15 ±2.50	–	–	–	–
Yolk weight.							
Mean	–	–	4.27 ± .34	–	–	15.77 ± .02	–
Standard deviation	–	–	2.01 ± .24	–	–	1.78 ± .02	–
Coefficient of variation	–	–	47,12 ±6.75	–	–	11,31 ± .11	–
Albumen weight.							
Mean	–	–	17.79 ± .53	–	–	31.55 ± .05	–
Standard deviation	–	–	3.15 ± .37	–	–	3.87 ± .04	–
Coefficient of variation	–	–	17.69 ±2.18	–	–	12.27 ± .11	–
Shell weight.							
Mean	–	–	4.18 ± .19	–	–	5.12 ± .01	–
Standard deviation	–	–	1.10 ± .13	–	–	.71 ± .01	–
Coefficient variation	–	–	26.37 ±3.35	–	–	13.86 ± .13	–

By means of the data given in Table 2 it is possible to compare the size, shape and degree of variability of the several groups of dwarf eggs both among themselves and with normal eggs.

A. SIZE RELATION OF DWARF AND NORMAL EGGS.

1. All classes of dwarf eggs are lighter in weight and both shorter and narrower than normal eggs. This fact is of course obvious from the most casual inspection of dwarf and normal eggs.

2. The cylindrical eggs studied were much lighter in weight, decidedly narrower, but slightly longer than the eggs of the prolate spheroidal type.

3. Small yolked dwarf eggs are significantly smaller than normal eggs and larger than the other classes of dwarf eggs. That is the small yolked eggs are nearer the size of normal eggs than are dwarf eggs with little or no yolk.

4. The average length, breadth and weight are all slightly higher for dwarf eggs which contain some free yolk than for yolkless dwarf eggs. These slight differences are not certainly significant.

These results confirm the evidence from a study of normal[6] and multiple yolked[7] eggs that the amount of yolk (or other nucleus) present in the oviduct is an important factor in determining the amount of albumen secreted in a given case.

B. THE RELATIVE SHAPE OF DWARF AND NORMAL EGGS.

Table 2 also gives data for a study of the comparative shape of the several classes of dwarf and of normal eggs. It has already been noted that there are two distinct shape groups of dwarf eggs, cylindrical and prolate spheroidal eggs. The cause for the distinctly different form cannot be certainly decided from the material at hand. In several cases of cy-

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[6]Curtis, M. R. 1914, a. Studies on the Physiology of Reproduction in the Domestic Fowl. VI. Double and Triple-Yolked Eggs. Biol. Bul. Vol. 26, pp. 55-83.

[7]Pearl, R. 1910. A Triple-Yolked Egg. Zool. Anz., Bd. 35, pp. 417-423.

lindrical dwarf eggs the form of the nucleus was not noted. However, in a few pronounced cases it was noted that the nucleus of coagulated fibers of albumen was drawn out in a line parallel to the long axis of the egg. In the prolate spheroidal eggs the nucleus is of globular form. That is, its shape is comparable to the shape of a normal yolk. All the eggs with small formed yolks were of the prolate spheroidal type. It seems probable that the form of the stimulating nucleus is one of the factors in determining the shape of the egg.

A comparison of the mean indices shows, first, that cylindrical dwarf eggs are longer in proportion to their breadth than are normal eggs, while prolate spheroidal eggs are proportionately shorter, and second, that dwarf eggs with small yolks are nearer the shape of normal eggs than are dwarf eggs without formed yolks.

It has been noted that indices for dwarf eggs with small yolks are higher than those for normal and lower than those for other prolate spheroidal eggs. The order for the value of index is thus the reverse of the order for the size characters. Later it will be shown that within each group of dwarf eggs the index is negatively correlated with weight. In earlier investigations[8] it has been shown, first, that the indices for multiple yolked eggs lie below the range of variation for the indices of normal eggs and, second, that within the normal eggs of an individual the index is negatively correlated with weight. The results from the study of dwarf eggs therefore extend the former evidence that the smaller the egg the broader it is in proportion to its length. Two factors may be working together to produce this negative correlation between index and weight. First, the greater the long diameter of the nucleus, be it yolk drop, normal yolk, or two or three yolks in tandem, the longer will be the area of oviduct stimulated at the same time and, second, when a plastic body is forced (by peristalsis) through an elastic tube the tube will offer more mechanical resistance to the passage of a large than a small body. The oviduct will therefore exert a greater elongating pressure on a large than on a small egg. This mechanical factor is probably of great importance in determining the shape of the egg.

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[8]Curtis 1914 a and b. Loc. cit.

C. THE RELATIVE VARIABILITY OF DWARF AND NORMAL EGGS.

Table 2 gives also the data for comparing the variability of the different classes of prolate spheroidal dwarf eggs with each other and with normal eggs. In comparing classes where the absolute difference in size is as great as it is between normal and dwarf eggs the coefficients of variation are more accurate measures of relative variability than are the standard deviations. In order to determine whether or not the apparent differences in degree of variability shown by the several classes is significant it is necessary to compare the coefficient of variation (given in Table 2) for each character in each group with the coefficient of variation for the same character in each of the other groups. If such comparisons are made, and if in each case the difference in the coefficients compared is considered in relation to its probable error, we find the following relations between the degree of variability in the several classes.. First, normal eggs are significantly less variable than the least variable class of dwarf eggs (small yolked dwarfs) in length, breadth, egg weight, yolk weight and probably shell weight. The significance of the smaller variation in albumen weight is doubtful. Second, small yolked dwarf eggs are almost certainly less variable than other dwarf eggs in length and probably also in weight. The significance of the smaller variation in breadth is doubtful. Third, the somewhat greater variation in every size character in the dwarf eggs with free yolk than in the yolkless eggs is not certainly significant. That is, it may be due to errors in sampling. In respect of shape the only deviation which can be considered of even probable significance is the difference between yolkless and small yolked dwarfs. That is, normal eggs and small yolked dwarf eggs are probably less variable in shape than dwarf eggs without a formed yolk.

The relative variability of the size characters within each group are also of some interest. In both normal and dwarf eggs the size characters may be arranged in the order of their variability as egg weight, length, and breadth.

IV. The Interrelation of the Dimensions Shape and Weight of Each Class of Dwarf Eggs Compared to the Same Relations in Normal Eggs.

We have seen that the dwarf eggs of each group vary greatly in each dimension and in weight and shape. We may now consider the correlation in the variation of the several characters in prolate spheroidal[9] dwarf eggs of each class.

The correlations studied are length with breadth, breadth with weight, length with weight, index with weight, yolk weight with egg weight and yolk weight with albumen weight. On account of the small number of dwarf eggs of known yolk weight the correlations involving yolk weight were calculated directly from the data. In the case of the other pairs of characters the usual correlation tables were made for each class of dwarf eggs.

Table 3 shows the correlation coefficients with their probable errors and also similar coefficients for normal eggs.

From Table 3 the following points may be noted:

1. In each class of dwarf eggs the correlation between the two dimensions is positive and is certainly significant. That is, a broad dwarf egg is also long and vice versa. The shape of the egg is no doubt determined by the action of the longitudinal and circular muscle fibers of the oviduct walls especially during the formation of the egg membrane and shell. The forming egg is a fluid body which tends to take a spherical shape when not under pressure. At the time an egg receives its membrane and shell a normal egg, and almost any dwarf egg, is larger than the normal diameter of the oviduct. It is, therefore, under pressure which tends to elongate it in the direction of the long axis of the duct. The degree of pressure and hence the resulting degree of elongation will depend on (a) the size of the egg compared to the diameter of a cross section of the duct, and (b) the relative tonus of the two sets of muscle fibers of the oviduct wall. A decrease in the tonus of the circular fibers, or an increase in that of the longitudinal fibers, or both, may counterbalance the increase in pressure due

[9]Cylindrical eggs appear to show the same relations among themselves as the prolate-spheroidal eggs but the number was too small to determine the significance of the relationship.

TABLE 3.

Showing the Correlation Coefficients for the Size and Shape Characters of the Dwarf and Normal Eggs.

Kind of Eggs.	Number of eggs.	Correlation Coefficients.					
		Length and breadth.	Length and weight.	Breadth and weight.	Index and weight.	Yolk weight and egg weight.	Yolk weight and albumen weight.
Free yolked dwarf	138	.874 ± .013	.933 ± .007	.950 ± .006	—.408 ± .048	–	–
Yolkless dwarf	83	.844 ± .021	.924 ± .011	.919 ± .011	—.368 ± .064	–	–
Small yolked dwarf	26	.759 ± .056	.844 ± .039	.883 ± .029	—.092 ± .131	.940 ± .020	.789 ± .064
Normal (mean or individual coefficient for 22 birds)	3,180	.378	.753	.830	—.185	.818	.566
Normal (eggs laid byflock on a single day)	450	.084 ± .032	.580 ± .021	.836 ± .010	.085 ± .032	–	–

to an increase in the diameter of the egg. The fact that the correlation between length and breadth is significantly higher for dwarf eggs with little or no yolk than for small yolked dwarf or normal eggs may indicate that in these very small eggs there is little or no differential stimulus on the muscle fibers of the oviduct wall, but that there is such a stimulus when the egg is larger.

2. Length and breadth are both highly correlated with weight. That is a large egg is both broad and long. These relations are also true for normal eggs.

3. The index-weight correlations are negative and they are significant for dwarf eggs with little or no yolk. That is for these two groups of small dwarf eggs the larger the egg the longer it is in proportion to its breadth, or the larger the egg the lower the index. The bearing of this fact has already been discussed (p. 297).

4. The correlation between yolk weight and albumen weight in dwarf eggs with small yolks is higher than the average correlation between yolk weight and albumen weight within the normal eggs of a single individual. This high correlation between yolk weight and albumen weight in dwarf eggs with small yolks adds to the evidence already presented (p. 297). that the amount of yolk present in the duct is an important factor in determining the amount of albumen secreted and thus both directly and indirectly influences the size of the egg.

V. The Frequency of the Occurrence of Dwarf Eggs Compared to Normal Eggs and of Dwarf Egg Producers Compared to Birds which do not Lay Dwarf Eggs.

The 298 dwarf eggs collected were produced by nine different flocks. During any year a few dwarf eggs may have escaped collection by being broken in the nest or laid on the floor and lost in the litter. This loss cannot have been large at any time. However, in order to guard against the possibility that there was an unequal loss during the several years the two years of highest dwarf egg production were selected for a comparison between the frequencies of dwarf and normal eggs.

The frequency of the occurrence of dwarf eggs compared to normal eggs may be determined by calculating the percentage of all the eggs produced which are dwarf. For convenience this percentage may be multiplied by 100. This number represents the number of dwarfs in 10,000 eggs. This percentage was calculated for each of the two years of highest dwarf egg production, i. e., 1911-12 and 1914-15. These data are given in Table 4.

TABLE 4.

Showing for the Years 1911-12 and 1914-15 the Total Number of Eggs, the Total Number of Dwarf Eggs and the Number of Dwarf Eggs per 10,000.

YEAR.	Total number of eggs.	Total number of dwarf eggs.	Number of dwarf eggs per 10,000.
1911-12	63,176	59	9.3
1914-15	88,560	72	8.1
Total	151,736	131	8.6

From these data it is seen that during the two years of maximum dwarf-egg production the proportion of dwarf to normal eggs was 8.6 dwarfs in 10,000 eggs, or one dwarf in 1,158 eggs. Warner and Kirkpatrick[10] show that during two laying contests at Storrs, Connecticut, 199,137 eggs were produced of which 103 weighed less than .09 lb. (40.82 gms.). From these figures we see that they obtained 5.2 dwarf eggs per 10,000, or one dwarf egg in 1,933 eggs.

The nine flocks which laid the dwarf eggs considered in this investigation contained approximately 4,800 different individual birds. Of these 4,800 birds about 5 per cent. produced at least one dwarf egg. By means of the data given by Warner and Kirkpatrick (*loc. cit.*) we see that during the third and fourth laying contest at Storrs, Connecticut, 85 out of 1,820

[10]Warner, D. E. and Kirkpatrick, W. F. 1916. What the Size of Egg Means. Jour. of Heredity, Vol. VII, pp. 128-131.

birds, or, 4.67 per cent. laid one or more dwarf eggs. The close agreement of the two approximations indicates that about 5 per cent. of the birds in an average flock will produce at least one dwarf egg.

VI. The Seasonal Frequency of Dwarf Eggs Compared to Normal Eggs.

Dwarf eggs are frequently found by poultrymen during the spring and early summer and somewhat less frequently at other seasons. During the eight years that these eggs have been collected at the Maine Station plant they have occurred during every one of the twelve months. However, 70.8 per cent. of them were laid during the five months from March 1 to July 31. During some years more than 80 per cent. were produced during these months. Table 5 gives the number of dwarf eggs produced each month for each of the eight years (1908-16). It also gives the percentage of all of the dwarf eggs (1908-16) and the percentage of the total annual yield of normal eggs (1899-1907)[11] produced during each calendar month.

This table shows that both dwarf and normal egg production is higher during the spring and summer than during the fall and winter. A comparison of the percentages at the foot of the table, however, shows that for May, June and July the percentage of the annual dwarf eggs is greater than the percentage of normal eggs. The monthly percentages of both normal and dwarf eggs are shown graphically in Fig. 52. It will be noted that the two polygons do not begin or end with the same month. The reason for this is that the data for the total egg production was collected for the September and October after the birds were one year old, while for the period during which dwarf egg production was studied, the data from September 1 to August 31, more nearly represents the data from a single group of birds.

[11]These percentages were determined by Pearl, R. and Surface, F. M. 1911. A Biometrical Study of Egg Production in the Domestic Fowl. II. Seasonal Distribution of Egg Production. U. S. Dept. of Agr., Bur. of Anim. Indus. Bul. 110, Pt. II, pp. 81-170.

TABLE 5.

Showing Number of Dwarf Eggs Recorded Each Month from February 1, 1908, to February 1, 1916, and the Percentage of both Dwarf and Normal Eggs Produced During Each Calendar Month.

YEAR.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April.	May	June	July	Aug.	Total
1907 and 1908	–	–	–	–	–	1	1	5	5	4	0	0	16[12]
1908 and 1909	0	0	0	0	0	3	7	5	1	3	0	1	20
1909 and 1910	2	1	1	0	0	3	7	5	5	0	10	0	34
1910 and 1911	0	1	2	3	1	2	3	3	12	6	4	6	43
1911 and 1912	2	1	2	2	2	0	7	7	10	17	2	7	59
1912 and 1913	1	1	1	1	3	0	1	0	7	1	1	0	17
1913 and 1914	0	3	0	0	2	0	4	8	4	5	1	0	27
1914 and 1915	1	0	6	3	4	3	5	8	7	10	20	5	72
1915 and 1916	0	5	2	2	1[13]	–	–	–	–	–	–	–	10[12]
Total	6	12	14	11	12	12	35	41	51	46	38	19	29.8
Per cent of total number produced during month	2.01[14]	4.03[14]	4.71	3.69	4.36	4.03	11.74	13.76	17.11	15.44	12.76	6.36	100
Per cent of total annual yield of normal eggs produced during month 1899-1907.	6.36	4.27	3.59	6.91	9.08	8.44	12.50	12.30	10.80	9.67	8.44	7.64	100

[12] Years incomplete.
[13] Calculations in earlier parts of paper were completed before this egg was laid.
[14] These should follow August as they are for the end and not the beginning of the year.

From the diagram it is seen, as would be expected on the theory of chance, that during the months of heaviest normal egg production more dwarf eggs are produced than at other seasons. Yet it is also seen that the two curves are by no means parallel. The egg production curve rises gradually through the fall and winter to its spring maximum and then

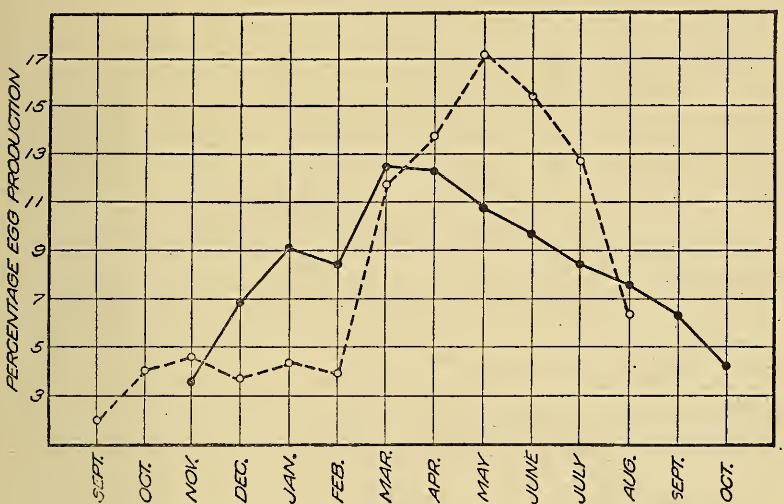

Fig. 52. Diagram showing the percentage of the yearly total egg production (8 year average, 1899-1907) and total dwarf egg production (8 year average, 1908-1916) which occurred during each month. Solid line = percentage of annual egg production. Dash line = percentage of annual dwarf egg production.

drops away even more gradually. The dwarf egg production curve does not rise during the fall and winter, but rises very abruptly during the spring to its maximum, which is three months later than the maximum for the normal egg curve. It remains relatively higher than the normal curve through the early summer.

Since the data for the two polygons are derived from entirely different birds it is desirable to pursue the investigations farther and compare the number of dwarf eggs and the number of normal eggs produced by the same birds. The two years of maximum dwarf egg production 1911-12 and 1914-15 were selected for this study. The data for this study are given in

Table 6, which shows the total egg production, the dwarf egg production and the number of dwarf eggs per 10,000 eggs for each month of the two years combined. The data given in the last three columns are shown graphically in Fig. 53.

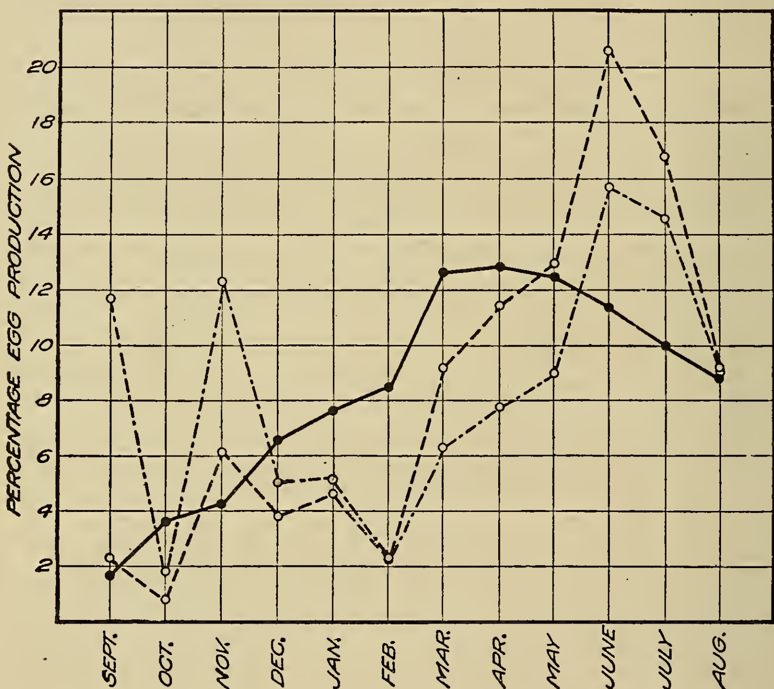

Fig. 53. Diagram showing for the years 1911-12 and 1914-15 combined the percentage of the yearly total egg production and dwarf egg production which occurred during each month and the per cent. (x 100) of the eggs produced each month which were dwarf. Solid line = per cent. of total yearly egg production per month. Dash line = per cent. of total yearly dwarf egg production per month. Dot-dash line = the per cent. (x 100) of eggs produced during the month which were dwarfs.

An examination of the diagram or the data given in Table 6 shows that not only is the actual number of dwarf eggs smallest during the winter, but that the number of dwarf eggs per 10,000 is also smallest. The irregular fluctuations of the fall are due to the fact that three birds which produced dwarf eggs because of a pathological condition of the sex organs laid

TABLE 6.

Seasonal Distribution of Dwarf Egg Production.

Month.	1911-12 and 1914-15 Combined.				
	Total number eggs.	Number dwarf eggs.	Number dwarf eggs per 10,000 eggs.	Per cent. of total number eggs produced during month.	Per cent. of total dwarf eggs produced during month.
September	2,564	3	11.7	1.69	2.29
October	5,529	1	1.8	3.64	.76
November	6,484	8	12.3	4.27	6.11
December	9,917	5	5.0	6.54	3.82
January	11,560	6	5.2	7.62	4.58
February	12,784	3	2.3	8.43	2.29
March	19,135	12	6.3	12.61	9.16
April	19,292	15	7.8	12.71	11.45
May	18,789	17	19.0	12.38	12.98
June	17,201	27	15.7	11.34	20.61
July	15,157	22	14.5	9.99	16.79
August	13,324	12	9.0	8.78	9.16
Total	151,736	131	8.6	100.0	100.0

during these months. The small number of normal eggs produced at this season gives great weight to these dwarf eggs in calculating the number of dwarf eggs per 10,000. Both the actual number of dwarf eggs and number per 10,000 increase through the spring, reaching a maximum in early summer some months later than the maximum for normal egg production. It is thus shown that the dwarf egg production is actually highest, and also highest in proportion to the normal egg production, during the spring and early summer.

It appears that the disturbances in physiology which result in the production of dwarf eggs become more frequent with the onset of the natural breeding season and continue to increase in frequency during this season. The probable nature of these disturbances will be discussed later.

VII. Dwarf Egg Production by Birds with Normal and with Pathological Oviducts.

The production of a dwarf egg is usually an isolated phenomenon. That is. a bird usually produces only one such egg. This fact is easily seen from Table 7.

TABLE 7.

Showing Number of Dwarf Eggs Laid by Each Bird which Produced One or More Such Eggs.

NUMBER OF DWARF EGGS LAID BY A BIRD.	Number of birds.	Per cent. of birds.	Number of eggs.
1	178	89.0	178
2	15	7.5	30
3	3	1.5	9
4	1	0.5	4
5	1	0.5	5
8	1	0.5	8
17	1	0.5	17
Total	200	100.0	251
Number of dwarf eggs laid by birds whose number was not known, i. e., mostly floor eggs			47
Total			298

From this table we see that of the 200 birds which produced one or more dwarf eggs, 178, or 89.0 per cent. produced only one, 15, or 7.5 per cent. produced two, and only 7, or 3.5 per cent. more than two. The figures given by Warner and Kirkpatrick (*loc. cit.*) for the birds in the Connecticut Station laying contest show an even larger percentage (94.11 per cent.) of the dwarf egg producers which lay only one dwarf egg. One bird laid 14 dwarf eggs and no normal eggs. Each of the other four (4.71 per cent.) laid two. It is thus apparent that the production of dwarf eggs is not usually an evidence of a permanent abnormality or derangement of the reproductive organs. This view is strengthened by a study of the egg records for the birds which produced dwarf eggs. In almost all cases these birds have a normal egg record. The dwarf egg is preceded and followed by normal eggs quite as though it were a normal egg. Only 11 (5.5 per cent.) of the 200 birds showed evidence of a permanent disturbance of the egg forming processes. It is evident that the disturbance which causes the production of a dwarf egg is usually of an accidental or at least temporary nature. However, there are certain pathological conditions of the oviduct which result in the formation of a dwarf egg instead of a normal egg.

The 11 cases where dwarf egg production appeared to be related to a permanent disturbance of the physiology of the sex organs include all of the cases where the bird produced more than three dwarf eggs, two that produced three, one that produced two, and four that produced only one dwarf egg. The production of a succession of dwarf eggs or of a long series of nesting records with one or two dwarf eggs should lead one to suspect a serious disturbance of the oviduct.

We will first consider dwarf egg production which is not associated with a morphological abnormality of the sex organs.

VIII. The Relation of Dwarf Egg Production by Normal Birds to the Age of the Bird and to the Position of the Egg in the Litter and Clutch.

A. *Age.* The age of the bird at the time the dwarf egg was laid could be determined in 202 cases where a dwarf egg was laid by a normal bird. The age frequency distribution is given below.

Age in Days.	*Dwarf Egg Frequency.*
150-209	11
210-269	14
270-329	22
330-389	65
390-449	52
450-509	19
510-569	4
570-629	0
630-689	3
690-749	6
750-809	2
810-869	2
870-929	0
930-989	0
990-1049	1
1050-1109	1
	202

It has already been noted that a large part of the birds are disposed of at the end of their first laying year. That is when they are 15 to 17 months of age. There were, therefore, many more chances for a bird to lay a dwarf egg during her first year than later in life. From data in hand it is not possible to decide whether or not a bird is more likely to lay a dwarf egg during the second or third year than during the pullet year. The flocks were not seriously depleted, however, until the end of the first laying year. It may be noted from the distribution that pullets are increasingly likely to lay dwarf eggs up to the time they are one year old and that the chances then decrease up to the end of the pullet year. The mean age for dwarf egg production among pullets may be calculated from the above distribution as far as and including the 450 to 509 day group. This mean is 361.96 ± 3.75 days. That is, approximately one year. It is apparent also that the second year maximum falls in the 690 to 749 day group. That is, when the bird is approximately two years old. Dwarf eggs are also produced by birds approximately three years old. From these data we see that dwarf egg production, unlike multiple yolked egg production, is not associated with immaturity of the bird, but that it is most likely to occur during the height of the breeding seasons in the successive years. These are of course the seasons of highest normal egg production. In the case of a very few of the young birds and in an appreciable percentage of the old birds this is the only season in which the birds are in laying condition.

B. *Position in the litter.* There is a wide spread popular belief that a dwarf egg marks the end of a laying period or litter. This belief has found frequent expression in the literature from an early period to the present day.

Since both dwarf eggs and broody hens are most common during the breeding season, it is not unnatural that a relationship between the two is assumed by poultrymen who do not trapnest their birds. The use of the trapnest, however, soon dispells this illusion. Pearl, Surface and Curtis[15] say that "The laying of one of these eggs is popularly supposed to mark the end of a laying period. This belief is without foundation in fact. They may be produced at any time." Warner and Kirkpatrick (*loc. cit.*) have lately arrived at the same conclusion after a study of the data collected during two laying contests at Storrs.

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[15]Pearl, R., Surface, F. M. and Curtis, M. R. 1911. Poultry Diseases and Their Treatment, Orono, pp. 1-216.

A few birds lay practically continuously from the beginning of laying until the first moult. Usually, however, there are well defined laying periods which alternate with periods of non-production. The periods of production vary in extreme cases from two weeks to several months. In the present investigation any period of practically continuous laying, whatever its length, is considered a litter. In order to determine the relation of the production of a dwarf egg to its position in the litter it is necessary to standardize the litter in order to summarize the data from the different cases. If the ordinal number of the days in the production period be divided by the whole number of days in the period, the resulting fraction will represent the position in the litter of an egg produced on that day. By this method the litter position of each dwarf egg produced by a normal bird which completed the litter was obtained. The frequency distribution for litter position of dwarf eggs is given below.

Fraction of litter.	*Dwarf egg frequency.*
0-.099	26
.100-.199	19
.200-.299	10
.300-.399	16
.400-.499	13
.500-.599	21
.600-.699	24
.700-.799	15
.800-.899	10
.900-.999	29
	183

Mean $= .506 \pm .015$
Standard deviation $= .307 \pm .011$

This distribution is shown graphically in Fig. 54.

The irregular fluctuations of the frequency curve for the litter position of dwarf eggs are not greater than the expected fluctuations of a random sample of the same size drawn from a population evenly distributed over the range.[16] The present

[16]For mathematical proof, see original paper.

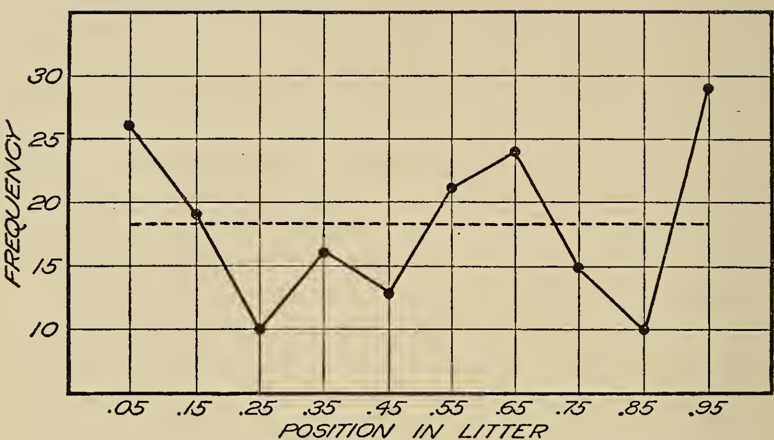

Fig. 54. Showing the number of dwarf eggs which occurred in each tenth of a litter. Dash line = the mean frequency.

data then indicate that a dwarf egg is equally likely to occur at any time during a period of production.

C. *The Position in the Clutch.* A fowl seldom lays on every day during a litter. The actual time between successive eggs depends on the rate of fecundity of the individual at the time. This rate differs greatly with the individual and with the season of the year. Since fecundity finds its manifestation in discrete units (eggs) the result of a very low rate is expressed by the production of an egg on a day preceded and followed by one to several days on which no egg is produced. A common low fecundity rhythm results in the production of an egg on every second day. More usually an egg is produced somewhat later on each of two or more successive days and then a day follows on which no egg is produced. The next egg is produced early on the following day. The litter is thus broken into a series of daily eggs, which we may call clutches, separated by one or more days on which no egg is produced. The size of a clutch varies from one egg to the extreme and unusual cases where a whole litter (sometimes of more than forty eggs) is laid in a continuous daily series.

The general acceptance of the notion that a dwarf egg marks the end of a period of production suggests an investigation of the position of the dwarf egg within its clutch. In 197 of the cases where a normal bird produced a dwarf egg the bird completed the clutch to which the dwarf egg belonged. Table 8 gives for every size of clutch the frequency distribution of clutch position of dwarf eggs.

Table 8.

Showing for Each Size of Clutch in which a Dwarf Egg was Produced the Frequency Distribution of Clutch Position of Dwarf Eggs.

Number of Eggs in the Clutch.	Ordinal Number of the Egg in the Clutch.															
	1st.	2nd.	3d.	4th.	5th.	6th.	7th.	8th.	9th.	10th.	11th.	12th.	13th.	14th.	15th.	Total.
1	50	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
2	26	20	–	–	–	–	–	–	–	–	–	–	–	–	–	46
3	10	19	13	–	–	–	–	–	–	–	–	–	–	–	–	42
4	5	5	7	7	–	–	–	–	–	–	–	–	–	–	–	24
5	2	4	3	2	5	–	–	–	–	–	–	–	–	–	–	16
6	0	2	2	0	1	0	–	–	–	–	–	–	–	–	–	5
7	1	1	0	0	1	3	0	–	–	–	–	–	–	–	–	6
8	0	0	0	0	1	0	2	0	–	–	–	–	–	–	–	3
9	1	0	0	1	0	0	0	0	0	–	–	–	–	–	–	2
11	0	0	1	0	0	0	0	0	0	0	0	–	–	–	–	1
15	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	2
Total	95	51	26	10	8	3	2	0	0	1	0	0	0	0	1	197

This table shows that 50 dwarf eggs occurred as one egg clutches. That is, no egg was produced on either the preceding or following day. Forty-six occurred in two egg clutches, the other egg being in each case a normal egg. Of these, twenty-six were the first and twenty the second of the two eggs. Similarly through the table we may compare the number of eggs produced in the successive positions in a clutch of any given size. The clutches in which dwarf eggs occurred vary in size from one to fifteen eggs. A study of this table shows no apparent uniform tendency for a dwarf egg to occur in any particular position in a clutch.

In order to summarize the data for the various sized clutches it is necessary to standardize the clutch. A clutch may be conceived as a line of definite length. This line may be divided into as many segments as there are eggs in the clutch. Each segment may be assigned a value equal to the fraction which the distance from the origin to the mid-point of the segment is of the whole length of the line. An egg then has a definite clutch position value expressed as a fraction of the clutch. These values are comparable for all sizes of clutches. For example, the value assigned to the middle egg of any clutch which contains an odd number of eggs is .500. A table was calculated which gives the value for each clutch position in each size of clutch. By means of this table the clutch position for each dwarf egg can be determined in terms which are comparable for all cases of dwarf egg production whatever the size of the clutch.

The clutch position frequency for the occurrence of dwarf eggs is given below.

Fraction of clutch.	*Dwarf egg frequency.*
0-.199	19
.200-.399	40
.400-.599	25
.600-.799	35
.800-.999	28
	147

Mean = .518±.015
Standard Deviation = .267±.011

This distribution is shown graphically in Fig. 55.

In this case as in the case of litter position the irregular fluctuations are not greater than would be expected to occur from errors of sampling.[17] The present data indicate then that a dwarf egg is equally likely to occur in any clutch position.

IX. Physiological Conditions and Effective Stimuli Which Lead to Dwarf Egg Production.

It has been shown that dwarf eggs usually represent some *temporary* disturbance or some *accident* in the physiology of reproduction since such eggs are preceded and followed by normal eggs. The disturbance is most likely to occur during the height of the breeding season although it may happen at

[17]For mathematical proof, see original paper.

any time during the year. During any particular litter or clutch a dwarf egg is equally likely to occur at any time. Although the cause of dwarf egg production is usually of a temporary character there are cases where a bird lays only or chiefly dwarf eggs. Other birds produce normal eggs for some time and then become "habitual" dwarf egg producers. In the present section we shall consider the nature of the disturbances,

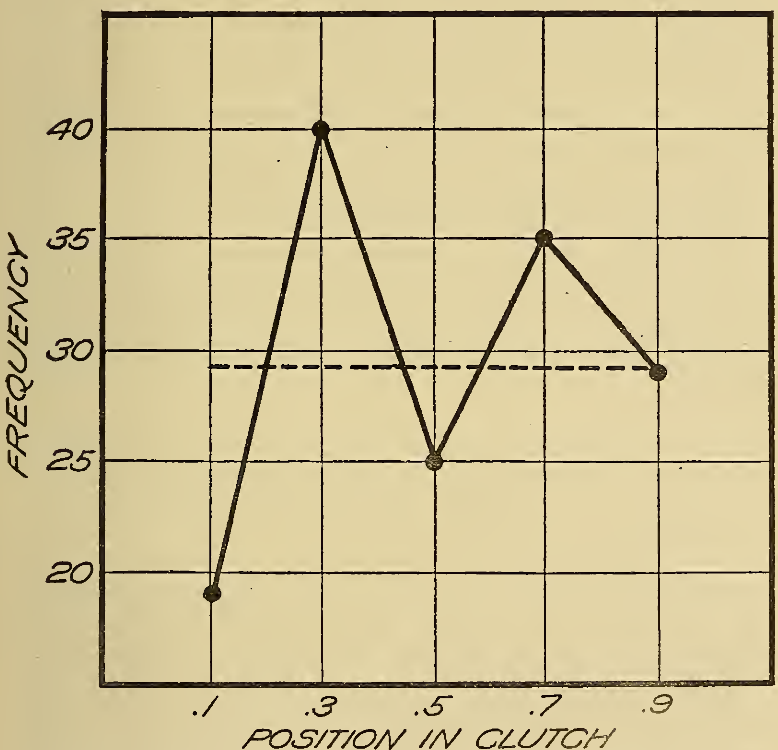

Fig. 55. Diagram showing the number of dwarf eggs which occurred in each fifth of a litter. Dash line shows the mean frequency.

both temporary and permanent, which lead to the production of dwarf eggs.

On the basis of unpublished data Pearl, Surface and Curtis (*loc. cit.*) made a statement of the factors which were probably involved in dwarf egg production. The data on which this statement was based are included in the data used in the present investigations. The data then on hand indicated that three fundamental factors are concerned in dwarf egg production. "These are:

"1. The bird must be in an active laying condition; the more pronounced the degree of physiological activity of the oviduct the more likely are these eggs to be produced.

"2. There must be some foreign body, however minute, to serve as the stimulus which shall start the albumen glands secreting. This foreign body may be either a minute piece of hardened albumen, a bit of coagulated blood, a small piece of yolk which has escaped from a ruptured yolk, etc.

"3. It seems likely, though this is a point not yet definitely settled, that ovulation (i. e., the separation of a yolk from the ovary) must precede the secretion of albumen around the foreign body to form one of these eggs."

To a large extent the complete investigation confirms and extends these conclusions. The data which contribute to our knowledge of the physiology of dwarf egg production are the complete egg records and the autopsy records of dwarf egg producers.

A. EVIDENCE FROM THE EGG RECORDS AND AUTOPSY RECORDS OF DWARF EGG PRODUCERS WITH ABNORMAL REPRODUCTIVE ORGANS.

It has already been noted that the egg records for eleven of the 200 known dwarf egg producers showed that few or no normal eggs were produced after the dwarf egg or eggs. Such birds usually make nesting records, the dwarf egg occurring in a series of the nesting records. As an illustration the egg record of Case No. 1 is reproduced in Fig. 56.

From this record it may be seen that the bird was a heavy layer producing 162 eggs up to May 28. After this she produced only one normal egg (on June 26). The nesting records occurring in clutches indicate that the ovary passed through its normal cycles. Four dwarf eggs were produced in a series of nesting records.

Five of the eleven cases of dwarf egg producers cited above were autopsied and found to have several things in common. (1) Each bird was a normal high laying individual which became unable to produce normal eggs on account of a patho-logical condition[18] of the oviduct. (2) In every case the part of the duct affected was the posterior end of the funnel or the anterior end of the albumen secreting region or both. (3) The disturbance in each case was of a nature to constrict or prevent the normal expansion of the lumen of the duct. (4) In

Date.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Totals.	
Sept																n			n						n		1		1	1		3	
Oct		1	1	1	1	1	1	1		1	1	1	n	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		27	
Nov	1		1		1	n	1	1	1	1	1	1	1	1	1	1		1		1	1	1	1	1	1	1	1	1	1	1		25	
Dec			1	1	1	1		1	1	1	1	1	1		1	1	1	1	1	1	1		1		1			n	n	1	1	21	
Jan		1	1	1		1	1		1	1		1	1	1		1		1	n	1		1			1	1		1		1		18	
Feb	1				1		1		1		1		1	n	1		1	n	1		1		1		n		1	1				13	107
Mar		1		1		1		1	1		1	1		1	1		1	1	1		1	1	n	1		1	1	1	n	1		19	
Apr	1	n	1	1	1	1	n		1	1	1	n	1		1	1	n	1	1		1	1	1	1		1	n					18	
May	1	1		1	1	1	1	1	1	n	1		1		1	1	n		n	1		1	1	n	1	1		1				18	162
June	n			n	n	n	n	n		n	n	n	n	n	n	n			n	n	n	n	n	n	n	1	n		n	n		1	
July	n	n	n	1—	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n			n	n	n	n	n	n	n	n	n	1—	
Aug	n	n	n	n	n	n		n	n	n	n	n	n	n		n		n	n	n	n	n	n	n								0	
Sept											n	n	n	n	n	n	n	n	n	n		n	n	n	n	n		n		n		0	
Oct																																0	
Nov										n	n		n	n	n	n			n		1—	n		1—		1—	n		n	n		3—	
Dec																	n															0	
Jan	n				n	n	n					n		n		n																0	
Feb									D																								

a "1" denotes a normal egg, "1–" a dwarf egg, "n" a visit to the trap nest but no egg, and "D" date killed for data.

Fig. 56. Egg record of Case No. 1, "1" denotes a normal egg, "1—" a dwarf egg, and "n" a visit to the trap nest but no egg.

no case was the passage completely closed. (5) In each case there was convincing evidence that the ovary was in a normal reproductive cycle at the time the dwarf egg was produced.

Five of the sixteen[19] dwarf eggs produced by these birds contained as a nucleus a small quantity of yolk not enclosed in a vitelline membrane. This yolk was no doubt a part of a normal yolk, the rest of which was absorbed by the visceral peritoneum. Three of the five birds were absorbing yolk in this manner at the time of autopsy. The presence of a part of

[18]Four of the five cases had tumorous growths on the walls of the duct. In two cases these involved a large part of the funnel and albumen secreting region. In the other two the affected tissue was confined to a narrow band in the lower funnel or albumen secreting region. In the fifth case there were two constrictions of the duct in the anterior end of the albumen secreting region. The constrictions were separated by one centimeter of duct with a normal diameter. The tissue in these constrictions did not appear pathological.

[19]In two other cases the presence or absence of yolk was not recorded.

a yolk in the egg may have been due to any one of several causes. The three which seem most probable are the following:

1. A yolk may have been broken during its passage into the duct and only a part of it may have entered the duct.

2. A part of a yolk ovulated into the body cavity and broken either before or after ovulation may have been picked up by the funnel.

3. A normal yolk may have entered the duct and being unable to pass the pathological portion may have been broken and a part of it extruded into the body cavity. The remaining portion may have passed the obstruction, becoming the effective stimulus for the formation of the egg envelopes.

The effective stimulus in the case of the dwarf eggs which do not contain any yolk is difficult to ascertain. Some of these eggs contained what were apparently normal chalazae. Most of them contained coagulated fibers which resembled the fibers of which chalazae are formed. It is possible that in some or all of these cases a normal yolk has entered the duct, stimulated the upper duct to secrete chalazae and some albumen, passed as far as the obstruction and then been extruded, leaving behind sufficient chalazae and albumen to furnish the mechanical stimulus necessary for the completion of the egg. Some of these eggs contained lumps of hardened albumen which may have arisen from albumen left in the duct or abnormally secreted. When the ovary is in a particular condition such a mechanical stimulus may cause the secretion of the egg envelopes. It must be kept in mind, however, that a dwarf egg did not occur unless the ovary was actively producing yolks. In none of the above mentioned cases was it impossible that a yolk had entered the duct and started the formation of the egg.

B. EVIDENCE FROM THE EGG RECORDS AND AUTOPSY RECORDS OF NORMAL DWARF EGG PRODUCERS WHICH WERE AUTOPSIED.

Attention has already been called to the fact that while occasional cases occur where dwarf egg production is due to a permanent disturbance of the reproductive apparatus it is in general not associated with such a condition. In fact a dwarf egg may occur at any time in a clutch or litter. The production of normal eggs continuing as if the dwarf had been a normal egg.

The autopsy records of normal birds which produce one or occasionally two or three dwarf eggs at wide intervals show that the sex organs are morphologically normal. In the cases where autopsy immediately followed the production of the dwarf egg the sex organs were in full functional activity and in every case but one the body cavity contained free yolk, indicating that all or a part of a yolk had failed to enter or had later been extruded from the duct. In one case the follicle had failed to rupture completely and was draining yolk from the torn yolk membrane. A part of this yolk was free in the body cavity and a part was in the dwarf egg.

C. EVIDENCE IN CASES WHERE A DWARF EGG FORMS A PART OF A COMPOUND OR A DOUBLE EGG.

1. *Compound eggs of which one part is a dwarf egg.*

Recently an abnormal egg was produced by a bird in the Station flock which gives additional evidence as to physiological conditions and nature of stimuli which may result in the production of a dwarf egg. The shell of this egg is shown in Figs. 57 and 58. This egg was a compound egg. The two parts were of quite unequal size. The component which filled the larger part of the shell contained a normal yolk in a normal membrane but there was a slight tear in this membrane and free yolk was protruding from this tear. The hole which faced the small component egg was quite small and little of the yolk had escaped. This part of the egg had normal chalazae and thick and thin albumen. The other part which filled the small portion of the shell contained a drop of free yolk surrounded by a thick albumen envelope which was quite distinct from the albumen of the large part of the egg. No thin albumen was present in this part of the egg. An incomplete shell membrane separated the two components.

The fact that when an egg is entering the isthmus as much and only as much of it as has passed in is covered with mem-

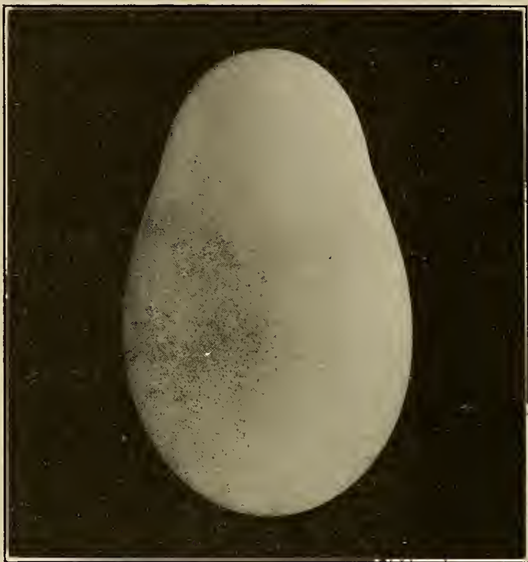

Fig. 57. Outside view of a compound egg which was composed of two albumen masses partly separated at the level of the seam in the shell by an incomplete egg membrane. The larger component contained a normal yolk with a slight puncture in the yolk membrane. The smaller one contained a drop of yolk which apparently came from the yolk in the other part.

Fig. 58. Inside view of shell of the egg shown in Fig. 57.

brane was first noted by Coste,[20] and has since been observed by many investigators including the authors. Since the compound egg was formed of two parts imperfectly separated by a fold of membrane, they must have united after all of the albumen was formed and before the whole of the first component had passed into the isthmus. That is, this compound egg evidently represents the union of a dwarf and a nearly normal egg at the anterior end of the isthmus.

Two other compound eggs where one component was a dwarf and the other a normal egg have been produced at the Station plant. In both of these cases the membrane of the yolk in the normal egg was uninjured. In neither case was there any yolk in the dwarf egg. The only visible nucleus in each case was a mass of chalaza-like coagulated albumen fibers.

2. *Double eggs in which the enclosed egg and sometimes also the enclosing egg was a dwarf egg.*

The double or enclosed eggs observed at the Maine Station are described in a recent paper.[21] It seems necessary to summarize here those cases in which one or both of the components was a dwarf. In three cases a dwarf egg was included within a normal egg. Evidently in each of these cases a dwarf egg was returned up the duct and meeting a normal yolk was included with it in a common set of egg envelopes.

In six cases a small dwarf egg was enclosed within a larger dwarf egg. In one of these cases there was a drop of yolk in the outer egg. In two there was a small amount of yolk in the inner egg. In each case the dwarf egg was covered by egg membrane, while in two it also had shell. Each of the outer eggs had normal egg membranes and shell. In three cases there were bunches of coagulated albumen fibers resembling chalazae attached to the poles of the enclosed dwarf egg. The complete egg records for two of the six birds show dwarf eggs or nesting records, which suggest that there may have been a permanent disturbance in the morphology or physiology of the

[20]Coste, M 1874. Histoire du developpement des corps organises. Tome I, Paris.

[21]Curtis, M. R. 1916. Studies on the Physiology of Reproduction in the Domestic Fowl. XVI. Double Eggs. Biol. Bul. Vol. XXXI, pp. 181-212.

sex organs at the time the double egg was produced. In each of the other four cases the bird producing the double egg was a normal heavy laying bird. The double egg occurred in a normal clutch of from two to five eggs. In each case the double egg was the only abnormal egg ever produced by the bird.

D. EVIDENCE FROM EGG RECORDS AND EGG CONTENTS.

In case a bird which produced a dwarf egg was not autopsied the morphological condition and the physiological state of the sex organs at the time the dwarf egg was laid can be judged reasonably accurately by the egg record. In all cases not discussed under the section on "Abnormal Physiological Conditions Associated with Dwarf Egg Production" the dwarf egg was produced within a litter, all the other eggs of which were normal. As already shown, the dwarf egg took any position in the clutch and litter. In all cases there was abundant evidence from the egg record that the sex organs were in active condition and were capable of producing normal eggs.

In the center of the thick albumen of every dwarf egg examined was found some firmer material. In a number of cases this firmer nucleus was simply a few coagulated threads of albumen which resembled the threads of a normal chalaza. Sometimes the mass of threads has the appearance of a normal chalaza, but more often it is an irregular mass of untwisted threads. Such a mass of threads or one (rarely two) more or less perfect chalaza is present in nearly all the dwarf eggs.

Table 9 shows the number and percentage of each kind of dwarf eggs classified as to the nature of the contained nucleus.

TABLE 9.

Dwarf Eggs Classified According to the Nature of the Contained Nucleus.

NATURE OF NUCLEUS.	Number dwarf eggs.	Per cent. dwarf eggs.	Subtotals or per cents.
Drop of yolk, no yolk membrane	141	51.46	-
Broken yolk membrane with some yolk	10	3.65	55.11
Small complete yolk	27	9.85	64.96
Chalazal threads with or without lumps of coagulated albumen or blood clots	96	35.04	100.00
Total	274	100.00	

This table shows that in 9.85 per cent. of the dwarf eggs the stimulus to the active duct was an abnormally small yolk which for some unknown reason was produced and ovulated by the ovary. These cases apparently differ from normal egg production only quantitatively. That is, in the size of the stimulating yolk.

From this table we see also that 55.11 per cent. of all the dwarf eggs opened contained a portion of a yolk and 3.65 per cent. contained a broken yolk membrane. This fact in connection with the autopsy records already discussed (pp. 316-318) for birds killed while a dwarf egg was in the duct or immediately after one was laid, indicate that in at least 55 per cent. of all the cases of dwarf egg production the immediate stimulus to the active duct was a part of an egg yolk, the rest of which was absorbed from the visceral peritoneum. In one case the vitelline membrane of the yolk which furnished the stimulus was still within its ovarian follicle although part of the yolk was in the dwarf egg found in the shell gland and the most of the rest in the body cavity. In this case the yolk was broken during ovulation and only a part of it entered the duct. In the other cases it is impossible to tell whether the yolk was broken during or after ovulation. It is theoretically possible either that the yolk was ovulated entire into the body cavity and subsequently broken and a part taken up by the duct, or, on the other hand, it may have entered the duct and later been broken and a large part of it expelled.

It is seen from the table that 64.96 per cent. of all the dwarf eggs produced were apparently initiated by the presence of yolk in the duct.

The presence of almost normal chalazae in a few of the eggs without yolk suggests that a yolk may sometimes enter the duct, stimulate secretion of chalazae and then be extruded, leaving behind enough chalazae and albumen to furnish the necessary stimulation for the completion of the egg. In a few cases, however, the arrangement of the chalazal threads and albumen envelopes around a blood clot or a lump of hardened albumen make it seem probable that these particles have furnished the stimuli necessary to start the secretion of the egg envelopes.

X. The Relation of Dwarf Egg Production to Other Observed Phenomena of Egg Production which Occur in Nature or Have Been Experimentally Produced and the Contribution of this Study to Our Knowledge of the Normal Physiology of Egg Production.

It has already been noted that the six birds autopsied while an egg was in the oviduct or imeediately after one was laid had large empty follicles in the ovary. Five of them were absorbing yolk through the visceral peritoneum. In two cases the dwarf egg did not contain yolk. This suggested, first, that ovulation or a specific condition of the sex organs immediately accompanying it was the essential stimulus for the secretion of the egg envelopes by the duct, or second, that such a specific condition being present the secretion of the egg envelopes was stimulated by the small lumps of hardened albumen which seemed to be the nuclei of these dwarf eggs without yolk, or third, that a yolk had entered and then been expelled from the duct.

That neither ovulation nor any condition of the sex organs associated with it is sufficient alone to cause the formation of a dwarf egg is certain. Birds known to have ovulated into the body cavity for a long time, due either to a morphological or physiological (Curtis and Pearl 1915, *loc. cit.*) or surgical (Pearl and Curtis 1914, *loc. cit.*) disturbances, which prevented the yolk from entering the duct but did not otherwise disturb the mechanism, did not produce dwarf eggs. Some stimulus other than the condition of the sex organs is necessary to start the secreting activity of the duct. In normal eggs or in dwarf eggs with yolk this stimulus (mechanical or chemical) is furnished by the yolk.

The fact that all dwarf eggs without yolks contain some nucleus firmer than normal albumen, together with the fact that in one case where the bird had a dwarf egg with such a nucleus in the shell gland at autopsy no yolk was found in the body cavity suggests that when the ovary is maturing and ovulating successive yolks a mechanical stimulus may initiate the secretion of the egg envelopes.

The results of surgical experimentation show conclusively that in a certain stage of activity the oviduct responds to a mechanical stimulus by the secretion of the egg envelopes.

Various facts indicate that the functional condition of the oviduct depends upon some substance formed in the ovary usually at the time yolks are maturing but in certain pathological cases at other times also. This substance is probably an internal secretion carried by the blood since the ovary can cause the enlargement to functional size of a small piece of oviduct, the normal nervous connections of which have been destroyed. The fact that dwarf eggs are produced only when the bird is maturing and ovulating yolks and the fact that more than 50 per cent. of the trials to induce egg formation around artificial yolks were failures, suggest that the sex organs must be and must remain in *absolute* functional condition until the egg is completed.

Summary.

1. An occasional individual of any breed of domestic fowls produces one or more small abnormal eggs. These eggs may be called dwarf eggs.

2. There are two distinct shape types of dwarf eggs: first, the prolate spheroidal or egg shaped type, and second, the cylindrical type. The prolate spheroidal shape is more common. In fact 95.4 per cent. of the dwarf eggs studied were of this type.

3. Dwarf eggs may be classified as yolkless, free yolked, or small yolked according to the yolk content.

4. Of the 274 dwarf eggs opened 35.03 per cent. were yolkless and 64.96 per cent. or nearly two-thirds contained yolk. The yolk was enclosed in membrane in only 9.85 per cent. of the dwarf eggs opened, while free yolk was present in 55.11 per cent. of these eggs.

5. Dwarf eggs with small yolks while distinctly smaller than normal eggs are significantly larger than dwarf eggs with little or no yolk.

6. A comparison of the relative size of the several groups of dwarf eggs, normal eggs, double-yolked and triple-yolked eggs furnishes a continuous line of evidence that the amount of albumen secreted depends to a large extent at least upon the degree of immediate stimulation due to the amount of yolk present.

7. Dwarf eggs with small yolks have shape indices which are higher than those for normal eggs and lower than those for other prolote spheroidal dwarf eggs. These differences in index in the three groups are the reverse of the differences in size.

8. This negative correlation between the shape index, and size extends the evidence from former researches that the smaller the egg the broader it is in proportion to its length.

9. Dwarf eggs of each class are exceedingly variable when compared to normal eggs. This greater variation occurs in all the physical characters measured, i. e., length, breadth, shape, index, egg weight, yolk weight, shell weight and possibly albumen weight.

10. Dwarf eggs with small yolk resemble normal eggs in degree of variability as well as in size and shape more nearly than do other classes of dwarf eggs.

11. The several size characters show different degrees of variation. They may be arranged from most to least variable as follows: egg weight, length and breadth. This arrangement is the same for dwarf and normal eggs.

12. The interrelation of the size and shape characters in prolate spheroidal[22] dwarf eggs of each class is as follows:

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[22]The same relations apparently also hold for cylindrical dwarf eggs but the number observed was too small to determine the degree of relationship.

a. Length and breadth, length and weight, and breadth and weight are significantly positively correlated in eggs of each group.

b. Index and weight are negatively correlated. The correlation is significant for dwarf eggs with little or no yolk.

c. In dwarf eggs with small yolks, yolk weight is highly correlated both with egg weight and with albumen weight.

13. During the two years of maximum dwarf egg production at the Maine Station plant the proportion of dwarf to normal eggs was one dwarf to each 1,158 normal eggs.

14. During the last eight years 5.15 per cent. of all the birds kept at the Maine Station plant are known to have produced at least one dwarf egg.

15. Both the actual dwarf egg production and the number of dwarf eggs per 10,000 eggs is lowest during the winter months. It increases through the spring, reaching a maximum in the early summer.

16. The production of a dwarf egg is usually an isolated phenomenon occurring only once or twice during the life of a bird. Only 3.5 per cent. of the birds which produced one or more dwarf eggs produced more than two.

17. A study of all the egg records and the available autopsy records for birds which produced one or more dwarf eggs, shows that, in most cases, the disturbance which caused the production of the dwarf egg was of temporary character and was not correlated with a morphological disturbance of the sex organs.

18. Eleven of the 200 dwarf egg producers, however, showed evidence that a permanent disturbance had occurred.. In these cases few or no normal eggs were produced after the dwarf egg or eggs, although nesting records indicate that the ovary passed through normal reproductive cycles.

19. Five of these cases were autopsied and all of them showed some pathological condition of the oviduct which interfered with the passage of the egg, but did not entirely close the duct.

20. In normal birds dwarf egg production is most likely to occur during the height of the breeding season. It is not associated with immaturity of the sex organs.

21. The popular notion that a dwarf egg marks the end of a period of production is without foundation. A dwarf egg is equally likely to occur at any time during a clutch or litter.

22. A dwarf egg may be overtaken by a normal egg and form one of the components of a compound egg similar to a double-yolked egg except that one part is a dwarf egg.

23. A dwarf egg after it has received its membrane or its membrane and shell, may be returned up the duct and be included in the succeeding normal egg, or it may act as the stimulus for the formation of a larger enclosing dwarf egg.

24. Dwarf eggs are produced only when the ovary is in the absolutely active condition associated with the maturing of yolks. This is true whether the bird has a normal or a pathological oviduct.

25. When the sex organs are in this condition a mechanical stimulation of the oviduct by an artificial yolk may result in the formation of a complete set of egg envelopes.

26. The mechanical stimulation need not begin at the funnel in order to be effective to the parts lower down.

27. The mechanical stimulation is local in its effect. That is, it is not transmitted down the duct any distance below the point to which it is applied.

28. Dwarf eggs may be, and probably often are, produced by the stimulation of an active duct by some material particle which is not yolk. At least 65 per cent. of the dwarf eggs studied, however, were initiated by an abnormal small yolk or by a part of a normal yolk. Certainly in some and probably in all the latter cases the rest of the yolk was absorbed by the visceral peritoneum.

BULLETIN 256.

ELM LEAF ROSETTE AND WOOLLY APHID OF THE APPLE.*

Schizoneura lanigera (*americana* in part).

Edith M. Patch.

White masses looking like patches of thick mold often occur on apple trees, especially about pruning wounds or other scars on the trunk and branches and upon water sprouts. Beneath this substance are colonies of rusty colored or purplish brown plantlice known as "woolly aphids" on account of the appearance of white covering which is, however, really composed of waxen filaments.

The species is common in Maine on hawthorn, mountain ash, and Baldwin and some other varieties of apple.

It is one of the migratory aphids and passes part of its life cycle upon the elm,** as is explained in the following treatment. It should not however, be confounded with those woolly aphids found upon alder† and maple,‡ as the woolly aphid of the apple cannot live upon those trees.

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*Papers from the Maine Agricultural Experiment Station: Entomology No. 91. The work upon which this bulletin is based was for the most part completed in 1913 and published by this Station as Bulletin 217, which is now out of print. As the interest in the insect concerned continues and as the discovery of its annual migration from elm to apple was first recorded by this Station, it seems desirable to print this revised edition of Bulletin 217, containing such changes as bring the subject down to date. Chas. D. Woods, *Director.*

**There are other elm aphids belonging to this same genus which do not migrate to apple.

†*Pemphigus tessellata* (*acerifolii.*)

‡*Pemphigus tessellata* (*acerifolii*) and *Pemphigus aceris.*

Habits and General Discussion.

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. 58 and 67.

On the roots its attacks induce enlargements 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. 66.

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, though it may be troublesome then, too. 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 growth of hard fibrous enlargements with the results in a year or two of the death of the rootlets and their ultimate decomposition with subsequent disappearance of the galls and also of the aphids, so that after this stage is reached the cause of the injury is often obscure.

On the trunks the presence of the aphids 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, even when insignificant, is useful as an indication of the probable existence of the aphids 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 aphids, 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. 63.

In August and later, among the wingless ones, winged females appear in abundance. Fig. 62. They are little, clear-winged aphids which look nearly black unless carefully examined when the abdomen is found to be dark yellowish red or rusty brown. These are the fall migrants that leave the apple and seek the elm before giving 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.

The flight of the fall migrants away from the apple is apparently a common observation of all who have studied this species either in this country or abroad,* but it is only recently that the significance of this flight has been appreciated, it having been thought previously to be merely a dispersal from one apple tree to another.

Where woolly aphid colonies are very thick, the true sexes and the winter eggs are sometimes found upon the apple tree. That such occurrences are accidental seems probable as fall migrants of most species will occasionally dispose of their progeny before reaching the appropriate winter host.

A record of such an occurrence is to be found 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 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."

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*Dr. O. Schneider-Orelli records also the development of winged forms in June.

Sonderabdruck aus Heft 7/8 des XII. *Bandes der Mitteilungen der Schweizerischen Entomologischen Gesellschaft.* 1915.

Mr. A. C. Baker of the Bureau of Entomology wrote me (Nov. 20, 1912): "I found that when the colonies are very thick the alate forms often stay on the apple and I have found on one tree a number of winged ones with the abdomen shriveled as it is after producing sexes. I saw some sexes crawling up and down the small twigs and though I have not yet seen any eggs which they laid they no doubt would lay eggs. On one occasion I found sexes on an apple leaf which had fallen to the ground."

That such occurrences are not a part of the ordinary life cycle is indicated by the usual wholesale flight of the fall migrants.*

On the elm the stem mother, which hatches from the over-wintering eggs sheltered probably 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.

The beak punctures on the rapidly expanding new leaves cause an unevenness of growth which forms a protection for the aphid. By the last of May the earliest of these wingless stem mothers are mature and found in the deformed elm leaves (Fig. 59) producing the next generation. The antenna is shown in Fig. 68.

These nymphs, like the stem mother, are a wingless form and they become fully developed about the tenth of June. They have wax glands, of the type shown in Fig. 61. Their progeny are the third generation and attain wings. These winged aphids are known as the spring migrants.

It takes three weeks or slightly more or less, beginning about the twentieth of June, for all the individuals of this third generation to get their growth so that the migration covers a considerable period. The deserted rosette or leaf cluster at this time looks like Fig. 60. During this time these winged aphids may be found alighting on the leaves of apple, mountain ash,

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*1904. Alwood, Wm. B. Circular in Relation to Some Injurious Insects and Plant Diseases. Special Bulletin (C. P. C. 45), Va. Exp. Sta.

1908. Gillette, C. P. Notes and Descriptions of Some Orchard Plant Lice, of the Family Aphididæ. Journal of Economic Entomology, Vol. 1, pp. 306-308.

1909. Börner, Carl. Kaiserliche Biologische Anstalt für Land-und Forstwirtschaft, August.

1913. Reh, L. Der Praktische Ratgeber im Obst—und Gartenbau, February 2.

and hawthorn. They creep to the under side of the leaf and remain there while they give birth to their progeny (i. e., the fourth generation). These young, before they feed at all, crawl to the stem of the water-shoots, or to some tender place on the bark often near a pruning wound, and there start the colony on the summer host plant. Such a young colony shown in Fig. 67, was on a mountain ash in Orono of which I kept a record during the season of 1912.

The main trunk of this tree was dead nearly to the ground, but 12 vigorous shoots had grown up measuring about 5 feet each. On June 28 this mountain ash had about 150 woolly masses of nymphs grouped on the stem at the leaf axils. These nymphs ranged from very tiny ones to half grown insects, none being mature at that date. One such woolly mass contained 155 individuals of various sizes. (See Fig. 67). On the ventral surfaces of the leaves of this mountain ash were stationed many elm leaf migrants producing there their broods of nymphs which could be seen, with the hand lens, to be augmenting the woolly masses on the stem. Collections of these migrants thus stationed were made as follows:—July 2, 88 migrants; July 3, 211 migrants; July 5, 92 migrants; July 8, 54 migrants; July 9, 80 migrants; July 10, 33 migrants; July 11, 14 migrants; July 12, 3 migrants. Only living individuals were collected, dead ones being brushed off and discarded in the counts. Microscopic examination showed them to be identical with winged forms collected in elm leaf. Two large elm trees with leaves well stocked with this species stood about a rod distant.*

In this connection it may be of interest to record a forced migration test. On June 21, 1912, I placed several hundred elm 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.

On June 17, 1913, a laboratory cage check was started with migrants from an elm rosette. The winged forms ready to desert the elm leaves were caged with a seedling mountain ash. Their progeny settled in woolly masses on the stem of the seedling and are shown in Fig. 58. By July 2 these had matured and were producing young which in turn had matured and were producing nymphs on July 26. This third mountain ash generation (sixth generation beginning with the stem mother)

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*Previously recorded in Journal of Economic Entomology, Vol 5, No. 5, 1912.

proved too much for the little seedling which was so nearly dead by August 10 that the last of the aphids perished at that time.

Schizoneura americana is a name which until recently has been commonly applied to two distinct species by American entomologists.

One of these species inhabits the leaf cluster or aphid rosette of the American Elm (Figs. 59 and 60). This migrates to apple, several varieties of mountain ash (*Pyrus* sp.) and to hawthorn (*Crataegus*), where it was familiar as *lanigera* long before its identity with the aphid of the elm rosette was suspected. The life cycle of this species so far as personally ascertained by the writer is recorded in the present paper. This species is found in Maine, Missouri, Colorado* and doubtless all the way between. Like other aphids it is fluctuating in its abundance, being conspicuous some years and comparatively rare during other seasons.

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*That Messrs. Gillette and Bragg were mistaken in their opinion that the rosette aphid in Colorado did not migrate to the apple in accordance with its habit in Maine (*Journal Economic Entomology, Vol. 8, p. 100*) is shown by the observations of Mr. Maxson (*Entomological News, Vol. 26, pp. 367-368*). Although Professor Gillette has not yet published his later observations, so far as we know; that they agree with those of Mr. Maxson is indicated in a letter from him to the writer under date of June 25, 1915, from which the following paragraphs are quoted:

"You will be interested to know that the rosette form of the elm *Schizoneuran* is very common about Fort Collins this year, and the winged forms are now leaving the leaf clusters in great numbers, and for the first time since we began the study of this insect, we find the lice locating in considerable numbers upon the under side of the leaves of apple trees.

"In many instances we are able to find the young that they are depositing, and in many instances, also, it seems probable that a colony of young lice in the axils of the leaves are the product of these winged lice from the elm. So it begins to look as though we shall have to admit that there is a natural migration of this elm *Schizoneuran* to our apple trees.

"We had been able, repeatedly, to get these lice to take in small numbers in our breeding-cages, and I find that last year Mr. Maxon of Longmont had found this louse going to the apple in the field, but until a few weeks ago, he had not communicated the fact to me. It really looks now as though our observations here would fully confirm your observations in Maine."

The experiments of Mr. Baker proved that in the localities in which he worked the elm is the winter host of *lanigera* (*Report No. 101, U. S. Department of Agriculture, Office of the Secretary. 1915*). The life cycle of this aphid, therefore, as discovered for Maine by the writer, does not seem to be exceptional for America.

The other species to which the name *Schizoneura americana* has been commonly applied is the aphid discussed in Bulletin 241 of this Station. Since the name *lanigera* takes care of the rosette species on elm as well as on apple, *S. americana* seems to be left conveniently for the aphid curling or rolling the leaf of the American Elm (Fig. 45 of Bulletin 241). Riley's description of the leaf deformations caused by *S. americana*† indicates clearly enough that he originally applied this name to both these species as his successors have certainly done until recently; and the synonomy "*Schizoneura lanigera* (*americana* in part, of authors)," correctly designates the "rosette aphid" of the elm.

There are apparently 3 summer generations of progeny of the elm leaf migrants upon the apple in Maine,—two apterous generations followed by a generation part of which, the fall migrants, become winged and leave the apple and part develop into apterous forms and remaining on the apple give birth to nymphs which while still young seek protection at the base of the tree for the winter and are known as the hibernating nymphs.

It is the function of the migrants to seek the winter host and there give birth to the true sexes. These are the tiny yellowish brown egg-laying females and the still smaller pale yellow males. Both sexes are wingless and with rudimentary mouth parts which are apparently functionless. One comparatively large yellow egg occupies nearly the whole abdomen of the female and with the deposition of this the cycle of the species closes,—or begins. It is too complicated a performance to follow easily but the outline on page 338 will be useful as a summary. Such a cycle with the annual migration to and from the apple with the elm serving as host for the first three spring generations is undoubtedly typical for *lanigera*. The hibernating nymphs which remain protected about the crown of the apple over winter and ascend to tender places on the bark before feeding in the spring give what looks like a "closed cycle" of apterous viviparous females persisting on the apple. How long

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†"Curling and gnarling the leaves of the White Elm (*Ulmus americana*), forming thereby a sort of pseudo-gall. The curl made by a single stem-mother in the spring takes the pretty constant form of a rather wrinkled roll of one side of the young leaf, but according as there is more than one stem-mother, or as several contiguous leaves are affected, the deformation assumes various distorted shapes, sometimes involving quite large masses of the leaves."

such a colony could maintain itself on the apple without fresh material from the elm I do not know.*

I am certain that in Maine the natural enemies of the woolly aphid would cut its career short and that it would not assume the status of a pest of consequence if it did not shift its food plant. As it is, a two days quest in the vicinity of Orono early in September, 1913, failed to locate a single colony which was not well nigh demolished by chalcid parasites and the colonies of 1912 met a similar fate the preceding year by virtue of syrphus maggots. Lady bird beetles are also very active some seasons. While in the elm leaf this aphid is preyed upon by syrphus maggots, capsid bugs and lady birds.

As if the hibernating nymphs were not enough to bewilder one, the case of the woolly aphid of the apple is still further complicated by the root colonies which although hidden in their operations are really often much more pernicious than the colonies on trunk and branches. These root colonies ordinarily remain underground all the year round, apparently until the roots become too badly demolished for feeding purposes.

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, 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 pro duction 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

*We have an exact parallel in *Pemphigus tessellata* or the woolly aphid of the alder with a cycle including a spring migration from the maple leaf to alder and a fall or return migration to the maple and also a generation of hibernating nymphs remaining under leaves about the base of the alder during the winter and ascending to the stem before feeding in the spring.

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.

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 aphids, 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.

During those seasons when the species is abundant it is also a serious pest on American elm. Some springs in the vicinity of Orono practically every branch of many trees is tipped with an unsightly cluster of deformed leaves or "rosette" gall. Such an infestation, to say the least, mars the beauty of a large tree and is a heavy handicap for a young one.

LIFE CYCLE OF WOOLLY APHID OF APPLE.

(Exclusive of root forms.)

ELM: Primary Host.

EGGS.
(Under bark all winter)

STEM-MOTHER.
(first generation in leaf.
Apterous viviparous females).

SECOND GENERATION.
(apterous viviparous females
in leaf).

SPRING MIGRANTS Migrates to apple . . . .
(third generation. Alate viviparous).

Apple: Alternate Host.

NYMPHS.
(Hibernating young migrating to trunk or branches in early spring)

SEVERAL GENERATIONS.

FOURTH GENERATION.
(apterous viviparous females).

FIFTH GENERATION.
(apterous viviparous females).

Migrate to elm . . .

FALL MIGRANTS.
(Alate viviparous
parthenogenetic
females, mature
Aug.-Sept.
sexuparae.)

APTEROUS VIVIPAROUS PARTHENOGENETIC FEMALES, mature in Aug.-Sept.

APTEROUS OVIPAROUS FEMALES
AND APTEROUS MALES.

EGGS.
(under bark all winter).

HIBERNATING NYMPHS
(protected during winter
about crown of tree).

STRUCTURE KEY.

Woolly Aphid of Apple.

A. Apterous forms. Antennæ without annulations.

B. Females.

C. Viviparous.

D. Antenna typically 5-jointed, Fig. 68. Wax glands not of type shown in Fig. 61. First spring generation hatched from over-wintering egg and found in elm rosette early in June.................*Stem Mother.*

DD. Antenna 6-jointed. Fig. 68, No. 80. Wax glands as shown in Fig. 61 and Fig. 68, No. 80. Progeny of stem mother developing in rosette in June ....*Second Elm Generation.*

DDD. Antenna 6-jointed. Fig. 68, No. 82. Wax glands of same type as those shown in Fig. 61. On apple bark or water shoots ....*Summer Generations.*

DDDD. Structure about as with summer generations On apple roots all times of year.............*Root Generations.*

DDDDD. Young born late in fall and living over winter about crown of tree, apparently without feeding until spring, when they ascend to apple bark and attain their growth ....*Hibernating Nymphs.*

CC. Oviparous.
Antenna 5-jointed, Fig. 64. Minute beakless form which deposits the over-wintering egg. Rarely seen but easily obtained by imprisoning fall migrant in vial..*True Female.*

BB. Minute beakless form smaller and more slender than true female. Antenna 5-jointed. Fig. 65. Rarely seen but easily obtained, by imprisoning fall migrant in vial................*True Male*

AA. Alate forms. Antennæ with annulations.

B. Antenna typically with III as long as or longer than IV+V+VI. VI typically without annulations. Fig. 68, No. 81. Developing in June-July in elm rosette and migrating to apple, hawthorn and mountain ash. Progenitor of summer generations ....*Spring Migrant*

BB. Antenna much as in spring migrant, though usually shorter. VI typically with 2 or more annulations. Fig. 68, Nos. 83, 84, 85. Developing in fall in woolly colonies on bark of apple, hawthorn and mountain ash. Fig. 62. Progenitor of true males and females ....*Fall Migrant*

HABITAT KEY.

Woolly Aphids of the Elm.

A key to aid in distinguishing the woolly aphid of the apple from the other elm species with which it may easily be confused in the spring of the year.

A. Conspicuous woolly colonies on bark of *Ulmus americana.* Throughout the summer on young elms. No alternate host known. Widely distributed in America...............*S. rileyi.*

AA. Spring generations in elm leaves, causing various types of deformation.

B. Large baggy gall on *Ulmus campestris.* Alternate host unknown. European species. Taken in Connecticut in 1913 ....*S. lanuginosa.*

BB. Terminal leaf cluster or rosette (Figs. 59-60) on *Ulmus americana.* Spring migration to apple, mountain ash, and hawthorn. Maine to Colorado.................... ....*S. lanigera* (*americana* in part, of authors).

BBB. Leaf curl or roll type of deformation.

C. Leaf roll of *Ulmus scabra* and *U. campestris.* Antenna of winged generations with V and VI without annulations. Spring migration to gooseberry and currant. European species. In America found in California, Oregon and Maine (1913).......................*S. ulmi* (*fodiens*).

CC. Leaf roll of *Ulmus americana.* Second apterous spring generation with wax gland distinctly unlike those of Fig. 61. Spring migrant with antenna typically with III not longer than IV+V+VI. Alternate host *Amelanchier* the roots of which are infested.* Maine to California ....*S. americana* in part, of authors.

*Bulletin 241. Maine Agricultural Experiment Station.

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 leaf, 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.

An August spray to kill out colonies before the migrants fly and the hibernating young are produced is particularly desirable.

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 aphids removed.

Some nurseries are said to make a practice of "puddling" roots of infested stock, that is packing mud about the roots to conceal their condition. Before purchasing puddled nursery stock, the buyer should insist that the mud be washed off thoroughly so that the roots are exposed for inspection.

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.

Tobcco 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 of 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 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 800 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 aphids. 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.

* * * * * * * * *

In recent years tobacco extracts have rapidly taken the place of other remedies for aphids, and well informed apple growers are using them almost to the exclusion of other insecticides. It should be remembered that this is a contact insecticide and kills only the insects actually touched. It is, therefore, necessary to be very thorough in the spraying

FIG. 58. Seedling mountain ash photographed June 25, 1913 to show colony of woolly aphids which are the progeny of migrants from elm leaf rosette caged with mountain ash, June 17, 1913. Two apterous generations matured on this seedling, but the third generation proved too much for the little tree which was so nearly dead by August 10 that the last of the aphid colony perished at that time.

Fig. 59. Young rosette photographed June 6, 1913. Small picture at right.

Fig. 60. Old rosette photographed July 17, 1913.

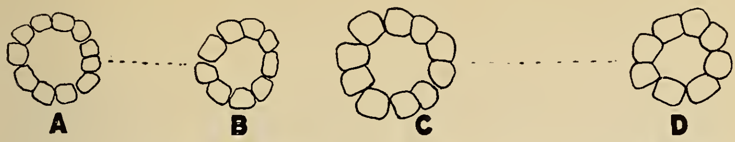
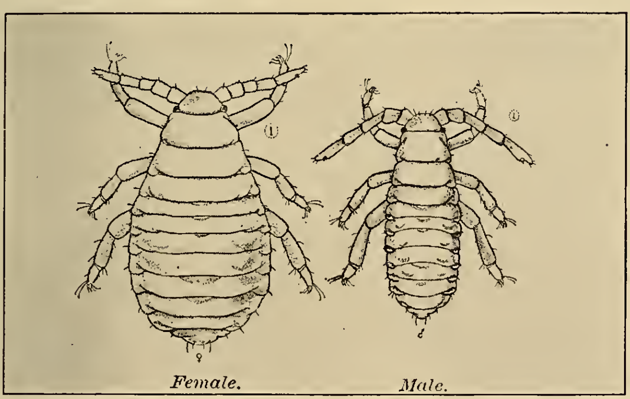


Fig. 61. Dorsal wax gland of rosette aphid, second generation. A & B, a pair on head. C & D, a pair on prothorax. Notice that the sections are not uniform in number as is often the case.

Figs. 62 and 63. Woolly Aphid. Winged and wingless forms. Greatly enlarged. (After Marlatt.)



Figs. 64 and 65. Mature sexual individuals of the Woolly Aphid,—the oviparous female and male. Real size shown in circles at right of figures. (After Alwood.)

Fig. 66. Apple root, showing knotty growth caused by Woolly Aphid.

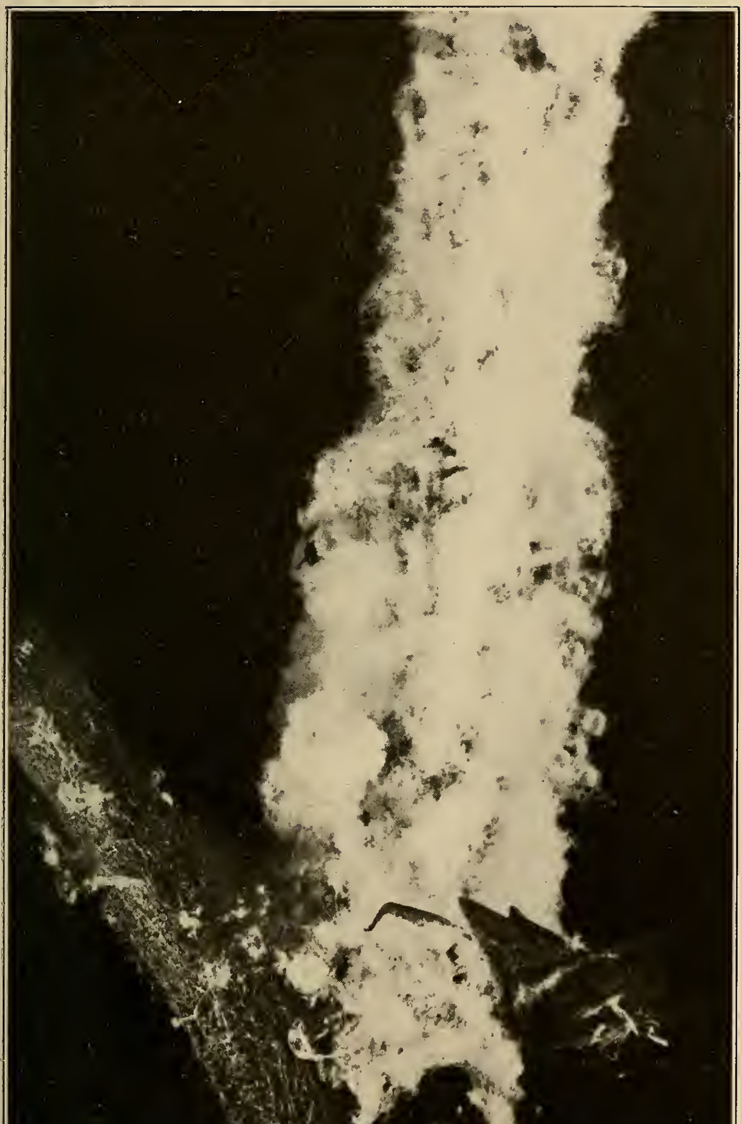


FIG. 67. Nymphs of the Woolly Aphid, *Schizoneura lanigera* on water shoot of mountain ash, *Pyrus americana*,—the immediate progeny of migrants from elm leaf rosette. Photographed at Orono, June 28, 1912. Enlarged.

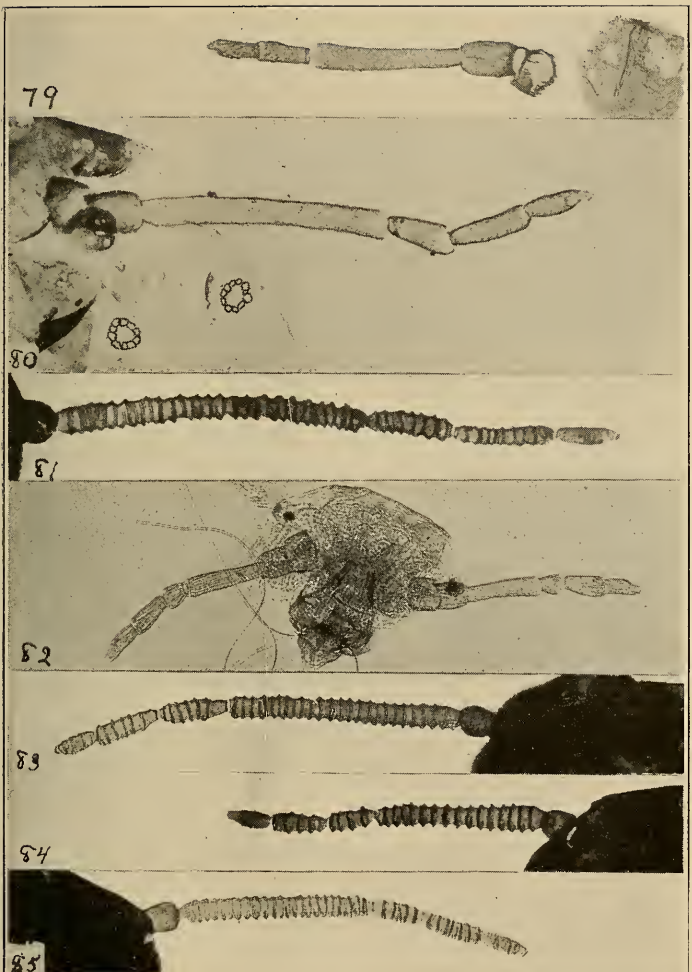


FIG. 68. Nos. 79-85. Antennæ of Woolly Aphid. No. 79—Stem mother from rosette June 5, 1913 (33-13); No. 80—Second generation from rosette June 12, 1913; No. 81—Spring migrant from rosette and progenitor of summer generations on *Pyrus* (57-13); No. 82—Apterous viviparous form on apple bark (98-08); No. 83—Fall migrant from apple (115-06; No. 84—Fall migrant from bred colony on apple; No. 85—Fall migrant from *Crataegus*.

BULLETIN 257.

ABSTRACTS OF PAPERS PUBLISHED BY THE STATION IN 1916 BUT NOT INCLUDED IN THE BULLETINS.

A complete list of all the publications issued by and from the Station in 1916 is given on pages xii to xiv of the introduction to this Report. The following pages contain abstracts of the papers issued during the year that are not included in the Bulletins or Official Inspections for the year.

A METHOD OF CORRECTING FOR SOIL HETEROGENEITY IN VARIETY TESTS.*

The correct interpretation of field trials, such as variety tests, fertilizer experiments, etc., is often rendered difficult, if not impossible, because of the great differences in soil in different parts of the same field. This is often true even in fields which to the eye appear quite uniform. Nevertheless, field trials are becoming more and more a necessity in many phases of agricultural investigation.

Within recent years a number of investigators have shown that the experimental error in such trials can be greatly reduced by the use of systematically repeated plots. Nevertheless, if the number of repetitions is not large, certain experiments may still be unduly influenced by irregularities in the field. It would therefore be desirable if some method could be devised by which the yields of individual plots could be corrected in such a way as to take account of these irregularities.

Check plots have frequently been used for this purpose. many cases.

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*This is an abstract from a paper by Frank M. Surface and Raymond Pearl having the same title and published in the Journal of Agricultural Research, Vol. V. pp. 1039-1050, 1916.

But, aside from the extra labor and expense involved, the results from check plots have been far from satisfactory in

In the present paper a method is proposed for use in correcting for differences in the soil of different plots. The method in its present form is adapted for use only when the plots are arranged in rectangular blocks. The method of obtaining this correction factor is as follows: In the first place the probable yield of each plot is obtained by the contingency method. This "calculated" yield represents the most probable yield of each plot on the supposition that they have all been planted with a hypothetical variety whose mean yield is the same as the observed means of the field.

This "calculated" yield may then be used as a basis for determining a correction factor. If the calculated yield of a given plot is above the mean of the field it must be taken that the soil of this plot is better than the average of the field and a corresponding amount must be deducted from the observed yield. Likewise, if the calculated yield is below the average, a proportional amount must be added to the observed yield in order to make the plots comparable.

Still more comparable results will be obtained if the correction factors are based upon the percentage of the mean rather than upon the absolute figures.

Tests of the efficiency of this method by means of the measure of soil heterogeneity proposed by Harris show in all cases a very marked reduction in the amount of heterogeneity when the corrected figures are used. When tested on our own experimental plots, this method leads to results which from other evidence, we have reason to believe, more nearly represent the truth than do the uncorrected yields.

It is realized that this method is not ideal and does not obviate all the difficulties connected with soil differences in plot experiments. It is hoped that this method may prove useful in certain kinds of plot experiments and that it may lead to further study of this problem.

FECUNDITY IN THE DOMESTIC FOWL AND THE SELECTION PROBLEM.*

The purpose of this paper was to answer certain criticisms which had been made of the writer's studies on the inheritance of fecundity and breeding for egg production. Also the paper contains a general discussion of certain theoretical aspects of the selection problem.

STUDIES ON OAT BREEDING III. ON THE INHERITANCE OF CERTAIN GLUME CHARACTERS IN THE CROSS *AVENA FATUA* x *A. SATIVA* var. KHERSON.†

This paper describes the results obtained from crosses between a wild oat of the species *Avena fatua* and a cultivated variety known as the Kherson. The object of this work is to find out how various characters of oats are inherited and this can be done much better when there are a large number of different characters as in the case of these two varieties.

The characters which were studied were (1) color of the glumes or grain; (2) the wild vs. cultivated character of the base; (3) awns on the grain; and (4) pubescence on various regions of the grain, viz. at the base of the grain, on the pedicel, and on the back of the lower and upper grain of each spikelet.

The wild parent in this cross has a black glume color, while the Kherson is a yellow oat. The F_1 grain is black and in the F_2 generation, plants with black, gray and yellow grains appear in the proportion of 12 black; 3 gray; 1 yellow. The wild and cultivated character of the base of the grain segregates, giving in the second generation 3 cultivated to 1 wild. The character of the base is entirely independent of the color of the grain.

The very heavy awns characteristic of the wild oats appear in the progeny only on the grains which have the wild type of base. There are, however, several intermediate types of awn-

*This is an abstract of a paper by Raymond Pearl, having the same title and published in the American Naturalist, Vol. L, pp. 89-105, 1916.

†This is an abstract of a paper by Frank M. Surface having the same title and published in Genetics, Vol. 1, pp. 252-286, 1916.

ing which appear on the cultivated grain in the second generation. The relation of these to the color and other characters is discussed.

The heavy pubescence at the base of the grain as well as that on the pedicel is also linked in its inheritance with the wild type of base. The linkage in these cases appears to be absolute since in this cross no wild plants were found which lack the heavy awns and the pubescence described above.

The pubescence on the back of the two grains is inherited in a peculiar manner. The pubescence on the back of the larger or lower grain of the spikelet is linked with the factor for black color, but the linkage is not absolute, although very close. This linkage is of such a nature that when the cross is made as described above, one out of every 150 F_2 plants will be either a black grain without pubescence or a non-black grain with pubescence.

On the other hand the pubescence on the back of the smaller or upper grain will appear only when the lower grain is also pubescent. Even then it appears very infrequently on grain which has a cultivated base. In other words, the factor for pubescence on the back of the upper grain is linked with the factor for the wild base of the grain.

STUDIES ON THE PHYSIOLOGY OF REPRODUCTION IN THE DOMESTIC FOWL. XVI. DOUBLE EGGS.*

Among the eggs of the domestic fowl an egg which contains another egg is quite rare, but one or more such specimens have been observed by most persons who have handled large numbers of eggs. This phenomenon has excited the interest of poultrymen and scientists and a number of specimens have been described in the agricultural and scientific literature. The purpose of the paper abstracted is to describe several specimens observed at the Maine Agricultural Experiment Station which have been laid or have been found partly formed within the

*This is an abstract of a paper by Maynie R. Curtis, having the same title and published in the Biological Bulletin, Vol. xxxi., No. 4, pp. 181-206, 1916.

oviduct at autopsy and to discuss the formation of these abnormalities from the physiological point of view.

The chief results of this study were as follows:

1. A membrane-covered or hard-shelled normal or dwarf egg may be returned up the duct and may either meet its successor and return with it, becoming enclosed in a common set of egg envelopes, or not meeting its successor it may again be forced through the duct stimulating the secretion of a set of egg envelopes around itself.

2. The number of egg envelopes common to the enclosed egg and the yolk of the enclosing egg or the number of egg envelopes which surround the enclosed egg when the enclosing egg has no yolk depends apparently on the level of the duct at which the enclosed egg resumes its normal direction toward the cloaca.

3. The enclosed egg is usually forced up the duct without turning on its axis but occasionally the poles are reversed.

4. A similar reversal of poles sometimes occurs in normal laying and it seems probable that in both cases this turning takes place in the uterus when the first powerful contractions of the uterus bring the outwardly directed end of the egg slightly above the opening from the shell gland into the vagina and tangentially against the curved caudo-dorsal angle of the uterus.

5. The enclosed egg usually precedes its successor through the duct and, therefore, usually lies in the pointed or anterior end of the enclosing egg, while the yolk of the enclosing egg lies in the blunt or posterior end.

6. However, in two known cases where the enclosed egg united with its successor after the latter had received practically all its thick albumen there is evidence that the two eggs came side by side in the duct with their long axis parallel and in one case they certainly passed through the duct side by side with their long axes parallel to each other and also parallel to the long axis of the duct.

7. There has been one case described with the yolk in the pointed and the enclosed egg in the blunt end of the enclosing egg. There is some doubt about the accuracy of this observation but it is possible that two eggs can pass in the duct.

8. A hard-shelled egg uncovered by membrane or albumen is sometimes found in the body cavity or upper oviduct while a hard-shelled egg enclosed with another egg is not usually immediately surrounded by an egg membrane. It would, therefore, seem that the egg does not cause the secretion of egg envelopes around itself on its way up the duct.

9. Since in the case of a double-yolked egg a second yolk closely following the first does stimulate the secretion of the successive envelopes, it does not seem probable that the failure of the duct to form envelopes around the returning egg is due to exhaustion of the glands.

10. The reason for this failure is not known. It may be that the return of the egg is very rapid and that the time of application of the stimulus is too short to be effectual, or there may be a real polarity of the duct so that it responds only to a downwardly directed stimulus.

11. A few cases are known where one or more of the normal egg envelopes have not been formed around an egg advancing in the normal direction (for example, a yolk enclosed by egg membrane and shell but with no albumen, or a laid egg composed only of normal yolk and albumen). The cause for these phenomena are not known. In these cases the movement of the egg may have been abnormally rapid.

12. The occurrence of membrane-covered or hard-shelled eggs in the body cavity, the albumen-secreting region of the oviduct or enclosed within the albumen of another egg shows that an egg may be moved up the duct, but since an egg has never been observed moving in this direction the nature of the motion can only be imagined.

13. The double egg results from a modification of the normal processes of egg formation due chiefly to a reversal in the direction of the egg after it has received its membrane or its membrane and shell. The backward movement must cease before the egg is expelled from the funnel mouth and the movement in the normal direction must be resumed.

14. If the backward movement sets in before the egg receives its membrane but stops before it is expelled from the funnel mouth and if the normal direction is then resumed, the result will be a normal egg with a large percentage of albumen

or in case the returned egg meets its successor, a double-yolked egg.

15. If the backward movement of an egg in any stage does not stop too soon the partly or fully formed egg will be expelled from the funnel mouth into the body cavity.

16. In case the oviduct is naturally or artificially closed the eggs are regularly expelled by forcing them out of the funnel mouth.

17. A double egg is the result of a combination of normal and abnormal processes which, when combined in other proportions, result in other abnormal phenomena of egg production.

18. An egg may move backward and forward several times in the duct as is shown by the production of an egg enclosed within a series of concentric egg membranes separated by thick albumen.

A NOTE ON THE INHERITANCE OF EYE PATTERN IN BEANS AND ITS RELATION TO TYPE OF VINE.*

This paper reports the results of some natural crosses between Improved and Old Fashioned Yellow Eye Beans. When these two types of Yellow Eye beans are crossed the seed of the first generation plants are all very much spotted. This type of bean has been called "piebald." When these piebald beans are planted the progeny consist of plants with three different kind of beans. These are Piebald, Improved Yellow Eye, and Old Fashioned Yellow Eye. These three types occur in the proportion of 8 Piebald; 3 Improved Yellow Eye; 4 Old Fashioned Yellow Eye. It is suggested that this ration is due to the presence of two independent factors, one of which is of such a nature that it causes the death of those zygotes which are homozygous for both factors. In this way the usual 8:4:4 ratio is modified to the 8:3:4 ratio found. This suggestion is only tentative and may be modified when a larger number of plants have been studied.

In reference to the type of vine, it had been noted that with few exceptions, all Old Fashioned Yellow Eye beans have a

*This is an abstract of a paper by Frank M. Surface, having the same title and published in the American Naturalist, Vol. 50, pp. 577-586, 1916 bush type of vine while the majority of the Improved Yellow Eyes have a short runner vine. The first generation of the cross between these two always has a runner type of vine. In the segregating generations it was found that the Old Fashioned Yellow Eye beans were always bush beans while the Piebald and Improved Yellow Eye segregates showed both runner and bush types of vine. The data given are not sufficient to make a detailed study of the inheritance of type of vine, but it is of interest to note that there is a very close linkage between the Old Fashioned Yellow Eye color pattern and the bush type of vine.

ON THE EFFECT OF CONTINUED ADMINISTRATION OF CERTAIN POISONS TO THE DOMESTIC FOWL, WITH SPECIAL REFERENCE TO THE PROGENY.*

The investigation here reported deals with the general problem of the origin and causation of new, heritable variations. That this is one of the most fundamental problems of breeding admits of no doubt. The method by which this general problem is attacked in the present investigation is that of exposing systematically the germ-cells of an animal to something unusual or abnormal in the surrounding conditions, and then analyzing, so far as may be, not only the new heritable variations themselves (provided any such appear), but also the factors which underlie their causation.

The specific problems with which this investigation deals are these:

1. Does the continued administration of certain narcotic poisons to the domestic fowl induce precise and specific changes in the germinal material, such as to lead to new, heritable, somatic variations?

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*This is an abstract of (a) a paper by Raymond Pearl, having the same title, and published in the Proceedings of the American Philosophical Society, Vol. LV, pp. 243-258, 1916, and (b) a paper by the same author, having the title "The Effect of Parental Alcoholism (and certain other Drug Intoxications) upon the Progeny in the Domestic Fowl," and published in the Proceedings of the National Academy of Sciences, Vol. 2, pp. 380-384, 1916.

2. Failing a specific effect is there a general effect upon the germinal material?

3. What in general are the effects upon the soma of the treated individual of the continued administration of such poisons?

4. Are the somatic effects upon the treated individuals of a sort to give any clue to the probable origin, or mechanism of the germinal changes?

The foundation stock used in these experiments came from pedigreed strains of two breeds of poultry, Black Hamburgs and Barred Plymouth Rocks. Both of the strains used have been so long pedigree-bred by the writer, and used in such a variety of Mendelian experiments, that they may be regarded as "reagent strains," whose genetic behavior under ordinary circumstances may be predicted with a degree of probability amounting practically to complete certainty. Furthermore, the results of crossing these two breeds reciprocally have been thoroughly studied.

Three poisons were used in the work, namely, ether, methyl alcohol, and ethyl alcohol. These substances were administered to the birds daily by the inhalation method.

Turning to the results we may note first that the egg production of the treated birds and the untreated controls was entirely normal in respect of its seasonal distribution, as well as in regard to its amount.

There has been *no significant difference* in the egg production of the treated birds and their untreated control sisters, either in the total average number of eggs produced per bird nor in the seasonal distribution of this production. The only conclusion which can be drawn from the statistically insignificant differences which appear between treated and control birds is that the inhalation treatment has not affected the egg production of the birds, either favorably or adversely.

Regarding the *offspring* the results show that out of 12 different characters for which we have exact quantitative data, the offspring of treated parents taken as a group are superior to the offspring of untreated parents in 8 characters. The offspring of untreated parents are superior to those of the treated in respect of but two characters and these are characters which are quite highly correlated with each other and really should be counted as but one single character. Finally with respect to two character groups there is no difference between the treated and the untreated.

We may evaluate our results in general terms as follows:

1. There is no evidence that *specific* germinal changes have been induced by the treatment, at least in those germ cells which produced zygotes.

2. There is no evidence that the germ cells which produced zygotes have in any respect been injured or deleteriously affected.

THE SEPARATE INHERITANCE OF PLUMAGE PATTERN AND PIGMENTATION IN PLYMOUTH ROCKS.*

This paper gives the proof, based on Mendelian breeding experiments, that in the Barred Plymouth Rock the barred pattern is inherited as a separate unit character, distinct from the pigment which makes the pattern visible, which constitutes another unit character. It is shown that the White Plymouth Rock inherits the same pattern as the Barred Plymouth Rock, but fails to show it because it lacks the hereditary determiner for pigment.

A PSYLLID GALL ON JUNCUS (*LIVIA MACULIPENNIS* FITCH).†

Since 1857 when Fitch described this beautiful little insect, nothing more definite in regard to its habits has been recorded than that it is found in swampy places. Thomas in 1879 said that it was "found on the sweet-flag," but there is nothing in his account which would indicate that it fed upon that plant.

This past summer, however, the secret of its habitation was discovered by Miss Cora H. Clarke of Boston, who made an interesting collection of Juncus galls near Magnolia Village,

*This is an abstract of a paper by Raymond Pearl, having the same title and published in Practical Husbandry of Maine, Vol. VI, pp. 567-568, 1916.

†This is an abstract of a paper with the same title, by Edith M. Patch, published in Psyche, Vol. xxiii, No. 1, with Plate vi.

Mass., on August 17, which she shared with the writer. At this date the galls contained only unknown nymphs of a Psyllid but they were about ready to wing and the adults began to emerge in large numbers on August 20-21. These proved to be *Livia maculipennis* Fitch.

CONCERNING PROBLEMS IN APHID ECOLOGY.*

It is apparent enough that in ecological work with an aphid, the fact of first importance to be ascertained is whether a given species is migratory, for, if it have two types of host plants, the problems that concern its life cycle are doubled, though the economic situation may be simplified by virtue of a greater choice in methods of control.

Why should it not be a simple matter—the mere finding out whether a species is migratory? Partly because every aphid cycle we learn is as likely to mislead as to guide us with the next species we investigate. We are in the habit of saying, for instance, that we know that *Aphis pomi, Myzus cerasi,* and *Schizoneura rileyi* do not migrate because they occur at all times of the year upon a single food plant, respectively the apple, the cherry, and the elm. That in itself is no reason for surety, for *Prociphilus tessellata, P. venafuscus,* and *Schizoneura lanigera* each occurs at all times of the year upon a single food plant, respectively the alder, the balsam fir, and the apple, and yet these are all migratory aphids. There is this distinction between these two cases, however, the three species first mentioned occur at all times of the year upon their *primary* food plant and the second three do not—with them it is their *secondary* food plant which harbors them for twelve months of the year in addition to their winter and spring residence upon their primary host. By "primary host" is understood that plant upon which the over-wintering egg is normally deposited and upon which the stem mother and her immediate progeny develop. The "secondary host" is that plant to which the spring migrants fly and from which they return to the primary host. At present I know of no member of the subfamily *Aphidinæ* which resides for twelve months upon its primary host and in

*This is an abstract of a paper with the same title, by Edith M. Patch, published in Journal of Economic Entomology, Vol. 9, pp. 44-51.

addition migrates for a part of the year to a secondary host. But it would be a rash person who felt safe in the conviction that such a cycle could not be.

Many migratory aphids, to be sure, alternate their primary and secondary host plants at regular intervals, each time entirely deserting the one for the other, thus existing for a part of the year only upon each. *Rhopalosiphum nympheae* Linn is an example of such a cycle with its winter and spring habitation on the plum and its summer residence upon various water plants.

For many reasons it becomes evident that a failure with a migration test gives no data.

If an investigator fails in one hundred attempts to colonize thistle with migrants from plum that will not be a safe reason for him to conclude that he is not working with *Aphis cardui,* or that this thistle aphid has nothing to do with the leaf deformations of the plum in the spring. It has been my own experience that negative data with aphids under such conditions are just no data at all. If the structural characters are such as warrant the migration test in the first place, they warrant a patient continuation even in the face of repeated failures.

On the other hand (and this is the most encouraging and stimulating circumstance in connection with aphid migration tests), a single success goes a long way to prove the case. Barring complications, a single success is enough, and repetitions and verifications are needed only as safeguards in that respect. For these insects are remarkably stable as to their exclusive tastes in vegetable juices and a given species will die before it will submit to the sap of any plant not on its approved dietary. So if the progeny of the migrants accept the food plants given them in the laboratory to the extent of developing upon it from the first instar to maturity, it is safe to conclude that that food plant is one which they would accept in the field under favorable conditions, even though, with the wider choice of the open, a different one might be given preference in certain localities. Such proof should rest with the behavior of the progeny of the migrants and not with the migrants themselves, for the migrants, as has been suggested, have many ways of tantalizing the hopeful investigator.

METEOROLOGICAL OBSERVATIONS.

For many years the meteorological apparatus was located in the Experiment Station building and the observations were made by members of the Station Staff. June 1, 1911, the meteorological apparatus was removed to Wingate Hall and the observations are in charge of Mr. James S. Stevens, professor of physics in the University of Maine.

In September, 1914, the meteorological apparatus was again moved to Aubert Hall, the present headquarters of the physics department.

The instruments used were at Lat. 44° 54′ 2″ N. Lon. 64° 40′ 5″ W. Elevation 135 feet.

The instruments used are the same as those used in preceding years, and include: Maximum and minimum thermometers; rain gauge; self-recording anemometer; vane; and barometers. The observations at Orono now form an almost unbroken record of forty-eight years.

Meteorological Summary for 1916.

Observations Made at the University of Maine.

1916.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Averages.	Totals.
Highest temperature	49	50	69	65	80	82	94	93	86	81	64	53	....	....
Lowest temperature	–14	–13	0	24	30	37	47	42	33	24	2	–3	....	....
Mean temperature	23.4	20.8	25.2	44.1	54.2	61.4	70.1	68.9	59.6	49.7	34.2	25.5	44.83	....
Mean temperature in 48 years	16.5	12.4	30.0	40.2	51.6	60.8	65.9	66.1	60.0	50.9	38.2	24.4	42.77	....
Total precipitation in inches	2.59	2.61	2.45	3.63	4.42	4.99	4.39	2.27	4.60	1.85	1.60	5.80	....	41.20
Mean precipitation in 48 years	2.49	3.49	4.07	2.96	3.58	3.42	3.42	2.30	3.46	3.79	3.51	3.56	....	....
Number of days with precipitation of .01 or more	10	8	8	9	12	16	11	7	8	6	6	9	....	110
Snowfall in inches	11.5	19.0	24.5	14.0	....	....	....	....	....	....	11.0	35.0	....	115.0
Mean snowfall in 48 years	21.48	21.31	15.19	5.79	0.18	....	....	....	....	0.70	7.11	16.4	....	....
Number of clear days	13	12	21	16	18	18	19	24	20	20	16	16	....	213
Number of fair days	5	4	3	7	5	4	3	4	4	6	2	5	....	52
Number of cloudy days	13	13	7	7	8	8	9	3	6	5	12	10	....	101
Total movement of wind in miles	4060	4171	5010	4289	5043	3570	3857	3251	3731	3886	3706	5244	4152	49818

REPORT OF THE TREASURER.

The Station is a department of the University and its accounts are kept in the office of the Treasurer of the University. The books, voucher files, etc., are, however, all distinct from those of the other departments of the University. The classification of accounts is that prescribed by the auditors on the part of the Federal Government, and approved by the State Auditor. All of the accounts are audited by the State Auditor, and the Hatch Fund and Adams Fund accounts are also audited by the Office of Experiment Stations acting for the United States Secretary of Agriculture in accordance with Federal Law.

The income of the Station from public sources for the year that ended June 30, 1916, was:

U. S. Government, Hatch Fund appropriation....	$15,000 00
U. S. Government, Adams Fund appropriation....	15,000 00
State of Maine, Animal Husbandry investigation appropriation	5,000 00
State of Maine, Aroostook Farm investigation....	5,000 00

The cost of maintaining the laboratories for the inspection analyses is borne by analysis fees and by the State Department of Agriculture. The income from sales at the experiment farms is used for the expense of investigations. The printing which costs about $4,500 is paid for by an appropriation to the University.

All of the disbursements except for printing and the sheep husbandry experiment are given in the tables that follow on the two succeeding pages. The sheep husbandry expenditures for the year ending October 31, 1916, were labor, $153.54; feeding stuffs, $669.68; sundry supplies, $13.33.

Report of Treasurer for Fiscal Year Ending June 30, 1916.

DISBURSEMENTS.

Receipts.	Hatch fund.	Adams fund.	Animal husbandry investigations.
Salaries	$6,957 21	$11,586 14	$4,750 32
Labor	2,722 75	30 23	–
Publications	115 67	–	–
Postage and Stationery	737 33	107 46	28 50
Freight and Express	201 73	123 59	4 87
Heat, light and power	557 13	76 03	–
Chemical and laboratory supplies	79 30	242 21	110 00
Seeds, plants and sundry supplies	536 63	153 76	–
Fertilizers	110 00	–	–
Feeding stuffs	635 35	1,619 31	–
Library	608 81	39 10	–
Tools, machinery and appliances	332 66	44 87	–
Furniture and fixtures	269 85	267 86	85 65
Scientific apparatus and specimens	161 61	223 69	–
Live stock	39 98	3 00	10 00
Traveling expenses	541 50	324 93	10 66
Contingent expenses	60 00	117 42	–
Buildings	332 49	40 40	–
Total	$15,000 00	$15,000 00	$5,000 00

Report of Treasurer for Fiscal Year Ending June 30, 1916 —Concluded.

DISBURSEMENTS.

Receipts.	Aroostook farm.	General account.	Inspection analysis.
Salaries	$1,205 00	$3,257 65	$10,567 67
Labor	2,611 05	2,126 90	–
Publications	–	–	–
Postage and stationery	30 16	233 93	486 06
Freight and express	32 80	238 47	170 86
Heat, light and power	56 52	55 87	376 77
Chemical and laboratory supplies	–	41 36	496 71
Seeds, plants and sundry supplies	541 43	1,353 77	47 46
Fertilizers	–	87 00	–
Feeding stuffs	38 92	231 15	–
Library	–	66 84	–
Tools, implements and machinery	321 09	76 29	–
Furniture and fixtures	400 83	–	182 24
Scientific apparatus	–	2 21	206 65
Live stock	255 00	542 00	–
Traveling expenses	76 29	180 30	127 27
Contingent expenses	62 39	116 50	12 83
Buildings	983 42	102 25	–
Total	$6,614 90	$8,712 49	$12,674 52

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APPENDIX

Official Inspections

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APPLE TREE INSECTS OF MAINE

POTATO GROWING AND POTATO DISEASES FROM MAINE TO CALIFORNIA

CONTENTS.

JANUARY, 1916.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director.

ANALYSTS.

James M. Bartlett
Royden L. Hammond
Elmer R. Tobey
Herman H. Hanson
Edward E. Sawyer
Walter H. Rogers

Official Inspections

75

FUNGICIDE AND INSECTICIDE INSPECTION.

The Commissioner of Agriculture is the executive of the law regulating the sale of fungicides and insecticides in Maine. It is the duty of the Director of the Maine Agricultural Experiment Station to make the analyses of the samples collected by the Commissioner, and to publish the results of the analyses together with the names of the persons from whom the samples were obtained, and such additional information as may seem advisable.

NOTE. All correspondence relative to the inspection laws should be addressed to the Bureau of Inspections, Department of Agriculture, Augusta, Maine.

Requirements of the Law.

The law regulating the sale of fungicides and insecticides was enacted by the legislature of 1911. It is comparatively new and is only coming to be fully understood. During the years 1912 and 1913 a large part of the work of inspection was instructing dealers relative to the law and what they must do to conform with it. Nearly all of the dealers in fungicides and insecticides were visited by the inspectors during those years and many hundred letters were written regarding the law and its requirements. While much progress was made the law is still only partly understood. The need for the law, shown in the results of the first general and imperfect survey, is still more apparent as the inspections have been continued. The situation at the start would have been very discouraging were it not for the fact that it was no worse than was the case with grass seeds or feeding stuffs when the laws regulating those commodities were enacted.

The scope of the law is the same as the National Law. It is very broad and includes all materials which are used for preventing, destroying, repelling or mitigating fungi and insects that infest vegetation, man and other animals, or houses, or any environment whatever.

Every lot or package shall be plainly marked with the number of net pounds in the package, the name or trademark under which the article is sold, the name and address of the manufacturer or shipper, the minimum percentage of total arsenic and the maximum percentage of water soluble arsenic.

Before a fungicide or insecticide can be lawfully sold in the State it is necessary that it be registered and for that purpose there must be deposited with the Commissioner of Agriculture a certified copy of the statements named above, a registration fee of $10.00, and, if the commissioner requires, a sample of the fungicide or insecticide.

The registration fee is not assessed on a brand consisting of organic matter and not containing any added inorganic matter or mineral chemical, provided that a complete chemical analysis is given in, and as a part of, the required certificate.

It is necessary that every insecticide containing arsenic carry in addition to the weight, a chemical analysis stating the minimum percentage of total arsenic and the maximum percentage of water soluble arsenic which it contains. Standards are fixed for Paris green following the Federal law so that Paris green is adulterated if it does not contain at least 50 per cent of arsenious oxide (As_2O_3) or if it contains arsenic in water soluble form that is equivalent to more than 3.5 per cent of arsenious oxide (As_2O_3); and in the case of lead arsenate it is adulterated if it contains more than 50 per cent of water, if it contains total arsenic equivalent to less than 12.5 per cent of arsenic oxide (As_2O_5) and if it contains arsenic in water soluble form equivalent to more than 75 per cent of arsenic oxide (As_2O_5).

A fungicide or insecticide is adulterated if:—its strength or purity falls below the professed standard under which it is sold; any substance has been substituted wholly or in part for the article; any valuable constituent of the article has been wholly or in part extracted; or if it contains any substance or substances injurious to vegetation.

A fungicide or an insecticide is misbranded if:—the package or label bears any statement, design or device which is false or misleading in any particular; the container does not carry the statements named above; the printed statement attached to the container differs from the statements in the certificate; the registration fee has not been paid; it is in imitation of or offered for sale under the name of another article; it is labeled or misbranded so as to deceive the purchaser; any of the contents of the package as originally put up have been removed in whole or in part and other contents placed in such packages; or it consists partially or completely of any inert substance or substances which do not prevent, destroy, repel or mitigate insects or fungi and does not have the percentage amount of such inert substances plainly stated on the label.

Results of Analyses.

The results of the examination of all of the samples received from the Commissioner of Agriculture during the year 1915 are given in the tables that follow. The reason for the small number of samples is given in the Statement by the Executive of the law on page 8.

Fungicides Analyzed in 1915.

Name and Address of Maker and Name of Goods, and Source of Sample.	Claims Made on Certificate or on Label.	Results of Examination.
BORDEAUX MIXTURE Sherwin-Williams Co., Cleveland, O. and Boston, Mass. "Fungi-Bordo." Kendall & Whitney, Portland.	Claimed to contain: Active ingredients, copper 11 per cent. 1 lb.	No. 30381. Weight and composition as claimed.
LIME-SULPHUR Thomsen Chemical Co., Baltimore, Md. "Orchard Brand Lime Sulphur Solution." Milliken-Philbrook, Portland	Claimed to contain not less than 25 per cent total sulphur.	No. 30378. Not in original package. Composition as claimed.

Combined Fungicides and Arsenical Insecticides Analyzed in 1915.

Name and Address of Maker, Name of Goods and Source of Sample	Claims Made on Certificate or on Label.	Results of Examination.
Bowker Insecticide Co., Boston, Mass. "Bowker's Pyrox." V. L. Warren, Dover.	Claimed to contain total arsenic not less than 3.42 per cent, arsenic in water soluble forms not more than 0.75 per cent, copper not less than 1.50 per cent. 1 lb.	No. 30385. Weight and composition as claimed.
Hemingway & Co., Inc., Bound Brook, N. J. "Caascu" (dry powder form). Elmer E. Cole, Foxcroft.	Claimed to contain not less than 31 per cent total arsenic and not more than ¾ of 1 per cent arsenic soluble in water.	No. 30384. Not in original package. Claim on certificate should probably have been arsenious oxide (As_2O_5). Carried 31.48 per cent arsenious oxide (As_2O_5) and 7.02 per cent copper.
Interstate Chemical Co., Jersey City, N. J. "Key Brand Bordo Lead." Ducke-Day Co., Gardiner.	Certificate: Contains not less than 4.5 per cent total arsenic and not more than 0.24 per cent arsenic soluble in water. Label: Contains arsenic oxide 7½ per cent, metallic copper 2 per cent.	No. 30373. Composition as claimed. Weight not stated on label, as required by law.
Sherwin-Williams Co., Cleveland, O. and Boston, Mass. "Dry Tuber-Tonic." J. C. Curtis, Camden.	Claimed to contain 60 per cent Paris green and copper of bordeaux materials 6 per cent, inert ingredients 34 per cent.	No. 30377. Not in original package. Composition as claimed.

Arsenical Insecticides Analyzed in 1915.

Name and Address of Maker, Name of Goods and Source of Sample.	Claims Made on Certificate or on Label.	Results of Examination.
ARSENATE OF LEAD PASTE		
Interstate Chemical Co., Jersey City, N. J. "Key Brand Arsenate of Lead." Mrs. D. B. Donnelly, Fairfield.	Contains not less than 9 per cent total arsenic, and not more than ¾ of 1 per cent arsenic soluble in water.	No. 30392. Composition as claimed. Weight not stated, as required by law.
Powers-Weightman-Rosengarten Co., Philadelphia, Pa. "Lead Arsenate Paste" Frank E. Robbins, Portland.	Certificate claims that it contains not less than 12.5 As_2O_5. Label claims not less than 15 per cent As_2O_5. Not more than 0.75 per cent water soluble arsenic. 1 pound.	No. 30366. Arsenic in accord with highest claim. Water soluble arsenic 1.57 per cent. Weight as claimed.
Sherwin-Williams Co., Cleveland, O., and Boston, Mass. "New Process Arsenate of Lead." No. 30371 from Storer Bros., Yarmouth, No. 30391 from F. E. Sherman, Bar Harbor.	Certificate claims to contain not less than 12½ per cent of total arsenic; label not less than 8.16 per cent arsenic. Not more than .49 per cent soluble. 1 pound.	No. 30371 and No. 30391. Carried 9.74 and 10.43 per cent metallic arsenic. In accord with label but not in accord with certificate. Weight as claimed.
Thomsen Chemical Co., Baltimore, Md., "Orchard Brand Arsenate of Lead Standard Paste." Milliken-Philbrook Portland.	On certificate: contains not less than 9.8 per cent metallic arsenic and not more than 0.48 per cent metallic arsenic soluble in water. 5 lbs.	No. 30380. Arsenic higher than claimed. Water soluble arsenic slightly high. Net weight as claimed.
ARSENATE OF LEAD POWDERED		
Corona Chemical Co., Milwaukee, Wis. "Corona Dry Arsenate of Lead." S. J. Record Co., Norway.	Not in original package. Claim on certificate: not less than 19.5 per cent total arsenic and not more than 0.5 per cent arsenic soluble in water	No. 30374. Practically in accord with guaranty.
Merrimac Chemical Co., Boston, Mass. "Swift's Arsenate of Lead Powdered." Eaton Hardware Co., Brunswick.	Contains not less than 25 per cent arsenic oxide (As_2O_5) and not over 1½ per cent water soluble arsenic. 1 lb.	No. 30365. Weight and composition as claimed.
Powers-Weightman-Rosengaten Co., Philadelphia, Pa., "Lead Arsenate Powder." H. M. Burnham, Old Town.	Contains not less than 25 per cent arsenic oxide (As_2O_5) and not more than 0.75 per cent arsenic soluble in water and not less than 6 per cent inert ingredients. 1 lb.	No. 30390. Weight and composition as claimed.
Sherwin-Williams Co., Cleveland, O., and Boston, Mass. "Dry Arsenate of Lead." No. 30364 from Eaton Hardware Co., Brunswick. No. 30382 from Kendall & Whitney, Portland.	On certificate: contains not less than 30 per cent of arsenic oxide and not more than 1 per cent of arsenic oxide soluble in water. 1 lb.	Nos. 30364 and 30382. Weight and composition as claimed.
ARSENITE OF ZINC PASTE		
Thomsen Chemical Co., Baltimore, Md. "Orchard Brand Arsenite of Zinc Paste." Milliken-Philbrook, Portland	Not less than 15.25 per cent total metallic arsenic and not more than 0.57 per cent metallic arsenic soluble in water. 5 lbs.	No. 30379. Weight and composition as claimed.

Arsenical Insecticides Analyzed in 1915—Concluded.

Name and Address of Maker, Name of Goods and Source of Sample	Claims Made on Certificate or on Label.	Results of Examination.
ARSITE Morris Herrmann & Co., New York City, "Arsite." Mason-Hall, Belfast.	Total arsenic not less than 28.8 per cent. One pint.	No. 30393. Slightly short measure. Composition sufficiently high so if diluted to the measure claimed it would have claimed composition.
PARIS GREEN Fred L. Lavanburg, New York City. "Star Brand Paris Green." Dunbar's Drug Store. Waterville.	Not less than 50 per cent of arsenious odixe (As_2O_3) and not more than 3½ per cent of arsenious oxide soluble in water. 1 lb.	No. 30388. Weight and composition as claimed.
F. W. Devoe & J. T. Reynolds Co., New York City. "Paris Green." Geo. Drapeau, Brunswick.	Certificate claims: not less than 50 per cent total arsenic and not more than 3½ per cent of arsenic soluble in water. On label: Not less than 56 per cent arsenious oxide (As_2O_3), and not more than 2 per cent arsenious oxide soluble in water. ½ lb.	No. 30363. Certificate evidently made in error. Weight and composition in accord with label.
SHEEP DIPPING POWDER Wm. Cooper & Nephews, Chicago, Ill. "Cooper's Sheep Dipping Powder." Geo. M. Barrows, Newport.	Contains not less than 16.75 per cent metallic arsenic, of which at least 14 per cent is in water soluble form.	No. 30386. Composition as claimed. Weight not stated, as required by law.

Non-arsenical Insecticides Analyzed in 1915. Arranged by Classes of Insects They are Intended to Combat.

Name and Address of Maker, Name of Goods and Source of Sample	Claims Made on Certificate or on Label	Results of Examination.
BED BUGS, ROACHES, ETC. Fred E. Hall, Inc., Providence, R. I. "Cearmist," Jaynes Drug Co., Portland.	Label claims goods to be a blend of coal oil, oil of cedar and other volatile and essential oils, together with carbolic acid. One pint.	No. 30367. Sample consisted chiefly of formaldehyde. Quantitative anaalysis not attempted. Weight as claimed.
FLEAS Dr. A. C. Daniels, Inc., Boston Mass. "Dr. Daniels Flea Powder, for Fleas and Vermin." P. J. Meserve, Brunswick.	On certificate claimed to contain not less than 12 per cent loam. On label: effective and harmless. 2¾ ozs.	No. 30362. Consists chiefly of insect powder, powdered tobacco stems and napthaline. Weight as claimed.
FLIES. Cook, Everett & Pennell, Portland, Me. "Cattle Oil." Cook, Everett & Pennell, Portland.	No claims on certificate. Sample not in original package.	No. 30372. Active ingredient oil of tar.

Non-arsenical Insecticides—Concluded.

Name and Address of Maker, Name of Goods and Source of Sample	Claims Made on Certificate or on Label.	Results of Examination.
Eureka-Mower Co., Utica, N. Y. "Cow's Favorite Oil." Jas. Fassett, Union.	No claims on certificate. Sample not in original package.	No. 30376, has the appearance of gas house refuse liquid. Contains oil of tar, and other tar compounds and ammonium carbonate.
Gould & Cutler Corp., Boston, Mass. "Cow Comfort Oil." Saunders Hardware Co., Old Town.	On certificate, claimed 75 per cent inert ingredients. Not in original package.	No. 30389. Active ingredient oil of tar.
Whitman Chemical Co., Inc., Boston, Mass. "Whitman Insectrun." Allen Drug Store, Brunswick.	On label: Contains alcohol 5 per cent. Prevents and relieves insect bites.	No. 30361. No. weight or volume stated, as required by law. Contains oil of tar, oil of pennyroyal, ammonia and similar simples. Complete analysis not made.
HEAD LICE		
Riker Laboratories, Inc., New York and Boston. "Jaynes Capitina." Jaynes Drug Co., Portland.	Label: "23 per cent alcohol. Contains the soluble constituents of larkspur seed." Four fluid ounces.	No. 30368. Volume and composition as claimed.
LICE		
The G. E. Conkey Co., Cleveland, Ohio. "Conkey's Lice Liquid." Allen, Sterling & Lothrop. Portland.	Claimed on certificate, 18 per cent inert ingredients. On label: "Also an excellent disinfectant and germicide." One quart.	No. 30369. Complete analysis not made. Apparently a gas house waste liquid. Volume as claimed.
The G. E. Conkey Co., Cleveveland, Ohio. "Conkey's Lice Powder." Allen, Sterling & Lothrop, Portland.	Claimed on certificate 83.45 per cent inert ingredients. On label: "Active ingredients: nicotine .10 per cent, phenol .60 per cent, sulphur sulphur 15.85 per cent." 15 ounces.	No. 30370. Carried 14 per cent sulphur, phenol and nicotine present. Weight as claimed.
Park & Pollard Co., Boston, Mass. "Overall Lice Powder." Saco Grain & Milling Co., Saco.	On certificate· 95 per cent inert ingredients. On label: "Trace of nicotine, 4½ per cent napthaline, 7½ per cent of sulphur, inert ingredients not over 88 per cent." 5 ozs.	No. 30383. Sulphur 7.51 per cent. Contains napthaline and nicotine. Weight as claimed.
PLANT INSECTS.		
Danforth Chemical Co., Leominster, Mass. "Bug Death" Darviau's Red Cross Pharmacy, Waterville.	On label and certificate: zinc oxide 47 per cent, lead oxide 5 per cent, inert ingredients 48 per cent. One pound.	No. 30387. Composition and weight as claimed.

STATEMENT BY THE EXECUTIVE OF THE LAW.

A. M. G. Soule, Chief Bureau of Inspections.

On the whole, the registration of fungicides and insecticides has been effected with considerably less labor than the year previous, and the results of inspection have been fully as satisfactory; this seems to be partly due to the fact that the law, being a year older, is more thoroughly understood by the dealers offering these products for sale, and also from the fact that the dealers are more familiar with just what constitutes an insecticide. In all, three hundred and forty-two brands of fungicides and insecticides were registered in Maine for 1915.

It is with regret that we report such a small number of samples collected as compared with the number taken last year; the variety of substances collected, however, was nearly as great, including arsenate of lead (paste and powdered form), lice killers (in liquid and powder form), cattle oils, tuber tonic, lime sulphur solution, Pyrox, sheep dipping powder, Paris green, etc. Only thirty-three samples were taken; inspection, however, was not started as early as last year and, because of this fact, before the Inspector had finished making a tour of the State, many of the brands were not to be found upon the dealers' shelves.

As for the results of the analyses—as noted in the tabulations—they do not show a serious deficiency in any one of the products. In one or two instances the product is considered unlawful as it did not bear the proper markings indicating the quantity of the contents, but the insecticidal qualities have been found to be up to the guarantees in the manufacturer's certificates and no hearings on this charge have been appointed.

Not as large a number of insecticides were found offered for sale unregistered as in previous years. Numerous dealers, however, were found handling two or three unregistered brands that have been sold extensively, and no apparent excuse could be offered as to why registration had been neglected. One hundred and sixty-two hearings were arranged. It will be the purpose of this department to start the inspections for 1916 earlier and to deal less leniently with those found offering unregistered goods for sale.

February, 1916

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director.

ANALYSTS

James M. Bartlett
Royden L. Hammond
Elmer R. Tobey
Herman H. Hanson
Edward E. Sawyer
Walter H. Rogers

Official Inspections

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ICE CREAM.

EVAPORATED MILK.

The Commissioner of Agriculture is the executive of the law regulating the sale of agricultural foods in Maine. It is the duty of the Director of the Maine Agricultural Experiment Station to make the analyses of the samples collected by the Commissioner and to publish the results of the analyses of the samples of foods, together with the names of the persons from whom the samples were obtained, and such additional information as may seem advisable.

Note. All correspondence relative to the inspection laws should be addressed to the Bureau of Inspections, Department of Agriculture, Augusta, Maine.

Evaporated Milk. Condensed Milk.

Evaporated milk should contain not less than 25.5 per cent milk solids and not less than 7.8 per cent milk fat. Unsweetened evaporated milk will therefore contain not more than 74.5 per cent water. Sweetened evaporated milk (commonly called condensed milk) carries about 45 per cent of added cane sugar. It has the milk solids and fat required for unsweetened milk and the cane sugar in addition. Its water content will be about 25 per cent. The tables that follow give the results of the examination of the samples of sweetened and unsweetened evaporated milk.

Results of the examination of samples of sweetened evaporated milk, arranged alphabetically by the names of the makers.

Station number.	Manufacturer, Brand, Name and Address of Dealer.	Water. %	Ash. %	Protein. %	Fat. %	Sugar. %
14269	Borden's Condensed Milk Co., N. Y. "Baby Brand." Thurston & Kingsbury, Bangor	26.77	1.63	6.82	8.38	56.40
14386	Borden's Condensed Milk Co., N. Y. "Challenge Brand," F. G. Davis & Co., Lewiston	16.12	1.75	7.79	9.47	64.87
14232	Borden's Condensed Milk Co., N. Y. "Dixie Brand." John Cassidy Co., Bangor	21.81	1.75	7.59	10.22	58.63
14264	Borden's Condensed Milk Co., N. Y. "Eagle Brand." Arthur Chapin Co., Bangor	25.05	1.69	7.65	9.92	55.69
14237	Borden's Condensed Milk Co., N. Y. "Moosehead Brand." Geo. I. Wescott & Son, Bangor	24.80	1.61	7.57	8.66	57.36
14231	Borden's Condensed Milk Co., N. Y. "Ruby Brand." Chas. Hayward & Co., Bangor	22.65	1.77	7.72	9.46	58.40
14266	Borden's Condensed Milk Co., N. Y. "Thistle Brand." T. R. Savage Co., Bangor	24.91	1.78	7.49	8.98	56.84
14291	Holland Food Corporation, N. Y. "Milkland Brand." Fuller-Holway Co., Augusta	21.32	1.73	8.01	11.18	57.76
14387	Hudson Condensed Milk Co., N. Y. "Bantam Brand." F. G. Davis & Co., Lewiston	23.19	1.66	7.82	9.84	57.49
14271	Hudson Condensed Milk Co., N. Y. "Golden Glow Brand." Thurston & Kingsbury, Bangor	24.65	1.64	8.10	10.40	55.21
14270	Libby, McNeil & Libby, Chicago, Ill. "Libby's." Thurston & Kingsbury, Bangor	25.79	1.62	8.55	9.61	54.43
14388	Mohawk Condensed Milk Co., N. Y. "Red Cross Brand." F. G. Davis & Co., Lewiston	21.80	2.08	7.98	10.22	57.92

Results of the examination of samples of unsweetened evaporated milk, arranged alphabetically by the names of the makers.

Station number.	Manufacturer, Brand, Name and Address of Dealer.	Water. %	Ash. %	Protein. %	Fat. %	Sugar. %
14236	Borden's Condensed Milk Co., N. Y. "Peerless Brand." Geo. I. Wescott & Son, Bangor	72.52	1.59	6.89	8.20	10.80
14230	Borden's Condensed Milk Co., N. Y. "Saint Charles Brand." Chas. Hayward & Co., Bangor	72.44	1.64	7.17	7.84	10.91
14233	Borden's Condensed Milk Co., N. Y. "Silver Cow Brand." John Cassidy Co., Bangor	73.73	1.54	6.60	7.76	10.37
14290	Boston Condensed Milk Co., Bellows Falls, Vt. "Quality Brand." Fuller-Holway Co., Augusta	72.02	1.65	6.86	8.02	11.45
14234	Delavan Condensed Milk Co., Delavan, Wis. "Beauty Brand." John Cassidy Co., Bangor	73.61	1.53	6.57	8.40	9.89
14265	Helvetia Milk Condensing Co., Highland, Ill. "Our Pet Brand." T. R. Savage Co., Bangor	73.05	1.52	6.73	8.49	10.21
14263	Highland Milk Condensing Co., Elkland, Pa. "Honor Brand." Arthur Chapin Co., Bangor	72.56	1.53	6.54	8.84	10.53
14262	Hires Condensed Milk Co., Philadelphia, Pa. "Hires Gold Brand." Murray Bros. Co., Bangor	74.98	1.47	6.48	7.76	9.31
14385	Indiana Condensed Milk Co., Sheridan, Ind. "Wilson's" F. G. Davis & Co., Lewiston	73.02	1.50	6.96	8.09	10.43
14235	Libby, McNeil & Libby, Chicago, Ill. "Libby's." Geo. I. Wescott & Son, Bangor	74.18	1.48	6.73	8.48	9.13
14267	Mohawk Condensed Milk Co., N. Y. "Gold Cross Brand." Thurston & Kingsbury, Bangor	75.93	1.34	5.71	7.62	9.40
14268	Van Camp Packing Co., Indianapolis, Ind. "Van Camp's." Thurston & Kingsbury, Bangor	72.15	1.54	7.05	8.02	11.24

Ice Cream.

Lawful ice cream, without fruit carries not less than 14 per cent milk fat. A fruit ice cream to be lawful must carry not less than 12 per cent milk fat. Judging from reports Maine has on the whole better ice cream than any other New England state. The standards are higher than in most states and the standards are well complied with. Of all the samples collected only 12 were more than one per cent below the standard and only two or three of these were greatly deficient in milk fat. The results of the examination of the samples collected are given in the tables that follow.

Ice Cream.

Table showing the results of the examination of samples of ice cream collected in the season of 1915, arranged alphabetically by towns.

Station number.	Town and Dealer.	Results of Examination.*
15348	Anson. S. G. Tinkham	Well above standard.
15251	Auburn. J. C. Barry	Well above standard.
15250	Auburn. F. A. Corey	Well above standard.
15253	Auburn. E. L. Fowles	Slightly below standard.
15254	Auburn. R. W. Millburn	Well above standard.
15249	Auburn. C. E. Packard	Well above standard.
15252	Auburn. Round & Sands	Well above standard.
15255	Auburn. F. L. Ruggles	Well above standard.
15169	Augusta. Augusta Fruit Co.	Well above standard.
15179	Augusta. Capitol Cafetaria Co.	Low.
15176	Augusta. John Coughlin	Lawful.
15173	Augusta. Devine & Chadbourne	Well above standard.
15172	Augusta. N. T. Folsom & Son	Well above standard.
15175	Augusta. J. G. Johnson	Low.
15177	Augusta. Mike Levine	Slightly below standard.
15178	Augusta. H. J. Marden	Well above standard.
15174	Augusta. Robert Miller	Lawful.
15171	Augusta. Willis R. Partridge	Lawful.
15224	Augusta. J. L. Piteau	Well above standard.
15180	Augusta. W. F. Turner	Well above standard.
15170	Augusta. E. L. Winslow	Well above standard.
15256	Ayer Junction. Mrs. A. A. Cortell	Lawful.
15153	Bar Harbor. E. W. Douglass	Well above standard.
15148	Bar Harbor. F. H. Gonyer	Lawful.
15150	Bar Harbor. C. B. Higgins	Well above standard.
15152	Bar Harbor. Hussey & Moran	Well above standard.
15149	Bar Harbor. C. H. Kucher	Well above standard.
15151	Bar Harbor. West End Drug Co., H.L.Gordon,Mgr.	Slightly below standard.
15421	Bath. Anderson Pharmacy	Lawful.

* Explanation of terms. Lawful, just above standard. Well above standard, at least one per cent above standard. Slightly below, not more than one per cent below standard. Low, more than one per cent below standard.

Ice Cream—Continued.

Station number.	Town and Dealer.	Results of Examination.*
15428	Bath. O. Breton	Well above standard.
15418	Bath. J. F. Clary	Well above standard.
15414	Bath. Colonial Cafe, C. H. Cahill, Prop	Lawful.
15416	Bath. Dairy Lunch, J. M. Footer, Prop	Well above standard.
15424	Bath. D. T. Dougherty	Well above standard.
15415	Bath. A. Hallett & Co	Well above standard.
15420	Bath. Keene & Green	Well above standard.
15417	Bath. Leonard & Mitchell	Well above standard.
15426	Bath. W. A. MacDonald	Well above standard.
15425	Bath. Wm. Mann	Well above standard.
15427	Bath. W. H. Small	Well above standard.
15419	Bath. L. B. Swett & Co	Slightly below standard.
15423	Bath. Webber's Drug Store	Lawful.
15422	Bath. Lewis E. Wilson	Well above standard.
15284	Biddeford. G. & A. Boucher	Well above standard.
15278	Biddeford. V. Coronias	Well above standard.
15277	Biddeford. Crowley's Pharmacy	Slightly below standard.
15282	Biddeford. Katherine Doyle	Well above standard.
15275	Biddeford. P. Frediani	Well above standard.
15283	Biddeford. Andrew Manter	Well above standard.
15274	Biddeford. H. L. Merrill	Well above standard.
15276	Biddeford. Morin Drug Co	Well above standard.
14381	Biddeford. James Papas	Well above standard.
15272	Biddeford. E. Partiglini	Lawful.
15280	Biddeford. Louis Pelletier	Well above standard.
15281	Biddeford. The Puritan, Jas. Papas, Prop	Well above standard.
15273	Biddeford. J. H. Seidel	Well above standard.
15279	Biddeford. George Vassill	Well above standard.
15429	Brunswick. Allen's Drug Store	Well above standard.
15432	Brunswick. J. A. Fortin	Well above standard.
15433	Brunswick. O. Fortin	Lawful.
15431	Brunswick. H. J. Given	Well above standard.
15430	Brunswick. P. J. Meserve	Well above standard.

* Explanation of terms. Lawful, just above standard. Well above standard, at least one per cent above standard. Slightly below, not more than one per cent below standard. Low, more than one per cent below standard.

Ice Cream—Continued.

Station number.	Town and Dealer.	Results of Examination.*
15434	Brunswick. Morton Bon Bon Co.	Lawful.
15223	Calais. L. Bernardini	Well above standard.
15219	Calais. A. R. Checci	Lawful.
15218	Calais. Jane Todd	Lawful.
15220	Calais. Tori Bros.	Lawful.
15196	Cherryfield. U. G. Gardner	Low.
15197	Cherryfield. W. A. Van Wort	Well above standard.
15198	Cherryfield. W. A. Van Wort	Lawful.
15245	Eastport. W. F. Capen	Well above standard.
15246	Eastport. Goulding's Restaurant	Well above standard.
15243	Eastport. Havey & Wilson	Lawful.
15244	Eastport. J. P. Hutchinson	Well above standard.
15213	Gardiner. C. H. Beane	Lawful.
15212	Gardiner. F. H. Call	Low.
15209	Gardiner. W. E. Colby	Well above standard.
15211	Gardiner. W. C. Curtis	Well above standard.
15210	Gardiner. C. W. Flynt	Low.
15214	Gardiner. R. W. Hill	Well above standard.
15410	Gorham. E. F. Carswell	Well above standard.
15408	Gorham. C. J. Pierce	Well above standard.
15409	Gorham. C. J. Pierce	Low.
15216	Hallowell. C. B. Hobbs	Well above standard.
15215	Hallowell. Guy K. White	Well above standard.
15205	Jonesport. C. N. Albee	Slightly below standard.
15207	Jonesport. Geo. A. Harmon	Well above standard.
15204	Jonesport. B. B. Mansfield	Well above standard.
15304	Kennebunk. E. A. Bodge	Well above standard.
15301	Kennebunk. J. W. Bowdoin	Well above standard.
15305	Kennebunk. W. Gilman Fiske	Lawful.
15306	Kennebunk. P. D. Greenleaf	Well above standard.
15300	Kennebunk. Jesse Ham	Low.
15302	Kennebunk. A. W. Meserve	Lawful.
15303	Kennebunk. S. M. Parrillo	Well above standard.

* Explanation of terms. Lawful, just above standard. Well above standard, at least one per cent above standard. Slightly below. not more than one per cent below standard. Low, more than one per cent below standard.

Ice Cream—Continued.

Station number.	Town and Dealer.	Results of Examination.*
15319	Kennebunkport. Mrs. F. N. Carter	Well above standard.
15318	Kennebunkport. W. F. Goodwin	Well above standard.
15321	Kennebunkport. Montgomery & Jackson	Well above standard.
15320	Kennebunkport. W. G. Wescott	Well above standard.
15154	Lewiston. H. R. Alden	Well above standard.
15181	Lewiston. P. W. Babcock	Well above standard.
15202	Lewiston. L. Beaumont	Well above standard.
15183	Lewiston. C. Bilodeau	Well above standard.
15164	Lewiston. N. Bonneau	Well above standard.
15187	Lewiston. E. Boucher	Well above standard.
15182	Lewiston. C. Bournakel	Well above standard.
15201	Lewiston. Cote & Beliveau	Well above standard.
15188	Lewiston. Mrs. E. Dubois	Lawful.
15166	Lewiston. E. Dumont	Well above standard.
15191	Lewiston. N. D. Estes	Low.
15158	Lewiston. A. L. Grant	Well above standard.
15167	Lewiston. Z. F. Guimond	Well above standard.
15185	Lewiston. A. E. Harlow	Well above standard.
15200	Lewiston. F. Huard	Well above standard.
15248	Lewiston. T. P. King & Co	Lawful.
15160	Lewiston. Kourakos Bros	Well above standard.
15157	Lewiston. S. S. Kresge	Well above standard.
15162	Lewiston. A. Leblanc	Well above standard.
15161	Lewiston. Chas. Morneau, Jr	Well above standard.
15163	Lewiston. H. Moron	Well above standard.
15189	Lewiston. Lewis Paradis	Well above standard.
15199	Lewiston. Omar Parent	Well above standard.
15155	Lewiston. Riker-Jaynes Drug Co	Well above standard.
15159	Lewiston. Warren E. Riker	Well above standard.
15190	Lewiston. T. J. Robinson	Well above standard.
15203	Lewiston. Philas A. Roy	Lawful.
15247	Lewiston. E. Simard	Well above standard.
15165	Lewiston. P. I. Simard	Well above standard.

* Explanation of terms. Lawful, just above standard. Well above standard, at least one per cent above standard. Slightly below, not more than one per cent below standard. Low, more than one per cent below standard.

Ice Cream—Continued.

Station number.	Town and Dealer.	Results of Examination.*
15184	Lewiston. S. B. Smith	Lawful.
15192	Lewiston. E. C. Teague	Well above standard.
15186	Lewiston. H. F. Walker	Well above standard.
15156	Lewiston. F. W. Woolworth & Co.	Well above standard.
15402	Lisbon. Lanio Berube	Well above standard.
15401	Lisbon. P. L. Cotton	Slightly below standard.
15403	Lisbon. A. G. Deschenes	Lawful.
15399	Lisbon Falls. A. N. Beal	Well above standard.
15398	Lisbon Falls. Kennebec Fruit Co.	Well above standard.
15396	Lisbon Falls. F. K. Small	Well above standard.
15397	Lisbon Falls. C. F. Wakeley	Well above standard.
15400	Lisbon Falls. E. H. Webber	Well above standard.
15242	Lubec. C. L. Adams	Well above standard.
15241	Lubec. Weston Baker	Well above standard.
15239	Lubec. T. G. Mitchell & Son	Well above standard.
15240	Lubec. T. E. Owen	Well above standard.
15195	Machias. R. D. Crane Drug Store	Well above standard.
15193	Machias. D. H. Curtis & Co.	Well above standard.
15194	Machias. John Farris	Slightly below standard.
15346	Madison. J. F. Belanger	Well above standard.
15345	Madison. N. Champagne	Well above standard.
15342	Madison. S. M. Curtis	Slightly below standard.
15344	Madison. E. H. Holt	Well above standard.
15347	Madison. G. F. Sylvester	Well above standard.
15343	Madison. E. W. Wright	Well above standard.
15221	Milltown. J. H. McMann	Low.
15143	Northeast Harbor. M. Abertucci	Well above standard.
15146	Northeast Harbor. A. G. Bain	Well above standard.
15145	Northeast Harbor. C. N. Small	Well above standard.
15144	Northeast Harbor. E. M. Staples	Well above standard.
15352	Oakland. Mildred Boynton	Well above standard.
15350	Oakland. S. J. Foster	Lawful.
15353	Oakland. H. H. Hatfield	Well above standard.

* Explanation of terms. Lawful, just above standard. Well above standard, at least one per cent above standard. Slightly below, not more than one per cent below standard. Low, more than one per cent below standard.

Ice Cream—Continued.

Station number.	Town and Dealer.	Results of Examination.*
15349	Oakland. C. H. Martin	Well above standard.
15351	Oakland. J. E. Morrisette	Well above standard.
15291	Old Orchard. Albert's Lunch Room, I. Krock, Prop.	Well above standard.
15292	Old Orchard. Elias F. Alkazin	Well above standard.
15295	Old Orchard. G. W. Armstrong, Dining Room & News Co	Lawful.
15289	Old Orchard. Bradbury-Bennett Co	Well above standard.
15288	Old Orchard. Carey & O'Brien	Low.
15296	Old Orchard. W. C. Child	Low.
15297	Old Orchard. Mrs. A. L. Evans	Well above standard.
15287	Old Orchard. Farrell & Bohlen	Low.
15298	Old Orchard. Ray Hass	Well above standard.
15293	Old Orchard. Rogers & Murrey	Lawful.
15290	Old Orchard. Sea Side Drug Co	Well above standard.
15294	Old Orchard. P. Victor	Slightly below standard.
15375	Portland. J. Bennett	Lawful.
15404	Portland. Chapman & Wyman	Well above standard.
15405	Portland. Chapman & Wyman	Well above standard.
14376	Portland. Deering Ice Cream Co	Well above standard.
15406	Portland. Deering Ice Cream Co	Well above standard.
15407	Portland. Deering Ice Cream Co	Well above standard.
15363	Portland. Peter Evagelos	Well above standard.
15366	Portland. Falmouth Hotel.	Low.
15372	Portland. L. C. Fowler	Well above standard.
15362	Portland. F. D. Harvey	Lawful.
14372	Portland. H. H. Hay Sons	Lawful.
153[illegible]	Portland. Heseltine & Tuttle	Well above standard.
15383	Portland. Heseltine & Tuttle	Well above standard.
15373	Portland. T. Hilton	Lawful.
15374	Portland. T. Hilton	Well above standard.
15364	Portland. Horin Bros	Low.
15379	Portland. K. Johnson	Well above standard.
15387	Portland. I. F. Lord & Son	Well above standard.

* Explanation of terms. Lawful, just above standard. Well above standard, at least one per cent above standard. Slightly below, not more than one per cent below standard. Low, more than one per cent below standard.

Ice Cream—Continued.

Station number.	Town and Dealer.	Results of Examination.*
15388	Portland. I. F. Lord & Son	Well above standard.
14368	Portland. O. S. Maxell	Well above standard.
15395	Portland. Alice Merrill	Well above standard.
15386	Portland. Morin's Lunch	Well above standard.
14369	Portland. Munjoy Ice Cream Co	Well above standard.
15358	Portland. Munjoy Ice Cream Co	Low.
15359	Portland. Munjoy Ice Cream Co	Low.
15360	Portland. J. H. Murphy	Well above standard.
15361	Portland. J. H. Murphy	Well above standard.
15393	Portland. Clifton C. Pooler	Well above standard.
15394	Portland. Clifton C. Pooler	Well above standard.
15356	Portland. G. W. Rankin	Lawful.
14371	Portland. Riker-Jaynes Co	Well above standard.
14373	Portland. George E. Sawyer	Well above standard.
15389	Portland. George E. Sawyer	Well above standard.
15390	Portland. George E. Sawyer	Well above standard.
15378	Portland. J. Serunian	Lawful.
14374	Portland. Simmons & Hammond	Lawful.
14375	Portland. Simmons & Hammond	Lawful.
15369	Portland. Simmons & Hammond	Lawful.
15370	Portland. Simmons & Hammond	Well above standard.
14367	Portland. Geo. F. Soule	Low.
14410	Portland. Geo. F. Soule	Low.
15380	Portland. Geo. F. Soule	Well above standard.
15381	Portland. Geo. F. Soule	Well above standard.
15391	Portland. A. G. Spear	Lawful.
15392	Portland. H. L. Stimson	Well above standard.
15376	Portland. C. Thomas	Slightly below standard.
15377	Portland. C. Thomas	Well above standard.
14370	Portland. John J. Thuss	Well above standard.
15384	Portland. John J. Thuss	Well above standard.
15385	Portland. John J. Thuss	Well above standard.
15365	Portland. Vonyik Cafe	Lawful.

* Explanation of terms. Lawful, just above standard. Well above standard, at least one per cent above standard. Slightly below, not more than one per cent below standard. Low, more than one per cent below standard.

Ice Cream—Continued.

Station number.	Town and Dealer.	Results of Examination.*
15357	Portland. A. A. Ward	Well above standard.
14377	Portland. West End Dairy Co	Slightly below standard.
15367	Portland. West End Dairy Co	Well above standard.
15368	Portland. West End Dairy Co	Well above standard.
15371	Portland. John Zakarian	Well above standard.
15449	Richmond. W. A. Bibber	Well above standard.
15450	Richmond. W. A. Bibber	Well above standard.
15451	Richmond. Frances R. Howe	Well above standard.
15447	Richmond. Hyman Bros	Lawful.
15448	Richmond. F. R. Winslow	Slightly below standard.
15285	Saco. W. L. Gordon	Well above standard.
15313	Sanford. Bourisk Bros	Well above standard.
15314	Sanford. Powers & Ackroyd	Well above standard.
15315	Sanford. Powers & Ackroyd	Well above standard.
15114	Sanford. N. K. Spinney	Well above standard.
15115	Sanford. N. K. Spinney	Well above standard.
15316	Sanford. N. K. Spinney	Well above standard.
15317	Sanford. N. K. Spinney	Lawful.
15335	Skowhegan. F. W. Bucknam	Well above standard.
15341	Skowhegan. Peter Dube & Co	Well above standard.
15339	Skowhegan. M. L. Greenleaf	Lawful.
15336	Skowhegan. Ned H. Lambert	Well above standard.
15340	Skowhegan. Sampson & Avore	Well above standard.
15337	Skowhegan. F. E. Sawyer	Well above standard.
15338	Skowhegan. J. D. Symons	Well above standard.
15112	Springvale. Nick Augustinos	Well above standard.
15113	Springvale. Nick Augustinos	Well above standard.
15323	Springvale. Nick Augustinos	Well above standard.
15324	Springvale. Nick Augustinos	Well above standard.
15325	Springvale. Nick Augustinos	Well above standard.
15326	Springvale. Mrs. J. J. Gibson	Lawful.
15327	Springvale. Mrs. J. J. Gibson	Well above standard.
15328	Springvale. Mrs. J. J. Gibson	Well above standard.

* Explanation of terms. Lawful, just above standard. Well above standard, at least one per cent above standard. Slightly below, not more than one per cent below standard. Low, more than one per cent below standard.

Ice Cream—Concluded.

Station number.	Town and Dealer.	Results of Examination.*
14594	Springvale. Chas. P. Rowe	Lawful.
15332	Springvale. Chas. P. Rowe	Well above standard.
15329	Springvale. M. Seferles	Well above standard.
15330	Springvale. M. Seferles	Well above standard.
15230	Waterville. R. B. Buzzell	Well above standard.
15235	Waterville. College Ave. Pharmacy	Well above standard.
15231	Waterville. J. H. DeOrsay	Well above standard.
15237	Waterville. Lewis Facos	Well above standard.
15227	Waterville. W. A. Hager & Co	Well above standard.
15228	Waterville. Mrs. M. W. Hayden	Well above standard.
15234	Waterville. E. Marchetti	Well above standard.
15226	Waterville. Joseph Noel	Well above standard.
15233	Waterville. J. D. Parents	Well above standard.
15238	Waterville. Red Cross Pharmacy	Well above standard.
15236	Waterville. The Soda Spa	Lawful.
15229	Waterville. Verzoni Bros	Well above standard.
15232	Waterville. Waterville Drug Store	Lawful.
15135	Wells Beach. John M. Davis	Lawful.
15307	Wells Beach. John M. Davis	Well above standard.
15309	Wells Beach. C. W. Goodwin & Son	Well above standard.
15311	Wells Beach. Herbert Littlefield	Well above standard.
15308	Wells Beach. L. G. Runnels	Slightly below standard.
15310	Wells Beach. A. J. Swasey	Well above standard.
15411	Westbrook. F. D. Anderson	Well above standard.
15412	Westbrook. F. D. Anderson	Well above standard.

* Explanation of terms. Lawful, just above standard. Well above standard, at least one per cent above standard. Slighly below, not more than one per cent below standard. Low, more than one per cent below standard.

April, 1916

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director.

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Official Inspections

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EXTRACTS AND SPIRITS

The Commissioner of Agriculture is the executive of the law regulating the sale of drugs and foods in Maine. It is the duty of the Director of the Maine Agricultural Experiment Station to make the analyses of the samples collected by the Commissioner, and to publish the results of the analyses together with the names of the persons from whom the samples were obtained, and such additional information as may seem advisable.

Note. All correspondence relative to the inspection laws should be addressed to the Bureau of Inspections, Department of Agriculture, Augusta, Maine.

EXTRACTS AND SPIRITS

This number of the Official Inspections contains the results of the examinations of both extracts and spirits. An extract is a food preparation and in the standards adopted for the State of Maine is defined as follows: "A flavoring extract is a solution in ethyl alcohol of proper strength, of the sapid and odorous principles derived from an aromatic plant, or parts of the plant, with or without its coloring matter, and conforms in name to the plant used in its preparation." A spirit is a medicinal preparation and is an alcoholic solution of volatile preparations formerly procured by distillation but now frequently made by simply dissolving the volatile principle in alcohol. The tabulated results of the analyses are given on pages 24 to 39 inclusive. A statement by the executive of the law is given on page 40.

Peppermint.

Spirit of peppermint (tabulated results of analyses on pages 24 and 25) is frequently called "essence of peppermint" by Maine druggists. When prepared in accordance with the United States Pharmacopoeia it carries 10 per cent of peppermint oil, 85.5 per cent of alcohol, and has a slightly greenish color from bruised peppermint leaves used in its preparation.

Extract of peppermint (tabulated results of analyses on pages 25 and 26) is prepared from oil of peppermint or from peppermint, or both, and contains not less than 3 per cent of oil of peppermint. There is no standard for the alcoholic content of the extract. Food extracts may be lawfully sold below standard strength if they are plainly labeled so as to show their quality. Below standard extracts of peppermint (tabulated results of analyses on page 27) are quite common and are probably used as a beverage by persons addicted to the use of alcoholic liquors.

Wintergreen, Checkerberry.

Spirit of gaultheria (wintergreen, checkerberry) (tabulated results of analyses on page 28) carries 5 per cent oil of gaultheria and 90 per cent of alcohol. Extract of wintergreen (tabulated results of analyses on pages 29 and 30) carries 3 per cent of oil of wintergreen, oil of birch or methyl salicylate. There is very little oil of wintergreen or oil of birch used.

Most of the spirit as well as the extract is prepared from the artificial ester. The below standard extracts of wintergreen (tabulated results of analyses on page 30) are mostly used for the same purpose as the weak extract of peppermint.

Orange and Lemon.

Extract of orange (tabulated results of analyses on page 31) is the flavoring extract prepared from oil of orange, or from orange peel, or both, and contains not less than 5 per cent of oil of orange.

Extract of lemon (tabulated results of analyses on pages 32 to 34) is prepared from oil of lemon, from lemon peel, or both, and contains not less than 5 per cent oil of lemon. Terpeneless extract of lemon (tabulated results of analyses on page 36) is the flavoring extract prepared by shaking oil of lemon with dilute alcohol or by dissolving terpeneless oil of lemon in dilute alcohol, and contains not less than 0.2 (two-tenths) per cent of citral derived from oil of lemon. The below standard extracts of lemon and the terpeneless extracts are sold as substitutes for and in competition with the pure extracts. There is no economy in their use. Their lessened flavoring value offsets the reduction in price (if any) at which they are sold.

Vanilla.

Extract of vanilla (tabulated results of analyses on pages 36 to 38) is the flavoring extract prepared from vanilla beans with or without sugar or glycerine and contains in 100 parts the soluble matters from not less than 10 parts of the vanilla bean. Imitation vanilla flavors (tabulated results of analyses on page 39) are variously compounded but for the most part depend upon coumarin or vanillin, or both, for their flavor. Unless purposely made weak these imitation products have a strong, though not pleasant, flavor. Some people prefer the flavor to the more delicate vanilla bean flavor.

Almond.

Extract of almond is prepared from oil of bitter almonds, free from hydrocyanic acid, and contains not less than one per cent of oil. Only one sample, "Baker's Pure Extract Almond" made by the Baker Extract Co., Portland, Me., and Springfield, Mass., was examined. The sample was passed as being in accord with the requirements.

Table showing the results of analyses of samples of spirit of peppermint (improperly called essence of peppermint by many Maine druggists), purchased in the fall and winter of 1915-16. Properly prepared spirit of peppermint will carry 85.5 per cent of alcohol and 10 per cent of oil of peppermint. Small deficiencies in alcohol are not reported. Samples are arranged alphabetically by towns.

Sta. No.	Name and Address of Dealer and Maker, and Brand.	Results of Analysis.
16005	Fifield & Co., Bangor. "Pure Concentrated Essence Peppermint, for nausea, fainting, etc. Oil 3 per cent. Alcohol 60 per cent."	Somewhat lower than claimed in both oil and alcohol. Improperly labeled.
15989	Fowler Drug Co., Bangor. "Essence Peppermint."	Practically up to standard.
15991	Louis H. Ham, Bangor. "Essence Peppermint."	Practically up to standard.
15986	Houlihan's Pharmacy, Bangor. "Essence Peppermint."	Up to standard. Passed.
16000	Hinckley's Pharmacy, Brewer. "Essence Peppermint."	Practically up to standard.
15696	M. Parent, Brunswick. "Dill's Essence of Peppermint. The Dill Medicine Co., Norristown, Pa."	Practically up to standard.
15515	W. R. Ward, China. "Harris' Pure Extract Peppermint. Frank E. Harris Co., Binghampton, N. Y."	Up to standard. Passed.
16157	L. K. Paine, Cumberland Mills. "Essence Peppermint."	Ninety-two per cent of standard.
16028	E. A. Brewster & Son Co., Dexter. "Essence Peppermint."	Ninety-two per cent of standard
15938	Clark & Varney, Fairfield. "Sauer's Pure Extract Peppermint. The C. F. Sauer Co., Richmond, Va."	Considerably above standard.
15614	Napoleon Bolduc, Lewiston. "Dill's Extract of Peppermint. The Dill Medicine Co., Norristown, Pa."	Up to standard. Passed.
15680	L. D. Hudon, Lisbon. "Dill's Essence Peppermint. The Dill Medicine Co., Norristown, Pa."	Up to standard. Passed.
15683	F. E. Jordan, Lisbon. "Sauer's Pure Extract Peppermint. C. F. Sauer Co., Richmond, Va."	Up to standard. Passed.
16031	E. W. Wright, Madison. "Essence Peppermint."	Up to standard. Passed.
16150	Deering Drug Co., Morrill's Corner. "Essence Peppermint.".	Half standard strength. Adulterated.
16041	Geo. M. Barrows, Newport. "Essence Peppermint."	Up to standard. Passed.
16040	Jones & McKenney, Newport. "Essence of peppermint."	Eighty-two per cent standard strength. Adulterated.
12925	Seaside Drug Co., Old Orchard. "Essence of Peppermint."	Nine-tenths standard strength. Adulterated.
16004	H. M. Burnham, Old Town. "Essence Peppermint."	Practically up to standard.

Spirit of Peppermint—Concluded.

Sta. No.	Name and Address of Dealer and Maker, and Brand.	Results of Analysis.
16030	Pittsfield Drug Store, Pittsfield. "Essence Peppermint."	Up to standard. Passed.
16153	S. B. Gamage, Portland. "Essence Peppermint."	Up to standard. Passed.
16149	Frank L. Winship, Portland. "Essence of Peppermint."	Fifty-five per cent of standard strength. Adulterated.
16019	G. R. Fogg, Skowhegan. "Essence Peppermint."	Up to standard. Passed.
13562	A. L. Hoyt, South Windham. "Essence of Peppermint."	Fifty-six per cent of standard strength. Adulterated.
16023	College Ave. Pharmacy, Waterville. "Essence Peppermint."	Practically up to standard.
16043	Geo. A. Daviau, Waterville. "Spirits Peppermint."	Up to standard. Passed.
16026	J. H. DeOrsay, Waterville. "Essence Peppermint."	Up to standard. Passed.
16042	Farland's Drug Store, Waterville. "Essence Peppermint."	Ninety-six per cent standard strength.
16013	Red Cross Pharmacy, Waterville. "Spirits Peppermint."	Up to standard. Passed.
16014	Waterville Drug Store, Waterville. "Essence Peppermint."	Up to standard. Passed.
16155	West End Drug Co., Westbrook. "Essence Peppermint."	Practically up to standard.

Table showing the results of analysis of samples of extract of peppermint, purchased in the fall and winter of 1915-16. Extract of peppermint, prepared as a food product, will carry 3 per cent of oil of peppermint. The samples are arranged alphabetically by maker.

Sta. No.	Dealer and Town.	Maker and Brand.	Results of Analysis.
15597	A. W. Miller, Auburn.	Baker Extract Co., Springfield, Mass. and Portland Me. "Baker's Pure Essence Peppermint."	All four samples up to standard. Passed.
15667	H. A. Ward, Auburn.		
15689	E. M. Alexander, Brunswick.		
15972	F. E. McCallum, Waterville.		
15534	Geo. B. McDonald, Alna.	Cook, Everett & Pennell, Portland. "Extract of Peppermint." On carton "Essence Pure."	Above standard. Passed.

Extract of Peppermint—Concluded.

Sta. No.	Dealer and Town.	Maker and Brand.	Results of Analysis.
15867 15912 15920	Direct Importing Co., Gardiner. Direct Importing Co., Skowhegan. L. H. White, Norridgewock.	Direct Importing Co., Boston, Mass. "Benefit Brand Pure Peppermint"	One sample slightly below. Other two samples slightly above standard.
15632	Grand Union Tea Co., Lewiston.	Grand Union Tea Co., Brooklyn, N. Y. "Extract Peppermint."	Up to standard. Passed.
15592	Great Atlantic & Pacific Tea Co., Auburn.	Great Atlantic & Pacific Tea Co., Jersey City, N. J. "A. & P. Peppermint for flavoring."	Above standard. Passed.
15596 15605 15612 15616 15884	L. Labarge, Auburn. Flaven Bedard, Auburn. Edmond Verrille, Lewiston. LeBlond Bros., Lewiston. E. B. Foster, Augusta.	Frank E. Harris Co., Binghampton, N. Y. "Good Value Extract Pure Peppermint."	One sample slightly below; others above standard.
15898	Edmond Doyon, Augusta.	W. O. Pitcher, Portland. "Pure Extract Peppermint."	Ninety per cent standard strength. Adulterated.
15669	J. W. Jordan, Auburn.	Schlotterbeck & Foss Co., Portland. "Foss Pure Extract Peppermint."	Above standard. Passed
15917	S. F. Waldron, Madison.	Thurston & Kingsbury, Bangor. "T. & K. Extract peppermint."	Above standard. Passed.
15520	E. M. Moody, Palermo.	Twitchell-Champlin Co., Portland. "Hatchet Brand Flavoring Extract Peppermint."	Up to standard. Passed.
15900	Patnaude & Sons, Augusta.	Van Duzer Extract Co., New York and Springfield, Mass. "Worth Brand Extract Peppermint."	Up to standard. Passed.
15688	Fred Heisterman, Lisbon Falls.	C. A. Weston Co., Portland "Solar Brand Pure Peppermint Extract."	The oil up to standard. Contents were not given upon the bottle. Looked as though it might hold 3 ounces, but held 7-8 of an ounce. Apparently an intentional deception.
15832	Sanford Cooperative Assoc. Sanford.	Williams & Carleton Co., Hartford, Conn. "Williams Pure Extract Peppermint."	Ninety per cent standard strength. Adulterated.
15895	L. S. Young, Augusta.	Nathan Wood & Son, Portland. "Colonial Brand Extract of Peppermint."	Eighty-five per cent of standard strength. Adulterated.
16007	F. D. Wyman, Bangor.	F. D. Wyman, Bangor. "Extract Peppermint for flavoring purposes."	Above standard. Passed.

Table showing the results of analyses of below standard extracts of peppermint purchased in the fall and winter of 1915-16. Low grade goods can be lawfully sold if properly labeled to show their exact strength. Samples are arranged alphabetically by maker.

Sta. No.	Dealer and Town.	Maker and Brand.	Results of Analysis.
15956	Burgoin Bros., Waterville.	Cole Extract Co., So. Portland. "Cole's Maine Brand Essence of Peppermint. One-half standard strength."	Not quite half standard strength.
15882 16037	Pomerleau & Huard, Augusta. Farwell Bros., Thorndike.	Cook, Everett & Pennell, Portland. "Extract Peppermint. One-half standard strength."	One sample slightly below and one slightly above half standard strength.
15692	C. A. Lemieux, Brunswick.	Chas. Crompton & Sons, Lynn, Mass. "Crompton's Bay State Brand Extract Peppermint. One-half standard."	Up to standard strength.
15959	Geo. A. Daviau, Waterville.	Geo. A. Daviau, Waterville. "Essence of peppermint. Under standard strength. For nausea, fainting, etc."	One-third food strength, one-tenth medicinal strength. Not properly branded to show strength.
15525	Achorn Bros., Coopers Mills	E. Hartshorn & Sons, Boston. "Clark Peppermint. Contains 1.5% oil of peppermint (half strength)"	Considerably less than half strength.
15888	G. D. Haskell & Son, Augusta.	R. G. Leighton, Portland. "Rigby's Extract Peppermint. Half Strength"	Less than one-third strength.
15615	Marcotte-Cote & Co., Lewiston.	Ocean Mills Co., Boston, Mass. "Essence of Peppermint. Oil of peppermint 1.5 per cent (one-half strength)."	One-fifth standard strength. Misbranded and adulterated.
16232	W. L. Helms, Hallowell.	W. T. Rawleigh Medical Co., Freeport, Ill. "Rawleigh's Peppermint Flavor. One-third standard strength."	One-third standard strength.
15940	W. W. Nye & Co., Fairfield.	T. R. Savage Co., Bangor. "Clifford Brand Extract Peppermint. One-fifth standard strength."	Contains only a trace of oil. Misbranded and adulterated.
15537 15604 15675 15948 15951	E. A. McIntire, Sheepscot. A. Bernard, Auburn. Fred W. R. Vickery, Auburn. G. P. Boynton, Oakland. L. M. Walman, Waterville.	Schlotterbeck & Foss Co., Portland. "Hall Brand Extract Peppermint. One-fifth standard strength."	One sample one-seventh standard strength. Other samples one-fifth standard strength.
15965	E. F. Cote, Waterville.	Twitchell-Champlin Co., Portland. "Gilt Edge Brand Peppermint. One-third standard strength."	About one-fourth standard strength.

Table showing the results of analyses of samples of spirit of gaultheria (improperly called essence of checkerberry by Maine druggists) purchased in the fall and winter of 1915-16. Properly prepared spirit of gaultheria will carry 90 per cent alcohol and 5 per cent of oil. Small deficiencies in alcohol are not reported. Samples are arranged alphabetically by towns.

Sta. No.	Name and Address of Dealer and Maker, and Brand.	Results of Analysis.
16033	F. A. Manter, Anson. "Essence of Checkerberry."	Up to standard. Passed.
15600	A. Beaucage, Auburn. "Dr. Dill's Essence Wintergreen," The Dill Medicine Co., Norristown, Pa.	Up to standard. Passed.
15878	Merrill Bros., Augusta. "Burnett's Essence Wintergreen. Joseph Burnett & Co., Boston."	Up to standard. Passed.
15894	A. L. Rose, Augusta. "Slade's Essence Cneckerberry. D. & L. Slade Co., Boston."	Up to standard. Passed.
15988	B. H. Burke, Bangor. "Essence of Checkerberry."	Above standard. Passed.
15990	Caldwell Sweet Co., Bangor. "EssenceCheckerberry."	Up to standard. Passed.
15995	Ara Warren, Bangor. "Essence Checkerberry."	Ninety-two per cent of standard.
16034	Old Corner Drug Store, Belfast. "Essence Checkerberry."	Ninety-two per cent of standard.
15999	Boynton's Pharmacy, Brewer. "Essence Checkerberry. Below standard."	Practically up to standard. Passed.
16158	King S. Raymond, Cumberland Mills. "Essence Checkerberry."	Low in oil and alcohol. Misbranded and adulterated.
16027	A. L. Davis, Dexter. "Essence Checkerberry."	Up to standard. Passed.
16010	E. H. Nickerson, Foxcroft. "Spirit Gaultheria."	Practically up to standard. Passed.
16032	Madison Pharmacy, Madison. "Essence of Checkerberry."	Up to standard. Passed.
16003	Mutty's Pharmacy, Old Town. "Essence Checkerberry."	Practically up to standard. Passed.
16029	Libby's Pharmacy, Pittsfield. "Essence Checkerberry."	Up to standard. Passed.
16152	V. D. Coombs & Son, Portland. "Essence Checkerberry."	Up to standard. Passed.
16151	O. J. & F. R. Pride, Portland. "Essence Checkerberry."	Up to standard. Passed.
16020	Frank W. Bucknam, Skowhegan. "Essence Checkerberry."	Practically up to standard. Passed.
16036	C. B. Mitchell, Unity. "Extract of Wintergreen."	Ninety-two per cent of standard.
16154	Chapman & Wyman, Woodfords. "Essence Checkerberry."	Up to standard. Passed.
16148	John M. Stevens, Woodfords. "Essence of Checkerberry."	Ninety-three per cent of standard.

Table showing the results of analyses of samples of extract of wintergreen (checkerberry) purchased in the fall and winter of 1915-16. Extract of checkerberry, prepared as a food product, will carry 3 per cent of oil of wintergreen. The samples are arranged alphabetically by makers.

Sta. No.	Dealer and Town.	Maker and Brand.	Results of Analysis.
15676	M. W. Robinson, Auburn	Atlantic Spice Co., Rockland. "Three Crow Brand. Above standard."	Above standard. Passed.
15658	Cash Market Co., Gardiner	Baker Extract Co., Portland, Me., and Springfield, Mass. "Baker's Pure Essence Checkerberry for flavoring."	Goods run very uneven in oil of wintergreen, containing from 2.6 to 4.6 per cent of oil. All samples except one above standard.
15672	S. L. Andrews, Auburn.		
15855	Bucknam & Stickney, Hallowell.		
15885	A. M. Brown, Augusta.		
15904	Mready & White, Randolph.		
15911	C. W. Day, Skowhegan.		
15967	S. E. Whitcomb Co., Waterville.		
15530	Cash Grain Co., No. Whitefield.	Cook, Everett & Pennell, Portland. "Extract Wintergreen."	Low in oil. Misbranded and adulterated.
15533	J. A. Jewett, Head Tide.	Cook, Everett & Pennell, Portland. "Extract of Checkerberry."	Above standard. Passed.
15617	Paradis & Baisvert, Lewiston.	Dill Medicine Co., Norristown, Pa. "Dill Essence Wintergreen."	Above standard in oil.
15629	J. Bowker, Lewiston....	Henry W. Goodwin & Co., Springfield, Mass. "Forest City Flavoring Extract Checkerberry."	Above standard. Passed.
15872	H.E. Sheridan, Sabattus.		
15634	Grand Union Tea Co., Lewiston.	Grand Union Tea Co., Brooklyn, N. Y. "Grand Union Extract Wintergreen."	Above standard. Passed.
15595	O. H. Olfene, Auburn...	Frank E. Harris Co., Binghampton, N. Y. Two brands "Harris Pure Extract Wintergreen" and "Good Value Extract Pure Wintergreen".	Above standard. Passed.
15599	Ovila Vincent, Auburn		
15652	A.F.Armstrong,Waterville.		
15861	D. C. Burr, Gardiner.		
15866	W. G. Burtt, Gardiner.		
15887	F. A. Howard, Augusta.		
15958	O. J. Pelletier, Waterville.		
15871	G. H. Cates, E. Vassalboro.	John W. Perkins Co., Portland. "Perkins' Pure Essence Checkerberry."	Low in oil. Adulterated and misbranded.
15677	O. J. Vermette, Lewisnto.	Stickney & Poor Spice Co., Boston, Mass. "Stickney & Poor's Best Checkerberry."	Above standard. Passed.
16038	Peter Harmon & Son Thorndike.		
15666	Spear & Webster, Lewiston.	Schlotterbeck & Foss Co., Portland. "Foss Pure Extract Checkerberry."	Above standard. Passed.
15859	D. C. Skillin, Hallowell		
15949	W. A. Goodwin & Son, Oakland.		

Extract of Wintergreen—Concluded.

Sta. No.	Dealer and Town.	Maker and Brand.	Results of Analysis.
15519	F. A. Doe, Palermo.....	Thurston & Kingsbury, Bangor. "T. & K. Extract Wintergreen."	Oil content uneven. 3.8 to 8.6 per cent oil. All above standard. Passed
15535	Mrs. W. W. Hilton, Alna.		
15852	Smith & Purington, Hallowell.		
15918	Brackett & Russell, Norridgewock.		
15942	W. C. Hayes, Fairfield.		
15916	Stanley Renier, Madison..	N. Wood & Son, Portland. "Essence Checkerberry for flavoring."	Above standard. Passed.

Table showing the results of analyses of below standard extracts of wintergreen (checkerberry) purchased in the fall and winter of 1915-16. Low grade goods can be lawfully sold if properly labeled to show their exact strength. The samples are arranged alphabetically by makers.

Sta. No.	Dealer and Town.	Maker and Brand.	Results of Analysis.
15686	A. O. White, Lisbon Falls.	Cole Extract Co., So. Portland. "Cole's Maine Brand Extract Wintergreen. ' One-half standard strength."	Slightly low in oil.
15526	P. E. Chancy, Whitefield.	Dolan & Furnival Co., Portland. "Daval Brand Checkerberry. One-sixth standard strength."	A fifth low in oil.
15868	W. A. Lord, N. Vassalboro.	E. Hartshorn & Sons, Boston, Mass. "Kidder Brand Checkerberry. Oil checkerberry 1.5 per cent."	Slightly low in oil.
15618	C. H. Cloutier & Co., Lewiston.	John W. Perkins Co., Portland. "Diaz Essence Checkerberry." On bottle "The best goods far above standard." On carton "Below standard."	Less than one per cent oil. Misbranded and adulterated.
15607	H. A. Smith, Lewiston...	Schlotterbeck & Foss(name not given on label), Portland. "Hall Biand Extract Checkerberry. One-fifth standard strength."	All samples above claimed content.Passed
15678	Golder & McCarthy, Lewiston.		
15864	D. C. Jewell, Gardiner.		
15953	Harry Pomerleau, Waterville.		
15849	C. T. Richardson, Brunswick.	Twitchell-Champlin Co., Portland. "Gilt Edge Brand Checkerberry.One third standard strength.	Oil as claimed. Passed.

Table showing the results of analyses of samples of extract of orange purchased in the fall and winter of 1915-16. Extract of orange is a food product and carries 5 per cent of oil of orange. Samples are arranged alphabetically by makers.

Sta. No.	Dealer and Town.	Maker and Brand.	Results of Analysis.
15514 15657 15668 15865 15892 15919 15944 15950 15955	Libby Bros., Albion..... R. E. & W. G. Manson, Gardiner............ Doe & Goss, Auburn.... J.D.Stephenson,Gardiner Edson Locke, Augusta. Lockwood & Smith, Norridgewock G. A. Savage, Fairfield Manson Libby, Oakland E. L. Gove, Waterville	Baker Extract Co., Springfield, Mass. and Portland Me. "Baker's Pure Extract Orange."	About two-fifths above standard strength. Passed.
15625	A. S. Cote, Lewiston......	John Bird Co., Rockland. "Three Crow Brand Extract Orange."	Up to standard. Passed.
15578 15695	R. J. Wiseman, Lewiston P. A. Morin, Brunswick.	Cook, Everett & Pennell, Portland. "Concentrated Extract of Orange."	Three-fifths standard strength. Misbranded and adulterated.
15624 15829	F. J. Ouellette, Lewiston C.L.Baston, No. Berwick	Chas. Crompton & Sons, Lynn, Mass. "Crompton's Pure Orange."	One sample a sixth below standard and one sample nearly up to standard strength.
15598 15609 15619 15909 15961	D. J. Sullivan, Auburn.. Miss Florida Morency, Lewiston. I.Simard & Sons,Lewiston John F. Currier, Skowhegan John Pilotte, Waterville.	The Dill Medicine Co.,Norristown, Pa. "Dill's Extract of Orange."	Two samples very slightly below and others up to standard.
15588	Direct Importing Co., Auburn.	Direct Importing Co., Boston, Mass. "Benefit Brand Pure Orange Extract."	Up to standard. Passed.
15628	Begin Bros., Lewiston.....	Pettingill Co., Portland. "10c. size P-C Brand Pure Flavoring Extract Orange."	Forty per cent above standard. Passed.
16233	W. L. Helms, Hallowell...	W. T. Rawleigh Medical Co., Freeport, Ill. "Rawleigh's Extract of Orange."	Up to standard. Passed.
15586	Riker-Jaynes Co.,Lewiston	W. B. Riker & Son Co.,New York. "Riker's True Extract Orange."	About half standard strength. Adulterated
15594 15914	West M. Dunn, Auburn S. W. Gould, Skowhegan	The C. F. Sauer Co., Richmond, Va. "Sauer's Pure Extract Orange."	Both samples above standard. Passed.
15621 15879 15939 15969	Guimond Simard, Lewiston. E. W. Church, Augusta. Frank E. Hammond, Fairfield. A. F. Armstrong, Waterville.	Schlotterbeck & Foss Co., Portland. "Foss Pure Extract Orange."	About forty per cent above standard strength. Passed.
15850	Marchant Epicier, Brunswick.	Stickney & Poor Spice Co., Boston, Mass. "Orange Extract."	Up to standard. Passed.
15902	F. M. Mooers, Randolph..	Twitchell-Champlin Co., Portland. "Hatchet Flavoring Extract Orange."	Up to standard. Passed.

Table showing the results of analyses of samples of extract of lemon purchased in the fall and winter of 1915-16. Extract of lemon prepared as a food product will carry 5 per cent of oil of lemon. The samples are arranged alphabetically by makers.

Sta. No.	Dealer and Town.	Maker and Brand.	Results of Analysis.
15589 15671	Damon & Cole, Auburn C. F. Burleigh, Auburn.	Atlantic Spice Co., Rockland. "Three Crow Brand Extract Lemon. Above standard."	Both samples slightly below standard. Misbranded.
15524 15531 15561 15601 15627 15656 15681 15857 15932	James R. Abbott, Cooper's Mills. Mrs. L. T. Hodgkins, No. Whitefield. Baker's Market, York Village. E. Z. Reny, Auburn. Geo.E.Roberge,Lewiston. A.W.Cunningham & Co., Gardiner. LeClair Bros., Lisbon. W. H. Bruce, Hallowell. Geo. H. Philbrook, Portland.	Baker Extract Co., Springfield, Mass. and Portland Me. "Baker's Pure Extract Lemon."	Above standard. Passed.
15954	Knowlton & Russell, Waterville.	Baker Extract Co., Springfield, Mass. and Portland Me. "Forest City Brand Lemon."	Up to standard. Passed.
15905	W. L. Moody, Randolph.	Baker Extract Co., Springfield, Mass. and Portland Me. "Imperial Pure Extract of Lemon."	Above standard. Passed.
15811 15854 15971	Geo.C.ShawCo.,Portland, C. A. Cole, Hallowell. B.K.Meservey,Waterville	Joseph Burnett Co., Boston, Mass. "Burnett's Extract Lemon."	All samples nearly double standard strength. Passed.
15952	Wm. Lacombe, Waterville.	The A. Colburn Co., Philadelphia, Pa. "Mayflower Extract Pure Lemon."	Up to standard. Passed.
15883	Casavant & Cloutier, Augusta.	Cook, Everett & Pennell, Portland. "Extract Lemon."	Above standard strength. Passed.
15513 15626 15873 15891 15915	E. J. Crosby, Albion. Nadeau & Michaud, Lewiston. W. F. Huen, Sabattus. J. A. Folsom, Augusta. Madison Union Co-op. Store, Madison.	The Dill Medicine Co., Norristown, Pa. "Dill's Pure Extract Lemon, for flavoring."	One sample slightly below; other samples up to or above guaranty.
15701	Direct ImportingCo.,Brunswick.	Direct Importing Co., Boston, Mass. "Benefit Brand Pure Lemon Extract."	Up to standard. Passed.
15831	Sanford CooperativeAssoc., Sanford.	Dolan & Furnival Co., Portland."McAndrews Brand Colored Lemon Flavor."	One-eighth below standard strength.
15685	Cooperative Assoc., Lisbon Falls.	Prepared at 27 & 29 Hampden St., Springfield, Mass. "Coburn's Pure Extract of Lemon."	Up to standard. Passed.

Extract of Lemon—Continued.

Sta. No.	Dealer and Town.	Maker and Brand.	Results of Analysis.
15536	A. R. Leighton, Sheepscot.	Henry W. Goodwin & Co., Springfield, Mass. "Forest City Brand Pure Flavoring Extract Lemon."	Up to standard. Passed.
15633	Grand Union Tea Co., Lewiston.	Grand Union Tea Co., Brooklyn, N. Y. "Grand Union Extract Lemon."	Up to standard. Passed.
15670 15856 15876 15973	E. A. Bickford, Auburn. JohnF. Quinn, Hallowell. W. F. Turner, Augusta. Hersom & Bonsall, Waterville.	Frank E. Harris Co., Binghampton, N. Y. "Good Value Extract PureLemon."	All samples up to standard. Passed.
15651 15673	A. F. Armstrong, Waterville. E. H. Brooks, Auburn.	Frank E. Harris Co., Binghampton, N. Y. "Harris' Pure Extract Lemon. Extra strength and superior quality."	Fifty per cent above standard strength. Passed.
15833	Sanford Cooperative Assoc., Sanford.	Hartford Extract Co., Hatrford, Conn. "Charter Oak Brand PureLemon."	Up to standard. Passed.
15860	E. E. Lancaster, Gardiner.	E. Hartshorn & Sons, Boston, Mass. "Hartshorn's Pure Extract Lemon."	Above standard.Passed.
15838	H. H. Hay Sons, Portland.	H. H. Hay Sons, Portland. "Concentrated Extract of Lemon."	Up to standard. Not "concentrated."Label misleading.
15881	G. W. Wadleigh, Augusta.	R. G. Leighton, Portland. "Leighton's Pure Extract Lemon."	Up to standard. Passed.
15662	Mohican Co., Lewiston.	Packed for the Mohican Co. U. S. A. "Mohican Pure Extract of Lemon."	Two-thirds standar strength. Adulterated and misbranded.
15836	S. D. Hanson, Springvale.	Moshier Bros., Ashland, Mass. "Moshier's Absolutely Pure Lemon Extract."	Above standard. Passed.
15582	R. F. Burnham, Auburn.	Parke, Davis & Co., Detroit, Mich. "Tincture of Lemon. Principally used for flavoring purposes."	Two-fifths standard strength. Misbranded and adulterated.
15583 15602	J. Phenix, Auburn. Pierre Nadeau, Auburn.	Joseph Phenix, Auburn. "Essence Lemon, for flavoring"	One-eighth below standard strength.
15690 15957	A. I. Snow, Brunswick. Gideon Mahew, Waterville.	W. O. Pitcher, Portland. "Pure Extract Lemon."	Practically up to standard.
16231	W. L. Helms, Hallowell.	The W. T. Rawleigh Medical Co., Freeport, Ill. "Rawleigh's Extract Lemon."	Up to standard. Passed.
15584	Riker-Jaynes Co., Lewiston.	Riker-Hegerman, NewYork Riker's True Extract Lemon."	Up to standard. Passed.

Extract of Lemon—Concluded.

Sta. No.	Dealer and Town.	Maker and Brand.	Results of Analysis.
15931 15947	Geo. H. Philbrook, Portland A. H. Oliver, Oakland.	The C. F. Sauer Co., Richmond, Va. "Sauer's Pure Extract Lemon."	One sample little above; one sample nearly double standard strength. Passed.
15518 15559 15606 15930	DinsmoreGrainCo.,Palermo. C. M. Prince & Son, Kittery. J. F. Eaton, Auburn. Geo.H. Philbrook, Portland.	Schlotterbeck & Foss Co., Portland. "Foss Pure Extract Lemon."	Nearly double standard strength. Passed.
15837	Simmons & Hammond, Portland.	Simmons & Hammond, Portland. "Extract of Lemon."	Above standard strength Passed.
15827 15893	O. H. & F. W. Johnson, No. Berwick. Webber & Hewett, Augusta.	D. & L. Slade Co., Boston, Mass. "Slade's Absolutely Pure Extract Lemon."	One sample little above, other sample nearly double standard strength. Passed.
15839	Smith & Broe, Portland.	Smith & Broe, Portland. "Essence of Lemon."	Up to standard. Passed.
15558 15698 15903	Kittery Grocery, Kittery. C. A. Pierce & Son, Brunswick. L. A. Perry, Randolph.	Stickney & Poor Spice Co., Boston, Mass. "Pure Lemon Extract."	Up to standard. Passed.
15853 15908	Clement Bros., Hallowell. A. R. Jewett, Skowhegan.	Thurston & Kingsbury, Bangor. "T. & K. Extract Lemon."	One sample three-fifths standard strength. Adulterated and misbranded. One sample above standard passed
15924	W. C. Remick, Springvale.	F. C. Tibbetts Mercantile Co., Portland. "Lemon Fruit S-ent-S. Flavor, Strength, Quality and Purity Fully Guaranteed. Use only two-thirds the quantity you use of other flavorings."	Below standard strength. Misbranded and adulterated.
15523 15529	P. G. Brown, Week's Mills. E. M. Hilton, N. Whitefield.	Twitchell-Champlin Co., Portland. "Hatchet Brand Lemon Extract."	Up to standard. Passed.
15653 15659	Elmer L. Craig, Waterville. F. L. Clark, Gardiner.	Van Duzer Extract Co., New York. "Van Duzer's Standard Quality Lemon Extract."	One-fourth above standard. Passed.
15687 15694	Bichrest & Marchak, Lis-bon Falls. E. D. Morin, Brunswick.	C. A. Weston Co., Portland "Solar Brand Pure Lemon Extract."	Up to standard. Passed.
15812	Geo. C. Shaw Co., Portland	Nathan Wood & Sons, Portland. "Colonial Brand Extract of Lemon. Excellent strength and finest flavor."	Just up to standard. Passed.
15936	W. C. Haggett, Portland.	Nathan Wood & Sons, Portland. "10 cent size P-C Brand Pure Flavoring Extract Lemon."	One-fourth above standard strength. Passed.
15889	H. D. Cooper, Augusta.	Worth Extract Co., New York. "Worth's Pure Lemon."	Up to standard. Passed.

Table showing results of the analysis of below standard extracts of lemon purchased in the fall and winter of 1915-16. Low grade goods can be lawfully sold if properly labeled to show their exact strength. Samples arranged alphabetically by makers.

Sta. No.	Dealer and Town.	Maker and Brand.	Results of Analysis.
15521 15913	J. W. Segee, Week's Mills. H. S. Hubbard Co., Skowhegan.	Atlantic Spice Co., Rockland. "Harris Brand Extract Lemon. Below Standard."	About one-fifth standard. Improperly labeled in that label did not show exact strength claims.
15863	C. M. Day, Gardiner.....	Cole Extract Co., So. Portland. "Cole's Maine Brand Lemon Flavor." On carton "Two-fifths standard."	Contained only a trac. of lemon oil.
15806	A. C. Partridge, Portland	Cook, Everett & Pennell, Portland. "Concentrated Extract Lemon. One-half standard strength."	Contained only a trace of oil. Misbranded and adulterated.
159 6	0Arthur Daviau,Waterville.	Daviau RedCross Pharmacy, Waterville. "Spirits Lemon. Not U. S. P."	Contained not much more than a trace of oil. Misbranded.
15590 15661 15840	A. M. Penley & Son, Auburn. PalermoMarket,Lewiston L.A.Mercier Co.,Portland	R. G. Leighton, Portland. "Rigby Extract of Lemon. One-half strength."	Contained practically no oil. Misbranded and adulterated.
15693	F. C. Webb, Brunswick...	John W. Perkins Co., Portland. "Diaz Essence Lemon." On carton "Below standard."	One-fifth standard strength. Not properly labeled to show strength."
15907	J. F. Pooler, Skowhegan..	G. L. McCurdy, Waterville. "Extract of Lemon. Below standard in amount of oil and alcohol."	Two-fifths standard strength. Not properly labeled to show strength.
15611 15679 15941	A. J. Auger, Lewiston.. A. J. Berube, Lisbon.... David King, Fairfield...	Schlotterbeck & Foss Co., Portland. "Hall Brand Extract Lemon. One-sixth standard strength."	Up to claimed strength.
15962	Reny&Veilleux, Waterv l e	Thurston &Kingsbury,Bangor. "Daisy Extract Lemon. Below standard strength."	One-tenth standard strength. Not properly labeled to show strength.
15630	Lewiston Cash Market, Lewiston.	Twitchell-Champlin Co., Portland. "Gilt Edge Brand Lemon. One-fifth standard strength."	Up to claimed strength.
15851	Tondreau Bros., Brunswick	Prepared at 27 & 29 Hampden St., Springfield, Mass. "Webber Brand Below Standard Lemon. Contains 4 minims 60% alcohol.".	One-fifth standard strength. Not properly labeled, to show strength.

Table showing the results of analyses of samples of terpeneless (imitation) extract of lemon, purchased in the fall and winter of 1915-16. Terpeneless extract of lemon contains not less than two-tenths per cent of citral derived from oil of lemon. Samples arranged alphabetically by makers.

Sta. No.	Dealer and Town.	Maker and Brand.	Results of Analysis.
15610	D. Mousette & Bro., Lewiston.	Anchor Mills Co., Charlestown, Mass. "Imperial Imitation Lemon Flavoring Compound."	Low in citral.
15608 15835	John J. Dunn, Lewiston. Rowe & Bartlett, Springvale.	The C. E. Brewster Co., Dover, N. H. "Brewster's Terpeneless Extract Lemon."	Low in citral.
15807	J. E. Libby, Portland.....	Dolan & Furnival Co., Portland. "Doval Brand Imitation FlavorLemon"	Contained very little citral.
15901	David Giroux, Augusta....	The R. T. French Co., Rochester, N. Y. "French's Terpeneless Extract of Lemon."	Low in citral.
15834	F. Broggi, Sanford........	Henry W. Goodwin & Son, Springfield, Mass. "Royal Star Brand Imitation Lemon Flavoring."	Very low in citral.
15943	Wm. Seltzer, Fairfield.....	Purity Drug Co., Lawrence, Mass. "Purity Lemon Flavoring Compound."	Contained very little citral.

Table showing the results of analysis of samples of extract of vanilla collected in the fall and winter of 1915-16 and passed by the chemists as pure vanilla extracts. Samples arranged alphabetically by names of makers.

Station number	Maker, Brand, Name and Address of Dealer, and Remarks.
15825	Allen's Drug Store. Brunswick, Me. "H. K. Wampole Extract of Vanilla." Allen's Drug Store, Brunswick.
15874	Anchor Mills Co., Charlestown, Mass. "Anchor Brand Pure Vanilla Extract," D. A. Wheeler, Sabattus.
15527	Atlantic Spice Co., Rockland, Me. "Three Crow Brand Extract Vanilla.' E. H. Allen, Whitefield.
15664	Atlantic Spice Co., Rockland, Me. "Three Crow Brand Extract Vanilla.' A. D. Morse, Lewiston.
15631	Baker Extract Co., Springfield, Mass. and Portland, Me. "Baker's Pure Extract Vanilla." Atwood Market, Lewiston. Rather weak in vanillin.
15682	Baker Extract Co., Springfield, Mass. and Portland, Me. "Baker's Pure Extract Vanilla." J. W. Blanchette, Lisbon.

Extract of Vanilla—Continued.

Station number	Maker, Brand, Name and Address of Dealer and Remarks.
15828	Baker Extract Co., Springfield, Mass. and Portland Me. "Baker's Pure Extract Vanilla." E. E. Snow, North Berwick.
15897	Baker Extract Co., Springfield, Mass. and Portland, Me. "Baker's Pure Extract Vanilla." Worthing & Parmentor, Augusta.
15700	Baker Extract Co., Springfield, Mass. and Portland, Me. "Forest City Brand Vanilla." S. A. Walker, Brunswick. Weak in vanillin.
15516	Joseph Burnett & Co., Boston, Mass. "Burnett's Extract of Vanilla."G. F. Rowe, China.
15560	Joseph Burnett & Co., Boston, Mass. "Burnett's Extract of Vanilla." Preble Market, York Village.
15623	Joseph Burnett & Co., Boston, Mass. "Burnett's Extract of Vanilla." D. E. Parlin, Lewiston.
15697	Joseph Burnett & Co., Boston, Mass. "Burnett's Extract of Vanilla." Tondreau Bros. Co., Brunswick.
15577	Burroughs Bros. Mfg. Co., Baltimore, Md. "Burrough's U. S. P. Flavoring Extracts, Tincture Vanilla." Nationale Pharmacie, Lewiston.
15580	Cook, Everett & Pennell, Portland, Me. "Concentrated Extract of Vanilla." Franco American Pharmacy, Lewiston.
15620	Dill Medicine Co., Norristown, Pa. "Dill's Absolutely Pure Extract Vanilla." Oscar Roger, Lewiston.
15532	Direct Importing Co., Boston, Mass. "Benefit Brand Pure Vanilla Extract." F. E. Douglass, No. Whitefield.
15636	Direct Importing Co., Boston, Mass. "Benefit Brand Pure Vanilla Extract." Direct Importing Co., Lewiston. Weak in vanillin.
15822	D. T. Dougherty, Bath, Me. "Extract Vanilla." D. T. Dougherty, Bath.
15896	B. E. Folsom, Augusta, Me. "Peerless Brand Pure Flavor of Vanilla." B. E. Folsom, Augusta.
15635	Grand Union Tea Co., Brooklyn, N. Y. "Grand Union Extract Vanilla." Grand Union Tea Co., Lewiston.
15824	A. Hallett & Co., Bath, Me. "Extract of Vanilla." A. Hallett & Co., Bath.
1562[illegible]	Frank E. Harris Co., Binghampton, N. Y. "Good Value Pure Extract Vanilla." E. Janelle & Co., Lewiston. Rather weak in vanillin.
15966	Frank E. Harris Co., Binghampton, N. Y. "Good Value Pure Extract Vanilla." City Market (Lamara & King), Waterville.
15674	Frank E. Harris Co., Binghampton, N. Y. "Harris Pure Extract Vanilla." I. A. Smith, Auburn.
15886	Frank E. Harris Co., Binghampton, N. Y. "Harris Pure Extract Vanilla." J. F. Turner, Augusta.
15862	E. Hartshorn & Sons, Boston. "Hartshorn's Pure Extract Vanilla.". R. W. Hill, Gardiner.
15823	Leonard & Mitchell, Bath, Me. "Extract of Vanilla. Non-official." Leonard & Mitchell, Bath.
15663	TheMohican Co., U. S. A. "Mohican Pure Extract of Vanilla." The Mohican Co., Lewiston. Weak in vanillin.
15946	John W. Perkins Co., Portland, Me. "Pure Vanilla." Blake Bros., Oakland.
15585	Riker-Hegerman Co., N. Y. "Riker's True Extract Vanilla." Riker-Jaynes Co., Lewiston.

Extract of Vanilla—Concluded.

Station number	Maker, Brand, Name and Address of Dealer and Remarks.
15591	C. F. Sauer Co., Richmond, Va. "Sauer's Pure Concentrated Extract Vanilla." F. B. Ross, Auburn.
15665	C. F. Sauer Co., Richmond, Va. "Sauer's Pure Concentrated Extract Vanilla." Walker's Cash Market, Lewiston.
15910	C.F. SauerC o., Richmond, Va. "Sauer's Pure Concentrated Extract Vanilla." Lashon & Butler, Skowhegan.
15637	Schlotterbeck & Foss Co., Portland, Me. "Foss Pure Extract Vanilla." Ash Street Market, Lewiston.
15660	Schlotterbeck & Foss Co., Portland, Me. "Foss Pure Extract Vanilla." Brann's Market, Gardiner.
15809	Geo. C. Shaw Co., Portland, Me. "Shaw's Vanilla." Geo. C. Shaw Co., Portland.
15587	Samuel B. Smith, Lewiston, Me. "Extract of Vanilla." Samuel B. Smith, Lewiston.
15691	Stickney & Poor Spice Co., Boston, Mass. "Stickney & Poor's Pure Vanilla Extract." W. F. McFadden, Brunswick.
15819	L. B. Swett Co., Bath. "Extract of Vanilla." L. B. Swett Co., Bath.
15858	Thurston & Kingsbury, Bangor, Me. "T. & K Extract Vanilla." Webber & Hewett Co., Hallowell.
15877	Thurston & Kingsbury, Bangor, Me. "T. & K. Extract Vanilla." Bearce & Jones, Augusta.
11805	Toiletine Co., Greenfield, Mass. "Miner's Pure Extract Vanilla." Correspondent's sample. Vanillin about half what it should be.
11830	Toiletine Co., Greenfield, Mass. "Miner's Pure Extract Vanilla." Corre spondent's sample.
15968	Twitchell-Champlin Co., Portland, Me. "Hatchet Brand Vanilla." Gould' Cash Market, Waterville.
15906	Van Duzer Extract Co., New York. "Van Duzer's Standard Quality Vanilla." Parker & Nay, Skowhegan.
15970	Van Duzer Extract Co., New York. "Van Duzer's Standard Quality Vanilla." E. L. Craig, Waterville. Rather weak.
15821	Webber's Drug Store, Bath, Me. "Extract of Vanilla." Webber's Drug Store, Bath. Rather weak.
15899	C. A. Weston Co., Portland, Me. "Solar Brand Vanilla Extract." O. J. Cote, Augusta. Rather weak.
15963	C. A. Weston Co., Portland, Me. "Solar Brand Vanilla Extract." Charles Pomerleau, Waterville.
15593	R. C. Williams & Co., New York. "Robin Hood Pure Flavoring Extract Vanilla." O. F. Holmes, Auburn.
15820	Lewis E. Wilson, Bath, Me. "Extract Vanilla." Lewis E. Wilson, Bath. Rather weak.
15522	Nathan Wood & Son, Portland, Me. "Wood's Extract of Vanilla." Kennebec Grain & Provision Co., Week's Mills.
15684	Worth Extract Co., New York. "Worth's Pure Flavoring Extract Vanilla." Fred Harding, Lisbon Falls.
15810	"Pure Extract of Vanilla made at 428 & 430 Fore St., Portland." Geo. C. Shaw Co., Portland.

Table giving a list of the brands of imitation vanilla flavors collected by the inspectors in the fall and winter of 1915-16 and examined and passed by the chemists as being properly branded. Samples arranged alphabetically by names of makers.

Station number	Maker, Brand, Name and Address of Dealer and Remarks.
15613	Anchor Mills Co., Charlestown, Mass. "Imperial Imitation Vanilla and Tonka Flavoring Compound. Colored." A. T. Reny, Lewiston.
11288	Baker Chemical Co., Auburn, Me. "Baker's Concentrated Compound Flavors Vanilla." Correspondent's sample. This compound is about ten times as strong as an ordinary imitation vanilla extract.
15603	Bay State Specialty Co., Boston, Mass. "Bay State Brand Vanilla Flavor Compound." Rose Rubin, Auburn.
15964	Dolan & Furnival Co., Portland, Me. "McAndrews Brand Imitation Vanilla Flavor." Silver Bros., Waterville.
15517	Kimball Bros. & Co., Enosburg Falls, Vt. "Kimball's Pure Gold Vanilla & Tonka Flavor." Kitchin & Clark, Palermo.
15925	Kimball Bros. & Co., Enosburg Falls, Vt., "Kimball's Pure Gold Compound Vanilla. Colored." W. C. Remick, Springvale.
15528	Kimball Bros. & Co., Enosburg Falls, Vt. "Kimball's Vanilla Flavor Substitute." C. I. York, Windsor.
15808	R. G. Leighton, Portland, Me. "Leighton's Extract Vanilla and Vanillin." J. E. Libby, Portland.
15890	R. G. Leighton, Portland, Me. "Leighton's Extract Vanilla and Vanillin." W. H. Bruce Concern, Augusta.
15805	R. G. Leighton, Portland, Me. "Rigby Imitation Vanilla." Congress Meat Market, Portland.
16234	The W. T. Rawleigh Medical Co., Freeport, Ill. "Rawleigh's Compound Extract of Vanilla, Vanillin and Coumarin." W. L. Helms, Hallowell.
11803	F. C. Tibbetts Mercantile Co., Portland, Me. "F. C. T. Brand Vanillin Flavor." C. E. Mack, Portland.
11687	F. C. Tibbetts Mercantile Co., Portland, Me. "Vanill S-ent-S." Correspondent's sample. Not properly labeled to show that it is an imitation.
11802	F. C. Tibbetts Mercantile Co., Portland, Me. "Vanill S-ent-S." Correspondent's sample. Not properly labeled to show that it is an imitation.

STATEMENT BY THE EXECUTIVE OF THE LAW.

A. M. G. Soule, Chief Bureau of Inspections.

In the late summer and early fall of 1915, about three hundred and twenty samples of flavoring extracts were collected; the results of the analyses of these samples are contained in the preceding pages.

An attempt was made to secure from the dealers goods manufactured within the State as well as the products of manufacturers located outside the State; we also endeavored to secure from the various druggists products of their own manufacture. Not only the pure vanilla and other flavors were obtained, but several of the imitations were found; in a very few cases the necessary branding indicated that it was an imitation product but quite frequently—probably due to the fact that they were old goods—the results of the analyses showed them to be a rather inferior product.

The newest phase of this statute, and one that has been treated up to the time of taking these samples, in an entirely educational way, is the Net Weight Law; the opportunity has now been given to judge how generally this statute is being complied with, and the results of these collections—giving an opportunity to note the labels and the particular language used, also to test the truth of the statements regarding the quantity of the contents—have been particularly gratifying. This requirement, which is found in section 23, under chapter 119 of the Public Laws of 1911, that the quantity of the contents be placed on all packages of food sold for more than five cents, has been almost universally complied with; in a few instances it has been proven, when an explanation for such violation has been asked for, that the goods were old or on hand prior to the time when the law went into effect.

It seems necessary to call attention particularly to a case of misbranding, where the carton is labeled plainly with the words "Extract of Vanilla" and with smaller type the language indicating that Vanillin colored with caramel had been added. On the other side appears the words "Extract of Vanilla" and also the word "Vanillin" in type nearly as large, while on the bottle the label shows the words "Vanilla" and "Vanillin colored with caramel", the words "Vanillin colored with caramel" in much smaller type. This case, together with a few others that require investigation, are still pending and are unsettled.

June, 1916

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director.

ANALYSTS.

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Official Inspections

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CLAMS, OYSTERS AND SCALLOPS

The Commissioner of Agriculture is the executive of the law regulating the sale of foods in Maine. It is the duty of the Director of the Maine Agricultural Experiment Station to make the analyses of the samples collected by the Commissioner, and to publish the results of the analyses together with the names of the persons from whom the samples were obtained, and such additional information as may seem advisable.

NOTE. All correspondence relative to the inspection laws should be addressed to the Bureau of Inspections, Department of Agriculture, Augusta, Maine.

Table showing results of examination of samples of opened clams purchased in the fall and winter of 1915-16, arranged alphabetically by towns.

Station number.	Town and Dealer.	Results of Examination.
16292	Augusta. W. H. Bruce Concern	Liquids too high. Solids too low.
16297	Augusta. Capitol Fish Market	Liquids slightly high.
16300	Augusta. Geo. D. Haskell & Son	Liquids too high. Solids too low.
16298	Augusta. M. M. Medini	Solids too low. Liquids slightly high.
16294	Augusta. A. L. Rose	Solids too low. Liquids slightly high.
16295	Augusta. J. F. Turner	Liquids too high. Solids too low.
16424	Augusta. L. S. Young	Liquids too high. Solids too low.
16425	Augusta. L. S. Young	Lawful.
16301	Augusta. Wm. Young	Liquids too high. Solids too low.
16047	Bangor. Frank Foster	Lawful.
16044	Bangor. Alfred Jones' Sons	Lawful.
16281	Bangor. Alfred Jones' Sons	Solids too low. Liquids slightly high.
16045	Bangor. Jones' Sanitary Market	Solids too low. Liquids slightly high.
16046	Bangor. Wentworth's Market	Lawful.
16303	Belfast. J. K. Dennett	Lawful.
16277	Biddeford. Andrews & Horigan Co	Liquids too high. Solids too low.
16272	Biddeford. Bibeau Bros	Solids too low. Liquids slightly high.
16269	Biddeford. Joseph Carrier	Liquids too high. Solids too low.
16274	Biddeford. J. P. Gartland	Solids too low.
16275	Biddeford. J. P. Gartland	Solids too low.
16276	Biddeford. J. P. Gartland	Lawful.
16279	Biddeford. G. A. Young	Lawful.
16359	Dover. S. Norton	Liquids too high. Solids too low.
16307	Fairfield. Geo. N. Snell	Liquids too high.
16286	Gardiner. A. A. Brann	Lawful.
16288	Gardiner. Cash Market Co	Solids too low.
16287	Gardiner. F. L. Clarke	Solids too low.
16290	Gardiner. A. W. Cunningham & Co	Lawful.
16289	Gardiner. Manson's Market	Lawful.
16291	Hallowell. Paine & Quinn	Solids too low.
16293	Hallowell. A. A. Shea	Solids too low.
16125	Lewiston. The Mohican Co.	Liquids too high. Solids too low.

CLAMS—Continued.

Station number.	Town and Dealer.	Results of Examination.
16356	Newport. H. H. Rich	Liquids too high. Solids slightly low.
14323	Old Orchard. Lewis & Milliken	Liquids too high. Solids too low.
16282	Pine Point. Leavitt Bros	Liquids slightly high.
16283	Pine Point. Leavitt Bros	Solids too low.
16285	Pine Point. Leavitt Bros	Liquids too high. Solids too low.
14321	Pine Point. G. T. Seavey	Liquids too high. Solids too low.
14322	Pine Point. Skillings	Liquids too high. Solids too low.
16284	Pine Point. H. B. Snow	Liquids too high. Solids too low.
16166	Portland. Brown & Bishop	Liquids too high. Solids too low.
16206	Portland. Brown & Bishop	Solids too low. Liquids slightly high.
16170	Portland. Lyman B. Chipman	Lawful.
15975	Portland. W. L. Daggett	Solids slightly low.
16213	Portland. Edward Doughty	Solids slightly low.
15977	Portland. E. C. Dyer	Lawful.
16210	Portland. E. C. Dyer	Solids too low.
16211	Portland. E. C. Dyer	Solids too low.
16212	Portland. E. C. Dyer	Liquids too high. Solids too low.
16214	Portland. E. C. Dyer	Lawful.
16215	Portland. E. C. Dyer	Liquids too high. Solids too low.
16216	Portland. E. C. Dyer	Liquids too high. Solids too low.
16230	Portland. Joseph E. Farr	Lawful.
16175	Portland. M. B. Greenleaf & Son	Lawful.
16167	Portland. Gribben Bros	Lawful.
16169	Portland. T. W. Holding	Solids too low.
16176	Portland. Johnson Bros	Solids slightly low.
14482	Portland. E. L. Landry	Solids slightly low.
16168	Portland. A. R. Littlejohn Fish Market	Lawful.
15980	Portland. J. H. McDonald	Liquids too high. Solids too low.
15979	Portland. J. H. McDonald	Solids too low.
16220	Portland. J. H. McDonald	Solids too low. Liquids slightly high.
16221	Portland. J. H. McDonald	Solids too low.
16222	Portland. J. H. McDonald	Lawful.
16223	Portland. J. H. McDonald	Solids too low.
16224	Portland. J. H. McDonald	Solids too low,

CLAMS—Concluded.

Station number.	Town and Dealer.	Results of Examination.
16209	Portland. S. Meserve	Liquids too high. Solids too low.
16164	Portland. Munjoy Fish Market	Solids too low.
14181	Portland. Geo. C. Shaw Co	Liquids too high. Solids too low.
16171	Portland. Geo. C. Shaw Co	Solids too low. Liquids slightly high.
16208	Portland. S. A. Skillings	Solids slightly low.
16165	Portland. Vickerson Bros	Solids slightly low.
16173	Portland. Charles H. Vose	Liquids too high. Solids too low.
16217	Portland. F. H. Whitney	Lawful.
14260	Rockland. Benj. Ames	Liquids too high. Solids too low.
14257	Rockland. Phillip Thomas	Liquids slightly high.
16227	Rumford. E. J. Roderick & Co	Solids too low.
14351	Scarboro. Leavitt Bros	Lawful.
14352	Scarboro. John Meserve	Lawful.
16260	Sanford. D. O. Forbes	Lawful.
16258	Sanford. Quality Market, J. M. McCarty	Solids too low.
16264	Springvale. H. Pitts	Lawful.
16309	Waterville. City Market Co	Liquids too high. Solids too low.
16311	Waterville. Knowlton & Russell	Solids too low. Liquids slightly high.
16310	Waterville. Maine Central Market	Liquids too high.
14324	Westbrook. Davis & Whitney	Lawful.

Table showing results of examination of samples of scallops purchased in the fall and winter of 1915-16, arranged alphabetically by towns.

Station number.	Town and Dealer.	Results of Examination.
16271	Biddeford. Bibeau Bros	Lawful.
15976	Portland. W. L. Daggett	Lawful.
15978	Portland. J. H. McDonald	Lawful.
16219	Portland. J. H. McDonald	Solids too low.

Table showing the results of examination of samples of oysters purchased in the fall and winter of 1915-16, arranged alphabetically by towns.

Station number.	Town and Dealer.	Results of Examination.
16299	Augusta. M. M. Medini	Solids slightly low.
16296	Augusta. J. F. Turner	Liquids too high. Solids too low.
16179	Bangor. Alfred Jones' Sons	Lawful.
16278	Biddeford. Andrews & Horigan Co	Solids too low.
16270	Biddeford. Bibeau Bros	Solids too low. Liquids slightly high.
14177	Biddeford. Joseph A. Carrier	Solids slightly low.
16268	Biddeford. Joseph A. Carrier	Lawful.
14178	Biddeford. Gartland & Dunn	Lawful.
16273	Biddeford. J. P. Gartland	Solids too low.
16280	Biddeford. John F. Hannaway	Lawful.
16134	Eastport. Gove's Cash Grocery	Solids too low.
16135	Eastport. Pike & Kilby	Solids too low.
16308	Fairfield. W. W. Nye & Co	Lawful.
16267	Livermore Falls. Frank C. Hurlbert	Liquids too high. Solids too low.
16355	Newport. H. H. Rich	Lawful.
14142	Portland. H. M. Arey	Lawful.
14138	Portland. Brown & Bishop Co	Solids too low.
16207	Portland. Brown & Bishop Co	Lawful.
14145	Portland. Lyman B. Chipman	Lawful.
14140	Portland. Congress Market	Lawful.
14156	Portland. W. L. Daggett & Co	Lawful.
14154	Portland. Doughty & Jewett	Lawful.
14150	Portland. Gem Fish Market	Solids too low.
14139	Portland. Gribben Bros	Lawful.
14152	Portland. Hamilton Bros	Liquids too high.
14155	Portland. R. D. Hamilton & Co	Lawful.
14141	Portland. Abner L. Littlejohn	Solids slightly low.
14144	Portland. Chauncey Lombard	Lawful.
14157	Portland. James H. McDonald	Lawful.
14147	Portland. L. A. Mercier	Lawful.
14137	Portland. Munjoy Fish Market	Lawful.
14151	Portland. Fred E. Peterson	Solids too low.

OYSTERS—Concluded.

Station number.	Town and Dealer.	Result of Examination.
14146	Portland. Geo. C. Shaw Co.	Solids too low.
14182	Portland. Geo. C. Shaw Co.	Solids slightly low.
14143	Portland. Sullivan & Osgood	Lawful.
14136	Portland. Frank Thorndike	Solids slightly low.
14149	Portland. Charles H. Vose	Lawful.
16174	Portland. Charles H. Vose	Solids slightly low.
16218	Portland. F. H. Whitney	Lawful.
14153	Portland. W. L. Wilson Co.	Lawful.
14259	Rockland. Benj. Ames	Solids too low.
14258	Rockland. Hart & Merritt	Lawful.
16228	Rumford. Dorion's Cash Market	Lawful.
16229	Rumford. J. A. Garneau & Co	Lawful.
16225	Rumford. Arthur Gauthier & Son	Lawful.
16226	Rumford. Oxford Co. Cooperative Ass'n.	Lawful.
14179	Saco. F. S. Wallace	Solids too low.
14379	Saco. F. S. Wallace	Liquids too high.
14180	Saco. E. K. Weymouth	Lawful.
16256	Sanford. Lizotte & Caron Co	Lawful.
16259	Sanford. Quality Market, J. M. McCarty	Liquids too high. Solids too low.
16257	Sanford. James P. Vallely	Solids too low.
16261	Springvale. D. H. Johnson	Solids too low.
16265	Springvale. Pelletier Bros	Lawful.
16263	Springvale. H. Pitts	Lawful.
16262	Springvale. H. P. Webber	Liquids too high. Solids too low.

The Nutritive Value of Shellfish.

In a general way, a pint and a half of oysters from which the liquids have been drained contain about the same quantity of actual nutritive substance as a quart of milk, a pound of very lean beef, a pound and a half of fresh codfish, or two-thirds of a pound of bread. While the weights of actual nutriment in those different quantities of these food materials is very nearly the same, their quality is widely different. The very lean meat of codfish consists mostly of protein or flesh formers—the substances which make blood, muscles, tendons, bone, brain and other nitrogenous tissues. A pound of bread contains considerably less of these and consists largely of starch with a little fat and other compounds which serve the body as fuel and supply heat and muscular power. The nutritive substance of oysters contains considerable of both the flesh forming and the more especially heat and force forming ingredients, and perhaps comes nearer to milk than almost any other common food materials as regards the relative proportion of nutrients. The food value of equal weights of milk and oysters—that is their value for supplying the body with materials to build up its parts, repair its waste and furnish it with heat and energy,—are in approximately the ratio of 4 to 3. The solid portion of oysters, opened fresh from salt water beds and drained from adhering liquids, will carry in the neighborhood of 18 per cent of dry solids, about one-half of which is protein, one-third carbohydrates, and one-sixth fat. Clams opened in the same way will carry at least 20 per cent of dry solids, and the solids of clams will contain relatively more protein and less carbohydrates and fat than oysters. Fresh opened scallops that are not washed in fresh water will carry not less than 22 per cent of solids. Practically two-thirds of this is protein, and the remainder is mostly carbohydrates and ash. There is practically no fat in scallops.

EFFECT OF PLACING SHELLFISH IN FRESH WATER.

It was long a practice to take oysters from the bed in the open sea in which they grew and place them in brackish water before opening or sending them to market. This so-called "floating" was referred to by the oyster men as a fattening process. An oyster that does not look at all plump when taken from its salt water bed will, if placed in brackish water, in the course of 24 to 48 hours increase very much in size and in plumpness. This also happens in the case of opened oysters that are taken directly from salt water beds and put into fresh water. The same is also true of clams and, to quite an extent, of scallops.

Explanation of what takes place is very simple. If one were to partly fill a bladder with sea water and immerse it in fresh water, by physical laws the water that is inside of the bladder carrying salt will diffuse through the walls of the bladder and fresh water from outside will also penetrate to the interior. This motion, due to osmosis, will be more rapidly in than out. That is, the crystalline substance will not go through the walls as rapidly as will the water. The result will be that in a short time the bladder becomes inflated (made plump) and this is precisely what happens when shellfish are taken from salt water beds and placed in fresh water.

The writer, when associated with the late Doctor Atwater, some thirty years ago investigated the effect of "floating" upon the chemical composition of oysters. It was found that so far as the effect of "floating" upon the nutritive value of the oysters was concerned, that while there is an increase in bulk and weight there is no corresponding gain, but rather a slight loss, of nutrients. A given weight of the solids from floated oysters will have considerably less nutritive value than the same oysters had before being thus treated.

Since the enforcement of the Federal Food Law, oysters have been put upon the markets without being "floated" and will for the most part carry not less than 16 per cent of dry solids.

The methods of handling clams in Maine have been discussed in this series before. Many of the clams offered in the market contain but a little more than half the nutritive value that they should, because of their having been placed in fresh water. Something of the same thing is the case with scallops.

The oyster situation has been regulated from the outside. It is necessary for the State authorities to endeavor to correct the abuses on clams and scallops within the State. As stated by the executive of the law in this number of Official Inspections, they are making every effort to bring it about that clams shall be sold as they come from the beds without being diluted with water.

While the nutritive value of these materials is not particularly great, the difference in nutritive value between floated and unfloated shellfish is very marked. Immersing clams in fresh water and soaking opened scallops in fresh water has the same effect upon the solid portions that the addition of water has to milk. The nutritive value is lessened and the purchaser pays a food price for the added water.

STATEMENT BY THE EXECUTIVE OF THE LAW.

A. M. G. SOULE, CHIEF, BUREAU OF INSPECTIONS.

Ever since the inauguration of the pure food law, the subject of regulating the sale of oysters, clams and scallops has demanded considerable attention and, during the last season, rather an unusual effort has been made to remedy the conditions as evidenced by the tabulations reporting the analyses of the samples collected, employing the usual methods of education, moral suasion and finally—in a few instances—prosecution.

Generally speaking, the oyster situation is greatly improved and in only a very few instances has it been noted that scallops were being sold in serious violation of the law, but in the sale of clams we have detected numerous cases of adulteration and it is to be greatly regretted that the sale of this commodity seems extremely hard to regulate; the statute employed for such regulation is found in section eleven of P. L., 1911, chapter 119, and reads:

"For the purpose of this act an article shall be deemed to be adulterated, in the case of food, if any substance has been mixed and packed with it so as to reduce or lower or injuriously affect its quality and strength."

It is generally well known by clam diggers and dealers that if clams are allowed to remain—if only for a few hours—in fresh water they will become considerably swollen and their quality impaired, as soaking clams—as well as oysters—in fresh water makes them plumper and larger, increases them in weight and size and, therefore, the profits of the dealer, but does not add to the value as a food product; and at their best, without adulteration, clams as a nourishing food cannot be considered of any very great importance and should be regarded as a condimental substance.

The principle of this process of floating or soaking is that a soft substance like a clam, having in its composition a mineral salt, when brought in contact with fresh water a process of diffusion takes place whereby water passes through the cell walls, enters the cells of the clam and the mineral substance is forced out, consequently the increased weight and size by the addition of water at the expense of the natural flavor. By the laboratory methods of analysis, it is not at all difficult to ascertain whether clams have been soaked or not, and clams opened under proper conditions, washed but not soaked, show an analysis of free liquids not more than 10% and total solids not less than 18%. A typical example of an analysis for a sample, purchased at a Portland market, which was properly shucked and washed without soaking showed free liquids 6.45 and total solids 21.76.

During the past season, as soon as a general sampling of clams was commenced and the reports of analyses returned, it became apparent that the method of dispensing clams needed more thorough investigation and an attempt was made to determine the source of such supply and from what source this food product was being supplied in its greatest quantity. An attempt was also made to visit and inspect the premises of the wholesale dealers and definitely determine their methods of shucking and preparing their product for market. As a result a very good idea of the proportions of the clam industry in this state and the statistics concerning it have been gathered. It was found that during the past winter from Pine Point in the town of Scarboro aside from the clams that were dug in that vicinity, approximately five thousand barrels of clams in the shell were received from points east, covering a territory as far as Saint Andrews, N. B. These clams, when received in Pine Point, were shucked by the dealers there and shipped to both intra and interstate points, and the examination of the freight records shows that the cities of Boston, Lowell, Worcester, Lawrence and Lynn, in Massachusetts, Manchester, N. H. and Providence, R. I., were supplied extensively by dealers in this place. It was also learned that the cities of the Kennebec valley in the State of Maine and other cities of the state were being supplied from this source. It was learned that clams were also being supplied in considerable quantity from Sorrento, Chebeague and other islands in Portland Harbor, through the wholesalers in Portland, and in small quantities from the vicinity of Popham, Bay Point, Friendship and Medomack.

In the course of inspection a few cases have been reported where the dealers in direct violation of the food standards have been found offering for sale clams with a piece of ice in the container and in direct contact with the clams; in all instances the offenders have been cited to hearings and the cases settled;

cases of this nature, however, have not been frequent and early in the investigation it was definitely decided that the retailers were not wholly to blame and that evidently the clams were being adulterated in the hands of the wholesalers. Accordingly, charges were brought against wholesale dealers, not only as a result of the analyses of samples obtained from their places of business and actual observation of their methods, but for violations based upon the analyses of other samples taken from retailers who had been supplied by these wholesale dealers and to which sources the deficient samples were traced. As a result, two large wholesale concerns were fined for such violations; a third concern doing a wholesale business was taken to court and a fine with costs imposed, which was appealed. This case was brought in the Portland muncipal court and appealed to the May term of the superior court for Cumberland county but, owing to the congestion of business, it was continued to the September term and will probably be tried at that time.

By virtue of the authority as collaborating official for the Federal Department and with knowledge that the Federal statute was being violated in shipping adulterated clams to interstate points, the matter was communicated to the Federal authorities at the nearest laboratory in Boston and as a result the offending wholesalers were cited to hearing.

In the settlement of the cases of violations and for the information of the public, the following standards for shell fish have been given; these standards are available for distribution upon application to this Bureau:

MAINE DEPARTMENT OF AGRICULTURE,
BUREAU OF INSPECTION.

REGULATORY ANNOUNCEMENT NO. 130.

STANDARDS FOR SHELL FISH.

Authority for making rules governing the sale of any article of food is given in a section of the statute quoted below:

"Chapter 119, P. L. 1911 (As amended by P. L. 1913, chapter 140.) Section 13: The commissioner of agriculture shall make unform rules and regulations for carrying out the provisions of this act. The said commissioner may also fix standards of purity, quality or strength when such standards are not specified or fixed by law and shall publish them together with such other information concerning articles of food as he may deem to be of public benefit."

Therefore, the following standards regulating the sale of shell fish have been made and will be enforced:

OPENED SHELL FISH, to be legally sold, must be from unpolluted beds, opened, packed and shipped under sanitary conditions, in sanitary containers, without the addition of water or direct contact with ice.

IT IS TO BE UNDERSTOOD that OPENED SHELL FISH shall include clams, oysters, scallops, mussels, etc.

OPENED CLAMS must be sold drained, without any surplus liquid.

CLAMS THAT ARE OPENED RAW must be drained and, if washing is necessary, the clams should not be allowed to stand in water for more than five minutes.

IF IT IS DESIRABLE TO HEAT THE CLAMS before opening, emersion in hot water is permitted; then they may immediately be put into cold water, but not allowed to stand for any length of time. Clams should then be opened, drained and handled exactly the same as raw opened clams.

NATURAL CLAM LIQUID or juice must be sold as such, but cannot be mixed with opened clams and the mixture sold as clams.

A. M. G. SOULE,
Chief, Bureau of Inspection.

With the possibilities for adulteration, the regulation of the sale of this commodity—even though a small item of our food supply—seems a subject worthy of consideration in order that the public may be safe-guarded. It is earnestly hoped that the conditions which have been brought to our attention by this investigation during the past season may be permanently remedied.

October, 1916

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director.

ANALYSTS.

James M. Bartlett
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Official Inspections

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COMMERCIAL FEEDING STUFFS, 1915-6.

CHAS. D. WOODS.

The Commissioner of Agriculture is the executive of the law regulating the sale of feeding stuffs in Maine. It is the duty of the Director of the Maine Agricultural Experiment Station to make the analyses of the samples collected by the Commissioner, and to publish the results of the analyses together with the names of the persons from whom the samples were obtained, and such additional information as may seem advisable.

NOTE. All correspondence relative to the inspection laws should be addressed to the Bureau of Inspections, Department of Agriculture. Augusta, Maine.

The following pages contain the description of all the feeding stuffs that were registered in Maine during the year beginning July 1, 1915, and ending with June 30, 1916. The results of the analyses of the 675 samples collected by the inspectors and sent in to the Station by correspondents since the publication of Official Inspections 72 and up to July 1, 1916, are here reported.

The description of classes of feeding stuffs, the terms of the law the reasons for not printing the numerical results of the analyses, and other notes were given quite fully in Official Inspections 72 and are not repeated here. The reference list that follows will make it easy for the reader to find any class of feed. Under each class the different brands are arranged alphabetically by makers' names.

The user of feeding stuffs should bear in mind that *the only analysis that he can safely go by is that of the guaranty on the label of the feed that he proposes to buy.* The object of collecting and analyzing samples is to make it as sure as possible that he will get the guaranteed analysis.

REFERENCE LIST OF FEEDING STUFFS IN 1915-16.

Table showing registrations of feeding stuffs and results of examination of samples.

COTTON SEED MEALS.

Brand, Maker and Guaranties.	Results of Examination.
Dove Brand Prime Cotton Seed Meal. F. W. Brode & Co., Memphis, Tenn. Cotton seed. Contains not more than 10 per cent. crude fiber, and not less than 6 per cent. fat and 38.63 per cent. protein. Registered in 1915 and 1916.	The three dealers' samples were all materially below in protein. Five of the six official samples were seriously below in protein, and seriously high in fiber. The other official sample was practically up to guaranty in protein.
Owl Brand Cotton Seed Meal. F. W. Brode & Co., Memphis, Tenn. Cotton seed. Contains not more than 10 per cent. crude fiber, and not less than 6 per cent. fat and 41 per cent. protein. Registered in 1915 and 1916.	Of thirty-two dealers' samples six were up to and above the minimum guaranty of protein; nine were within 1 per cent. of the guaranteed protein; ten were within 2 per cent. of the guaranteed protein; and seven were from 3 to 4 per cent. below the guaranteed protein. Of the 29 official samples, 7 were up to or above the minimum protein; 6 samples were within 1 per cent. of the claimed protein; 7 samples were within 2 per cent. of the claimed protein; and 5 samples were 4 per cent. or more below the claimed protein. All of the samples low in protein way overran in crude fiber.
"Buckeye" Prime Cotton Seed Meal. Buckeye Cotton Oil Co., Cincinnati, O. Manufactured from cotton seed only. Contains not more than 12 per cent. crude fiber, and not less than 6 per cent. fat and 38.62 per cent. protein. Registered in 1915 and 1916.	The four dealers' samples all exceeded the guaranty for protein. Nine of the 11 official samples were up to or above the minimum protein; 2 of the samples were about 2 per cent. below the minimum protein. One of these low samples overran the maximum guaranty of fiber. This was the Buckeye Prime with a guaranty of 38.62 per cent. of protein.
"Buckeye" Prime Cotton Seed Meal(41%). Buckeye Cotton Oil Co., Cincinnati, O. Manufactured from cotton seed only. Contains not more than 10 per cent. crude fiber, and not less than 6.5 per cent. fat and 41 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Single Hump Camel Brand. C. L. Campbell & Co., Little Rock, Ark. Cotton seed meal with such portion of the fibre or hull and oil as may be left in the ordinary course of manufacture. Contains not more than 12 per cent. crude fiber, and not less than 6 per cent. fat and 38.5 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Good Luck Brand Cotton Seed Meal. S. P. Davis, Little Rock, Ark. Made from decorticated cotton seed. Contains not more than 9 per cent. crude fiber, and not less than 6 per cent. fat and 41 per cent protein. (1915 certificate gives 7 per cent. as minimum fat.) Registered in 1915 and 1916.	Of the four official samples, 2 were well above the minimum guaranty of protein, and these exceeded in the maximum guaranty of fiber; the 2 other samples were within 1 per cent. of the minimum guaranty of protein.
Veribest Brand Cotton Seed Meal. S. P. Davis, Little Rock, Ark. Made from decorticated cotton seed. Contains not more than 10 per cent. crude fiber, and not less than 6 per cent. fat and 38.5 per cent. protein. (1915 certificate gives 12 per cent. as maximum fiber.) Registered in 1915 and 1916.	Three of the dealers' samples slightly overran the guaranty in protein, and one was about 2 per cent. short. The one official sample was up in protein and fat and did not exceed in fiber.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
East St. Louis Brand Cotton Seed Meal. East St. Louis Cotton Oil Co., National Stock Yards, Ill. Contains not more than 12 per cent. crude fiber, and not less than 6 per cent. fat and 38.62 per cent. protein. Not registered in 1915. Registered in 1916.	The three dealers' samples substantially agreed with the guaranteed protein. The one official sample slightly exceeded the guaranty in protein and fat, and did not overrun in fiber.
Illinois Brand Cotton Seed Meal. East St. Louis Cotton Oil Co., National Stock Yards, Ill. Contains not more than 10 per cent. crude fiber, and not less than 6 per cent. fat and 41 per cent. protein. (1915 certificate gives 7 per cent. as minimum fat.) Registered in 1915 and 1916.	Three dealers' samples were practically in accord with guaranty of protein. No official samples received.
Milko Brand Cotton Seed Meal. H. F. H. Eberts, Little Rock, Arkansas. Made from pressed cotton seed. Contains not more than 12 per cent. of crude fiber, and not less than 5.50 per cent. of fat and 38.62 per cent. of protein. Registered in 1916.	No dealers' or official samples received.
Big League Cotton Seed Meal. Eldred Mill Co., Jackson, Mich. Made from decorticated cotton seed. Contains not more than 12 per cent. crude fiber, and not less than 6 per cent. fat and 38.62 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
"Eldred" Cotton Seed Meal. Eldred Mill Co., Jackson, Mich. Made from decorticated cotton seed. Contains not more than 10 per cent. crude fiber, and not less than 7 per cent. fat and 41 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Bull Brand Cotton Seed Meal. Humphreys-Godwin Co., Memphis, Tenn. Made from pressed cotton seed. Contains not more than 10 per cent. crude fiber, and not less than 6 per cent. fat and 41 per cent. protein. Registered in 1915 and 1916.	The three dealers' samples up to guaranteed protein. One official sample up in protein and fat, and did not exceed in fiber.
Colonial Brand Cotton Seed Meal. Humphreys-Godwin Co., Memphis, Tenn. Made from pressed cotton seed. Contains not more than 15 per cent. crude fiber, and not less than 6 per cent. fat and 34 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Danish Brand Cotton Seed Meal. Humphreys-Godwin Co., Memphis, Tenn. Made from pressed cotton seed. Contains not more than 15 per cent. crude fiber, and not less than 5 per cent. fat and 36 per cent. protein. Not registered in 1915. Registered in 1916.	One dealer's sample, protein in accord with guaranty. No official samples received
Dixie Brand Cotton Seed Meal. Humphreys-Godwin Co., Memphis, Tenn. Made from pressed cotton seed. Contains not more than 12 per cent. crude fiber, and not less than 6 per cent. fat and 38.62 per cent. protein. Registered in 1915 and 1916.	Of the 20 dealers' samples, 11 were practically up to or above the guaranteed percentage of protein. One sample was 1 per cent. below the guaranty; 5 samples were within 2 per cent. of the guaranteed protein; 3 samples were about 5 per cent. below the guaranty for protein. Four of the 10 official samples were practically up to or above the guaranteed protein; one sample was within 1 per cent.; 2 samples were within 2 per cent.; and 3 samples were more than 3 per cent. below the guaranteed protein. All but one of the samples examined for crude fiber overran the maximum guaranty.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Forfat Brand Cotton Seed Meal. Humphreys-Godwin Co., Memphis, Tenn. Made from pressed cotton seed. Contains not more than 12 per cent. crude fiber, and not less than 6 per cent. fat and 38.55 per cent. protein. (1915 certificate gives 38.62 per cent. as minimum protein.) Registered in 1915 and 1916.	One dealer's sample was slightly below; another sample more than one per cent. below the minimum protein. Three official samples were up to the minimum protein; one official sample was within 1 per cent. The fiber slightly exceeded the maximum guaranty.
Canary Brand Cotton Seed Meal. Lanier Bros., Nashville, Tenn. Fully decorticated cotton seed. Contains not more than 10 per cent. crude fiber, and not less than 6 per cent. fat and 41 per cent. protein. Registered in 1915. Not registered in 1916.	The two dealers' samples exceeded the protein guaranty. No official samples received.
Jersey Brand High Grade Cotton Seed Meal. Lanier Bros., Nashville, Tenn. Decorticated cotton seed ground, only. Contains not more than 10 per cent. crude fiber, and not less than 6 per cent. fat and 38.62 per cent. protein. Registered in 1915 and 1916.	The one dealer's sample was slightly low in protein. One of the two official samples was up to guaranteed protein; the other more than 1 per cent. below the guaranteed protein. The fiber way exceeded the maximum guaranty.
Kineda Prime Cotton Seed Meal. J. M. Macdonald, Cincinnati, O. Cotton seed product. Contains not more than 12 per cent. crude fiber, and not less than 6 per cent. fat and 38.6 per cent. protein. Registered in 1915 and 1916.	One dealer's sample about ½ per cent. and another about 3 per cent. below guaranty in protein. Both official samples were more than 4 per cent. below in protein, and way exceeded the maximum guaranty of fiber.
Macade Cotton Seed Meal. J. M. Macdonald, Cincinnati, O. Cotton seed product. Contains not more than 12 per cent. crude fiber, and not less than 6 per cent. fat and 41 per cent. protein. Registered in 1915 and 1916.	Three official samples, practically in accord with guaranty.
"Selden" Cotton Seed Meal. Memphis Cotton Seed Products Co., Memphis, Tenn. Manufactured from pressed cotton seed. Contains not more than 10 per cent. crude fiber, and not less than 6 per cent. fat and 41 per cent. protein. Registered in 1915. Not registered in 1916.	No dealer's or official samples received.
Canary Brand Cotton Seed Meal. (Registered in 1915 as Canary Extra Brand Cotton Seed Meal.) C. L. Montgomery & Co., Memphis, Tenn. Fully decorticated cotton seed. On 1915 certificate Contains not more than 10 per cent. crude fiber, and not less than 6 per cent. fat and 41 per cent. protein. On 1916 certificate: Contains not more than 12 per cent. crude fiber, and not less than 6 per cent. fat and 38.63 per cent. protein. Registered in 1915 and 1916.	The four dealers' samples were from 1 to 4 per cent. below the guaranteed protein. Two of the six official samples were practically in accord with the guaranteed protein; two of the official samples were 1½ per cent. below the minimum protein; and 2 samples about 3 per cent. below in protein. Those low in protein exceeded the maximum guaranty of fiber.
Eagle Brand Cotton Seed Meal. C. L. Montgomery & Co., Memphis, Tenn. Fully decorticated cotton seed. Contains not more than 14 per cent. crude fiber, and not less than 5 per cent. fat and 36 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample practically in accord in protein and fat, but exceeded considerably the maximum guaranty in fiber.
M Brand Cotton Seed Meal. C. L. Montgomery & Co., Memphis, Tenn. Contains not more than 14 per cent. crude fiber, and not less than 6 per cent. fat and 36 per cent. protein. Not registered in 1915. Registered in 1916.	No dealer's or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Prime Cotton Seed Meal. National Feed Co., St. Louis, Mo. Contains not more than 14.5 per cent. crude fiber, and not less than 7.5 per cent. fat, and 41 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample, practically in accord with guaranty.
Bee Brand Cotton Seed Meal. W. C. Nothern, Little Rock, Ark. Made from pressed cotton seed. Contains not more than 10 per cent. crude fiber, and not less than 6 per cent. fat and 41 per cent. protein. Registered in 1915 and 1916.	One official sample, up in protein and fat, exceeded the maximum guaranty of fiber by more than 2 per cent.
Butterfly Brand Cotton Seed Meal. W. C. Nothern, Little Rock, Ark. Made from pressed cotton seed. Contains not more than 10 per cent. crude fiber, and not less than 6 per cent. fat and 39 per cent. protein. (1915 certificate gives 12 per cent. as maximum fiber.) Registered in 1915 and 1916.	No dealer's or official samples received.
Dairy Brand Cotton Seed Meal. W. C. Nothern, Little Rock, Ark. Made from pressed cotton seed. Contains not more than 12 per cent. crude fiber, and not less than 6 per cent. fat and 35 per cent. protein. Registered in 1915. Not registered in 1916.	No dealer's or official samples received.
Baltimore Brand Cotton Seed Meal. W. Newton Smith, Baltimore, Md. Contains not more than 10 per cent. crude fiber, and not less than 7 per cent. fat and 38.62 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Dirigo Brand Cotton Seed Meal. W. Newton Smith, Baltimore, Md. Contains not more than 10½ per cent. crude fiber, and not less than 6 per cent. fat and 41 per cent. protein. Registered in 1915. Not registered in 1916.	One official sample was below guaranty in protein.
Pilgrim Cotton Seed Meal. J. E. Soper Co., Boston, Mass. Contains not more than 10 per cent. crude fiber, and not less than 5 per cent. fat and 38½ per cent. protein. Registered in 1915 and 1916.	One dealer's sample, up to guaranty in protein. One official sample, 3 per cent. low in protein; nearly 4 per cent. above in fiber; well up in fat.
Pioneer Cotton Seed Meal. J. E. Soper Co., Boston, Mass. Contains not more than 10 per cent. crude fiber, and not less than 7 per cent. fat and 41 per cent. protein. Registered in 1915 and 1916.	Seven of the 12 dealers' samples were up in protein; 1 was ½ per cent. low in protein; 3 were within 2 per cent. of the guaranty; and 1 was more than 3 per cent. below the guaranty of protein. Six of the 15 official samples were up to the guaranteed protein; 5 were within 1 per cent. of the guaranteed protein; 3 within 2 per cent; and 1 more than 2 per cent. below the guaranteed protein. The fibers so far as made, all exceeded the maximum guaranty.
Puritan Cotton Seed Meal. J. E. Soper Co., Boston, Mass. Pure cotton seed meal. Contains not more than 16 per cent. crude fiber, and not less than 5½ per cent. fat and 36 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Cotton Seed Meal. Swift & Co., Atlanta, Ga. Made from cotton seed only. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 38.62 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Interstate Brand Prime Cotton Seed Meal and Cake. Texas Cake & Linter Co., Dallas, Texas. Made from decorticated cotton seed. Contains not more than 12 per cent. crude fiber, and not less than 6 per cent. fat and 38.62 per cent. protein. (1915 certificate gives 10 per cent. as maximum fiber.) Registered in 1915 and 1916.	No dealers' or official samples received.
Sunset Brand Prime Cotton Seed Meal and Cake. Texas Cake & Linter Co., Dallas, Texas. Made from decorticated cotton seed. Contains not more than 10 per cent. crude fiber, and not less than 6 per cent. fat and 41 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Durjan Cotton Seed Meal. Union Brokerage & Commission Co., Vicksburg, Miss. Decorticated cotton seed only. Contains not more than 10 per cent. crude fiber, and not less than 7.5 per cent. fat and 41 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Magnolia Cotton Seed Meal. Union Brokerage & Commission Co., Vicksburg, Miss. Decorticated cotton seed only. Contains not more than 10 per cent. crude fiber, and not less than 7.5 per cent. fat and 38.62 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
American Red Tag Cotton Seed Meal. Union Seed & Fertilizer Co., New York, N. Y. Cotton seed meal only. Contains not more than 11.5 per cent. crude fiber, and not less than 6.5 per cent. fat and 38.55 per cent. protein. (1915 certificate gives 7 per cent. as minimum fat). Registered in 1915 and 1916.	One dealer's sample, practically in accord with guaranty for protein. No official samples received.
Yellow Tag Choice Cotton Seed Meal. Union Seed & Fertilizer Co., New York, N. Y. Contains not more than 16 per cent. crude fiber, and not less than 8 per cent. fat and 41.18 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.

COTTON SEED FEEDS.

Kuku Brand Cotton Seed Feed. F. W. Brode & Co., Memphis, Tenn. Cotton seed. Contains not morethan 14 per cent. crude fiber, and not less than 5 per cent. fat and 32 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
"Buco" Cotton Seed Feed. Buckeye Cotton Oil Co., Cincinnati, Ohio. Cotton seed meal and cotton seed hulls. Contains not more than 23 per cent. crude fiber and not less than 4 per cent. fat and 20 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample, low in protein and fat, and exceeded maximum guaranty of fiber.

FEEDING STUFFS—Continued.

BRAND, MAKER AND GUARANTIES.	RESULTS OF EXAMINATION.
77 Cotton Seed Feed. Humphreys-Godwin Co., Memphis, Tenn. Cotton seed meal and delinted cotton seed hulls. Contains not more than 28 per cent. crude fiber, and not less than 4 per cent. fat and 20 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers or official samples received.
Golden Rod Cotton Seed Feed. J. M. Macdonald, Cincinnati, O. Ground cotton seed. Contains not more than 14 per cent. crude fiber, and not less than 6 per cent. fat and 33.5 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample, practically in accord with guaranty.
Cyclone Cotton Seed Feed. Memphis Cotton Hull & Fiber Co., Ltd., Memphis, Tenn. Cotton seed meal, ground cotton seed hulls. Contains not more than 23 per cent. crude fiber, and not less than 3 per cent. fat and 20 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
LINSEED MEALS.	
Amco Old Process Linseed Meal. American Milling Co., Peoria, Ill. Flax seed product. Contains not more than 10 per cent. crude fiber, and not less than 5 per cent. fat and 30 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample, practically in accord with guaranty.
Cleveland Flax Meal. American Linseed Co., New York, N. Y. Flax seed. Contains not more than 9 per cent. crude fiber, and not less than 2 per cent. fat and 36 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Hypro Pure Old Process Linseed Meal. American Linseed Co., New York, N. Y. Flaxseed. On 1915 certificate Contains not more than 9 per cent crude fiber, and not less than 2 per cent fat and 36 per cent protein. On 1916 certificate Contains not more than 8 per cent crude fiber, and not less than 5 per cent fat and 34 per cent protein. Registered in 1915 and 1916.	Two official samples found to accord with guaranty in protein, overrun in fat, and exceeded the maximum fiber guaranty.
Old Process Linseed Meal. American Linseed Co., New York, N. Y. Flaxseed. Contains not more than 8 per cent crude fiber, and not less than 5 per cent fat and 34 per cent protein. Registered in 1915 and 1916.	Four samples, three official and one dealers' practically in accord with guaranty.
Archer-Daniels Linseed Co's Old Process Ground Oil Cake. Archer-Daniels Linseed Co., Minneapolis, Minn., and Buffalo, N. Y. By product from the manufacture of linseed oil. Contains not more than 10 per cent crude fiber, and not less than 6 per cent fat and 32 per cent protein. Not registered in 1915. Registered in 1916.	One official sample practically in accord with guaranty.
Pure Old Process Oil Meal made from Linseed Cake. Spencer Kellogg & Sons, Inc., Buffalo, N. Y. and Minneapolis, Minn. Ground linseed cake. Contains not more than 10 per cent crude fiber, and not less than 5 per cent fat and 33 per cent protein. Registered in 1915 and 1916.	One sample, practically in accord with guaranty.

FEEDING STUFFS—Continued.

BRAND, MAKER AND GUARANTIES.	RESULTS OF EXAMINATION.
Old Process Linseed Oil Meal. Mann Bros. Co., Buffalo, N. Y. Flaxseed. Contains not more than 10 per cent crude fiber, and not less than 6 per cent fat and 34 per cent protein. Registered in 1915. Not registered in 1916.	No dealers' or officials samples received.
Old Process Oil Meal. Metzger Seed and Oil Co., Toledo, O. Flaxseed. Contains not more than 10 per cent crude fiber, and not less than 5 per cent fat and 30 per cent protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Midland Brand Pure Old Process Ground Linseed Cake. Midland Linseed Products Co., Minneapolis, Minn. Flaxseed only. Contains not more than 9½ per cent crude fiber, and not less than 5 per cent fat and 32 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Major Brand Old Process Oil Meal. Toledo Seed & Oil Co., Toledo, O. Flaxseed. Contains not more than 10 per cent crude fiber, and not less than 5 per cent fat and 30 per cent protein. Registered in 1915 and 1916.	Two official samples, practically in accord with guaranty.

GLUTEN FEEDS AND MEAL.

Cream of Corn Gluten Feed. American Maize Products Co., New York, N. Y. On 1915 certificate: Corn starch by-product with corn bran. Contains not more than 8½ per cent crude fiber and not less than 2½ per cent fat and 23 per cent protein. On 1916 certificate: Corn gluten feed. Contains not more than 8½ per cent crude fiber and not less than 1½ per cent fat and 24 per cent protein. Registered in 1915 and 1916.	One official sample, in accord with guaranty
Clinton Corn Gluten Feed. Clinton Sugar Refining Co., Clinton, Iowa. Corn gluten feed. Contains not more than 8 per cent crude fiber, and not less than 3 per cent fat and 23 per cent protein. Registered in 1915 and 1916.	One official sample in accord with guaranty. No weed seeds found.
Buffalo Corn Gluten Feed. Corn Products Refining Co., New York, N. Y. Corn gluten feed. Contains not more than 8.5 per cent crude fiber, and not less than 1 per cent fat and 23 per cent protein. Registered in 1915 and 1916.	Two dealers' and 11 official samples, all in excess of guaranteed protein, and guaranteed fat. In no case was the fiber found to overrun the maximum guaranty. No weed seeds found.
Crescent Corn Gluten Feed. Corn Products Refining Co., New York. Corn gluten feed. Contains not more than 8.5 per cent crude fiber, and not less than 1 per cent fat and 23 per cent protein. Registered in 1915 and 1916.	One official sample, above guaranty in protein and fat, and did not exceed maximum fiber. No weed seeds found.
Diamond Corn Gluten Meal. Corn Products Refining Co., New York, N. Y. Corn gluten meal. Contains not more than 4 per cent crude fiber, and not less than 1 per cent fat and 40 per cent protein. (1915 certificate gives 1.5 per cent as minimum fat). Registered in 1915 and 1916.	Two official samples found to overrun in protein, underrun in fat, and overrun in fiber. No weed seeds found.

FEEDING STUFFS—Continued.

BRAND, MAKER AND GUARANTIES.	RESULTS OF EXAMINATION.
Globe Corn Gluten Feed. Corn Products Refining Co., New York, N. Y. Corn gluten feed. Contains not more than 8.5 per cent crude fiber, and not less than 1 per cent fat and 23 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Douglas Corn Gluten Feed. Douglas Co., Cedar Rapids, Iowa. Corn gluten feed. Contains not more than 8 per cent crude fiber, and not less than 1 per cent fat and 23 per cent protein. (1915 certificate gives 2 per cent as minimum fat). Registered in 1915 and 1916.	No dealers' or official samples received.
K K K Corn Gluten Feed. J. C. Hubinger Bros. Co., Keokuk, Iowa. Corn starch by-product with corn solubles. Contains not more than 7.5 per cent crude fiber, and not less than 2.4 per cent fat and 23 per cent proteim. Registered in 1915 and 1916.	One official sample, substantially in accord with guaranty. No weed seeds found.
Jenks Corn Gluten Feed. Huron Milling Co., Harbor Beach, Mich. Corn starch by-product with corn bran. Contains not more than 8 per cent crude fiber, and not less than 3 per cent fat and 22 per cent protein. Registered in 1915 and 1916.	Five official samples practically in accord with guaranty. No weed seeds found.
Staley's Corn Gluten Feed. A. E. Staley Manufacturing Co., Decatur, Ill. Composed of corn bran, corn gluten, germ oil meal and concentrated steep water. Contains not more than 12 per cent crude fiber, and not less than 2½ per cent fat and 23 per cent protein. Not registered in 1915 Registered in 1916.	One official sample, practically in accord with guaranty. No weed seeds found.

CORN OIL CAKE MEAL.

Argo Corn Oil Cake Meal. Corn Products Refining Co., New York, N. Y. Corn oil cake meal. Contains not more than 13 per cent. crude fiber, and not less than 7 per cent. fat and 18 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.

BREWERS' GRAINS AND DISTILLERS' GRAINS.

Ajax Flakes. Manufactured by Chapin & Co., Hammond, Ind., for Ajax Milling & Feed Co., New York, N. Y. (Registered by Chapin & Co.) Corn distillers' grains. Contains not more than 14 per cent. crude fiber, and not less than 10 per cent. fat and 30 per cent. protein. (1915 certificate gives 11 per cent. as minimum fat.) Registered in 1915 and 1916.	Four official samples in accord with guaranty. One sample carried a few seeds of mustard. No weed seeds found in the other samples.
Continental Gluten Feed, Continental Cereal Co., Peoria, Ill. A distillery by-product manufactured from corn, oats, rye and barley. Contains not more than 10 per cent. crude fiber, and not less than 10 per cent. fat and 29 per cent. protein. Registered in 1915 and 1916.	One dealer's sample and one official sample Three per cent. below in protein; official sample 2 per cent. below in fat, slightly overrun in fiber. No weed seeds found.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Corn Three D Grains. The Dewey Brothers Co., Blanchester, Ohio. Distillers' dried grains principally from corn. Contains not more than 13 per cent. crude fiber, and not less than 9 per cent. fat and 26 per cent. protein. Registered in 1915 and 1916.	One official sample, practically in accord with guaranty. No weed seeds found.
Bull Brand Dried Brewers' Grains. Farmers Feed Co., Buffalo, N. Y. Composed of barley malt, rice, grit and corn. Contains not more than 15.2 per cent. crude fiber, and not less than 6.3 per cent. fat and 27.2 per cent. protein. (1915 certificate gives 17.2 as maximum fiber.) Registered in 1915 and 1916.	No dealers' or official samples received.
Hector Distillers Dried Grains. The Hottelet Co., Milwaukee, Wis. Distillers dried grains is the offal of distilleries. No mixture of other ingredients. Contains not more than 14 per cent. crude fiber, and not less than 10 per cent. fat and 30 per cent. protein. Registered in 1915 and 1916.	Two official samples, practically in accord with guaranty. No weed seeds found.
Brownie Grains. Larrowe Milling Co., Detroit, Mich. Steam dried distillers' grains made principally from corn. Contains not more than 9 per cent. crude fiber, and not less than 7 per cent. fat and 26 per cent. protein. Registered in 1915 and 1916.	Two official samples well up to guaranty in protein and fat; one sample exceeded the maximum guaranty of fiber. No weed seeds found.
Fourex (XXXX) Distillers Dried Corn Grains. Ubiko Milling Co., Cincinnati, O. Contains not more than 13 per cent. crude fiber, and not less than 12 per cent. fat and 31 per cent. protein. Registered in 1915 and 1916.	Four official samples. One in accord with guaranty in protein; 1 slightly below guaranty in protein; 2 about 1½ per cent below guaranty in protein. One sample examined for fiber and fat found to slightly overrun maximum guaranty of fiber, and about 2½ per cent below minimum guaranty of fat. No weed seeds found.

DRIED BEET PULP.

Dried Beet Pulp. Larrowe Milling Co., Detroit, Mich. Residue of sugar beets dried after extraction of sugar. Contains not more than 20 per cent. crude fiber, and not less than ½ of 1% fat and 8 per cent. protein. Registered in 1915 and 1916.	Two official samples practically in accord with guaranty. No weed seeds found.
Dried Beet Pulp. Charles Pope, Riverdale, Cook Co., Ill. Composed only of residue of sugar beets dried after extraction of sugar. Contains not more than 20 per cent. crude fiber, and not less than ½ per cent. fat and 8 per cent. protein. Registered in 1915 and 1916.	Two official samples practically in accord with guaranty. No weed seeds found.

BRAN, MIDDLINGS, MIXED FEED, RED DOG FLOUR.

Acme Feed. Acme-Evans Co., Indianapolis, Ind. Composed of wheat bran, wheat middlings and not exceeding mill's run of ground, cleaned wheat screenings. Contains not more than 9 per cent. crude fiber and not less than 4 per cent. fat and 16.5 per cent. protein. Registered in 1915 and 1916.	One official sample. Practically in accord with guaranty. Contained few hulls of corn cockle.

FEEDING STUFFS—Continued.

BRAND, MAKER AND GUARANTIES.	RESULTS OF EXAMINATION.
Wheat Bran and Scourings. Aetna Mills Co., Wellington, Kans. No certificate filed. Claims on package Not more than 10 per cent. crude fiber, and not less than 3.5 per cent. fat and 14.5 per cent. protein. Unregistered.	One official sample. Above guaranty in protein and fat. Below maximum guaranty of fiber.
Trojan Bran. Allen & Wheeler Co., Troy, Ohio. Pure offal from wheat. Contains not more than 9.5 per cent. crude fiber, and not less than 4 per cent. fat and 14.5 per cent. protein. Registered in 1915 and 1916.	Two official samples in accord with guaranty. Contained few hulls of corn cockle.
Trojan Middlings. Allen & Wheeler Co., Troy, Ohio. Offal from wheat containing wheat screenings not exceeding mill run. Contains not more than 6 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Trojan Mixed Feed. Allen & Wheeler Co., Troy, Ohio. Offal from wheat containing wheat screenings not exceeding mill run. Contains not more than 8 per cent. crude fiber, and not less than 4 per cent. fat and 14.5 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty. Contained few hulls of corn cockle.
Bran (Registered in 1915 as William Tell Bran with ground screenings not exceeding mill run.) Ansted & Burk Co., Springfield, Ohio. Composed of wheat bran with ground screenings not exceeding mill run. Contains not more than 11½ per cent. crude fiber, and not less than 3 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Middlings (Registered in 1915 as William Tell Middlings with ground screenings not exceeding mill run.) Ansted & Burk Co., Springfield, Ohio. Composed of wheat middlings with ground screenings not exceeding mill run. Contains not more than 7½ per cent. crude fiber, and not less than 4 per cent. fat and 14½ per cent. protein. Registered in 1915 and 1916.	Three official samples. In accord with guaranty. No weed seeds found.
Mixed Feed (Registered in 1915 as William Tell Mixed Feed with ground screenings not exceeding mill run). Ansted & Burk Co., Springfield, Ohio. Composed of wheat bran and middlings mixed with ground screenings not exceeding mill run. Contains not more than 11½ per cent. crude fiber, and not less than 3½ per cent. fat and 14½ per cent. protein. Registered in 1915 and 1916.	One official sample practically in accord with guaranty. Contained few hulls of corn cockle and wild buckwheat.
Wheat Bran and Wheat Screenings. Aunt Jemima Mills Co., St. Joseph, Mo. Composed of wheat bran and wheat screenings (not exceeding mill run). Contains not more than 10 per cent. crude fiber, and not less than 3.5 per cent. fat and 14.5 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Banner Flour Middlings. Banner Milling Co., Buffalo, N. Y. Wheat middlings with ground screenings not exceeding mill run. Contains not more than 9.75 per cent. crude fiber, and not less than 4.25 per cent. fat and 15 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Bran Flakes. Barber Milling Co., Minneapolis, Minn. Pure wheat. Contains not more than 13 per cent. crude fiber, and not less than 4 per cent. fat and 13 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Fancy Low Grade. Barber Milling Co., Minneapolis, Minn. Pure wheat. Contains not more than 4 per cent. crude fiber, and not less than 5 per cent. fat and 18 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Reddog Flour. Bay State Milling Co., Winona, Minn. Pure wheat product. On 1915 certificate: Contains not more than 2.5 per cent. crude fiber, and not less than 4.05 per cent. fat and 18 per cent. protein. On 1916 certificate: Contains not more than 2 per cent. crude fiber, and not less than 5 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
"Winona" Coarse Wheat Bran. Bay State Milling Co., Winona, Minn. Pure wheat product. On 1915 certificate: Contains not more than 11 per cent. crude fiber, and not less than 5 per cent. fat and 15 per cent. protein. On 1916 certificate: Contains not more than 12 per cent. crude fiber, and not less than 4 per cent. fat and 13 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples receive
"Winona" Fancy Mixed Wheat Feed & Wheat Screenings. Bay State Milling Co., Winona, Minn. Composed of wheat bran, middlings and reddog flour, and less than 6 per cent. ground screenings from wheat. On 1915 certificate: Contains not more than 10 per cent crude fiber, and not less than 5 per cent. fat and 17 per cent. protein. On 1916 certificate: Contains not more than 8 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
"Winona" Fancy White Flour Middlings. Bay State Milling Co., Winona, Minn. Pure wheat product. On 1915 certificate: Contains not more than 3 per cent. crude fiber, and not less than 4.5 per cent. fat and 18 per cent. protein. On 1916 certificate: Contains not more than 2.5 per cent. crude fiber, and not less than 5 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
"Winona" Wheat Middlings and Wheat Screenings. Bay State Milling Co., Winona, Minn. Pure wheat product and less than 8 per cent. ground screenings from wheat. Contains not more than 8 per cent. crude fiber, and not less than 5 per cent. fat and 15 per cent. protein. (1915 certificate gives 17 per cent. as minimum protein guaranty). Registered in 1915 and 1916.	One official sample in accord with guaranty. Screenings apparently as claimed.
Big Diamond Bran. Big Diamond Mills Co., Minneapolis, Minn. Wheat bran with ground screenings not exceeding mill run. Contains not more than 11.07 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Big Diamond Wheat Mixed Feed, composed of wheat bran, flour middlings, and ground screenings not exceeding mill run. Big Diamond Mills Co., Minneapolis, Minn. Contains not more than 8 per cent. crude fiber, and not less than 4.5 per cent. fat and 19 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Wheat Bran with mill run screenings. Blacker Flour Mills Co., Kansas City, Mo. No certificate filed. Claims on package: Contains not more than 8.5 per cent. crude fiber, and not less than 3.5 per cent. fat and 15.5 per cent. protein. Unregistered.	One official sample in accord with claims on package. Not tested for weed seeds.
Blanton Mixed Feed. Blanton Milling Co., Indianapolis, Ind. Wheat bran, middlings and whole wheat screenings. Contains not more than 10 per cent. crude fiber and not less than 3.7 per cent. fat and 15.7 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Bull's Eye Mixed Feed. Blish Milling Co., Seymour, Ind. Bran and middlings. Contains not more than 9.1 per cent. crude fiber, and not less than 4.4 per cent. fat and 16 per cent. protein. Registered in 1915 and 1916.	One official sample substantially in accord with guaranty. Contained some hulls of corn cockle.
Pure Wheat Bran. Bowersock Mills & Power Co., Lawrence, Kansas. Bran and screenings. Contains not more than 12 per cent. crude fiber, and not less than 3.75 per cent. fat and 14.5 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample in accord with guaranty. Contained few hulls of wild buckwheat.
Middlings. Christian Breisch & Co., N. Lansing, Mich. Contains not more than 4.13 per cent. crude fiber, and not less than 14.96 per cent. protein. Ash 4.21 per cent., ether extract 5.25 per cent., nitrogen-free extract 61.23 per cent. Registered in 1915 and 1916.	No dealers' or official samples received.
Mixed Feed, Ground Screenings not to exceed mill run. Christian Breisch & Co., N. Lansing, Mich. On 1915 certificate: Contains not more than 8.47 per cent. crude fiber, and not less than 13.56 per cent. protein. Ether extract 2.58 per cent. Nitrogen-free extract 58.54 per cent. On 1916 certificate: Contains not more than 7.06 per cent. crude fiber, and not less than 14.61 per cent. protein. Ash 12.07 per cent. Ether extract 3.63 per cent. Nitrogen-free extract 57.19 per cent. Registered in 1915 and 1916.	No dealers' or official samples received.
Flour Middlings. Buffalo Cereal Co., Buffalo, N. Y. With not to exceed mill run ground screenings. Contains not more than 8 per cent. crude fiber, and not less than 4½ per cent. fat and 16 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Middlings. W. A. Burling. (Registered by Chas. M. Cox Co., Boston, Mass.) Wheat middlings. Contains not more than 7.2 per cent. crude fiber, and not less than 3.7 per cent. fat and 14.6 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Choice Bran. L. G. Campbell Mfg. Co., Owatonna, Minn. Contains not more than 12.2 per cent. crude fiber, and not less than 4.5 per cent. fat and 13.4 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Unadulterated Wheat Mixed Feed. Cavalier Milling Co., Cavalier, N. D. (Registered by Chas. M. Cox Co., Boston, Mass.) Composed of wheat bran and wheat middlings. Contains not more than 10 per cent. crude fiber, and not less than 4.5 per cent. fat and 14 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Bran with screenings not exceeding mill run. The Central Minn. Power & Milling Co., Sauk Center, Minn. Contains not more than 12 per cent. crude fiber, and not less than 4.5 per cent. fat and 13 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample, 1½ per cent. under guaranty in protein. Fiber and fat practically as claimed. Contained many hulls of corn cockle.
Jersey Wheat Bran with ground screenings not exceeding mill run. Geo. C. Christian & Co., Minneapolis, Minn. Contains not more than 12 per cent. crude fiber, and not less than 4 per cent. fat and 13 per cent. protein. Registered in 1915. Not registered in 1916.	One official sample practically in accord with guaranty. Contained a few seeds of pigweed, green foxtail, mustard and Lady's thumb. Some hulls of corn cockle and wild buckwheat.
Poland Wheat Standard Middlings with ground screenings not exceeding mill run. Geo. C. Christian & Co., Minneapolis, Minn. Contains not more than 9.5 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Matchless Wheat Middlings. L. Christian & Co., Minneapolis, Minn. No certificate filed. Claims on package: Contains not more than 6.4 per cent. crude fiber, and not less than 4.65 per cent. fat and 15.5 per cent. protein. Unregistered.	One official sample practically in accord with guaranty. Contained few seeds and many hulls of wild buckwheat.
Claro Mixed Feed with ground screenings. Claro Milling Co., Waseca, Minn. Composed of wheat bran, standard and flour middlings, red dog and ground screenings not exceeding mill run. Contains not more than 12 per cent. crude fiber, and not less than 3 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Claro Standard Middlings. Claro Milling Co., Waseca, Minn. Pure wheat by-product with ground screenings not exceeding mill run. Contains not more than 12 per cent. crude fiber, and not less than 3 per cent. fat and 14 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Claro Wheat Bran. Claro Milling Co., Waseca, Minn. Wheat bran with ground screenings not exceeding mill run. Contains not more than 12 per cent. crude fiber, and not less than 3 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	One official sample, protein and fiber in accord with guaranty. Fat above guaranty Contained a few seeds of lady's thumb, penny cress, pigweed and mustard. Many hulls of wild buckwheat and a few of corn cockle.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Middlings with ground screenings not exceeding mill run. The Colton Bros. Co., Bellefontaine, Ohio. Contains not more than 6 per cent. crude fiber, and not less than 4.5 per cent. fat and 16 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Wheat bran with ground screenings not exceeding mill run. The Colton Bros. Co., Bellefontaine, Ohio. Contains not more than 9 per cent. crude fiber, and not less than 4.5 per cent. fat and 15 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Mixed Feed. The Colton Bros. Co., Bellefontaine, Ohio. Wheat with ground screenings not exceeding mill run. Contains not more than 8 per cent. crude fiber, and not less than 4.5 per cent. fat and 15.5 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample. Slightly high in protein and slightly low in fat. Fiber, below maximum. Contained a few hulls of corn cockle.
Commander Bran. Commander Mill Co., Minneapolis, Minn. Wheat bran with ground screenings not exceeding mill run. Contains not more than 11 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Standard Wheat Middlings with ground screenings not exceeding mill run. The Commercial Milling Co., Detroit, Mich. On 1915 certificate: Contains not more than 9 per cent. crude fiber, and not less than 5 per cent. fat and 16 per cent. protein. On 1916 certificate: Contains not more than 10 per cent. crude fiber, and not less than 4.5 per cent. fat and 13.5 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Wheat Bran with ground screenings not exceeding mill run. The Commercial Milling Co., Detroit, Mich. Contains not more than 12 per cent. crude fiber, and not less than 3.5 per cent. fat and 14.5 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Wheat Fine Middlings with ground screenings not exceeding mill run. The Commercial Milling Co., Detroit, Mich. Contains not more than 6 per cent. crude fiber, and not less than 7 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Wheat Mill Feed Middlings. The Commercial Milling Co., Detroit, Mich. Wheat middlings with ground screenings not exceeding mill run. Contains not more than 11 per cent. crude fiber, and not less than 4 per cent. fat and 13.5 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Wheat Mixed Feed with ground screenings not exceeding mill run. The Commercial Milling Co., Detroit, Michigan. Contains not more than 11 per cent. crude fiber, and not less than 4.5 per cent. fat and 14 per cent. protein (1915 certificate gives 15 per cent. as minimum protein). Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Wheat Bran. Wm. A. Coombs Milling Co., Coldwater, Mich. Wheat bran with ground screenings not exceeding mill run. Contains not more than 10 per cent. crude fiber, and not less than 3 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	Two official samples. In accord with guaranty. Contained seeds of corn cockle and chess. Few hulls of corn cockle and wild buckwheat.
Wheat Middlings. Wm. A. Coombs Milling Co., Coldwater, Mich. Wheat middlings with ground screenings not exceeding mill run. Contains not more than 9 per cent. crude fiber, and not less than 3 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916	No dealers' or official samples received.
Wheat Mixed Feed. Wm. A. Coombs Milling Co., Coldwater, Mich. Wheat mixed feed with ground screenings not exceeding mill run. Contains not more than 10 per cent. crude fiber, and not less than 3 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	One official sample practically in accord with guaranty. Contains a few seeds of mustard, yellow foxtail, green foxtail, pigweed and lady's thumb. Many hulls of wild buckwheat and a few of corn cockle.
Dudley Wheat Bran with ground screenings not exceeding mill run. Chas. M. Cox Co., Boston, Mass. Contains not more than 9 per cent. crude fiber, and not less than 4 per cent. fat and 15.5 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Monogram Fancy Bran. Chas. M. Cox Co., Boston, Mass. Wheat bran, ground screenings not exceeding mill run. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Newport Winter Bran with ground screenings not exceeding mill run. Chas. M. Cox Co., Boston, Mass. Contains not more than 11 per cent. crude fiber, and not less than 3.5 per cent. fat and 14.5 per cent. protein. Registered in 1915. Not registered in 1916.	One official sample practically in accord with guaranty. Contained a few seeds of mustard, green foxtail, and lady's thumb. Few hulls of yellow foxtail, wild buckwheat and corn cockle.
Wirthmore Middlings. Chas. M. Cox Co., Boston, Mass. Wheat middlings and reddog flour. Contains not more than 7 per cent. crude fiber, and not less than 4 per cent. fat and 14½ per cent. protein. (1915 certificate gives 15 as minimum protein). Registered in 1915 and 1916.	No dealers' or official samples received.
Wirthmore Wheat Feed. Chas. M. Cox Co., Boston, Mass. Composed of wheat bran, reddog flour, less than mill run of screenings. Contains not more than 7 per cent. crude fiber and not less than 4½ per cent. fat and 15 per cent. protein (1915 certificate gives 4 per cent. as minimum fat and 16 per cent. as minimum protein). Registered in 1915 and 1916.	One official sample, 1 per cent. low in protein; 2 per cent. high in fiber; in accord with guaranty in fat. Contained few seeds of pigweed. Some hulls of wild buckwheat and corn cockle.
Wheat Bran with ground screenings not exceeding mill run. Crystal Milling Co. (Registered by Chas. M. Cox Co., Boston, Mass.) Contains not more than 11.8 per cent. crude fiber, and not less than 3.65 per cent. fat and 13.25 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.

FEEDING STUFFS—Continued.

BRAND, MAKER AND GUARANTIES.	RESULTS OF EXAMINATION.
Boston Mixed Feed. Duluth-Superior Milling Co., Duluth, Minn. Bran, middlings, reddog flour, and not to exceed mill run of screenings. Contains not more than 9.75 per cent crude fiber, and not less than 4.25 per cent fat and 15 per cent protein. Registered in 1915 and 1916.	One dealers' sample and one official sample. Both in accord with guaranty. Contained few hulls of corn cockle and wild buckwheat.
Duluth Imperial Bran. Duluth-Superior Milling Co, Duluth, Minn. Bran and not exceeding mill run screenings. Contains not more than 12.25 per cent crude fiber, and not less than 3.75 per cent fat and 14.5 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Flour Middlings. Duluth-Superior Milling Co., Duluth, Minn. On 1915 cetrificate Contains not more than 7.5 per cent crude fiber and not less than 5 per cent fat and 16.25 per cent protein. On 1916 certificate Contains not more than 7 per cent crude fiber, and not less than 5 per cent fat and 16.5 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Red Dog Flour. Duluth-Superior Milling Co., Duluth, Minn. Contains not more than 3 per cent crude fiber, and not less than 4.25 per cent fat and 16.75 per cent protein. Registered in 1915 and 1916.	One official sample, 1 per cent low in protein. Practically in one accord with guaranty in fiber and fat.
S Middlings. Duluth-Superior Milling Co., Duluth, Minn. Middlings and not exceeding mill run screenings. Contains not more than 7.75 per cent crude fiber, and not less than 4.75 per cent fat and 16.5 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Durham Mixed Feed. Eastern Grain Co., Portland, Maine. Composed of wheat bran and middlings, with ground screenings not to exceed mill run. Contains not more than 7 per cent crude fiber, and not less than 4 per cent fat and 16 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Superb Red Dog Flour. Eagle Roller Mills, New Ulm, Minn. No certificate filed. Claims on package Contains not more than 7.4 per cent crude fiber, and not less than 4.4 per cent fat and 17 per cent protein. Unregistered.	One official sample in accord with guaranty in protein and fat. Much less fiber than the maximum claimed.
Mill Feed. Eldred Mill Co., Jackson, Mich. Straight offal run of mill with no mixture of ground screenings or receiving separation dust. This feed is a strictly pure wheat feed. Contains not more than 9.62 per cent crude fiber, and not less than 4.37 per cent fat and 14.57 per cent protein. Registered in 1915. Not registered in 1916.	One official sample in accord with guaranty. Contained few hulls of Corn cockle.
Pure Bran. Eldred Mill Co., Jackson, Mich. Made from pure wheat with no admixture of ground screenings or receiving separator dust. Contains not more than 9.24 per cent crude fiber, and not less than 4.99 per cent fat and 16.19 per cent protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Pure Middlings. Eldred Mill Co., Jackson, Mich. These middlings made from pure wheat with no mixture of ground screenings or receiving separator dust. Contains not more than 6.74 per cent crude fiber, and not less than 6.2 per cent fat and 16.93 per cent protein. Registered in 1915. Not registered in 1916.	No dealers' or officials samples received.
Elmore Flour Middlings. Elmore Milling Co., Oneonta, N. Y. Low grade wheat flour—wheat middlings. Contains not more than 5 per cent crude fiber, and not less than 4.25 per cent fat and 16.5 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Elmore Snow Middlings. Elmore Milling Co., Oneonta, N. Y., Low grade wheat flour—wheat middlings. Contains not more than 4.5 per cent crude fiber, and not less than 4.25 per cent fat and 17 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
E-A-CO Mixed Feed. Everett, Aughenbaugh & Co., Waseca, Minn. Wheat bran, middlings and ground screenings not exceeding mill run. Contains not more than 12 per cent crude fiber, and not less than 3 per cent fat and 15 per cent protein. (1915 certificates give 5 per cent as minimum fat). Registered in 1915 and 1916.	No dealers' or official sample received.
E-A-CO Wheat Bran. Everett, Aughenbaugh & Co., Waseca, Minn. Wheat bran and ground screenings not exceeding mill run. Contains not more than 12 per cent crude fiber, and not less than 3 per cent fat and 14 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
E-A-CO Wheat Middlings. Everett, Aughenbaugh & Co., Waseca, Minn. Standard and flour middlings and ground screenings not exceeding mill run. Contains not more than 10 per cent crude fiber, and not less than 3 per cent fat and 15 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Durum Wheat Mixed Feed. Farmers Mill Grain Co., Milnor, No. Dak. Durum wheat bran and middlings mixed, full mill run of feed. Contains not more than 10 per cent crude fiber, and not less than 4.09 per cent fat and 12.05 per cent protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
National Wheat Bran. Farmers Union Grain & Supply Co., Waterville, Maine. Wheat bran and screenings. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Dairy Maid Winter Wheat Bran with ground screenings not exceeding mill run. Federal Milling Co., Lockport, N. Y. Winter wheat offal with ground screenings not exceeding mill run. On 1915 certificate: Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 14.5 per cent. protein. On 1916 certificate: Contains not more than 14 per cent. crude fiber, and not less than 2.5 per cent. fat and 13 per cent. protein. Registered in 1915 and 1916.	Three official samples in accord with 1916 guaranty. Contained few seeds of corn cockle, mustard, chess, dock and quack grass. Some hulls of corn cockle and wild buckwheat.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Dairy Maid Winter Wheat Middlings with ground screenings not exceeding mill run. Federal Milling Co., Lockport, N. Y. Winter wheat offal with ground screenings not exceeding mill run. Contains not more than 8.5 per cent. crude fiber, and not less than 3.5 per cent. fat and 13.5 per cent. protein. (1915 certificate gives 9 per cent. as maximum fiber). Registered in 1915 and 1916.	One official sample. Protein and fat in accord with claims. Fiber much less. Not examined for weed seeds.
Dairy Maid Winter Wheat Mixed Feed with ground screenings not exceeding mill run. Federal Milling Co., Lockport, N. Y. Winter wheat offal with ground screenings not exceeding mill run. On 1915 certificate: Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. On 1916 certificate: Contains not more than 11 per cent. crude fiber, and not less than 3 per cent. fat and 13.5 per cent. protein. Registered in 1915 and 1916.	Two official samples in accord with guaranty. Contained a few seeds of mustard, penny cress and cow herb, wild buckwheat and mustard. Some hulls of corn cockle and wild buckwheat.
"Dairy" Winter Wheat Middlings with ground screenings not exceeding mill run. Federal Milling Co., Lockport, N. Y. Winter wheat offal with ground screenings not exceeding mill run. Contains not more than 8 per cent. crude fiber, and not less than 4.5 per cent. fat and 14 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Kennel Club Flour. Federal Milling Co., Lockport, N. Y. Second clear wheat flour. Contains not more than 1 per cent. crude fiber, and not less than 2 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Lucky Spring Wheat Bran with ground screenings not exceeding mill run. Federal Milling Co., Lockport, N. Y. Spring wheat offal with ground screenings not exceeding mill run. On 1915 certificate: Contains not more than 11 per cent. crude fiber, and not less than 4.5 per cent. fat and 15 per cent. protein. On 1916 certificate. Contains not more than 14 per cent. crude fiber, and not less than 2.5 per cent. fat and 13 per cent. protein. Registered in 1915 and 1916.	Two official samples. Protein and fat very considerably above guaranty. Fiber below maximum claimed. Contained many seeds of mustard and pigweed. A few of field peppergrass, penny cress and peppergrass. Many hulls of mustard, pigweed and wild buckwheat. Few of yellow foxtail and corn cockle.
Lucky Spring Wheat Flour Middlings with ground screenings not exceeding mill run. Federal Milling Co., Lockport, N. Y. Spring wheat offal with ground screenings not exceeding mill run. On 1915 certificate: Contains not more than 9 per cent. crude fiber, and not less than 5 per cent. fat and 17 per cent. protein. On 1916 certificate: Contains not more than 8.5 per cent. crude fiber, and not less than 3.5 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Lucky Spring Wheat Mixed Feed with ground screenings not exceeding mill run. Federal Milling Co., Lockport, N. Y. Spring wheat offal with ground screenings not exceeding mill run. On 1915 certificate: Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. On 1916 certificate: Contains not more than 11 per cent. crude fiber, and not less than 3 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Sphinx Fancy Spring Wheat Flour Middlings with ground screenings not exceeding mill run. Federal Milling Co., Lockport, N. Y. Spring wheat offal with ground screenings not exceeding mill run. On 1915 certificate: Contains not more than 9 per cent. crude fiber, and not less than 4.5 per cent. fat and 17 per cent. protein. On 1916 certificate: Contains not more than 8 per cent. crude fiber, and not less than 3.5 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Sphinx Fancy Spring Wheat Mixed Feed, with ground screenings not exceeding mill run. Federal Milling Co., Lockport, N. Y. Spring wheat offal with ground screenings not exceeding mill run. Contains not more than 11 per cent. crude fiber, and not less than 3 per cent. fat and 13.5 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Ideal Mixed Feed. Fergus Flour Mills Co., Fergus Falls, Minn. Wheat bran and wheat middlings. Contains not less than 4.6 per cent. fat and 17 per cent. protein. (Crude fiber guaranty not given on certificates). Registered in 1915 and 1916.	One official sample. More than 2 per cent. below guaranty in protein. Contained about 9 per cent. of fiber. Fat in accord with guaranty. Contained few hulls of corn cockle and wild buckwheat.
"Peerless" Mixed Feed. Fuller-Holway Co., Augusta, Me. Wheat bran, middlings, low grade flour, with ground screenings not to exceed mill run. Contains not more than 7.9 per cent. crude fiber, and not less than 4 per cent. fat and 15.5 per cent. protein. (1915 certificate gives 4.15 per cent. fat and 16.5 per cent. protein as minimum guarantees). Registered in 1915 and 1916.	No dealers' or official samples received.
Wheat Standard Middlings. Gardner Mills (Shane Bros. & Wilson, Proprietors), Hastings, Minn. Wheat middlings with ground screenings not exceeding mill run, manufactured from wheat. Contains not more than 10 per cent. crude fiber, and not less than 4.5 per cent. fat and 15.9 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Garland Mixed Feed. Garland Milling Co., Greensburg, Ind. Winter wheat product: Bran, middlings, screenings and wheat cleanings not exceeding mill run. Contains not more than 9 per cent. crude fiber, and not less than 4 per cent. fat and 16 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Globe Dairy Feed. Globe Elevator Co., Buffalo, N. Y. Composed of wheat bran, wheat middlings, ground wheat screenings, low grade flour. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Grafton Wheat Feed. The Grafton Roller Mill Co., Grafton, N. Dak. Mill feed made of wheat. Contains not more than 9.3 per cent. crude fiber, and not less than 4.5 per cent. fat and 15.4 per cent. protein. Registered in 1915 and 1916.	Two official samples. Quite uneven. One sample up to guaranty. The other nearly 1 per cent. below guaranty in protein. One sample below the maximum claimed for fiber, and the other 4 per cent. above the maximum claim of fiber. Fat somewhat above guaranty. Contained a few hulls of charlock. Few seeds of mustard.
Red Dog. Griswold & Mackinnon, St. Johnsbury, Vt. Wheat. Contains not more than 3.74 per cent. crude fiber, and not less than 4 per cent. fat and 15.05 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Xtragood Mixed Feed. Griswold & Mackinnon, St. Johnsbury, Vt. Wheat by-products. Contains not more than 7.5 per cent. crude fiber, and not less than 4 per cent. fat and 16 per cent. protein. Registered in 1915 and 1916.	One official sample, 1 per cent. low in protein. Fiber and fat in accord with guaranty. Contained some hulls of corn cockle.
Dairy Feed with screenings not exceeding mill run. Gwinn Milling Co., Columbus, Ohio. Bran and middlings with screenings not exceeding mill run. On 1915 certificate: Contains not more than 7 per cent. crude fiber, and not less than 4 per cent. fat and 16 per cent. protein. On 1916 certificate: Contains not more than 9 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	Two official samples. One sample low in protein. Otherwise in accord with guaranty. Contained few hulls of corn cockle, wild buckwheat and chess.
Gwinn's Red Dog. Gwinn Milling Co., Columbus, O. Wheat product. Contains not more than 5 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Gwinn's Wheat Bran with screenings not exceeding mill run. Gwinn Milling Co., Columbus, Ohio. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. (1915 certificate gives 8 per cent. as maximum fiber). Registered in 1915 and 1916.	Two official samples practically in accord with guaranty in protein and fat. Overrun a few per cent. in fiber. Contained a few hulls of corn cockle.
Wheat Middlings with screenings not exceeding mill run. Gwinn Milling Co., Columbus, O. Contains not more than 7.5 per cent. crude fiber, and not less than 4 per cent. fat and 16 per cent. protein. (1915 certificate gives 6 per cent. as maximum fiber). Registered in 1915 and 1916.	No dealers' or official samples received.
Acme Middlings. Jonathan Hale & Sons, Lyons & Ionia, Mich. Contains not more than 7.2 per cent. crude fiber, and not less than 3.7 per cent. fat and 14.6 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Acme Mixed Feed. Jonathan Hale & Sons, Lyons and Ionia, Mich. Bran and middlings mixed. Contains not more than 7.4 per cent. crude fiber, and not less than 3.6 per cent. fat and 14.53 per cent. protein. Registered in 1915. Not registered in 1916.	One official sample. Protein and fat in accord with guaranty. Fiber 2 per cent. too high. Contained few seeds of chess and corn cockle, and some hulls of corn cockle.
Flake Bran. Jonathan Hale & Sons, Lyons and Ionia, Mich. Contains not more than 7.5 per cent. crude fiber, and not less than 3.5 per cent. fat and 14 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Harter's Mainspring Mixed Feed. The Harter Milling Co., Toledo, O. Wheat and wheat screenings not exceeding mill run. Contains not more than 8 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Not registered in 1915. Registered in 1916.	Two official samples. Practically in accord with guaranty. Contained some hulls of corn cockle and a few of wild buckwheat.
Choice Wheat Bran with Trace of Screenings. Hecker-Jones-Jewell Milling Co., Buffalo, N. Y. Made from wheat. On 1915 certificate: Contains not more than 11.75 per cent. crude fiber, and not less than 3.5 per cent. fat and 15 per cent. protein. On 1916 certificate: Contains not more than 11.5 per cent. crude fiber, and not less than 4.25 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty. Contained a few seeds of mustard, and some hulls of wild buckwheat and corn cockle.
Fancy White Middlings. Hecker-Jones-Jewell Milling Co., Buffalo, N. Y. Made from wheat. Contains not more than 5.5 per cent. crude fiber, and not less than 5 per cent. fat and 16.75 per cent. protein. (1915 certificate gives 16.5 per cent. as minimum fiber). Registered in 1915 and 1916.	No dealers' or official samples received.
Flour Middlings with mill run screenings. Hecker-Jones-Jewell Milling Co., Buffalo, N. Y. Made from wheat. Contains not more than 8 per cent. crude fiber, and not less than 5.5 per cent. fat and 16 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Mixed Feed with mill run screenings. Hecker-Jones-Jewell Milling Co., Buffalo, N. Y. Made from wheat. On 1915 certificate Contains not more than 9 per cent. crude fiber, and not less than 5 per cent. fat and 15.75 per cent. protein. On 1916 certificate: Contains not more than 9.25 per cent. crude fiber, and not less than 5.25 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Standard Middlings with mill run screenings. Hecker-Jones-Jewell Milling Co., Buffalo, N. Y. Made from wheat. Contains not more than 8.5 per cent. crude fiber, and not less than 6 per cent. fat and 16.5 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Red Dog. Hecker-Jones-Jewell Milling Co., Buffalo, N. Y. Made from wheat. On 1915 certificate: Contains not more than 5.25 per cent. crude fiber, and not less than 5 per cent. fat and 16.75 per cent. protein. On 1916 certificate: Contains not more than 5 per cent. crude fiber, and not less than 4.5 per cent. fat and 16.75 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Wheat Bran with screenings not exceeding mill run. Highland Milling Co., Highland, Ill. Bran from wheat with screenings not exceeding mill run, screenings to amount to less than 5 per cent. Contains not more than 10 per cent. crude fiber, and not less than 3.55 per cent. fat and 14.3 per cent. protein. Registered in 1915 and 1916.	One official sample. Well in accord with guaranty. Contained some hulls of corn cockle and wild buckwheat.
Wheat bran and middlings run together. (Trade name for it, "Mixed Feed"). Highland Milling Co., Highland, Ill. Wheat bran and middlings run together with screenings not exceeding mill run. Contains not more than 9 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	One official sample. Above in protein and fat, and fiber below maximum guaranty. No weed seeds found.
Wheat Middlings with ground screenings not exceeding mill run. Highland Milling Co., Highland, Ill. Wheat middlings with not over 5 per cent. screenings. Contains not more than 6 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	One official sample. Above guaranty in protein and fat. Fiber as claimed. No weed seeds found.
Winter Wheat Mixed Feed, with screenings not exceeding mill run. Highland Milling Co., Highland, Ill. No certificate filed. Claims on package: Contains not more than 8 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Unregistered.	One official sample. Well above guaranty in protein. Contained few hulls of corn cockle.
Dreadnaught Bran and Screenings. Hunter-Robinson-Wenz Milling Co., St. Louis, Mo. Bran with ground screenings not exceeding mill run. Contains not more than 11 per cent. crude fiber, and not less than 4 per cent. fat and 15.5 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample. Above guaranty in protein; slightly below in fat; fiber below the maximum guaranty. Contained few hulls of corn cockle.
Jenks Mixed Feed. Huron Milling Co., Harbor Beach, Mich. Wheat bran and ground screenings not exceeding mill run. Contains not more than 5.85 per cent. crude fiber, and not less than 4.6 per cent. fat and 12.18 per cent. protein. (1915 certificate gives 12 per cent. as minimum protein). Registered in 1915 and 1916.	One official sample. Above guaranty in protein; low in fat; fiber overruns maximum guaranty by more than 2 per cent. Contained few seeds of chess, and few hulls of corn cockle.
Jenks White Middlings. Huron Milling Co., Harbor Beach, Mich. Contains not more than 3½ per cent. crude fiber, and not less than 2½ per cent. fat and 13 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty.
Wheat Bran. Indiana Milling Co., Terre Haute, Ind. Wheat bran with ground screenings not exceeding mill run. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Kehlor's Mill Feed. Kehlor Flour Mills Co., East St. Louis, Mo. Composed of pure wheat bran and brown middlings run together. Contains not more than 8 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Palace Bran. Kehlor Flour Mills Co., East St. Louis, Mo. Made from pure hard winter wheat. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 14½ per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Anchor Bran with ground wheat screenings not exceeding mill run. Kemper Mill & Elevator Co., Kansas City, Mo. Pure wheat bran and ground wheat screenings not exceeding the mill run. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 14.5 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty. No weed seeds found.
Anchor Pure Bran. Kemper Mill & Elevator Co., Kansas City, Mo. Pure winter wheat. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 14.5 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Carnation Gray Middlings with screenings not exceeding mill run. Kemper Mill & Elevator Co., Kansas City, Mo. Wheat shorts and ground screenings. Contains not more than 8 per cent. crude fiber, and not less than 4.3 per cent. fat and 16 per cent. protein. Registered in 1915. Not registered in 1916.	Two official samples. Protein above guaranty; fat in accord with guaranty; fibre somewhat below the maximum guaranty. Contained few seeds of rib grass and few hulls of wild buckwheat.
Crescent Middlings with ground wheat screenings not exceeding mill run. Kemper Mill & Elevator Co., Kansas City, Mo. Middlings and ground wheat screenings. Contains not more than 8 per cent. crude fiber, and not less than 4.25 per cent. fat and 10 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Crescent Mixed Feed with ground screenings not exceeding mill run. Kemper Mill & Elevator Co., Kansas City, Mo. Pure wheat bran and middlings with ground screenings. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 16 per cent. protein. (1915 certificate gives 5 per cent. as maximum fiber). Registered in 1915 and 1916.	Two official samples. In accord with guaranty. Contained some seeds of wild buckwheat, yellow foxtail and Pennsylvania persicaria. Also a few of green foxtail, pigweed, lady's thumb, bladder ketmia, chess and mustard.
Diamond "K" Bran with ground wheat screenings not exceeding mill run. Kemper Mill & Elevator Co., Kansas City, Mo. Wheat bran and ground wheat screenings. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 14.5 per cent. protein. Registered in 1915 and 1916.	Two official samples. Well above guaranty in protein. Fiber and fat in accord with guaranty. Contained a few seeds of wild buckwheat, dock and chess. Few hulls of corn cockle and wild buckwheat.

FEEDING STUFFS—Continued.

BRAND, MAKER AND GUARANTIES.	RESULTS OF EXAMINATION.
Pyramid Mixed Feed. Kimball Bros. Co., Bath, Me. Bran and middlings. Contains not more than 8.47 per cent. crude fiber, and not less than 3.5 per cent. fat and 13.56 per cent. protein. (1915 certificate gives 3.25 per cent. fat and 14 per cent. protein as minimum guarantees). Registered in 1915 and 1916.	No dealers' or official samples received.
Badger Fancy Middlings. Chas. A. Krause Milling Co., Milwaukee, Wis. Made from Maizo red dog flour and wheat middlings with ground screenings not exceeding mill run. Contains not more than 7 per cent. crude fiber, and not less than 4½ per cent. fat and 12 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Badger Fancy Mixed Feed. Chas. A. Krause Milling Co., Milwaukee, Wis. Made from Maizo red dog flour and wheat bran with ground screenings not exceeding mill run. Contains not more than 9 per cent. crude fiber, and not less than 4 per cent. fat and 12½ per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Wheat Bran with mill run screenings not to exceed 8 per cent. Larrabee Flour Mills Co., Hutchinson and Safford, Kans., and Clinton, Mo. Contains not more than 10 per cent. crude fiber, and not less than 3.5 per cent. fat and 14.5 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
"Golden Bull" Bran. Lawrenceburg Roller Mills Co., Lawrenceburg, Ind. Pure wheat product. Contains not more than 11.5 per cent. crude fiber and not less than 2 per cent. fat and 15.5 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
"Golden Bull" Middlings. Lawrenceburg Roller Mills Co., Lawrenceburg, Ind. Pure wheat product. Contains not more than 8 per cent. crude fiber, and not less than 3 per cent. fat and 17.5 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
"Golden Bull" Mixed Feed. Lawrenceburg Roller Mills Co., Lawrenceburg, Ind. Wheat bran and middlings with ground screenings not exceeding mill run. Contains not more than 10.2 per cent. crude fiber, and not less than 2.5 per cent. fat and 16 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
"Snowflake" Bran. Lawrenceburg Roller Mills Co., Lawrenceburg, Ind. Pure wheat product. Contains not more than 9.5 per cent. crude fiber, and not less than 3.8 per cent. fat and 14.5 per cent. protein. (1915 certificate gives 14.2 per cent. as minimum protein). Registered in 1915 and 1916.	One official sample. Above guaranty in protein; fiber 1 per cent. too high; fat in accord with guaranty. Contained a few seeds of corn cockle, yellow foxtail and apetalous, and some hulls of corn cockle.
"Snowflake" Middlings. Lawrenceburg Roller Mills Co., Lawrenceburg, Ind. Pure wheat product. Contains not more than 6 per cent. crude fiber, and not less than 5.1 per cent. fat and 16 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

FEEDING STUFFS—Continued.

BRAND, MAKER AND GUARANTIES.	RESULTS OF EXAMINATION.
"Snowflake" Mixed Feed. Lawrenceburg Roller Mills Co., Lawrenceburg, Ind. Wheat bran and middlings with ground screenings not exceeding mill run. Contains not more than 8 per cent. crude fiber, and not less than 4.3 per cent. fat and 15.2 per cent. protein. Registered in 1915 and 1916.	One official sample. Above guaranty in protein. Practically in accord with guaranty in fiber and fat. Contained few seeds of chess and dock. Few hulls of corn cockle.
Perfection Roller Mills Winter Wheat Bran. John C. Liken Co., Sebewaing, Michigan. Made from winter wheat. Contains not more than 12 per cent. crude fiber, and not less than 3 per cent. fat and 12 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Perfection Roller Mills Winter Wheat Middlings. John C. Liken Co., Sebewaing, Mich. Made from winter wneat. Contains not more than 8 per cent. crude fiber, and not less than 4 5 per cent. fat and 13.5 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Elmco Bran. Listman Mill Co., LaCrosse, Wis. Pure wheat goods. On 1915 certificate: Contains not more than 12.16 per cent. crude fiber, and not less than 3.86 per cent. fat and 15.69 per cent. protein. On 1916 certificate: Contains not more than 11.37 per cent. crude fiber, and not less than 3.63 per cent. fat and 15.51 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Elmco Mixed Feed. Listman Mill Co., La Crosse, Wis. Pure wheat goods. On 1915 certificate: Contains not more than 9.15 per cent. crude fiber, and not less than 4.09 per cent. fat and 15.55 per cent. protein. On 1916 certificate: Contains not more than 8.97 per cent. crude fiber, and not less than 4.38 per cent. fat and 15.01 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Elmco Red dog. Listman Mill Co., LaCrosse, Wis. On 1915 certificate: Contains not more than 5 per cent. crude fiber, and not less than 3 per cent. fat and 15.5 per cent. protein. On 1916 certificate: Contains not more than .93 per cent. crude fiber, and not less than 3.57 per cent. fat and 15.91 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Waseo Bran. Lyon & Greenleaf, Wauseon, O. Wheat bran. Contains not more than 9.5 per cent. crude fiber, and not less than 4 per cent. fat and 14,5 per cent. protein. Registered in 1915 and 1916.	One official sample. Two per cent. above guaranty in protein; fat in accord with guaranty; fiber well below the maximum guaranty. Contained few seeds of yellow foxtail and a few hulls of wild buckwheat and corn cockle.
Waseo Middlings with ground screenings not exceeding mill run. Lyon & Greenleaf, Wauseon, O. Wheat middlings with ground screenings not exceeding mill run. Contains not more than 6 per cent. crude fiber, and not less than 4 per cent. fat and 17 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Waseo Mixed Feed with ground screenings not exceeding mill run. Lyon & Greenleaf, Wauseon, Ohio. Wheat bran and middlings with ground screenings not exceeding mill run. Contains not more than 8 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	One official sample. Practically in accord with guaranty. Contained some seeds of chess, a few of wild buckwheat, and a few hulls of corn cockle.
Madelia Roller Mills Wheat Flour Middlings with ground screenings not exceeding mill run. Madelia Roller Mills. (Registered by Chas. M. Cox Co., Boston, Mass.) Contains not more than 5.35 per cent. crude fiber, and not less than 3 per cent. fat and 14.25 per cent.protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Triangle Bran. Mansfield Milling Co., Mansfield, Ohio. Composed of wheat bran with not to exceed mill run of screenings. Contains not more than 13 per cent. crude fiber, and not less than 4 per cent. fat and 13 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Triangl^ Middlings. Mansfield Milling Company, Mansfield, Ohio. Composed of wheat middlings with not to exceed mill run of screenings. Contains not more than 13 per cent. crude fiber, and not less than 4 per cent. fat and 13 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Bran. Maple Leaf Milling Co., Ltd., Toronto, Ont., Can. (Registered by Chas. M. Cox Co., Boston, Mass.) Wheat bran. Contains not more than 12 per cent. crude fiber, and not less than 4½ per cent. fat and 15½ per cent. protein. Registered in 1915 and 1916.	One official sample. Protein, fiber and fat correspond very well with guaranty. Contained few hulls of wild buckwheat.
Rex Middlings. Maple Leaf Milling Co., Ltd., Toronto, Ont., Can. (Registered by Chas. M. Cox Co., Boston, Mass.) Wheat middlings. Contains not more than 10 per cent. crude fiber, and not less than 5.5 per cent. fat and 16 per cent. protein. Registered in 1915. Not registered in 1916.	One official sample. In accord with guaranty. No weed seeds found.
Fancy Pure Bran. Melrose Milling Co., Melrose, Minn. Contains not more than 11 per cent. crude fiber, and not less than 3 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Middlings. Melrose Milling Co., Melrose, Minn. Contains nor more than 14 per cent. crude fiber, and not less than 3 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Big B Choice Wheat Bran, Moseley & Motley Milling Co., Rochester, N. Y. Wheat bran. Contains not more than 12 per cent. crude fiber, and not less than 3 per cent. fat and 14 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Big B Mixed Feed. Moseley & Motley Milling Co., Rochester, N. Y. Wheat bran and wheat middlings and ground screenings not exceeding mill run. Contains not more than 12 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Not registered in 1915. Registered in 1915.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Wheat Middlings with ground screenings not exceeding mill run. Moseley & Motley Milling Co., Rochester, New York. Contains not more than 10 per cent. crude fiber and not less than 4.5 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Brook's Fancy Mixed Feed. A. H. McLeod Milling Co., St. Johnsbury, Vt. Bran and red dog flour. Contains not more than 9 per cent. crude fiber, and not less than 4.5 per cent. fat and 16 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Wheat Bran with screenings not exceeding mill run. National Feed Co., St. Louis, Mo. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 14.5 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Wheat Mixed Feed with screenings not exceeding mill run. National Feed Co., St. Louis, Mo. Composed of wheat bran, wheat middlings and wheat screenings not exceeding mill run. Contains nor more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 14.5 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Bob Red Dog Flour, National Milling Co., Minneapolis, Minn. No certificate filed. Claims on package. Contains not more than 5 per cent. crude fiber, and not less than 4 per cent. fat and 16 per cent. protein. Unregistered.	One official sample. More than 1 per cent. below guaranty in protein; fat in accord with guaranty; fiber about half the maximum guaranty.
Seal of Minnesota bran with ground screenings not exceeding mill run. New Prague Flouring Mill Co., New Prague, Minn. On 1915 certificate: Contains not more than 11 per cent. crude fiber, and not less than 4.75 per cent. fat and 14.6 per cent. protein. On 1916 certificate: Contains not more than 10.5 per cent. crude fiber, and not less than 4.5 per cent. fat and 13.1 per cent. protein. Registered in 1915 and 1916.	Two official samples. Practically in accord with guaranty. Contained some hulls of corn cockle and wild buckwheat.
Seal of Minnesota Standard Middlings. New Prague Flouring Mill Co., New Prague, Minn. Pure wheat feed. On 1915 certificate: Contains not more than 6.75 per cent. crude fiber, and not less than 5.8 per cent. fat and 17.75 per cent. protein. On 1916 certificate: Contains not more than 6 per cent. crude fiber, and not less than 6 per cent. fat and 13.5 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Niagara Falls Milling Co. Choice Wheat Bran. Niagara Falls Milling Co., Buffalo, N. Y. Contains not more than 13 per cent. crude fiber, and not less than 3 per cent. fat and 13 per cent. protein. (1915 certificate gives 14 per cent. as minimum protein). Registered in 1915 and 1916.	One official sample. Well above the protein and fat guaranties; below the maximum fiber guaranty. Contained some hulls of corn cockle.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Niagara Falls Milling Co. Choice Wheat Low Grade Flour. Niagara Falls Milling Co., Buffalo, N. Y. Contains not more than 4 per cent. crude fiber, and not less than 3 per cent. fat and 15 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample. Two and a half per cent. low in protein. Fat and fiber in accord with guaranty.
Niagara Falls Milling Co. Choice Wheat Middlings. Niagara Falls Milling Co., Buffalo, N. Y. Contains not more than 11 per cent. crude fiber, and not less than 4 per cent. fat and 16 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Niagara Falls Milling Co. Perfect Mixed Feed. Niagara Falls Milling Co., Buffalo, N. Y. Low grade flour and bran. Contains not more than 10½ per cent. crude fiber, and not less than 3 per cent. fat and 15 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
N. M. Co. Middlings. Noblesville Milling Co., Noblesville, Ind. Contains not more than 7 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
N. M. Co. Mixed Feed. Noblesville Milling Co., Noblesville, Ind. Wheat bran, middlings and ground wheat screenings not exceeding mill run. Contains not more than 8 per cent. crude fiber, and not less than 4 per cent. fat and 16 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty. Contained some hulls of corn cockle.
N. M. Co. Wheat Bran and Screenings. Noblesville Milling Co., Noblesville, Ind. Wheat bran and ground wheat screenings not exceeding mill run. Contains not more than 8 per cent. crude fiber, and not less than 3.7 per cent. fat and 14.5 per cent. protein. Registered in 1915 and 1916.	Two official samples. Well above guaranty in both protein and fat, fiber overruns maximum guaranty by 3 per cent. Contained few seeds of chess and corn cockle. Also, some hulls of corn cockle.
Planet Feed. Northwestern Consolidated Milling Co., Minneapolis, Minn. Wheat bran and red dog flour. Contains not more than 8 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Pure Wheat Bran. Northwestern Consolidated Milling Co., Minneapolis, Minn. Pure wheat bran. Contains not more than 11 per cent. crude fiber, and not less than 4 per cent. fat and 14.5 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Wheat Flour Middlings with ground screenings not exceeding mill run. Northwestern Consolidated Milling Co., Minneapolis, Minn. Contains not more than 6 per cent. crude fiber, and not less than 4.5 per cent. fat and 15.5 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Wheat Mixed Feed composed of wheat bran, flour middlings and ground screenings not exceeding mill run. Northwestern Consolidated Milling Co., Minneapolis, Minn. Contains not more than 10 per cent. crude fiber, and not less than 4.5 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Wheat Standard Middlings with ground screenings not exceeding mill run. Northwestern Consolidated Milling Co., Minneapolis, Minn. Contains not more than 11 per cent. crude fiber, and not less than 4.5 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	Three official samples practically in accord with guaranty. No weed seeds found.
XXX Comet. Northwestern Consolidated Milling Co., Minneapolis, Minn. Red dog flour. Contains not more than 3 per cent. crude fiber, and not less than 4 per cent. fat and 16.5 per cent. protein. Registered in 1915 and 1916.	One official sample in accord with guaranty.
Taylor's Feed. Northwestern Elevator & Mill Co., Toledo, O. Wheat product with screenings not exceeding mill run. Contains not more than 6½ per cent. crude fiber, and not less than 4 per cent. fat and 13 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Wheat Bran with ground screenings not exceeding mill run. Northwestern Elevator & Mill Co., Toledo, O. Wheat product. Contains not more than 6 per cent. crude fiber, and not less than 4 per cent. fat and 13 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Fancy Wheat Bran with ground screenings not exceeding mill run. Ogilvie Flour Mills Co. No certificate filed. Claims on package: Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Unregistered.	One official sample. 1 per cent. low in protein, 2 per cent. above the maximum of fiber, and 1 per cent. above minimum guaranty of fat. Many hulls of wild buckwheat.
Wheat Bran with ground screenings not exceeding mill run. Peninsular Milling Co., Flint, Mich. Contains not more than 11 per cent. crude fiber, and not less than 3.5 per cent. fat and 14 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample, 1½ per cent. low in protein; fiber and fat in accord with guaranty. Contained few hulls of corn cockle.
Wheat Middlings with ground screenings not exceeding mill run. Peninsular Milling Co., Flint, Mich. On 1915 certificate: Contains not more than 7 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. On 1916 certificate: Contains not more than 9 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Wheat Mixed Feed with ground screenings not exceeding mill run. Peninsular Milling Co., Flint, Mich. Composed of bran and middlings with ground screenings not exceeding mill run. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample. Considerably below guaranty in protein and fat. Fiber below its maximum guaranty. Contained few seeds of corn cockle and wild buckwheat, and some hulls of corn cockle.
Mixed Feed. Pilliod Milling Co., Swanton, O. Bran, middlings and ground screenings not to exceed mill run. Contains not more than 9.25 per cent. crude fiber, and not less than 4.25 per cent. fat and 15.5 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Pilco Fancy Winter Bran with not exceeding mill run of screenings. Pilliod Milling Co., Swanton, O. Contains not more than 11 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Pillsbury's Durum Wheat Bran with ground screenings not exceeding mill run. Pillsbury Flour Mills Co., Minneapolis, Minn. Durum wheat bran and ground screenings. Contains not more than 14 per cent. crude fiber, and not less than 4 per cent. fat and 11 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Pillsbury's Durum Wheat Standard "B" Middlings with ground screenings not exceeding mill run. Pillsbury Flour Mills Co., Minneapolis, Minn. Durum wheat shorts and ground screenings. Contains not more than 11 per cent. crude fiber, and not less than 4 per cent. fat and 12.5 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Pillsbury's Fancy Wheat Mixed Feed with ground screenings not exceeding mill run. Pillsbury Flour Mills Co., Minneapolis, Minn. Wheat bran, ground screenings and low grade wheat flour. On 1915 certificate: Contains not more than 9 per cent. crude fiber, and not less than 4½ per cent. fat and 16 per cent. protein. On 1916 certificate: Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	Three official samples. One of the samples above, the others below in protein. Fiber and fat as guaranteed. Contained a few seeds of night-flowering catchfly and green foxtail. Few hulls of wild buckwheat and corn cockle.
Pillsbury's Wheat Bran with ground screenings not exceeding mill run. Pillsbury Flour Mills Co., Minneapolis, Minn. Wheat bran and ground screenings. On 1915 certificate: Contains not more than 12 per cent. crude fiber, and not less than 4 per cent. fat and 14.5 per cent. protein. On 1916 certificate: Contains not more than 13 per cent. crude fiber, and not less than 4 per cent. fat and 13 per cent. protein. Registered in 1915 and 1916.	Three official samples in accord with guaranty. Contained few seeds of flax. Some hulls of wild buckwheat.
Pillsbury's Wheat "A" Middlings with ground screenings not exceeding mill run. Pillsbury Flour Mills Co., Minneapolis, Minn. Wheat shorts, ground screenings and low grade wheat flour. On 1915 certificate: Contains not more than 7 per cent. crude fiber, and not less than 4½ per cent. fat and 15 per cent. protein. On 1916 certificate: Contains not more than 8 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Pillsbury's Wheat Standard "B" Middlings with ground screenings not exceeding mill run. Pillsbury Flour Mills Co., Minneapolis, Minn. Wheat shorts and ground screenings. On 1915 certificate: Contains not more than 10 per cent. crude fiber, and not less than 4½ per cent. fat and 15 per cent. protein. On 1916 certificate: Contains not more than 11 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	One official sample. Well up in protein and fat. Fiber in accordance with guaranty. No weed seeds found.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Pillsbury's XX Daisy. Pillsbury Flour Mills Co., Minneapolis, Minn. Low grade wheat flour. On 1915 certificate: Contains not more than 4 per cent. crude fiber, and not less than 4½ per cent. fat and 17 per cent. protein. On 1916 certificate: Contains not more than 4 per cent. crude fiber, and not less than 4 per cent. fat and 16 per cent. protein. Registered in 1915 and 1916.	Two official samples, well up in protein and fat. Fiber below the maximum guaranty.
Champion Mixed Feed with ground screenings not exceeding mill run. Portland Milling Co., Portland, Mich. Wheat offal. Contains not more than 8.46 per cent. crude fiber, and not less than 3.58 per cent. fat and 13.56 per cent. protein. Registered in 1915 and 1916.	Two official samples, above guaranty in protein and fat. Fiber practically in accord with guaranty. Contained some seeds of chess, and some hulls of corn cockle.
Quaker City Flour Mills Co. Bran. Quaker City Flour Mills Co., Philadelphia, Pa. (Registered in 1915 by Chas. M. Cox Co., Boston, Mass.) Wheat bran and ground screenings not to exceed mill run. Contains not more than 10½ per cent. crude fiber, and not less than 3 per cent. fat and 13 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Quaker City Winter Wheat Middlings. Quaker City Flour Mills Co., Philadelphia, Pa. Made from pure wheat with ground screenings not to exceed mill run. Contains not more than 5½ per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	One official sample. Well above guaranty in protein; fat and fiber, in accordance with guaranty. No weed seeds found.
Bell Cow Bran. Quaker Oats Co., Chicago, Ill. Wheat bran with ground screenings not exceeding mill run. Contains not more than 7.6 per cent. crude fiber, and not less than 5.5 per cent. fat and 15.3 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Bell Cow Middlings. Quaker Oats Co., Chicago, Ill. Wheat middlings with ground screenings not exceeding mill run. Contains not more than 7.6 per cent. crude fiber, and not less than 5.5 per cent. fat and 15.5 per cent. protein. Registered in 1915. Not registered in 1916.	One official sample. Considerably above guaranty in protein and fat. Fiber practically as claimed. No weed seeds found.
Queen Bee Bran. Queen Bee Flour Mills Co., Minneapolis, Minn. Wheat bran only. Contains not more than 10.5 per cent. crude fiber, and not less than 4.3 per cent. fat and 14.5 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Queen Bee Red Dog or Low Grade. Queen Bee Flour Mills Co., Minneapolis, Minn. Low grade flour or red dog milled from wheat only. Contains not more than 5.2 per cent. crude fiber, and not less than 3.2 per cent. fat and 17.2 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Queen Bee Standard Middlings with not to exceed mill run of ground screenings. Queen Bee Flour Mills Co., Minneapolis, Minn. Contains not more than 9.5 per cent. crude fiber, and not less than 4.5 per cent. fat and 16.5 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Bixota Bran with ground screenings. Red Wing Milling Co., Red Wing, Minn. Wheat bran witn ground screenings not exceeding mill run. Contains not more than 13.2 per cent. crude fiber, and not less than 4.8 per cent. fat and 14 per cent. protein. Not registered in 1915. Registered in 1916.	Two official samples in accord with guaranty. Contained some seeds of pigweed, night-flowering catchfly, mustard, false flax, penny cress and wild buckwheat, and many hulls of wild buckwheat and corn cockle.
Richardton Mixed Feed. Richardton Roller Mills, Richardton, No. Dakota. On 1915 certificate: It is made from pure hard spring wheat, contains no wheat screenings, contains steam scourings from one scourer of mill run. Contains not more than 6.7 per cent. crude fiber, and not less than 4.9 per cent. fat and 16.88 per cent. protein. On 1916 certificate: Pure wheat bran, middlings, shorts, and wheat screenings not exceeding mill run. Contains not more than 9.2 per cent. crude fiber, and not less than 3.7 per cent. fat and 16.7 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Robin Hood Bran. Robin Hood Mills, Ltd., Moose Jaw, Sask. Wheat bran. Contains not more than 9.8 per cent. crude fiber, and not less than 5.2 per cent. fat and 16.25 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Standard Middlings. Rush City Milling Co., Rush City, Minn. A by-product obtained from wheat in manufacturing flour. Contains not more than 8.2 per cent. crude fiber, and not less than 4.2 per cent. fat and 13.5 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Bran. Russell-Miller Milling Co., Minneapolis, Minn. Wheat only. Contains not more than 11 per cent. crude fiber, and not less than 4 per cent. fat and 13 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Flour Middlings. Russell-Miller Milling Co., Minneapolis, Minn. Wheat only. Contains not more than 6 per cent. crude fiber, and not less than 5 per cent. fat and 15 per cent. protein. (1915 certificate gives 16 per cent. as minimum protein). Registered in 1915 and 1916.	No dealers' or official samples received.
Occident Wheat Feed. Russell-Miller Milling Co., Minneapolis, Minn. Wheat only. Contains not more than 10 per cent. crude fiber, and not less than 4.5 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	Three official samples. Well up in protein. Fat and fiber as claimed. Contained a few hulls of corn cockle and wild buckwheat.
Red Dog Flour. Russell-Miller Milling Co., Minneapolis, Minn. Wheat only. Contains not more than 6 per cent. crude fiber, and not less than 4.5 per cent. fat and 16 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Standard Middlings. Russell-Miller Milling Co., Minneapolis, Minn. Wheat only. Contains not more than 9 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty. Contained few hulls of wild buckwheat and corn cockle.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Wheat Bran and screenings not to exceed 8 per cent. screenings. Shellabarger Mill & Elevator Co., Salina, Kans. No certificate filed. Claims on package: Contains not more than 10 per cent. crude fiber, and not less than 3.5 per cent. fat and 14.5 per cent. protein. Unregistered.	One official sample. Above guaranty in protein. Fat and fiber as claimed.
"Gold Mine" Feed. Sheffield-King Milling Co., Minneapolis, Minn. Composed of bran, shorts, low grade flour, wheat product, and pulverized screenings. Contains not more than 8.98 per cent. crude fiber, and not less than 4.9 per cent. fat and 15.9 per cent. protein. Registered in 1915 and 1916.	Two official samples. Practically in accord with guaranty. Contained few seeds of pigweed, and some hulls of corn cockle.
Sleepy Eye Bran (Registered in 1916 as Pure Wheat Bran). Sleepy Eye Milling Co., Minneapolis, Minn. (Registered in 1916 by Chas. M. Cox Co., Boston, Mass.) On 1915 certificate: Contains not more than 10.5 per cent. crude fiber, and not less than 4.3 per cent. fat and 14.5 per cent. protein. On 1916 certificate: Contains not more than 14.5 per cent. crude fiber, and not less than 4.5 per cent. fat and 10.5 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty. Contained some hulls of corn cockle.
Sleepy Eye Red Dog or Low Grade. Sleepy Eye Flour Mills Co., Minneapolis, Minn. Pure wheat red dog or low grade. Contains not more than 5.2 per cent. crude fiber, and not less than 3.2 per cent. fat and 17.2 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Sleepy Eye Standard Middlings, with not to exceed mill run of ground screenings. Sleepy Eye Flour Mills Co., Minneapolis, Minn. Pure wheat middlings with not to exceed mill run of ground screenings. Contains not more than 9.5 per cent. crude fiber, and not less than 4.5 per cent. fat and 16.5 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Wheat Bran with ground screenings not exceeding mill run. Southwestern Milling Co., Kansas City, Mo. No certificate filed. Claims on package: Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 16.5 per cent. protein. Unregistered.	One official sample well up in protein and fat. Fiber in accord with guaranty.
Try Me Mixed Feed. Sparks Milling Co., Alton, Ill. Pure wheat bran, middlings, and ground screenings not exceeding mill run. Contains not more than 8 per cent. crude fiber, and not less than 3.5 per cent. fat and 16 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Star & Crescent Bran with ground screenings not exceeding mill run. Star & Crescent Milling Co., Chicago, Ill. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	One official sample. Slightly low in protein; small overrun in fiber; fat as claimed. Contained some seeds of lady's thumb, mustard, pigweed, barnyard grass, false flax, green foxtail, yellow foxtail and wild buckwheat. Some hulls of corn cockle and wild buckwheat.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Atlas Mixed Wheat Feed with ground screenings not exceeding mill run. Bernhard Stern & Sons, Inc. (Atlas Flour Mills), Milwaukee, Wis. Composed of wheat bran, middlings, low grade flour, with ground screenings not exceeding mill run. Contains not more than 7.5 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Atlas Wheat Bran with ground screenings not exceeding mill run. Bernhard Stern & Sons, Inc. (Atlas Flour Mills), Milwaukee, Wis. Contains not more than 11 per cent. crude fiber, and not less than 3 per cent. fat and 13 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Atlas Wheat Flour Middlings with ground screenings, not exceeding mill run. Bernhard Stern & Sons, Inc. (Atlas Flour Mills), Milwaukee, Wis. Contains not more than 7 per cent. crude fiber, and not less than 3 per cent. fat and 14 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Standard Wheat Middlings with ground screenings, not exceeding mill run. Bernhard Stern & Sons, Inc. (Atlas Flour Mills), Milwaukee, Wis. Contains not more than 10.5 per cent. crude fiber, and not less than 3.5 per cent. fat and 13.5 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Middlings. F. W. Stock & Sons, Hillsdale, Mich. Made from wheat. Contains not more than 6 per cent. crude fiber, and not less than 4 per cent. fat and 16½ per cent. protein. Registered in 1915 and 1916.	One official sample. Two and a half per cent. below in protein. Fiber and fat as claimed.
Monarch Mixed Feed. F. W. Stock & Sons, Hillsdale, Mich. Composed of wheat bran, middlings and mill run screenings. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 16 per cent. protein. Registered in 1915 and 1916.	Two official samples. Slightly low in protein. Fat and fiber as claimed. Contained some seeds of pigweed, night-flowering catchfly, penny cress and mustard. Some hulls of corn cockle.
Stock's Bran. F. W. Stock & Sons, Hillsdale, Mich. Made from wheat. Contains not more than 10 per cent. crude fiber, and not less than 3 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Superior Mixed Feed. F. W. Stock & Sons, Hillsdale, Mich. Composed of wheat bran, middlings, low grade flour, with mill run screenings. Contains not more than 7 per cent. crude fiber, and not less than 4½ per cent. fat and 16 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Climax Middlings. David Stott Flour Mills, Inc., Detroit, Mich. Composed of white and brown wheat middlings. On 1915 certificate: Contains not more than 8 per cent. crude fiber, and not less than 5 per cent. fat and 17 per cent. protein. On 1916 certificate: Contains not more than 6 per cent. crude fiber, and not less than 5 per cent. fat and 16 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Stag Flour. David Stott Flour Mills, Inc., Detroit, Mich. Low grade fine wheat flour. On 1915 certificate: Contains not more than 3 per cent. crude fiber, and not less than 1½ per cent. fat and 15 per cent. protein. On 1916 certificate: Contains not more than 2 per cent. crude fiber, and not less than 3 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Stott's Fine White Middlings. David Stott Flour Mills, Inc., Detroit, Mich. On 1915 certificate: Contains not more than 6 per cent. crude fiber, and not less than 5 per cent. fat and 16 per cent. protein. On 1916 certificate: Contains not more than 6 per cent. crude fiber, and not less than 4½ per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Stott's Heavy Mixed Pure Wheat Feed. David Stott Flour Mills, Inc., Detroit, Mich. Composed of wheat flour, wheat bran and wheat middlings. On 1915 certificate: Contains not more than 7 per cent. crude fiber, and not less than 4½ per cent. fat and 16 per cent. protein. On 1916 certificate: Contains not more than 8 per cent. crude fiber, and not less than 4½ per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Stott's Honest Mixed Feed. David Stott Flour Mills, Inc., Detroit, Mich. Composed of winter wheat bran and middlings. On 1915 certificate: Contains not more than 8 per cent. crude fiber, and not less than 5 per cent. fat and 16½ per cent. protein. On 1916 certificate: Contains not more than 8 per cent. crude fiber, and not less than 4½ per cent. fat and 15½ per cent. protein. Registered in 1915 and 1916.	One official sample of 1915 goods in accord with 1915 guaranty. Contained some seeds of wild buckwheat, field peppergrass and pigweed. Few hairy stick seed. Some hulls of corn cockle and wild buckwheat.
Stott's Pennant Middlings. David Stott Flour Mills, Inc., Detroit, Mich. On 1915 certificate: Brown wheat middlings. Contains not more than 7 per cent. crude fiber, and not less than 5 per cent. fat and 17 per cent. protein. On 1916 certificate: Brown wheat middlings with ground screenings not exceeding mill run. Contains not more than 8 per cent. crude fiber, and not less than 5 per cent. fat and 15½ per cent. protein. Registered in 1915 and 1916.	Two official samples. Two and a half per cent. low in protein; also low in fat. Fiber in accord with guaranty. No weed seeds found.
Stott's Spring Bran with ground screenings. David Stott Flour Mills, Inc., Detroit, Mich. On 1915 certificate: Contains not more than 10 per cent. crude fiber, and not less than 4½ per cent. fat and 16 per cent. protein. On 1916 certificate: Contains not more than 10½ per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	Two official samples in accord with 1916 guaranty. Contained many seeds of mustard, wild buckwheat, cow-herb, yellow foxtail, hairy stick seed and false flax. Some seeds of corn cockle, lady's thumb, chess, corn gromwell and wild rose. About 1 per cent. by weight of weed seeds.
Stott's Winter Bran. David Stott Flour Mills, Inc., Detroit, Mich. Pure winter wheat bran. On 1915 certificate: Contains not more than 10 per cent. crude fiber, and not less than 4½ per cent. fat and 16 per cent. protein. On 1916 certificate: Contains not more than 10½ per cent. crude fiber, and not less than 4½ per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty except that it overran 1½ per cent. in fiber. Contained few seeds of yellow foxtail, green foxtail, mustard, corn cockle, lady's thumb and penny cress. Few hulls of corn cockle and wild buckwheat.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Bran. Tennant & Hoyt Co., Lake City, Minn. Contains ground screenings not exceeding mill run. Contains not more than 11 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Wheat Middlings with ground screenings not exceeding mill run. Tennant & Hoyt Co. (Registered by Chas. M. Cox Co., Boston, Mass.) Contains not more than 8 per cent. crude fiber, and not less than 5 per cent. fat and 15 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Angelus Bran. Thompson Milling Co., Lockport, N. Y. This feed is made entirely from wheat and contains the mill run of screenings. Contains not more than 14 per cent. crude fiber, and not less than 4 per cent. fat and 13 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Angelus Middlings. Thompson Milling Co., Lockport, N. Y. This feed is made entirely from wheat and contains the mill run of screenings. Contains not more than 14 per cent. crude fiber, and not less than 4 per cent. fat and 13 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Wheat Bran with ground screenings not exceeding mill run. George Urban Milling Co., Buffalo, N. Y. Contains not more than 12.5 per cent. crude fiber, and not less than 3.5 per cent. fat and 14 per cent. protein. (1915 certificate gives 15 per cent. as minimum protein). Registered in 1915 and 1916.	No dealers' or official samples received.
Wheat Middlings with ground screenings not exceeding mill run. George Urban Milling Co., Buffalo, N. Y. Contains not more than 9.5 per cent. crude fiber, and not less than 4.5 per cent. fat and 16 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Wheat Mixed Feed with ground screenings not exceeding mill run. George Urban Milling Co., Buffalo, N. Y. On 1915 certificate: Contains not more than 10.5 per cent. crude fiber, and not less than 4 per cent. fat and 16 per cent. protein. On 1916 certificate: Contains not more than 12 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	One official sample. Practically in accord with guaranty. Contained a few seeds of wild buckwheat, penny cress, yellow foxtail, mustard, false flax, hairy stick seed, corn cockle, night-flowering catchfly and flax. Some hulls of wild buckwheat and corn cockle.
Farmers Favorite Bran. Valley City Milling Co., Grand Rapids, Mich. Wheat bran with mill run of screenings. On 1915 certificate: Contains not more than 10 per cent. crude fiber, and not less than 3.7 per cent. fat and 15.25 per cent. protein. On 1916 certificate: Contains not more than 11.2 per cent. crude fiber, and not less than 5 per cent. fat and 13.8 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Farmers' Favorite Cowfeed. Valley City Milling Co., Grand Rapids, Mich. Wheat bran and middlings with mill run of screenings. On 1915 certificate: Contains not more than 8.1 per cent. crude fiber, and not less than 4.2 per cent. fat and 15 per cent. protein. On 1916 certificate: Contains not more than 7.10 per cent. crude fiber, and not less than 4.73 per cent. fat and 15.6 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Farmers Favorite Middlings. Valley City Milling Co., Grand Rapids, Mich. Wheat middlings with mill run of screenings. On 1915 certificate: Contains not more than 5.8 per cent. crude fiber, and not less than 4.2 per cent. fat and 15 per cent. protein. On 1916 certificate: Contains not more than 7.1 per cent. crude fiber, and not less than 5.26 per cent. fat and 14.4 per cent. protein. Registered in 1915 and 1916.	One official sample. Well above the guaranteed protein. Fat in accord with guaranty. Fiber considerably lower than maximum guaranty.
Victor Spring Wheat Bran with ground screenings not exceeding mill run. Victor Milling Co., Victor, N. Y. Contains not more than 15 per cent. crude fiber, and not less than 4 per cent. fat and 14.6 per cent. protein. Registered in 1915 and 1916.	One official sample. Protein in accord with guaranty; fat above guaranty; fiber considerably lower than maximum guaranty. Contained a few seeds of charlock, false flax, penny cress and night-flowering catchfly. Some hulls of corn cockle and wild buckwheat.
Victor Spring Wheat Middlings with ground screenings not exceeding mill run. Contains not more than 10 per cent. crude fiber, and not less than 5 per cent. fat and 17.5 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Victor Spring Wheat Mixed Feed with ground screenings not exceeding mill run. Victor Milling Co., Victor, N. Y. Spring wheat and screenings. Contains not more than 10 per cent. crude fiber, and not less than 4.5 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Crescent (Brand) Bran Containing Mill Run of Screenings. Voigt Milling Co., Grand Rapids, Mich. Contains not more than 10 per cent. crude fiber, and not less than 3.5 per cent. fat and 15 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample. Low in protein and fat. Fiber less than maximum guaranty. Contained a few seeds of mustard and wild buckwheat, and a few hulls of corn cockle.
Crescent (Brand) Middlings. Voigt Milling Co., Grand Rapids, Mich. Contains not more than 8 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Voigt Middlings. Voigt Milling Co., Grand Rapids, Mich. No screenings in middlings. Contains not more than 8 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Voigt's Mixed Feed containing screenings not exceeding mill run. Voigt Milling Co., Grand Rapids, Mich. Contains not more than 9 per cent. crude fiber, and not less than 4 per cent. fat and 14.25 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Voigt's Pure Bran with ground screenings not exceeding mill run. Voigt Milling Co., Grand Rapids, Mich. Contains not more than 11 per cent. crude fiber, and not less than 3½ per cent. fat and 14 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Voigt's Pure Cow Feed containing mill run of screenings. Voigt Milling Co., Grand Rapids, Mich. Composed of wheat bran and wheat middlings as run by the mill. Contains not more than 10 per cent. crude fiber, and not less than 3.5 per cent. fat and 15 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Big Jo Bran. Wabasha Roller Mill Co., Wabasha, Minn. Contains not more than 11.6 per cent. crude fiber, and not less than 3.2 per cent. fat and 15.3 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Big Jo Flour Middlings. Wabasha Roller Mill Co., Wabasha, Minn. Contains not more than 3.5 per cent. crude fiber, and not less than 4.3 per cent. fat and 16.5 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Big Jo Middlings. Wabasha Roller Mill Co., Wabasha, Minn. Contains not more than 10.85 per cent. crude fiber, and not less than 4.65 per cent. fat and 15.4 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Big Jo Mixed Feed. Wabasha Roller Mill Co., Wabasha, Minn. Composed Big Jo Bran, Big Jo Middlings and Big Jo Flour Middlings. Contains not more than 9.35 per cent. crude fiber, and not less than 3.75 per cent. fat and 15.8 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Mixed Feed. Waggoner-Gates Milling Co., Independence, Mo. (Registered by Chas. M. Cox Co., Boston, Mass.) Pure wheat bran and middlings. Contains not more than 9 per cent. crude fiber, and not less than 3 per cent. fat and 15 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Red Dog Flour (Adrian). Washburn Crosby Co., Minneapolis, Minn. Wheat. Contains not more than 4 per cent. crude fiber, and not less than 4 per cent. fat and 16 per cent. protein. (1915 certificate gives 5 per cent. as minimum fat and 17 per cent. as minimum protein). Registered in 1915 and 1916.	Three official samples. In accord with 1916 guaranty.
Second Clear Flour (Arlington). Washburn Crosby Co., Mimneapolis, Minn. Wheat. Contains not more than 4 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent.protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Wheat Bran with ground screenings not exceeding mill run. Washburn Crosby Co., Minneapolis, Minn., and Buffalo, N. Y. On 1915 certificate: Contains not more than 12 per cent. crude fiber, and not less than 4 per cent. fat and 14.5 per cent. protein. On 1916 certificate: Contains not more than 13 per cent. crude fiber, and not less than 4 per cent. fat and 13 per cent. protein. Registered in 1915 and 1916.	Seven official samples substantially in accord with guaranty. In the different samples there were some seeds of pigweed pepper grass, night-flowering catchfly, wild buckwheat, mustard, false flax, and some hulls of wild buckwheat and corn cockle. None of the samples carried all of the weed seeds named.
Wheat Flour Middlings with ground screenings not exceeding mill run. Washburn-Crosby Co., Minneapolis, Minn., and Buffalo, N. Y. Wheat standard middlings, red dog flour and ground screenings not exceeding mill run. On 1915 certificate: Contains not more than 6.5 per cent. crude fiber, and not less than 5 per cent. fat and 17 per cent. protein. On 1916 certificate: Contains not more than 8 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Wheat Mixed Feed with ground screenings not exceeding mill run. Washburn Crosby Co., Minneapolis, Minn., and Buffalo, N. Y. Wheat bran, wheat flour middlings and ground screenings nor exceeding mill run. On 1915 certificate: Contains not more than 9 per cent. crude fiber, and not less than 4.5 per cent. fat and 16 per cent. protein. On 1916 certificate: Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Wheat Standard Middlings with ground screenings not exceeding mill run. Washburn Crosby Co., Minneapolis, Minn., and Buffalo, N. Y. On 1915 certificate: Contains not more than 9.5 per cent. crude fiber and not less than 5 per cent. fat and 15 per cent protein. On 1916 certificate: Contains not more than 11 per cent. crude fiber and not less than 4 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	Six official samples, all practically in accord with guaranty. Some of the samples were free from weed seeds. One carried a few seeds and hulls of mustard. Another carried some seeds of nightflowering catchfly, lady's thumb, pigweed, mustard, penny cress and field peppergrass, and some hulls of wild buckwheat.
Black Hawk Bran with ground screenings not exceeding mill run. Manufactured by Western Flour Mill Co., Davenport, Iowa. (Registered by New Prague Flouring Mill Co., New Prague, Minn.) On 1915 certificate: Contains not more than 11 per cent. crude fiber, and not less than 4.75 per cent. fat and 14.6 per cent. protein. On 1916 certificate: Contains not more than 10,5 per cent. crude fiber, and not less than 4.5 per cent. fat and 13.1 per cent. protein. Registered in 1915 and 1916.	Two official samples. Protein well above guaranty; fat in accord with guaranty; fiber in accord with guaranty. Contained few hulls of corn cockle and wild buckwheat.
Middlings. Western Canada Flour Mills Co., Toronto, Ont., Can. (Registered by Chas. M. Cox Co., Boston, Mass.) Contains not more than 9 per cent. crude fiber and not less than 4.5 per cent. fat and 15.5 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Spring Wheat Bran with ground screenings not exceeding mill run. Western Canada Flour Mills Co., Ltd., (Registered by Chas. M. Cox Co., Boston, Mass). On 1915 certificate: Contains not more tnan 10 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. On 1916 certificate: Contains not more than 11 per cent. crude fiber, and not less than 4 per cent.fat and 14½ per cent.protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty. Contained few hulls of corn cockle and wild buckwheat.
Kent Mixed Feed. Williams Bros. Co., Kent, O. Pure wheat bran and middlings. Contains not more than 15 per cent. crude fiber, and not less than 2 per cent. fat and 12 per cent. protein. Registered in 1915 and 1916.	One official sample. Above guaranty in protein and fat. Fiber considerably less than maximum guaranty. Contained a few hulls of corn cockle.
Webster Mixed Feed. E. S. Woodworth & Co., Minneapolis, Minn. Bran, middlings and low grade, and ground screenings not exceeding mill run. Contains not more than 10 per cent. crude fiber, and not less than 4.8 per cent. fat and 15.3 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Bran. Yerxa, Andrews & Thurston, Inc., Minneapolis, Minn. Contains not more than 13 per cent. crude fiber, and not less than 5.5 per cent. fat and 12 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Flour Middlings. Yerxa, Andrews & Thurston, Inc., Minneapolis, Minn. Contains not more than 6.5 per cent. crude fiber, and not less than 5.5 per cent. fat and 15.5 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Golden Mixed Feed. Yerxa, Andrews & Thurston, Inc., Minneapolis, Minn. Pure durum wheat by-products only. Contains not more than 8.5 per cent. crude fiber, and not less than 5.5 per cent. fat and 15.5 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples recei ed.
Hector Durum Wheat Red Dog Flour. Yerxa, Andrews & Thurston, Inc., Minneapolis, Minn. Contains not more than 3 per cent. crude fiber, and not less than 5 per cent. fat and 18 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Nokomos Durum Wheat Middlings. Yerxa, Andrews & Thurston, Inc., Minneapolis, Minn. Contains not more than 10.5 per cent. crude fiber, and not less than 5.5 per cent. fat and 14.5 per cent. protein. Registered in 1915. Not registered in 1916.	One official sample. Far below claimed protein. Much excess of fiber. Fat as claimed.

ADULTERATED WHEAT FEEDS.

Holstein Feed. Indiana Milling Co., Terre Haute, Ind. Wheat bran with ground screenings not exceeding mill run, cob meal. Contains not more than 16 per cent. crude fiber, and not less than 3 per cent. fat and 12 per cent. protein. Registered in 1915. Not registered in 1916.	Two official samples. More than 1 per cent. below guaranty in protein; in accord with guaranty in fat; more than 2 per cent. in excess of maximum guaranty of fiber. Contained a few seeds of wild buckwheat, yellow foxtail, pigweed, flax, and corn cockle. Few hulls of corn cockle and wild buckwheat.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Sterling Feed. Indiana Milling Co., Terre Haute, Ind. Composed of wheat bran, with ground screenings not exceeding mill run, ground corn and cob. Contains not more than 16 per cent. crude fiber, and not less than 3 per cent. fat and 10 per cent. protein. Registered in 1915. Not registered in 1916.	One official sample. Slightly below guaranty in protein; in accord with guaranty in fat and fiber. Contained a few seeds of nightflowering catchfly, pigweed, mustard and yellow foxtail. Some hulls of corn cockle, and a few of yellow foxtail and wild buckwheat.
Dairy Winter Mixed Feed. Henry Jennings, Boston, Mass. Winter wheat bran, winter wheat middlings and corn cob meal. Contains not more than 25 per cent. crude fiber, and not less than 2 per cent. fat and 9 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Blue Grass Valley Feed. A. Waller & Co., Henderson, Ky. Composed of winter wheat bran, winter wheat middlings, ground corn and cob. Contains not more than 17 per cent. crude fiber, and not less than 2 per cent. fat and 9 per cent. protein. Registered in 1915 and 1916.	One official sample. Practically in accord witn guaranty. Contained a few seeds and many hulls of corn cockle.

CORN AND OATS GROUND TOGETHER.

Corn and Oats, Half and Half. Buffalo Cereal Co.. Buffalo, N.Y. Contains not more than 4 per cent. crude fiber, and not less than 4 per cent. fat and 9 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Corn & Oat Chop. Carll Brothers, Waterboro, Me. Corn and oats. Contains not more than 5 per cent. crude fiber, and not less than 4 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Flaked Corn & Oats. The Colton Bros. Co., Bellefontaine, Ohio. Oats and corn. Contains not more than 9 per cent. crude fiber, and not less than 4 per cent. fat and 10 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Corn and Oat Feed. Eastern Grain Co., Portland, Me. Corn and oats ground together. Contains not more than 6 per cent. crude fiber, and not less than 5 per cent. fat and 10 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Pure Corn & Oats. Elmore Milling Co., Oneonta, N. Y. Ground oats-corn meal. Contains not more than 6 per cent. crude fiber, and not less than 5 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
G M Co. Corn & Oat Feed. Gray Milling Co., E. Gray, Me. Composed of corn meal and barley, mixed oats. Contains not more than 7 per cent. crude fiber, and not less than 4 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Gwinn's Horse & Mule Feed. Gwinn Milling Co., Columbus, Ohio. Corn and oats. Contains not more than 9 per cent. crude fiber, and not less than 4 per cent. fat and 10 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.

FEEDING STUFFS—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Corn and Oat Chop. J. B. Ham Co., Lewiston, Me. Corn and oats. Contains not more than 5 per cent. crude fiber, and not less than 4 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Corn and Oat Feed. Houlton Mills & Light Co., Houlton, Me. Oats and corn. Contains not more than 8 per cent. crude fiber, and not less than 4 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Corn and Oat Chop. Kimball Bros. Co., Bath, Me. Corn and oats. Contains not more than 5.82 per cent. crude fiber, and not less than 4 per cent. fat and 10 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Monmouth Corn & Oats Feed. (Registered in 1915 as Monmouth Pure Corn & Oats Feed). F. M. Marks, Monmouth, Me. On 1915 certificate: Corn and oats ground together. Contains not more than 9 per cent. crude fiber, and not less than 5 per cent. fat and 9 per cent. protein. On 1916 certificate: Pure corn and oats ground with small per cent. oat feed mixed. Contains not more than 10 per cent. crude fiber, and not less than 3 per cent. fat and 7 per cent. protein. Registered in 1915 and 1916.	One official sample. Slightly below guaranty in protein and fat; about 3 per cent. above maximum guaranty in fiber. No weed seeds noted.
Corn and Oat Chop. Merrill & Mayo Co., Waterville, Me. Corn and oats. Contains not more than 6 per cent. crude fiber, and not less than 5 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	One official sample. Slightly below guaranty in protein; more than 1 per cent. below guaranty in fat; practically in accord with guaranty in fiber. Contained a few seeds of large false flax and mustard.
Corn and Oats, Half and Half. A. Nowak & Son, Buffalo, N. Y. Composed of ground corn and crushed oats. Contains not more than 7 per cent. crude fiber, and not less than 4 per cent. fat and 9 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Corn and Oat Chop. Park & Pollard Co., Boston, Mass. Ground corn and oats. Contains not more than 8 per cent. crude fiber, and not less than 3.5 per cent. fat and 10 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Puritas Corn & Oat Feed. Portland Milling Co., Portland, Mich. Corn and oats ground. Contains not more than 6.38 per cent. crude fiber, and not less than 4.23 per cent. fat and 10.41 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Chop Feed. A. A. Wilson, Springvale, Me. Corn and oats. Contains not more than 6 per cent. crude fiber, and not less than 4 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Corn & Oats. Yeaton's Mills, South Berwick, Me. Corn and oats ground together and nothing else. Contains not more than 5.5 per cent. crude fiber, and not less than 5 per cent. fat and 10.5 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

FEEDING STUFFS—Continued.

HOMINY FEEDS.

Brand, Maker and Guaranties.	Results of Examination.
Homco Feed. American Hominy Co., Indianapolis, Ind. Manufactured from white corn only. Contains not more than 7 per cent. crude fiber, and not less than 6 per cent. fat and 10 per cent. protein. (1915 certificate gives 7 per cent. as minimum fat guaranty). Registered in 1915 and 1916.	Three official samples. In accord with guaranty. No weed seeds noted.
Homcoline Feed. American Hominy Co., Indianapolis, Indiana. White corn only. Contains not more than 7 per cent. crude fiber, and not less 5 per cent. fat and 17 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Cooked Hominy Feed. Baltimore Pearl Hominy Co., Baltimore, Md. Pure corn. Contains not more than 6 per cent. crude fiber, and not less than 7 per cent. fat and 14 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Bufceco Hominy Feed. Buffalo Cereal Co., Buffalo, N. Y. Contains not more than 5 per cent. crude fiber, and not less than 6 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty in protein; slightly low in fat; in accord with fiber guaranty. No weed seeds noted.
Paragon Hominy Meal. Chas. M. Cox Co., Boston, Mass. Ground white corn. Contains not more than 7 per cent. crude fiber, and not less than 7½ per cent. fat and 9½ per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Wirthmore Hominy Meal. Chas. M. Cox Co., Boston, Mass. White corn. Contains not more than 5 per cent. crude fiber, and not less than 7½ per cent. fat and 9½ per cent. protein. Registered in 1915. Not registered in 1916.	One official sample. In accord with guaranty. No weed seeds noted.
Success Hominy Feed. Deutsch & Sickert Co., Milwaukee, Wis. Corn mill offal manufacturing hominy, grits, meal, etc. Contains not more than 6 per cent. crude fiber, and not less than 6 per cent. fat and 9 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample. In accord with guaranty in protein; more than 1 per cent. below guaranty in fat; more than 2 per cent. below maximum guaranty in fiber. No weed seeds noted.
Evans Hominy Feed. Evans Milling Co., Indianapolis, Ind. Manufactured from white corn. Contains not more than 7 per cent. crude fiber, and not less than 7½ per cent. fat and 10 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample. In accord with guaranty in protein; slightly below guaranty in fat; 2 per cent. below maximum guaranty of fiber. No weed seeds noted.
Cracked Corn. Gwinn Milling Co., Columbus, O. Corn. Contains not more than 3 per cent. crude fiber, and not less than 4 per cent. fat and 9 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Snowflake Brand Hominy. Oscar Holway Co., Auburn, Me. Corn hominy. Contains not more than 7 per cent. crude fiber, and not less than 7 per cent. fat and 9.75 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty in protein; more than 2 per cent. below guaranty in fat; about 3 per cent. below maximum guaranty in fiber.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Badger Hominy Feed. Chas. A. Krause Milling Co., Milwaukee, Wis. Made from white corn. Contains not more than 5 per cent. crude fiber, and not less than 6 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty. No weed seeds noted.
Choice Steam Cooked Hominy Feed. Miner-Hillard Milling Co., Wilkes Barre, Pa. Contains not more than 5 per cent. crude fiber, and not less than 5 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Hominy Feed. Mystic Milling Co., Sioux City, Iowa. No certificate filed. Claims on package. Contains not more than 5 per cent. crude fiber, and not less than 6.5 per cent. fat and 11 per cent. protein. Unregistered.	Three official samples. Practically in accord with guaranty. No weed seeds noted.
Hominy Feed. Patent Cereal Co., Geneva, N. Y. Corn. Contains not more than 5 per cent. crude fiber, and not less than 6 per cent. fat and 10 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample. In accord with guaranty. No weed seeds noted.
Iowa Hominy Feed (White & Yellow). Purity Oats Co., Davenport, Iowa. Hominy feed. Contains not more than 7 per cent. crude fiber, and not less than 5 per cent. fat and 9 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Yellow Hominy Feed. Quaker Oats Co., Chicago, Ill. Contains not more than 4 per cent. crude fiber, and not less than 4 per cent. fat and 9 per cent. protein. Registered in 1915 and 1916.	Three official samples. Above guaranty in protein and fat; one sample in accord with fiber guaranty; the other two about 1 per cent. in excess of the maximum guaranty for fiber. One sample contained a few hulls of corn cockle.
"Blue Ribbon" Hominy Chop. J. E. Soper Co., Boston, Mass. By-product pure white corn. Contains not more than 5 per cent. crude fiber, and not less than 6 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty in protein and fiber; fat slightly below guaranty.
Logan Hominy Feed. Standard Cereal Co., Chillicothe, O. Portions of the grain of corn. Contains not more than 6 per cent. crude fiber, and not less than 7 per cent. fat and 9 per cent. protein. Registered in 1915. Not registered in 1916.	Two official samples. In accord with guaranty in protein and fat; fiber more than 1 per cent below maximum guaranty. No weed seeds noted.
Frumentum Hominy Feed. United States Frumentum Co., Detroit, Mich. Composed of bran, germ, part of the starchy portion of the corn kernel and chaff obtained from the manufacture of hominy grits. Contains not more than 7 per cent. crude fiber, and not less than 7.3 per cent. fat and 9.5 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.

FEEDS UTILIZING CORN AND OAT BY-PRODUCTS.

Portage Stock Feed. Akron Feed & Milling Co., Akron, Ohio. Composed of white or yellow shelled corn, barley, oats shorts, oat hulls, oat middlings and ½ of 1 per cent. of salt. Contains not more than 10 per cent. of crude fiber, and not less than 4 per cent. of fat and 8 per cent of protein. Registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Bufceco Chop Feed. Buffalo Cereal Co., Buffalo N. Y. Composed of ground corn, oats and barley, hominy feed, oat shorts and oat hulls. On 1915 certificate: Contains not more than 9 per cent. crude fiber, and not less than 3 per cent. fat and 7 per cent. protein. On 1916 certificate: Contains not more than 10 per cent crude fiber, and not less than 4 per cent fat and 8 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Bufceco Dairy Feed. Buffalo Cereal Co., Buffalo, N. Y. Composed of ground corn, wheat bran and middlings, hominy feed, corn gluten feed, oat shorts, oat middlings, oat hulls, ½ of 1 per cent. salt. Contains not more than 9 per cent. crude fiber, and not less than 3 per cent fat and 12 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty in protein and fat; fiber exceeds maximum guaranty by about 2½ per cent.
Bufceco Horse Feed. Buffalo Cereal Co., Buffalo, N. Y. Composed of ground oats, corn and barley, wheat middlings, hominy feed, oat shorts, oat middlings, oat hulls, linseed meal, corn gluten feed. Contains not more than 9 per cent. crude fiber, and not less than 4 per cent. fat and 11 per cent. protein. (1915 certificate gives 10 per cent. as minimum protein). Registered in 1915 and 1916.	No dealers' or official samples received.
Bufceco Steam Cooked Feed. Buffalo Cereal Co., Buffalo, N. Y. Composed of ground corn and oats, hominy feed, oat shorts, oat middlings, oat hulls and ½ of one per cent. salt. Contains not more than 8 per cent. crude fiber, and not less than 4 per cent. fat and 10 per cent. protein. (1915 certificate gives 8 per cent. as minimum protein). Registered in 1915 and 1916.	Three official samples. Practically in accord with guaranty. No weed seeds noted.
Bufceco Stock Feed. Buffalo Cereal Co., Buffalo, N. Y. Composed of ground corn, oats and barley, wheat middlings, corn gluten feed, hominy feed, oat shorts, oat middlings, oat hulls, ½ of 1 per cent. salt. On 1915 certificate: Contains not more than 9 per cent. crude fiber, and not less than 4 per cent. fat and 8 per cent. protein. On 1916 certificate: Contains not more than 10 per cent. crude fiber, and not less than 5 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Iroquois Chop Feed. Buffalo Cereal Co., Buffalo, N. Y. Composed of ground corn, hominy feed, oat shorts and oat hulls. Contains not more than .9 per cent. crude fiber, and not less than 3 per cent. fat and 7 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Henkel's Coarse Feed Corn Meal. Commercial Milling Co., Detroit, Mich. Corn. Contains not more than 3 per cent. crude fiber, and not less than 3 per cent. fat and 8.5 per cent protein. (1915 certificate gives 2 per cent as maximum fiber). Registered in 1915 and 1916.	No dealers' or official samples received.

FEEDING STUFFS—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Henkel's Chop Feed. The Commercial Milling Co., Detroit, Mich. Composed of corn meal, rye and oat middlings, oats and oat hulls. On 1915 certificate. Contains not more than 9 per cent. crude fiber, and not less than 4.5 per cent. fat and 9 per cent. protein. On 1916 certificate Contains not more than 10 per cent. crude fiber, and not less than 3½ per cent. fat and 8.5 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty in protein and fat; about 2 per cent. below maximum guaranty in fiber. Contained a few seeds of corn cockle. charlock, ragweed, dock and wild buckwheat.
Wirthmore Stock Feed. Chas. M. Cox Co., Boston, Mass. A compound of ground barley, ground oats, ground hominy meal, ground corn, oat meal mill by-products (oat middlings, oat shorts, oat hulls), and ½ of 1per cent salt. Part of the ingredients having been cooked or steamed are more easily assimilated than raw grains and have better keeping qualities. Contains not more than 9½ per cent. crude fiber, and not less than 4 per cent. fat and 9 per cent. protein. Registered in 1915 and 1916.	Five official samples. Above guaranty in protein and fat; slightly below maximum guaranty of fiber. Contained a few seeds of field peppergrass, pigweed and mustard.
Sterlingworth Stock Feed. Eastern Grain Co., Portland, Me. Composed of corn meal, hominy, dried brewers grain, wheat bran, oat meal, and oat middlings, salt. Contains not more than 15 per cent. crude fiber, and uot less than 5 per cent. fat and 10 per cent protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Elmore Stock Feed. Elmore Milling Co., Oneonta, N. Y. Composed of corn meal, hominy, dried brewers grains, wheat bran, oat mill by-products (oat hulls, oat middlings, oat shorts), salt. Contains not more than 12 per cent. crude fiber, and not less than 4 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Farmers Union Stock Feed. Farmers Union Grain and Supply Co., Waterville, Me. Composed of corn meal, hominy, dried brewers grain, wheat bran, oat meal, mill by-products (oat hulls, oat middlings, oat shorts), salt. Contains not more than 12 per cent. crude fiber, and not less than 4 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Lucky Oat-Corn Feed. Federal Milling Co., Lockport, N. Y. Composed of crushed oats, cracked corn, corn feed meal, and hominy feed. Contains not more than 8 per cent. crude fiber, and not less than 3 per cent. fat and 8 per cent protein. (1915 certificate gives 9 per cent as minimum protein). Registered in 1915 and 1916.	No dealers' or official samples received.
Empire Feed. Felt Bros. & Gage Co. Empire Mills), Olean, N. Y. Composed of corn, hominy, oat hulls. Contains not more than 9 per cent. crude fiber, and not less than 3 per cent fat and 7.5 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Buffalo Stock Feed. Globe Elevator Co., Buffalo, N. Y. Composed of corn, barley, oats, red dog flour, oat hulls, oat middlings hominy feed, cottonseed meal, salt. Contains not more than 9 per cent. crude fiber, and not less than 4 per cent. fat and 9 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
No. 1 Coop Feed. Globe Elevator Co., Buffalo, N. Y. Composed of ground corn and oats and oat hulls, flour middlings, salt ½ of 1 per cent. Contains not more than 9 per cent. crude fiber, and not less than 3 per cent. fat and 9 per cent. protein Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Grandin's Stock Feed. D. H. Grandin Milling Co., Jamestown, N.Y. Composed of fine white hominy feed, oat meal mill by-products (oat middlings, oat hulls, oat shorts) and salt. On 1915 certificate: Contains not more than 10 per cent crude fiber, and not less than 3½ per cent. fat and 8½ per cent. protein. On 1916 certificate. Contains not more than 13 per cent crude fiber, and not less than 4 per cent. fat and 8.5 per cent. protein. Registered in 1915 and 1916.	Six official samples. Above guaranty in protein and fat; the one sample examined for fiber slightly exceeded the maximum guaranty. One sample contained a few seeds of mustard.
Xtragood Stock Feed. Griswold & Mackinnon, St. Johnsbury, Vt. Composed of ground corn, hominy feed, ground barley, wheat flour, wheat middlings, with ground screenings not exceeding mill run, cottonseed meal ground puffed rice, ground puffed wheat, oat meal by-products (oat middlings, oat hulls, oat shorts) ½ of 1 per cent salt. On 1915 certificate: Contains not more than 9 per cent. crude fiber, and not less than 2.97 per cent. fat and 7.5 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Haskell's Stock Feed. W. H. Haskell & Co., Toledo, O. Composed of ground corn, ground oats, hominy feed, oat hulls, oat shorts and salt. On 1915 certificate: Contains not more than 8 per cent. crude fiber, and not less than 4 per cent. fat and 8 per cent protein. On 1916 certificate: Contains not more than 9 per cent. crude fiber, and not less than 6 per cent. fat and 9 per cent protein. Registered in 1915 and 1916.	Three official samples. Well in accord with 1915 guaranty in protein and fat; about 2 per cent. above maximum guaranty of fiber. No weed seeds noted.
Purity Stock Feed. Wm. S. Hills Co., Boston, Mass. Composed of corn, barley, middlings, oat feed, salt. Contains not more than 7 per cent. crude fiber, and not less than 3.25 per cent. fat and 10 per cent protein. (1915 certificate gives 9 per cent as maximum fiber). Registered in 1915 and 1916.	One official sample. Slightly below guaranty in protein; about 3 per cent. above guaranty in fat; 2 per cent. above maximum guaranty of fiber. No weed seeds noted.
The H-O Co.'s Algrane Milk Feed. The H-O Co., Buffalo, N. Y. Composed of oat hulls, wheat middlings, cottonseed meal, oat shorts, corn gluten feed, ground corn, ground oats, ground grain screenings, molasses, salt ½ of 1 per cent. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
JEM Stock Feed. Jamestown Electric Mills, Jamestown, N. Y. Composed of ground corn hominy feed, corn oil meal, ground oats, oat middlings, oat shorts, reground oat hulls, linseed oil meal, small percentage of fine salt, nothing more. Contains not more than 9 per cent. crude fiber, and not less than 5 per cent. fat and 10 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Park City Stock Feed. Lake Erie Milling Co., Toledo, O. Corn, oats, oat groats, oat middlings, oat hulls, corn meal offal and ½ of 1 per cent salt. Contains not more than 9 per cent. crude fiber, and not less than 3½ per cent. fat and 8 per cent. protein. (1915 certificate gives 9 per cent. as minimum protein). Registered in 1915 and 1916.	No dealers' or official samples received.
Brooks Fancy Corn & Oats Stock Feed. A. H. McLeod Milling Co., St. Johnsbury, Vt. Corn, oats and gluten feed. Contains not more than 8.5 per cent. crude fiber, and not less than 3 per cent. fat and 9 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Daily Dividend Stock Feed. Merrill & Mayo Co., Waterville, Me. Composed of wheat middlings, corn meal, hominy feed, brewers dried grains, oat meal mill by-product (oat shorts, oat hulls, oat middlings) and 1 per cent. table salt, Contains not more than 12.75 per cent. crude fiber, and not less than 4 per cent. fat and 10 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Park City Stock Feed. Mollett Grain & Milling Co., Toledo, O. Composed of corn, oats, oat groats, oat middlings and oat hulls, ¾ of 1 per cent. salt. Contains not more than 10 per cent. crude fiber, and not less than 3½ per cent. fat and 8½ per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Buffalo Horse Feed (Formerly Monarch Chop Feed). A. Nowak & Son, Buffalo, N. Y. Composed of ground oats, corn feed meal, hominy feed, oat hulls, clipped oat by-product containing some seeds, wheat middlings, ¾ of 1 per cent. salt. Contains not more than 12 per cent. crude fiber, and not less than 3 per cent. fat and 7 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Domino Stock Feed. Nowak Milling Corporation, Buffalo, N. Y. Composed of hominy feed, low grade flour, oat hulls, oat middlings, salt ¾ of 1 per cent. Contains not more than 9 per cent. crude fiber, and not less than 3 per cent. fat and 10 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Justice Stock Feed. Nowak Milling Corporation, Buffalo, N. Y. Composed of ground oats, corn feed meal, linseed oil meal, wheat middlings, oat middlings, oat hulls, salt ¾ of 1 per cent. Contains not more than 9 per cent. crude fiber, and not less than 3 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Park & Pollard Co. Stock Feed. Park & Pollard Co., Boston, Mass. Ground: corn, hominy feed and oat feed. Contains not more than 12 per cent. crude fiber, and not less than 1½ per cent. fat and 9 per cent. protein. (1915 certificate gives 3 per cent. as minimum fat). Registered in 1915 and 1916.	Two official samples. Above guaranty in protein and fat; fiber about 2 per cent. below maximum guaranty. No weed seeds noted.
White Clover Stock Feed. Park & Pollard Co., Boston, Mass. Ground: corn, hominy feed and oat feed. Contains not more than 15 per cent. crude fiber, and not less than 1 per cent. fat and 6½ per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Pilco Chop or Stock Feed. Pilliod Milling Co., Swanton, O. Contains not more than 9 per cent. crude fiber, and not less than 4 per cent. fat and 10 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Pilco Stock Feed. Pilliod Milling Co., Swanton, O. Composed of corn meal, corn bran, corn, oat hulls, oat by-products. Contains not more than 13.5 per cent. crude fiber, and not less than 3.75 per cent. fat and 7.5 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Iowa Dairy Feed. Purity Oats Co., Davenport, Iowa. Composed of cottonseed meal, corn meal, hominy feed, brewers dried grains, oat meal mill by-product (oat shorts, oat hulls, oat middlings) and 1 per cent. table salt. Contains not more than 14 per cent. crude fiber, and not less than 4.5 per cent. fat and 16 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample. In accord with guaranty in protein and fat; fiber 2 per cent. below maximum guaranty. Contained few seeds of mustard.
Iowa Stock Feed. Purity Oats Co., Davenport, Iowa. Composed of corn meal, wheat middlings, hominy feed, brewers dried grains, oat meal mill by-product (oat hulls, oat shorts, oat middlings) and 1 per cent. table salt. Contains not more than 12.75 per cent. crude fiber, and not less than 4 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	Two official samples. Above guaranty in protein and fat; fiber about 2 per cent. below maximum guaranty. Two dealers' samples. Practically in accord with guaranty. One sample contained a few seeds of mustard.
Tom Boy Horse Feed. Purity Oats Co., Davenport, Iowa. Composed of cracked corn, whole oats, alfalfa meal, oat mill by-products (oat shorts, oat hulls, oat middlings), cottonseed meal and molasses. Contains not more than 18 per cent. crude fiber, and not less than 2 per cent. fat and 9 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Boss Feed. Quaker Oats Co., Chicago, Ill. Composed of ground corn, hominy feed, oat meal mill by-product (oat middlings, oat hulls, oat shorts), ½ of 1 per cent. salt. Contains not more than 12 per cent. crude fiber, and not less than 3 per cent. fat and 8 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Maz-All Corn Feed. Quaker Oats Co., Chicago, Ill. Corn by-products. Contains not more than 2 per cent. crude fiber, and not less than 1.4 per cent. fat and 8 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Schumacher Feed. Quaker Oats Co., Chicago, Ill. Composed of ground corn, hominy feed, ground barley, wheat barley, wheat middlings, cottonseed meal, oat meal mill by-product (oat middlings, oat hulls, oat shorts), ½ of 1 per cent. salt, ground puffed rice, ground puffed wheat. Contains not more than 10 per cent. crude fiber, and not less than 3.25 per cent. fat and 10 per cent. protein; Registered in 1915 and 1916.	Nine official samples. Seven were in accord with guaranty in protein; the other two were slightly below guaranty in protein. All were in accord with guaranty in fat. Three samples were about 1 per cent. above maximum guaranty of fiber two exceeded maximum guaranty of fiber by more than 2 per cent.; the other four, as far as examined, were in accord with fiber guaranty. Contained many seeds of pigweed, some of mustard, and a few of lady's thumb, wild buckwheat, night-flowering catchfly and field peppergrass.
Sterling Feed. Quaker Oats Co , Chicago, Ill. Composed of ground corn, hominy feed, ground barley, wheat flour, wheat middlings, cottonseed meal, oat meal mill by-product (oat middlings, oat hulls, oat shorts), ½ of 1 per cent. salt, ground puffed rice, ground puffed wheat. Contains not more than 10 per cent. crude fiber, and not less than 3.25 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Victor Feed. Quaker Oats Co., Chicago, Ill. Composed of ground corn, hominy feed, oat meal mill by-product (oat middlings, oat hulls, oat shorts), ½ of 1 per cent. salt. Contains not more than 12 per cent. crude fiber, and not less than 3 per cent. fat and 8 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
White Diamond Feed. Quaker Oats Co., Chicago, Ill. Composed of ground corn, hominy feed, oat meal mill by-product (oat middlings, oat hulls, oat shorts), ½ of 1 per cent. salt. Contains not more than 9 per cent. crude fiber, and not less than 3.25 per cent. fat and 8 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Oat Feed. Robin Hood Mills, Ltd., Moose Jaw, Sask. On 1915 certificate: Oat hulls and oat shorts. On 1916 certificate: Oats. Contains not more than 28 per cent. crude fiber, and not less than 2.5 per cent. fat and 5.25 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty in protein and fat; fiber over 3 per cent. below maximum guaranty. No weed seeds noted.
All Round Quality Go-to-it. Stanley, Harlow, Hamlin, Inc., Boston, Mass. Composed of crushed oats, barley, corn and cob meal, dried distillers and yeast grains, alfalfa and salt. Contains not more than 16 per cent. crude fiber, and not less than 2 per cent. fat and 9 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Stott's Winner Feed. David Stott Flour Mills, Inc., Detroit, Mich. Composed of corn meal, oats, ground wheat screenings, oat hulls and salt. On 1915 certificate: Contains not more than 10 per cent. crude fiber, and not less than 5 per cent. fat and 9 per cent. protein. On 1916 certificate: Contains not more than 8½ per cent. crude fiber, and not less than 5 per cent. fat and 10½ per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
MOLASSES FEEDS, PROTEIN UNDER 15 PER CENT.	
Bufcolene Horse Feed. Buffalo Cereal Company, Buffalo, New York. Composed of crushed oats, cracked corn, corn feed meal, wheat bran and molasses. Contains not more than 7 per cent. crude fiber, and not less than 3 per cent. fat and 9 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Iroquois Horse Feed. Buffalo Cereal Co., Buffalo, N. Y. Composed of ground corn and oats, crushed oats, alfalfa meal, oat middlings, oat shorts, oat hulls and molasses. Contains not more than 11 per cent. crude fiber, and not less than 2 per cent. fat and 9 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Iroquois Stock Feed. Buffalo Cereal Co., Buffalo, N. Y. Composed of ground corn and oats, gluten feed, ground grain screenings, oat middlings, oat hulls, oat shorts and molasses. Contains not more than 11 per cent. crude fiber, and not less than 3 per cent. fat and 8 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Anchor Brand Horse Feed (Molasses Feed). Globe Elevator Co., Buffalo, N. Y. Composed of crushed and ground oats, ground and cracked corn, corn bran, wheat bran, crushed barley, molasses. Contains not more than 9 per cent. crude fiber, and not less than 3 per cent. fat and 9 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Anchor Brand Stock Feed (Molasses Feed). Globe Elevator Co., Buffalo, N. Y. Composed of ground oats, ground corn and corn bran, ground wheat and barley screenings, clipped oat by-products, molasses, salt ¾ of 1 per cent. Contains not more than 14 per cent. crude fiber, and not less than 3 per cent. fat and 8 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
H. & S. Horse, Mule & Dairy Feed. Dwight E. Hamlin, Pittsburg, Pa. Composed of alfalfa, pure cane molasses, oil meal, brewers and distillers grains and ½ of 1 per cent. salt. Contains not more than 16 per cent. crude fiber, and not less than 3½ per cent. fat and 14 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.

FEEDING STUFFS—Continued.

BRAND, MAKER AND GUARANTIES.	RESULTS OF EXAMINATION.
The H-O Co.'s Algrane Horse Feed. The H-O Co., Buffalo, N. Y. Composed of oats, oat shorts, ground corn, oat hulls, wheat middlings, hominy feed, corn gluten feed, molasses, salt ½ of 1 per cent. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 11 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
The H-O Co.'s De-Fi Feed. The H-O Co., Buffalo, N. Y. Composed of oat hulls, oat shorts, ground corn, hominy feed, wheat middlings, oat middlings; molasses, salt ½ of 1 per cent. Contains not more than 21 per cent. crude fiber, and not less than 3 per cent. fat and 8 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
The H-O Co.'s New England Stock Feed. The H-O Co., Buffalo, N. Y. Composed of wheat middlings, ground corn, hominy feed, oat hulls, oat shorts, ground oats, molasses, salt ½ of 1 per cent. Contains not more than 10 per cent. crude fiber and not less than 4 per cent. fat and 9 per cent. protein. Registered in 1915 and 1916.	One official sample. Practically in accord with guaranty. Contained many seeds of pigweed, and a few of wild buckwheat and mustard. Few hulls of corn cockle.
Molassine Meal. Molassine Co. of America, Boston, Mass. Molasses and cooked sphagnum moss. Contains not more than 7 per cent. crude fiber, and not less than ½ per cent. fat and 7 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Domino Horse Feed with Alfalfa. (Formerly Pure-Mo-Lene Horse Feed). Nowak Milling Corporation, Buffalo, N. Y. Composed of cracked corn, crushed oats, whole oats, ground alfalfa, molasses, salt ¾ of 1 per cent. Contains not more than 12 per cent. crude fiber, and not less than 2 per cent. fat and 9 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample. Slightly above guaranty in protein and fat. Slightly below maximum guaranty of fiber. No weed seeds noted.
Vim-O-Lene Horse Feed. A. Nowak & Son, Buffalo, N. Y. Composed of crushed oats, cracked corn, corn feed meal, wheat bran, molasses, salt ¾ of 1 per cent. Contains not more than 9 per cent. crude fiber, and not less than 2 per cent. fat and 8 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Peerless Alfalmo Horse Feed. Omaha Alfalfa Milling Co., Omaha, Neb. Composed of corn, oats, alfalfa meal, molasses. Contains not more than 12 per cent. crude fiber, and not less than 2 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Peters' Arab Horse Feed. M. C. Peters Mill Co., Omaha, Neb. Composed of corn, oats, alfalfa and molasses. Contains not more than 15 per cent. crude fiber, and not less than 2 per cent. fat and 9 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Peters' King Corn. M. C. Peters Mill Co., Omaha, Neb. Composed of corn, oats, alfalfa and molasses. Contains not more than 18 per cent. crude fiber, and not less than 1.5 per cent. fat and 9 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Green Cross Horse Molasses Mixed Feed. Quaker Oats Co., Chicago, Ill. Composed of alfalfa meal, ground corn, crushed oats, cottonseed meal, molasses, oat meal mill by-product (oat middlings, oat hulls, oat shorts). Contains not more than 12 per cent. crude fiber, and not less than 2.5 per cent. fat and 10 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Purina Feed with Molasses. Ralston Purina Co., Buffalo, N. Y., and St. Louis, Mo. Composed of cracked corn, crushed oats, ground alfalfa, molasses and one per cent. salt. Contains not more than 11.7 per cent. crude fiber, and not less than 1.7 per cent. fat and 9.3 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
All Round Quality Hobo. Stanley, Harlow, Hamlin, Inc., Boston, Mass. Composed of dried brewers yeast and distillers grains, alfalfa, molasses and salt. Contains not more than 14 per cent. crude fiber, and not less than 3 per cent. fat and 12 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Xtra-vim Feed. Xtravim Molasses Feed Co., Boston, Mass. Composed of cane sugar molasses and sphagnum moss. Contains not more than 4.5 per cent. crude fiber, and not less than .81 per cent. fat and 1.61 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

MOLASSES FEEDS, PROTEIN OVER 15 PER CENT.

Sucrene Dairy Feed. American Milling Co., Peoria, Ill. Composed of molasses, cottonseed meal, corn gluten feed, ground and bolted grain screenings, clipped oat by-product, linseed meal and salt. Contains not more than 12 per cent. crude fiber, and not less than 3.5 per cent. fat and 16.5 per cent. protein. Registered in 1915. Not registered in 1916.	One official sample. Above guaranty in protein and fat; slightly above maximum guaranty of fiber. Contained few hulls of wild buckwheat.
Arcady Dairy Feed. Arcady Farms Milling Co., Rondout, Ill. Composed of malt sprouts, brewers grains (dried), cottonseed meal; corn gluten, ground and bolted clipped oat by-product, cleaned, ground and bolted grain screenings, molasses, salt. Contains not more than 15 per cent. crude fiber, and not less than 3.5 per cent. fat and 16 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Iroquois Dairy Feed. Buffalo Cereal Co., Buffalo, N. Y. Composed of ground corn, corn gluten feed, cottonseed meal, ground grain screenings, molasses, ½ of 1 per cent. salt. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 17 per cent. protein. (1915 certificate gives 16 per cent. as minimum protein). Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued

Brand, Maker and Guaranties.	Results of Examination.
Clover Leaf Dairy Feed. Clover Leaf Milling Co., Buffalo, N. Y. Composed of cottonseed meal, corn gluten feed, mixed broken grains consisting of wheat, corn, barley, flax, speltz, ground grain screenings, cocoa shell meal, clipped oat by-product, molasses and one-half of one per cent. of salt. On 1915 certificate: Contains not more than 12 per cent. crude fiber, and not less than 3.5 per cent. fat and 16.5 per cent. protein. On 1916 certificate: Contains not more than 15 per cent. crude fiber, and not less than 4 per cent. fat and 13.5 per cent. protein. Registered in 1915 and 1916.	Four official samples. Above guaranty in protein; practically in accord with guaranty in fat and fiber. Contained some seeds of pigweed, and a few of wild buckwheat, night-flowering catchfly, mustard, false flax and lady's thumb. Few hulls of wild buckwheat.
Anchor Brand Dairy Feed (Molasses Feed). Globe Elevator Co., Buffalo, N. Y. Composed of cottonseed meal, corn gluten feed, linseed oil meal, malt sprouts, brewers dried grains, corn meal, ground grain screenings, clipped oat by-product, wheat middlings, molasses, salt, corn bran. Contains not more than 12 per cent. crude fiber, and not less than 3.5 per cent. fat and 16 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
H. & S. Alfalfa Feed (For Milch Cows). Dwight E. Hamlin, Pittsburg, Pa. Composed of alfalfa, cottonseed meal, pure cane molasses, brewers and distillers dried grains and ½ of 1 per cent. salt. Contains not more than 16 per cent. crude fiber, and not less than 3½ per cent. fat and 20 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
International Special Dairy Feed. International Sugar Feed Co., Minneapolis, Minn. Composed of cottonseed meal, molasses, ground cleaned grain screenings, ground clipped oat by-product, salt. Contains not more than 12 per cent. crude fiber, and not less than 4.5 per cent. fat and 15 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample. Above guaranty in protein and fat; about 3 per cent. below maximum guaranty of fiber. Contained many seeds of pigweed and a few of mustard, penny cress and false flax. Few hulls of wild buckwheat.
Domino Calf Meal. Nowak Milling Corporation, Buffalo, N. Y. Composed of carob beans, flaxseed, wheat flour, cottonseed meal, beans, lintils, fenugreek, anise, cocoa meal and salt. Contains not more than 6 per cent. crude fiber, and not less than 5 per cent. fat and 25 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Domino Cream-O-Lene Dairy Ration. (Registered in 1915 as Cream-O-Lene Dairy Ration). Nowak Milling Corporation, Buffalo, N. Y. Composed of cottonseed meal, corn gluten feed, linseed oil meal, wheat middlings, corn distillers dried grains, corn feed meal, clipped oat by-product, malt sprouts, brewers dried grains, ground and bolted grain screenings, cocoanut oil meal, salt ¾ of 1 per cent., molasses. Contains not more than 12 per cent. crude fiber, and not less than 4 per cent. fat and 20 per cent. protein. (1915 certificate gives 9 per cent. as maximum crude fiber). Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Blue Ribbon Dairy Feed. Quaker Oats Co., Chicago, Ill. Composed of hominy feed, malt sprouts, wheat bran (with ground screenings not exceeding mill run), cottonseed meal, oat meal mill by-product (oat middlings, oat hulls, oat shorts), molasses, new process linseed oil meal, ½ of 1 per cent. salt. Contains not more than 12 per cent. crude fiber, and not less than 3.5 per cent. fat and 25 per cent. protein. Registered in 1915 and 1916.	One official sample. Practically in accord with guaranty. Contains few seeds of knot grass, and few hulls of corn cockle and yellow foxtail.
Quaker Dairy Feed with Molasses. Quaker Oats Co., Chicago, Ill. Composed of molasses, malt sprouts, cottonseed meal, ground grain screenings, new process linseed oil meal, oat meal by-product (oat middlings, oat hulls, oat shorts), ½ of 1 per cent. salt. Contains not more than 14.5 per cent. crude fiber, and not less than 4 per cent. fat and 16 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Purina Cow Chow Feed. Ralston Purina Co., Buffalo, N. Y., and St. Louis, Mo. Composed of cottonseed meal, gluten feed, brewers dried grains, molasses, ground alfalfa and 1 per cent. salt. Contains not more than 12 per cent. crude fiber, and not less than 5 per cent. fat and 24 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Hammond Dairy Feed. Western Grain Products Co., West Hammond, Ill. Composed of cottonseed meal, corn distillers grains, malt sprouts, ground clipped oat by-product, ground grain screenings, molasses and salt. Contains not more than 12 per cent. crude fiber, and not less than 3.5 per cent. fat and 16.5 per cent. protein. (1915 certificate gives 11 per cent. as maximum crude fiber). Registered in 1915 and 1916.	No dealers' or official samples received.

MISCELLANEOUS COMPOUNDED FEEDS.

With Protein Over 15 Per Cent.

Ohio Farm Feed. Ansted & Burk Co., Springfield, Ohio. Composed of ½ wheat middlings, ¼ corn bran and corn meal, balance wheat bran and cleaned wheat screenings not to exceed mill run. Contains not more than 8½ per cent. crude fiber, and not less than 4½ per cent. fat and 11½ per cent. protein. Not registered in 1915. Registered in 1916.	One official sample. Protein and fat practically in accord with guaranty; fiber over 3 per cent. below maximum guaranty. Contained a few hulls of corn cockle.
"B-G" Cow Feed. Bath Grain Co., Bath, Me. Composed of beet pulp, cottonseed meal, gluten, bran, middlings, hominy and salt. Contains not more than 14 per cent. crude fiber, and not less than 4 per cent. fat and 20 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.

FEEDING STUFFS—Continued.

BRAND, MAKER AND GUARANTIES.	RESULTS OF EXAMINATION.
Blatchford's Calf Meal. Blatchford Calf Meal Factory, Waukegan, Ill. Composed of locust bran meal, unpressed flaxseed, wheat flour, blood flour, barley meal, ground beans and peas, rice polish, old process oil meal, cocoa shell meal, cocoanut meal, recleaned cottonseed meal, fenugreek, dried milk, anise and salt. Contains not more than 6¾ per cent. crude fiber, and not less than 5 per cent. fat and 24 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty.
Blatchford's Pig Meal. Blatchford Calf Meal Factory, Waukegan, Ill. Composed of linseed oil meal, bean and locust bean meal, oat meal, blood flour, wheat flour, barley meal, recleaned cottonseed meal, rice polish, corn meal, cocoa shell meal, crushed flaxseed, anise and salt. Contains not more than 7 per cent. crude fiber, and not less than 5 per cent. fat and 18 per cent. protein. Registered in 1915 and 1916.	One official sample. Practically in accord with guaranty. No weed seeds found.
Bufceco Creamery Feed. Buffalo Cereal Co., Buffalo, N. Y. Composed of ground corn, wheat bran and middlings, hominy feed, corn gluten feed, cottonseed meal, oat shorts, oat middlings, oat hulls, ½ of 1 per cent. salt. Contains not more than 9 per cent. crude fiber, and not less than 4 per cent. fat and 18 per cent. protein. Registered in 1915 and 1916.	One official sample. Slightly below guaranty in protein; about 2 per cent above guaranty in fat; over 3 per cent above maximum guaranty in fiber.
Acorn Dairy Ration. Chapin & Co., Hammond, Ind. Composed of cottonseed meal, corn distillers grains, linseed meal, hominy meal, gluten feed, corn starch by-products with corn bran, barley feed, malt sprouts, brewers grains, pure wheat bran and salt. Contains not more than 12 per cent. crude fiber, and not less than 5.5 per cent. fat and 23.5 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Unicorn Dairy Ration. Chapin & Co., Hammond, Ind. Composed of corn distillers grains, cottonseed meal, linseed meal, hominy meal, gluten feed, corn starch by-products with corn bran, barley feed, malt sprouts, brewers grains, and pure wheat bran and salt. Contains not more than 10 per cent. crude fiber, and not less than 5.5 per cent. fat and 26 per cent. protein.	Twelve official samples. Five were in accord with the guaranty in protein and fat; fiber about 1 per cent. above maximum guaranty. Four of the samples were slightly below guaranty in protein; in accord with guaranty in fat; fiber more than 1 per cent. above maximum guaranty. Two of the samples were more than 1 per cent. below guaranty in protein; fat in accord with guaranty; fiber more than 1 per cent. above maximum guaranty. One sample was more than 2 per cent. below guaranty in protein; fat in accord; fiber more than 1 per cent. above maximum guaranty. Two dealers' samples. Both were 1 per cent. low in protein; in accord with guaranty in fat; about 1 per cent. above maximum guaranty in fiber. Contained few seeds of mustard, pigweed, lady's thumb, night-flowering catchfly, wild buckwheat, green foxtail, yellow foxtail and false flax. Few hulls of Corn cockle and wild buckwheat.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Henkel's Fine White Feed. The Commercial Milling Co., Detroit, Mich. Composed of wheat and rye middlings with ground screenings not exceeding mill run and corn products. Contains not more than 6 per cent. crude fiber and not less than 7 per cent. fat and 15 per cent protein. (1915 certificate gives 4 per. cent as minimum fat and 16 per cent as minimum protein). Registered in 1915 and 1916.	No dealers' or official samples received.
Wirthmore Balanced Ration. Chas. M. Cox Co., Boston. Mass. Composed of choice cottonseed meal, linseed, gluten feed, fancy distillers grains, bran, choice malt sprouts, hominy or corn meal and not over ¾ of 1 per cent. salt. On 1915 certificate: Contains not more than 8¾ per cent. crude fiber, and not less than 5 per cent. fat and 26 per cent. protein. On 1916 certificate: Contains not more than 8½ per cent. crude fiber, and not less than 5 per cent. fat and 25 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Dewey's Ready Ration. The Dewey Brothers Co., Blanchester, O. Composed of Eagle distillers dried grains from corn, linseed oil meal, cottonseed meal, wheat bran, wheat middlings, hominy feed, malt sprouts and ½ per cent. salt. Contains not more than 10 per cent. crude fiber, and not less than 6 per cent. fat and 25 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Elmore Milk Grains. Elmore Milling Co., Oneonta, N. Y. Composed of corn distillers dried grains, 41 per cent. cottonseed meal, old process linseed meal, corn gluten feed, hominy meal, choice wheat bran, barley malt sprouts, dried brewers grains, salt. Contains not more than 10 per cent. crude fiber, and not less than 6 per cent. fat and 25 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Farmers Union Ready Ration. Farmers Union Grain & Supply Co., Waterville, Me. Composed of corn distillers grains, 41 per cent. cottonseed meal, linseed meal, corn gluten, hominy, wheat bran, barley, malt sprouts, brewers grains, salt. Contains not more than 10 per cent. crude fiber, and not less than 6 per cent. fat and 25 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty. Contained few seeds of wild buckwheat.
Purity Milk Maker. Wm. S. Hills Co., Boston, Mass. Composed of distillers grains, wheat middlings, salt, cottonseed meal, malt sprouts, oil meal, gluten feed, hominy. Contains not more than 9 per cent. crude fiber, and not less than 7 per cent. fat and 24 per cent. protein. Registered in 1915. Not registered in 1916.	One official sample. Above guaranty in protein; slightly below guaranty in fat; about 2 per cent above maximum guaranty in fiber. Contained few seeds of yellow foxtail and charlock.
Jersey Cow Feed. Houlton Mills & Light Co., Houlton, Me. Composed of wheat, corn, buckwheat and cottonseed meal. Contains not more than 16 per cent. crude fiber, and not less than 5 per cent. fat and 17 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
JEM Milk Maker. Jamestown Electric Mills, Jamestown, N. Y. Composed of corn distillers dried grains, brewers dried grains, wheat bran, wheat middlings, corn gluten feed, cottonseed meal, linseed oil meal, corn meal, corn, oil meal, malt sprouts and small percentage of fine salt, nothing more. Contains not more than 11 per cent. crude fiber, and not less than 6 per cent. fat and 24 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Ri-Co Feed. Lanier Brothers, Nashville, Tennessee. Contains not more than 9 per cent crude fiber, and not less than 14 per cent. fat and 13 per cent. protein. Not registered in 1915. Registered in 1916.	One dealer's sample. Found to be about 1½ per cent. below minimum guaranty of protein. No official samples received.
Larro-Feed. Larrowe Milling Co., Detroit, Mich. Composed of cottonseed meal, corn gluten feed, dried distillers' grains (mainly from corn), dried beet pulp, standard wheat bran, standard wheat middlings, and ¾ of 1 per cent. salt. Wheat bran and wheat middlings may contain ground screenings not exceeding mill run. Contains not more than 14 per cent. crude fiber, and not less than 3 per cent fat and 20 per cent. protein. (1915 certificate gives 19 per cent. as minimum protein). Registered in 1915 and 1916.	Four official samples. In accord with guarranty. No weed seeds noted.
Mingo. Larrowe Milling Co., Detroit, Mich. Composed of dried beet pulp, cottonseed meal, malt sprouts, corn gluten feed, linseed oil meal, wheat bran which may contain ground screenings not exceeding mill run, dried distillers grains (mainly from corn) and ¾ of 1 per cent.) of salt. Contains not more than 12 per cent. crude fiber, and not less than 4 per cent fat and 25 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Park & Pollard Co. Calf Meal. Park & Pollard Co., Boston, Mass. Composed of flaxseed, beans and lentils, wheat flour, cottonseed meal, locust beans, cocoa meal, anise, fenugreek, trace of salt. Contains not more than 6 per cent. crude fiber, and not less than 5 per cent. fat and 25 per cent protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Stevens Dairy Ration 44. Park & Pollard Co., Boston, Mass. Composed of oil meal, cottonseed meal, winter wheat bran, gluten feed, cocoanut oil meal, pea meal, distillers grains, brewers grains, ground barley, wheat middlings, hominy meal, corn germ meal, buckwheat middlings, corn meal, salt. Contains not more than 14 per. cent crude fiber, and not less than 5 per cent. fat and 24 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample. One per cent. below guaranty in protein; in accord with guaranty in fiber and fat. One dealer's sample. Slightly below guaranty in protein.
Buckeye Feed. Quaker Oats Co., Chicago, Ill. Wheat mixed feed with ground screenings, not exceeding mill run, and rye shorts. Contains not more than 8.5 per cent. crude fiber, and not less than 4.5 per cent. fat and 15.5 per cent protein. Registered in 1915 and 1916.	Two official samples. In accord with guaranty in protein and fat; one sample 1 per cent. above the maximum guaranty of fiber, the other practically in accord with the fiber guaranty. Contained many seeds of pigweed, green foxtail, mustard, night-flowering catchfly and lady's thumb and a few of false flax. Many hulls of corn cockle and wild buckwheat.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Schumacher Calf Meal. Quaker Oats Co., Chicago, Ill. Composed of oat meal, wheat meal, ground flax seed, dried casein, ½ of 1 per cent bicarbonate of soda, cottonseed meal. Contains not more than 3 per cent. crude fiber and not less than 8 per cent fat and 19 per cent. protein. Registered in 1915 and 1916.	Two official samples. One in accord with guaranty. The other slightly below guaranty in protein. The first sample contained no weed seeds. The second contained a few hulls of wild buckwheat.
Ryde's Cream Calf Meal. Ryde & Co., Chicago, Ill. Composed of Carob beans, flaxseed, wheat flour, cottonseed meal, beans and lentils, fenugreek, anise, cocoa meal, trace of salt. Contains not more than 6 per cent. crude fiber, and not less than 5 per cent. fat and 25 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
All Round Quality Stock. Stanley, Harlow, Hamlin, Inc., Boston, Mass. Composed of corn feed meal, hominy feed, rice meal, dried distillers and yeast grains and salt. Contains not more than 15 per cent. crude fiber, and not less than 7 per cent fat and 13 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Towle's Balanced Ration. J. N. Towle & Co., Bangor, Me. Composed of wheat bran, choice cottonseed meal, old process linseed meal, hominy meal, corn meal, fine salt. Contains not more than 9.13 per cent. crude fiber, and not less than 5.72 per cent. fat and 22.13 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Towle's Pig Feed. J. N. Towle & Co., Bangor, Me. Composed of wheat bran, old process linseed meal, hominy meal, corn meal, meat meal. Contains not more than 7.22 per cent. crude fiber, and not lesst han 6.72 per cent. fat and 18.63 per cent. protein (1915 certificate gives 20.63 as minimum. protein). Registered in 1915 and 1916.	No dealers' or official samples received.
Ubiko Horse and Stock Feed. Ubiko Milling Co., Cincinnati, O. Composed of wheat middlings, hominy meal, wheat bran, brewers dried grains, old process linseed meal, and nothing else. Contains not more than 9 per cent. crude fiber, and not less than 6 per cent fat and 16 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Union Grains, Ubiko, Biles' Ready Dairy Ration. Ubiko Milling Co., Cincinnati, O. Composed of Fourex (corn) distillers dried grains, choice cottonseed meal, old process linseed meal, white wheat middlings, winter wheat bran, hominy meal, brewers dried grains, barley malt sprouts, one-half per cent. of fine table salt. Contains not more than 9 per cent. crude fiber, and not less than 7 per cent. fat and 24 per cent. protein. Registered in 1915 and 1916.	One dealer's sample. In accord with guaranty. Five official samples. In accord with guaranty in protein; as far as examined slightly low in fat; 1½ per cent. above maximum guaranty of fiber. Contained some seeds of wild buckwheat, and a few of mustard, pigweed, cow herb, and knot-grass. Few hulls of corn cockle and wild buckwheat.

FEEDING STUFFS—Continued.

BRAND, MAKER AND GUARANTIES.	RESULTS OF EXAMINATION.
Crescent Dairy Feed. Wentworth Bros., Cornish, Me. Composed of corn cereal wheat bran, distillers grains, gluten meal, cottonseed meal, linseed oilmeal and salt. On 1915 certificate: Contains not more than 9 per cent. crude fiber, and not less than 7 per cent. fat and 24 per cent. protein. On 1916 certificate: Contains not more than 10 per cent crude fiber, and not less than 5 per cent. fat and 22 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

COMPOUNDED POULTRY FEEDS.

Homco Chick Feed. American Hominy Co., Indianapolis, Indiana. Composed of cracked corn, cracked wheat, cracked Kaffir corn, Hen-e-ta No. 2 (Sodium,lime, silica, and phosphorus compound), millet. Contains not nore than 5 per cent. crude fiber, and not less than 2.5 per cent. fat and 9 per cent protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Homco Dry Mash. American Hominy Co., Indianapolis, Indiana. Composed of Homcoline (corn germ meal), Homco, wheat middlings, bran, Hen-e-ta (sodium, lime, silica and phosphorus compound), linseed oil meal. Contains not more than 7 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Registered in 1915 . Not registered in 1916.	No dealers' or official samples received.
Homco Scratch Feed. American Hominy Co., Indianapolis, Ind. Composed of cracked corn, wheat, barley, Homcoline (corn germ meal), Kaffir corn. Contains not more than 6 per cent. crude fiber, and not less than 2.5 per cent. fat and 10 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Homco Superior Scratch Feed. American Hominy Co., Indianapolis, Ind. Composed of cracked corn, whole wheat, barley, Kaffir corn, sunflower seed, Homcoline (corn germ meal). Contains not more than 5 per cent. crude fiber, and not less than 2.5 per cent. fat and 10.5 per cent protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Humpty-Dumpty Scratch Feed. Ansted & Burk Co., Springfield, Ohio. Composed of wheat, corn, kaffir corn, milo maize, buckwheat, barley, rye, charcoal, sunflower seed, wheat screenings, grit. Contains not more than 4 per cent crude fiber, and not less than 3 per cent fat and 11 per cent protein. Not registered in 1915. Registered in 1916.	Two official samples. Practically in accord with guaranty. Contained many seeds of mustard, wild buckwheat and yellow foxtail. Some of Apetalous peppergrass, lady's thumb, corn cockle, dock, penny cress, night-flowering catchfly, green foxtail, cow herb, and corn gromwell.
"B-G" Dry Mash. Bath Grain Co., Bath, Maine. Composed of corn meal, meat scraps, bran, linseed oil meal, gluten, bone and meat meal, cottonseed meal, hominy, alfalfa and granulated charcoal. Contains not more than 12 per cent. crude fiber, and not less than 4 per cent. fat and 18 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
"B-G" Scratch Feed. Bath Grain Co., Bath, Maine. Composed of cracked corn, kaffir corn, wheat, buckwheat, barley, oats, sunflower seed and charcoal. Contains not more than 5 per cent. crude fiber, and not less than 2½ per cent. fat and 10 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Blatchford's "Fill-the Basket" Egg Mash. Blatchford Calf Meal Factory, Waukegan, Ill. Composed of locust bean meal, unpressed flaxseed, wheat flour, rice polish, blood flour, barley meal, ground beans and peas, old process oil meal, cocoa shell meal, cocoanut meal, recleaned cottonseed meal, fenugreek, dried milk, anise and salt, also alfalfa, bone, corn, and oat meals, wheat bran, wheat middlings, meat scraps, fish, capsicum and powdered limestone. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 19 per cent. protein. Registered in 1915 and 1916.	Two official samples. In accord with guaranty in protein and fat; fiber below maximum guaranty. No weed seeds found.
Blatchford's Milk Mash. Blatchford Calf Meal Factory, Waukegan, Ill. Composed of locust bran meal, unpressed flaxseed, wheat flour, barley meal, blood flour, ground beans and peas, rice polish, old process oil meal, cocoa shell meal, cocoanut meal, recleaned cottonseed meal, fenugreek, dried milk, anise and salt, also bone, corn, and oat meals, wheat middlings, meat scraps, fish, and powdered limestone. Contains not more than 7½ per cent crude fiber, and not less than 4 per cent. fat and 20 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Monarch Poultry Mash. F. H. Brastow & Son, South Brewer, Me. Composed of wheat bran, wheat middlings, gluten feed, beef scraps, alfalfa and corn meals. Contains not more than 7 per cent. crude fiber, and not less than 5.50 per cent. fat and 20 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Bufceco Chick Feed. Buffalo Cereal Co., Buffalo, N. Y. Composed of corn, wheat, kaffir corn, peas, millet and oat groats. Contains not more than 2 per cent. crude fiber, and not less than 2 per cent. fat and 12 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Bufceco Intermediate Scratching Grains. Buffalo Cereal Co., Buffalo, N. Y. Composed of corn, wheat, kaffir corn, buckwheat, millet and peas. Contains not more than 4 per cent. crude fiber, and not less than 2 per cent fat and 10 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Bufceco Laying Mash. Buffalo Cereal Co., Buffalo, N.Y. Composed of ground corn, oats, wheat and kaffir corn, wheat bran, wheat middlings, linseed meal, alfalfa meal, oat middlings, meat and bone scrap, ½ of 1 per cent. salt. Contains not more than 6 per cent crude fiber, and not less than 5 per cent. fat and 20 per cent. protein. Registered in 1915 and 1916.	One official sample. Above guaranty in protein and fat; fiber exceeds maximum by about 2 per cent. Contained few hulls of wild buckwheat.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Bufceco Pigeon Feed. Buffalo Cereal Co., Buffalo, N. Y. Composed of cracked corn, wheat, peas and kaffir corn. Contains not more than 4 per cent. crude fiber, and not less than 3 per cent. fat and 10 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Bufceco Poultry Mash. Buffalo Cereal Co., Buffalo, N. Y. Composed of ground corn, wheat bran and middlings, hominy feed, corn gluten feed, oats middlings and rolled oats. Contains not more than 6 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Bufceco Scratching Grains. Buffalo Cereal Co., Buffalo, N. Y. Composed of corn, oats, barley, buckwheat, kaffir corn, wheat sunflower seed and peas. Contains not more than 5 per cent crude fiber, and not less than 3 per cent fat and 10 per cent. protein. Registered in 1915 and 1916.	One official sample. Up to guaranty in protein; practically up to guaranty in fat; fibre slightly below the maximum guaranty. Contained some seeds of mustard, a few of wild buckwheat, corn cockle, ragweed and lady's thumb.
Iroquois Chick Feed. Buffalo Cereal Co., Buffalo, N. Y. Composed of corn, wheat, kaffir corn, peas and millet. Contains not more than 3 per cent crude fiber, and not less than 2 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Iroquois Poultry Mash. Buffalo Cereal Co., Buffalo, N. Y. Composed of ground corn, wheat bran and middlings, corn gluten feed and alfalfa meal. Contains not more than 12 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. (1915 certificate gives 10 per cent as maximum crude fiber). Registered in 1915 and 1916.	No dealers' or official samples received.
Iroquois Scratching Grains. Buffalo Cereal Co., Buffalo, N. Y. Composed of corn, oats, barley, kaffir corn, wheat, buckwheat and sunflower seed. Contains not more than 5 per cent. crude fiber, and not less than 3 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	One official sample. Up to guaranty in protein; practically up to guaranty in fat; fiber about 2½ per cent. below maximum guaranty. Contained some seeds of corn cockle, giant ragweed, mustard, yellow foxtail, wiid buckwheat, chess and dock.
Target Scratching Grains. Buffalo Cereal Co., Buffalo, New York. Composed of corn, oats, barley, wheat, kaffir corn, and buckwheat. Contains not more than 5 per cent. crude fiber, and not less than 3 per cent. fat and 10 per cent. protein. Not registered in 1915. Registerd in 1916.	No dealers' or official samples received.
Peerless Baby Chick Feed. E. A. Clark & Co., Portland, Maine. Composed of cracked wheat, hulled oats, cracked kaffir, cracked corn and millet seed. Contains not more than 4 per cent. crude fiber, and not less than 3 per cent. fat and 12 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Peerless Growing Feed. E. A. Clark & Co., Portland, Me. Composed of ground oats, wheat bran, wheat meal, corn meal, bone meal, meat meal, granulated milk and powdered charcoal. Contains not more than 5 per cent. crude fiber, and not less than 4 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Peerless Intermediate Chick Feed. E. A. Clark & Co., Portland, Me. Composed of cracked corn, wheat, kaffir corn, hulled oats, barley and millet seed. Contains not more than 4 per cent. crude fiber, and not less than 3 per cent. fat and 12 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Peerless Poultry Mash. E. A. Clark & Co., Portland, Me. Composed of ground oats, fish meal, corn meal, alfalfa meal, wheat bran, wheat meal, gluten milk albumen, meat meal and powdered charcoal. Contains not more than 10 per cent. crude fiber, and not less than 3 per cent. fat and 20 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Peerless Screened Scratch Feed. E. A. Clark & Co., Portland, Me. Composed of cracked corn, wheat, oats, buckwheat, barley, kaffir corn and sunflower seed. Contains not more than 5 per cent. crude fiber, and not less than 3 per cent. fat and 10 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Yankee Cereal Mash (with Fish). O. L. Clark, Freeport, Me. Composed of corn meal, bran, fish meal, corn flour, rolled oats, alfalfa, charcoal and peanut meal. On 1915 certificate: Contains not more than 6.5 per cent. crude fiber, and not less than 3.5 per cent. fat and 16 per cent. protein. On 1916 certificate: Contains not more than 6.5 per cent. crude fiber, and not less than 3 per cent. fat and 15 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Yankee Chick Feed. O. L. Clark, Freeport, Me. Composed of cracked corn, cracked wheat, cracked milo maize, flax seed, hulled oats. Contains not more than 6 per cent. crude fiber, and not less than 3 per cent. fat and 9 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Yankee Scratch Feed. O. L. Clark, Freeport, Me. Composed of cracked corn, wheat, buckwheat, oats, Milo maize, hemp and sunflower seed. On 1915 certificate: Contains not more than 4.5 per cent. crude fiber, and not less than 3 per cent. fat and 10 per cent. protein. On 1916 certificate: Contains not more than 5 per cent. crude fiber, and not less than 3 per cent. fat and 9 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Conkey's "Buttermilk" Starting Food for Chicks. The G. E. Conkey Co., Cleveland, O. Composed of hulled oats, wheat middlings, wheat, corn, prepared buttermilk, bone, iron sulphate, gentian root and prepared mustard seed. Contains not more than 4 per cent. crude fiber, and not less than 3 per cent. fat and 12 percent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Conkey's Starting Food for Chicks. The G. E. Conkey Co., Cleveland, Ohio. Composed of gentian root, mustard seed, sulphur, iron sulphate. bone ash, corn, wheat, hulled oats, wheat middlings, meat, bone and salt. Contains not more than 4 per cent. crude fiber, and not less than 4 per cent. fat and 12 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Wirthmore Fish & Scrap Poultry Mash. Chas. M. Cox. Co., Boston, Mass. Composed of ground oats, ground barley, gluten feed, alfalfa meal, wheat bran, ground corn, choice fine ground beef scraps, fish meal, wheat middlings and about ¾ of 1 per cent. salt. Contains not more than 9½ per cent. crude fiber, and not less than 3½ per cent. fat and 18½ per cent. protein. Not registered in 1915. Registered in 1916.	One official sample. Above guaranty in protein and fat; fiber in accord with guaranty. Contained few seeds of corn cockle.
Wirthmore Gritless Chick Feed. Chas. M. Cox Co., Boston, Mass. Composed of cracked Milo maize, white corn, yellow corn, wheat, hulled oats, kaffir corn, peas and fish. Contains not more than 3½ per cent. crude fiber, and not less than 3 per cent. fat and 11 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Wirthmore Gritless Intermediate Chick Feed. Chas. M. Cox Co., Boston, Mass. Composed of cracked white corn, cracked yellow corn, wheat kaffir corn, buckwheat and peas. Contains not more than 3½ per cent crude fiber, and not less than 3 per cent. fat and 11 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Wirthmore Growing Feed, All Grain. Chas. M. Cox Co., Boston, Mass. Composed of ground wheat, corn, oats, barley, peas, Milo maize, beet pulp, wheat middlings and salt. Contains not more than 4½ per cent. crude fiber, and not less than 4 per cent. fat and 12 per cent protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Wirthmore Growing Feed with Scraps. Chas. M. Cox Co., Boston, Mass. Composed of beet pulp, wheat middlings, ground corn, wheat, barley, oats, Milo maize, peas, salt and choice fine ground beef scraps. Contains not more than 4½ per cent. crude fiber, and not less than 4½ per cent. fat and 17 per cent. protein. (1915 certificate gives 15 per cent. as minimum protein). Registered in 1915 and 1916.	No dealers' or official samples received.
Wirthmore Poultry Mash. All Grain. Chas. M. Cox Co., Boston, Mass. Composed of ground oats, ground barley, gluten feed, alfalfa meal, wheat bran, ground corn, wheat middlings and about ¾ oi 1 per cent. salt. Contains not more than 9½ per cent. crude fiber, and not less than 3 per cent. fat and 13 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Wirthmore Poultry Mash, Fish & Scrap. Chas. M. Cox Co., Boston, Mass. Composed of ground oats, ground barley, gluten feed, alfalfa meal, wheat bran, ground corn, choice fine ground beef scraps, fish meal, wheat middlings, and about ¾ of 1 per cent. salt. Contains not more than 9½ per cent. crude fiber, and not less than 4 per cent fat and 17 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Wirthmore Scratch Feed. Chas M. Cox Co., Boston, Mass. Composed of wheat, kaffir corn, sunflower seed, buckwheat, barley, oats, cracked corn and Milo maize. Contains not more than 5 per cent crude fiber, and not less than 3 per cent. fat and 11 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Globe Chick Feed. Albert Dickinson Co., Chicago, Ill. Composed of corn, wheat, kaffir corn, hulled oats, millet, grit. Contains not more than 5 per cent. crude fiber, and not less than 2.5 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Globe Developing Feed. Albert Dickinson Co., Chicago, Ill. Composed of corn, wheat, kaffir corn, hulled oats, buckwheat, millet and grit. Contains not more than 5 per cent. crude fiber, and not less than 2.5 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Globe Egg Mash. The Albert Dickinson Co., Chicago, Ill. Composed of wheat bran, wheat middlings, alfalfa meal, corn bran, corn feed meal, linseed oil cake, meat scraps, salt ½ of 1 per cent. Contains not more than 10 per cent. crude fiber, and not less than 3 per cent. fat and 15 per cent. protein. (1915 certificate gives 16 as minimum protein). Registered in 1915 and 1916.	No dealers' or official samples received.
Globe Scratch Feed. Albert Dickinson Co., Chicago, Ill. Composed of corn, wheat, barley, oats, kaffir corn, buckwheat, sunflower, linseed oil cake, grit. Contains not more than 5 per cent. crude fiber, and not less than 2.5 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
King Pigeon Feed. Albert Dickinson Co., Chicago, Ill. Composed of corn, wheat, buckwheat, kaffir corn, millet, hemp, grit. Contains not more than 5 per cent. crude fiber, and not less than 2.5 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Queen Poultry Mash. Albert Dickinson Co., Chicago, Ill. Composed of alfalfa meal, corn feed meal, wheat meal, ground corn bran, wheat bran, meat scraps, linseed oil cake, salt ½ of 1 per cent. Contains not more than 10 per cent. crude fiber, and not less than 2.5 per cent fat and 11 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty in protein; considerably above minimum guaranty of fat; and somewhat below maximum guaranty of fiber. Contained few seeds of pigweed.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Poultry Scratch Feed Brand LA-IN. Eastern Grain Co., Portland, Me. Composed of corn, wheat, barley, oats buckwheat, kaffir corn, sunflower seed. Contains not more than 15 per cent. crude fiber, and not less than 5 per cent. fat and 10 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Elmore Chick Feed. Elmore Milling Co., Oneonta, N. Y. Composed of millet seed, cracked wheat, cracked kaffir corn, oat meal, cracked corn. Contains not more than 3.5 per cent. crude fiber,and not less than 3.5 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Elmore Dry Mash. Elmore Milling Co., Oneonta, N. Y. Composed of wheat bran, wheat middlings, corn meal, hominy feed, old process oil meal, corn gluten feed, alfalfa meal, ground barley, salt. Contains not more than 7 per cent. crude fiber, and not less than 4 per cent. fat and 15 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Elmore Egg Mash. Elmore Milling Co., Oneonta, N. Y. Composed of corn meal, rolled oats, ground barley, wheat flour middlings, hominy feed, wheat bran, meat and bone meal, corn gluten feed, alfalfa meal, old process oil meal. and salt. Contains not more than 8 per cent. crude fiber, and not less than 4 per cent. fat and 18 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Elmore Intermediate Chick Feed. Elmore Milling Co., Oneonta, N. Y. Composed of cracked corn, buckwheat, wheat, kaffir corn, millet seed. Contains not more than 3 per cent crude fiber, and not less than 3 per cent fat and 10 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Elmore Scratch Feed. Elmore Milling Co., Oneonta, N. Y. Composed of wheat, cracked corn, barley, buckwheat, oats, kaffir corn, sunflower seed. Contains not more than 5 per cent. crude fiber, and not less than 3.5 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
O-NE-ON-TA Scratch Feed. Elmore Milling Co., Oneonta, N. Y. Composed of wheat, cracked corn, barley, buckwheat, oats, kaffir corn, sunflower seed. Contains not more than 5 per cent. crude fiber, and not less than 3.5 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Farmers Union Scratch Grain. Farmers Union Grain & Supply Co., Waterville, Me. Composed of wheat, cracked corn, barley, oats, buckwheat, kaffir corn, sunflower seeds. Contains not more than 5 per cent. crude fiber, and not less than 3.5 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Anchor Brand Scratch Feed. Globe Elevator Co., Buffalo N. Y. Made from a combination of various seeds with buckwheat, cracked corn, kaffir corn, wheat, barley, oats, cracked peas. Contains not more than 6 per cent. crude fiber, and not less than 3 per cent. fat and 12 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Blue Ribbon Laying Mash. Globe Elevator Co., Buffalo, N. Y. Composed of wheat bran, wheat middlings, wheat flour, ground oats, corn meal, corn gluten meal, pea meal, ground alfalfa, linseed oil meal, meat meal, fish scrap, ground bone. Contains not more than 10 per cent. crude fiber, and not less than 3 per cent. fat and 20 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Blue Ribbon Scratch Feed. Globe Elevator Co., Buffalo, N. Y. Composed of cracked corn, wheat, barley, kaffir corn, oats, buckwheat, sunflower seeds, green split peas. Contains not more than 4 per cent. crude fiber, and not less than 4 per cent. fat and 12 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Greene's Chick Feed. Greene Chick Feed Co., Marblehead, Mass. Composed of corn, wheat, flax screenings, oats. On 1915 certificate: Contains not more than 3 per cent. crude fiber, and not less than 3 per cent. fat and 10 per cent. protein. On 1916 certificate: Contains not more than 5 per cent. crude fiber, and not less than 3 per cent. fat and 12 per cent. protein. Registered in 1915 and 1916.	One official sample. Somewhat above guaranty in protein and fat. Contained very many seeds of mustard, yellow foxtail, wild buckwheat, green foxtail, corn cockle, lady's thumb, wild rose and others. Probably at least 50 per cent. weed seeds.
Greene's "First Feed." Greene Chick Feed Co., Marblehead, Mass. Composed of white corn steam cooked, yellow corn germ meal, shredded codfish steam cooked, ground hulled oats steam cooked, dried milk steam cooked, entire wheat, cod livers steam cooked, ground flaxseed, gluten meal steam cooked, dried blood steam cooked, shell lime and fine ground meat scraps steam cooked, Contains not more than 5 per cent. crude fiber, and not less than 3 per cent fat and 17 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Greene's Growing Feed. Greene Chick Feed Co., Marblehead, Mass. Composed of fish scraps, yellow and white corn, dried milk, wheat, oats, corn cockle, barley, yellow foxtail, winter rape, shell lime, mustard, salt and perfectly sweet meat scraps. Contains not more than 5 per cent crude fiber, and not less than 3 per cent fat and 12 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Greene's Intermediate Chick Feed. Greene Chick Feed Co., Marblehead, Mass. Composed of corn, kaffir corn, flax screenings, oats. On 1915 certificate: Contains not more than 3 per cent crude fiber, and not less than 3 per cent fat and 10 per cent protein. On 1916 certificate: Contains not more than 5 per cent. crude fiber, and not less than 3 per cent fat and 12 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Greene's Meat Mash. Greene Chick Feed Co., Marblehead, Mass. Composed of meat scraps, fish scraps, corn meal, wheat, shell lime, hominy feed flax screenings, oats, wheat bran, cocoa bran, salt. Contains not more than 7 per cent. crude fiber, and not less than 3 per cent. fat and 12 per cent protein. (1915 certificate gives 5 per cent as minimum fat). Registered in 1915 and 1916.	One official sample. Considerably above the guaranty in protein and fat; fiber about 3 per cent. above maximum guaranty. Contained many seeds of green foxtail and yellow foxtail, a few of wild buckwheat, mustard and lady's thumb.
Greene's Old Fashioned Meat Scraps. Greene Chick Feed Co., Marblehead, Mass. Meat, bone and gristle. Contains not more than 3 per cent crude fiber, and not less than 5 per cent. fat and 30 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Greene's Poultry Food. Greene Chick Feed Co., Marblehead, Mass. Fish meat and bone. Contains not more than 3 per cent. crude fiber, and not less than 3 per cent. fat and 40 per cent. protein. (1915 certificate gives 5 per cent. as maximum fiber). Registered in 1915 and 1916.	No dealers' or official samples received.
Xtragood Scratch Feed. Griswold & Mackkinnin, St. Johnsbury, Vt. Composed of wheat, cracked corn, barley, oats, buckwheat, kaffir corn and sunflower seed. Contains not more than 5 per cent. crude fiber, and not less than 3 per cent fat and 11 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Dry Mash. J. B. Ham Co., Lewiston, Me. Corn meal, ground oats, wheat bran, wheat middlings, linseed meal, meat scraps, charcoal and alfalfa. Contains not more than 12 per cent. crude fiber, and not less than 3.5 per cent fat and 15 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
H-8 Special Scratch Feed. E. T. Hathaway, Yarmouthville, Me. Composed of whole corn, cracked corn, oats, wheat, buckwheat, barley, kaffir corn, sunflower seed, and a little charcoal. Contains not more than 5 per cent. crude fiber, and not less than 2 per cent fat and 10 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Orono Brand Dry Mash. E. T. Hathaway, Yarmouthville, Maine. Composed of corn meal, wheat bran, wheat middlings, gluten meal, linseed meal, meat scrap, alfalfa and a small amount charcoal. On 1915 certificate: Contains not more than 7.5 per cent. crude fiber, and not less than 6.5 per cent fat and 20 per cent protein. On 1916 certificate: Contains not more than 3 per cent. crude fiber, and not less than 5 per cent fat and 18 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Purity Chick Feed. Wm. S. Hills Co., Boston, Mass. Composed of corn, wheat, millet, oats. Contains not more than 7 per cent. crude fiber, and not less than 2½ per cent. fat and 9 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Purity Growing Feed. Wm. S. Hills Co., Boston, Mass. Composed of corn meal, hominy, middlings, beef scraps, fish meal and oatmeal. Contains not more than 14 per cent. crude fiber, and not less than 6 per cent. fat and 19 per cent. protein. Registered in 1915. Not registered in 1916.	One official sample. More than 1 per cent. low in protein; fat in accord with guaranty; fiber about 4 per cent. below the maximum guaranty. No weed seeds found.
Purity Poultry Mash. Wm. S. Hills Co., Boston. Mass. Composed of bran, corn, oat products, middlings, beef scraps, fish meal, alfalfa. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent fat and 17 per cent protein. Registered in 1915 and 1916.	One official sample. Above guaranty in protein and fat; more than 1 per cent. below the maximum guaranty of fiber No weed seeds noted.
Purity Scratch Feed. Wm. S. Hills Co., Boston, Mass. Composed of corn, wheat, kaffir corn, oats, barley, buckwheat and sunflower seed. Contains not more than 6 per cent crude fiber, and not less than 3 per cent. fat and 10 per cent protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty in protein and fat; about 2 per cent. below maximum guaranty of fiber. Contained some seeds of mustard, corn cockle, ragweed, wild buckwheat, lady's thumb, chess, yellow foxtail, false flax, spurry and hemp nettle.
The H-O Co's Algrane Scratching Feed. The H-O Co., Buffalo, N. Y. Composed of wheat, oats, kaffir corn, buckwheat, wheat screenings, cracked corn, milo maize, sunflower seed, hulled oats, cracked peas, barley. Contains not more than 9 per cent. crude fiber, and not less than 3.5 per cent. fat and 11 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
The H-O Co's Chick Feed. The H-O Co., Buffalo, N. Y. Composed of cracked corn, cut oat meal, cracked wheat, cracked kaffir corn, cracked peas, millet. Contains not more than 9 per cent. crude fiber, and not less than 3 per cent. fat and 12 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
The H-O Company's Dry Poultry Mash. The H-O Co., Buffalo, N. Y. Composed of oat middlings, corn gluten feed, wheat middlings, rolled oats, alfalfa meal, ground corn, hominy feed, cracked wheat, wheat bran, ground grain screenings. Contains not more than 9 per cent crude fiber, and not less than 3.5 per cent fat and 18 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
The H-O Co's Poultry Feed. The H-O Co., Buffalo, N. Y. Composed of ground corn, corn gluten feed, wheat middlings, oat middlings, wheat bran, hominy feed, rolled oats, ground peas, ground grain screenings, molasses. Contains not more than 9 per cent. crude fiber, and not less than 4.5 per cent. fat and 17 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
The H-O Co's Steam Cooked Chick Feed. The H-O Co., Buffalo, N. Y. Composed of cracked corn, cut oat meal, cracked wheat, cracked kaffir corn, cracked peas, millet. Contains not more than 9 per cent. crude fiber, and not less than 3 per cent. fat and 12 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

FEEDING STUFFS—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Dirigo Egg Mash. Oscar Holway Co., Auburn, Me. Composed of alfalfa meal, bran, middlings, wheat meal, corn feed meal, ground corn, bran, linseed meal, meat scraps, salt ½ of 1 per cent. Contains not more than 10 per cent. crude fiber, and not less than 3 per cent fat and 16 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Dirigo Little Chick Feed. Oscar Holway Co., Auburn, Me. Composed of wheat, kaffir corn, millet, corn, oat groats, pigeon grass and charcoal. Contains not more than 5 per cent. crude fiber, and not less than 2.5 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Dirigo Scratch Grains. Oscar Holway Co., Auburn, Me. Composed of kaffir corn, wheat, barley, cracked Indian corn, buckwheat, sunflower seed. Contains not more than 5 per cent.crude fiber, and not less than 2.5 per cent. fat and 10 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Hopkins Dry Mash. A. R. Hopkins Co., Bangor, Me. Composed of corn meal, beef scraps, wheat bran, linseed meal, white middlings and Buffalo gluten. Contains not more than 8 per cent crude fiber, and not less than 6 per cent. fat and 22 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Hopkins Scratch Feed. A. R. Hopkins Co., Bangor, Me. Composed of cracked corn, wheat, kaffir corn, oats, barley, buckwheat, sunflower seed and grit. Contains not more than 4 per cent. crude fiber, and not less than 3 per cent. fat and 9½ per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Ideal Scratch Feed No. 2. E. T. & H. K. Ide, St. Johnsbury, Vt. Composed of corn, wheat, kaffir corn, oats, buckwheat, barley and sunflower seed. Contains not more than 10 per cent. crude fiber, and not less than 3 per cent. fat and 10 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
JEM Growing Feed. Jamestown Electric Mills, Jamestown, N. Y. Composed of cut oatmeal, kiln dried corn meal, linseed oil meal, corn oil meal, purified fish meal, wheat middlings, refined beef scrap, and pea meal. Contains not more than 5 per cent. crude fiber, and not less than 6 per cent. fat and 19 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
JEM Poultry Mash. Jamestown Electric Mills, Jamestown, N. Y. Composed of refined beef scrap, linseed oil meal, alfalfa meal, corn oil meal, wheat bran, wheat middlings, purified fish meal, rolled oats, corn gluten feed, hominy meal, kiln dried corn meal. Contains not more than 9 per cent. crude fiber, and not less than 4 per cent. fat and 18 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brands, Maker and Guaranties.	Results of Examination.
Dry Feed. W. A. Jennison, Bangor, Me. Composed of wheat bran, hominy feed, gluten feed, meat scrap, linseed oil meal, wheat middlings. Contains not more than 9 per cent. crude fiber, and not less than 5 per cent. fat and 22 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
K. & W. Chick Feed. Kendall & Whitney, Portland, Me. Composed of corn, wheat, kaffir corn, hulled oats, millet. Contains not more than 5 per cent. crude fiber, and not less than 2.5 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
K. & W. Mash Feed. Kendall & Whitney, Portland, Me. Composed of alfalfa meal, corn feed meal, wheat meal, ground corn bran, wheat bran, meat scraps, linseed oil cake, salt ½ of 1 per cent. Contains not more than 10 per cent. crude fiber, and not less than 2.5 per cent fat and. 11 cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
K. & W. Scratch Feed. Kendall & Whitney, Portland, Me. Composed of corn, wheat, barley, oats, kaffir corn, buckwheat, sunflower, oil cake. Contains not more than 5 per cent. crude fiber, and not less than 2.5 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Monmouth Dry Mash. E. M. Marks, Monmouth, Me. Pure wheat bran, wheat middlings, ground oats, corn meal, ground alfalfa, beef scraps, gluten feed, stock feed, cottonseed meal. Contains not more than 8 per cent. crude fiber, and not less than 5 per cent fat and 18 per cent. protein (1915 certificate gives 10 per cent as maximum fiber). Registered in 1915 and 1916.	No dealers' or official samples received.
Elm City Scratch Feed. Merrill & Mayo, Co., Waterville, Me. Composed of corn, wheat, rye, barley, oats, kaffir corn, buckwheat, sunflower and oil cake. Contains not more than 5 per cent. crude fiber, and not less than 2.5 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Domino Justice Chick Feed. (Registered in 1915 as Justice Chick Feed). Nowak Milling Corporation, Buffalo, N. Y. Composed of cracked corn, cracked wheat, milo maize, split green peas, millet, hulled oats. Contains not more than 5 per cent. crude fiber, and not less than 2 per cent. fat and 11 per cent. protein. Registered in 1915 and 1916.	One official sample. Slightly below guaranty in protein; in accord with guaranty in fat; fiber about 2 per cent. below maximum guaranty. Contained few seeds of corn cockle, yellow foxtail and ragweed.
Domino Justice Developing Feed. Nowak Milling Corporation, Buffalo, N. Y. Composed of cracked peas, buckwheat, milo maize, wheat, cracked corn. Contains not more than 5 per cent. crude fiber, and not less than 3 per cent.fat and 10 per cent.protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Domino Justice Growing Mash. Nowak Milling Corporation, Buffalo, N. Y. Composed of oat meal, corn gluten feed, linseed oil meal, corn feed meal, wheat bran, wheat middlings. Contains not more than 7 per cent. crude fiber, and not less than 5 per cent fat and 15 per cent protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Domino Justice Scratch Feed. (Registered in 1915 as Justice Scratch Feed). Nowak Milling Corporation, Buffalo, N. Y. Composed of cracked corn, whole wheat, milo maize, whole barley, buckwheat, split green peas, sunflower seeds. Contains not more than 5 per cent. crude fiber, and not less than 3 per cent fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Fidelity Scratch Feed. A. Nowak & Son, Buffalo, N. Y. Composed of cracked corn, whole wheat, milo maize, whole barley, buckwheat, sunflower seeds. Contains not more than 5 per cent. crude fiber, and not less than 3 per cent. fat and 10 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Justice Growing Mash. Nowak Milling Corporation, Buffalo, N. Y. Composed of oat meal, corn gluten feed, linseed oil meal, corn feed meal, wheat bran, wheat middlings. Contains not more than 7 per cent. crude fiber, and not less than 5 per cent. fat and 15 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Justice Laying Mash. Nowak Milling Corporation, Buffalo, N. Y. Composed of linseed oil meal, ground oats, wheat flour, wheat bran, wheat middlings, corn feed meal, corn gluten feed, alfalfa meal, ground bone, meat scrap. Contains not more than 10 per cent crude fiber, and not less than 3 per cent fat and 20 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Lay-Egg-O Dry Mash. A. Nowak & Son, Buffalo, N. Y. Composed of corn feed meal, corn gluten feed, wheat bran, wheat middlings, Heneta (phosphorus, lime, sodium and silica). Contains not more than 4 per cent crude fiber, and not less than 3 per cent. fat and 12 per cent protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Marathon Scratch Feed. Nowak Milling Corporation, Buffalo, N. Y. Composed of wheat, milo maize, cracked corn, barley, buckwheat. Contains not more than 5 per cent crude fiber, and not less than 3 per cent fat and 10 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Baby Buster Chick Feed. (Registered in 1915 as Gritless Chick Feed). Park & Pollard Co., Boston, Mass. Cracked corn, wheat kaffir corn, milo, whole millet seed, oats, and shredded fish. Contains not more than 5 per cent. crude fiber, and not less than 2 per cent. fat and 11 per cent protein. (1915 certificate gives 3½ per cent as minimum fat). Registered in 1915 and 1916.	One official sample. In accord with guaranty in protein and fat; fiber about 2 per cent. below maximum guaranty. Contained very many yellow foxtail seeds, probably 2 per cent. Many seeds of wild buckwheat, green foxtail and chess.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Growing Feed. Park & Pollard Co., Boston, Mass. Ground: corn, wheat, barley, oats, meat, bone, alfalfa, kaffir corn, commercial wheat bran, commercial wheat middlings, buckwheat, beet pulp, calcium carbonate and salt. Contains not more than 8 per cent crude fiber, and not less than 1½ per cent fat and 10 per cent protein. (1915 certificate gives 3½ per cent as minimum fat). Registered in 1915 and 1916.	No dealers' or official samples received.
Intermediate Chick Feed. Park & Pollard Co., Boston, Mass. Composed of cracked corn, wheat, buckwheat, oats, millet, kaffir corn, and milo. Contains not more than 5 per cent crude fiber, and not less than 1½ per cent. fat and 10 per cent protein. (1915 certificate gives 3½ per cent as mimimum fat). Registered in 1915 and 1916.	One official sample. Slightly below guaranty in protein and 1915 guaranty of fat; more than 2 per cent. below maximum guaranty of fiber. Contained very many seeds of yellow foxtail, probably about 2 per cent. Many seeds of wild buckwheat, chess and green foxtail. A few of mustard, Pennsylvania persicaria and lady's thumb.
Lay or Bust (Dry Mash). Park & Pollard Co., Boston, Mass. Ground: commercial wheat bran, commercial wheat middlings, corn, wheat, oats, barley, kaffir corn, buckwheat, alfalfa, fish, meat, bone, beet pulp, calcium carbonate and salt. Contains not more than 12 per cent crude fiber, and not less than 1½ per cent fat and 18 per cent protein. (1915 certificate gives 3½ per cent as minimum fat). Registered in 1915 and 1916.	Three official samples. In accord with guaranty in protein and fat; fiber about 5 per cent. below maximum guaranty. Contained few seeds of pigweed, mustard, wild buckwheat and night-flowering catchfly. Few hulls of wild buckwheat.
Margaiet Mahaney Turkey Feed. Park & Pollard Co., Boston, Mass. Ground: wheat, barley, oil meal, oats, meat, bone, calcium hydroxide, calcium carbonate and salt. Contains not more than 12 per cent. crude fiber, and not less than 1½ per cent fat and 10 per cent. protein. (1915 certificate gives 3½ per cent as minimum fat). Registered in 1915 and 1916.	No dealers' or official samples received.
Overall Chick Feed. Park & Pollard Co., Boston, Mass. Cracked: corn, wheat, kaffir corn, milo and oats. Contains not more than 5 per cent crude fiber, and not less than 2 per cent fat and 10 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Overall Pigeon Feed. Park & Pollard Co., Boston, Mass. Cracked corn, wheat, buckwheat, peas, kaffir corn and milo. Contains not more than 10 per cent crude fiber, and not less than 1 per cent. fat and 10 per cent protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Pontiac Scratch Feed. Park & Pollard Co., Boston, Mass. Composed of cracked corn, wheat, barley, buckwheat, oats, kaffir corn, and milo. Contains not more than 5 per cent. crude fiber, and not less than 1½ per cent. fat and 10 per cent. protein. Not registered in 1915. Registered in 1916.	Two official samples. In accord with guaranty in protein; about 2 per cent. below guaranty in fat; 8 per cent. below maximum guaranty of fiber. Contained many seeds of mustard, yellow foxtail, chess, corn cockle and wild buckwheat. A few seeds of ragweed, night-flowering catchfly and false flax.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Red Ribbon Chick Feed. Park & Pollard Co., Boston, Mass. Cracked: corn, wheat oats, kaffir corn, milo and whole millet seed. Contains not more than 5 per cent. crude fiber, and not less than 2 per cent fat and 10 per cent protein. (1915 certificate gives 3½ per cent as minimum fat). Registered in 1915 and 1916.	Two official samples. In accord with guaranty in protein and fat; more than 2 per cent below maximum guaranty of fiber. Contained very many seeds of yellow foxtail (probably as many as 2 per cent.). Many of wild buckwheat, green foxtail and pigweed. A few of mustard, rough pigweed, ragweed, cow herb, hairy stick weed and false flax.
Red Ribbon Scratch Feed. Park & Pollard Co., Boston, Mass. Composed of cracked corn, wheat, buckwheat, barley, oats, kaffir corn, milo and sunflower seed. Contains more than 5 per cent crude fiber, and not less than 1½ per cent. fat and 10 per cent. protein. (1915 certificate gives 3½ per cent. as minimum fat). Registered in 1915 and 1916.	One official sample. In accord with guaranty in protein and fat; slightly below maximum guaranty of fiber. Contained few seeds of mustard, ragweed, wild buckwheat, corn cockle, yellow foxtail, lady's thumb, pigweed, false flax and giant ragweed.
Screened Scratch Feed. Park & Pollard Co., Boston, Mass. Composed of cracked corn, wheat, buckwheat, barley, oats, kaffir corn, milo and sunflower seed. Contains not more than 5 per cent. crude fiber, and not less than 1½ per cent fat and 10 per cent protein. (1915 certificate gives 3½ per cent. as minimum fat). Registered in 1915 and 1916.	One official sample. In accord with guaranty in protein and fat; considerably below maximum guaranty of fiber. Contained some seeds of corn cockle; a few of ragweed, mustard, yellow foxtail, lady's thumb and wild buckwheat.
Cornish Dry Mash. Pendexter Bros., Cornish, Me. Composed of wheat bran, corn meal, beef scraps, linseed meal, gluten, alfalfa, oat feed, wheat, middlings, charcoal and salt. On 1915 certificate: Contains not more than 9 per cent. crude fiber, and not less than 4½ per cent. fat and 16 per cent protein. On 1916 certificate: Contains not more than 8½ per cent. crude fiber, and not less than 4¾ per cent fat and 16 per cent. protein. Registered in 1915 and 1916.	No official sample. Sample received from the manufacturers well within guaranty.
Cornish Growing Feed for Chickens. Pendexter Bros., Cornish, Me. Composed of wheat bran, corn meal, meat meal, linseed meal,gluten, ground oats, charcoal and salt. Contains not more than 7 per cent crude fiber, and not less than 5 per cent fat and 19 per cent protein. Not registered in 1915. Registered in 1916.	No official sample. Sample received from the manufacturers well within guaranty.
Pilco All Grain Scratch Feed. Pilliod Milling Co., Swanton, O. Composed of cracked corn, wheat, oats, barley, buckwheat, rye and wheat screenings. Contains not more than 4 per cent crude fiber, and not less than 4 per cent. fat and 9 per cent protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Champion Egg Mash. Arthur E. Pratt Co., (Registered by Eastern Grain Company, Portland, Maine). Composed of high grade beef scraps, corn meal, gluten feed, wheat middlings, wheat bran, linseed oil meal and Hen-E-Ta (composed of phosphorous, silica, lime and soda). Contains not more than 4 per cent.crude fiber, and not less than 3.03 per cent fat and 13 per cent protein. Not registered in 1915. Registered in 1916.	Two official samples. Slightly above guaranty in protein and fat; more than 1 per cent. above maximum guaranty of fiber. Contained few hulls of wild buckwheat and corn cockle.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Purina Chick Feed. Purina Mills, Branch, Ralston Purina Co., St. Louis, Mo., and Buffalo, N. Y. Composed of wheat, corn, millet, kaffir and milo maize. Contains not more than 4 per cent crude fiber, and not less than 2.5 per cent. fat and 11 per cent protein. (1915 certificate gives 3 per cent. as minimum fat). Registered in 1915 and 1916.	One official sample. In accord with guaranty in protein and fat; slightly below maximum guaranty of fiber. Contained many seeds of yellow foxtail, green foxtail and pigweed. Also some of wild buckwheat and lady's thumb.
Purina Chicken Chowder Feed with charcoal, not over 1 per cent. Purina Mills, Branch, Ralston Purina Co., St. Louis, Mo., and Buffalo, N. Y. Composed of wheat middlings, wheat bran, corn meal, alfalfa meal, linseed meal, granulated meal and not over 1 per cent salt. Contains not more than 9 per cent. crude fiber, and not less than 4 per cent fat and 19 per cent. protein. Not registered in 1915. Registered in 1916.	One official sample. In accord with guaranty. Contained few hulls of wild buckwheat.
Iowa Chick Feed. Purity Oats Co., Davenport, Iowa. Composed of cracked corn, cracked wheat, cracked kaffir corn or Milo maize, steel cut oats, recleaned wheat screenings and millet. Contains not more than 5 per cent crude fiber, and not less than 3.5 per cent fat and 10 per cent protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Iowa Scratch Feed. Purity Oats Co., Davenport, Iowa. Composed of cracked corn, buckwheat, hulled oats, kaffir corn or milo maize, barley, recleaned wheat screenings and sunflower seed and wheat. Contains not more than 5 per cent crude fiber, and not less than 3.25 pei cent fat and 10 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Tom Boy Chick Feed. Purity Oats Co., Davenport, Iowa. No certificate filed. Claims on package: Contains not more than 5 per cent. crude fiber, and not less than 3 per cent fat and 10 per cent protein. Unregistered.	One official sample. In accord with guaranty.
Tom Boy Scratch Feed. Purity Oats Co., Davenport, Iowa. Composed of cracked corn, cracked wheat, cracked kaffir corn, or milo maize, steel cut oats, recleaned wheat screenings, millet (and grit). Contains not more than 5 per cent. crude fiber, and not less than 2.75 per cent fat and 10 per cent. protein. (1915 certificate gives 3 per cent. as minimum fiber). Registered in 1915 and 1916.	One official sample. In accord with guaranty in protein and fat; 2 per cent. below maximum guaranty in fiber. Contained few seeds of mustard, wild buckwheat, yellow foxtail and ragweed.
American Poultry Feed. Quaker Oats Co., Chicago, Ill. Composed of hominy feed, cottonseed meal, ground barley, wheat mixed feed and rye shorts. Contains not more than 9 per cent crude fiber, and not less than 3.5 per cent fat and 12 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Blue Ribbon Scratch Grains. Quaker Oats Co., Chicago, Ill. Composed of whole wheat, whole kaffir corn, whole barley, cracked Indian corn, whole buckwheat, sunflower seeds. Contains not more than 5 per cent. crude fiber, and not less than 2.5 per cent fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Quaker Chick Feed. Quaker Oats Co., Chicago, Ill. Composed of cracked wheat, cracked kaffir corn, cracked Indian corn, whole millet seed, oat meal, charcoal, marble grit, wild buckwheat (with not to exceed ½ of 1 per cent. miscellanoeus wild seeds occurring in above seeds and grains). Contains not more than 5 per cent crude fiber, and not less than 2.5 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Quaker Poultry Mash. Quaker Oats Co., Chicago, Ill. Composed of meat scraps, oat meal, wheat bran, with ground screenings not exceeding mill run, alfalfa meal, yellow hominy feed, corn gluten feed, ground grain screenings. Contains not more than 10 per cent crude fiber, and not less than 4 per cent fat and 17.5 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Quaker Scratch Grains. Quaker Oats Co., Chicago, Ill. Composed of whole wheat, whole kaffir corn, whole barley, cracked Indian corn, whole buckwheat, sunflower seeds. Contains not more than 5 per cent. crude fiber, and not less than 2.5 per cent fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Schumacher Little Chick Feed. Quaker Oats Co., Chicago, Ill. Composed of cracked wheat, cracked kaffir corn, cracked Indian corn, whole millet seed, oat meal, charcoal, marble grit, wild buckwheat (with not to exceed ½ of 1 per cent. miscellaneous wild seeds occurring in above seeds and grains). Contains not more than 5 per cent crude fiber, and not less than 2.5 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Schumacher Poultry Mash. Quaker Oats Co., Chicago, Ill. Composed of oat meal, meat scraps, alfalfa meal, wheat bran, with ground screenings not exceeding mill run, yellow hominy feed, corn gluten feed, ground grain screenings. Contains not more than 10 per cent. crude fiber, and not less than 4 per cent. fat and 17.5 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Schumacher Scratch Grains. Quaker Oats Co., Chicago, Ill. Composed of whole wheat, whole kaffir corn, whole barley, cracked Indian corn, whole buckwheat, sunflower seeds. Contains not more than 5 per cent crude fiber, and not less than 2.5 per cent fat and 10 per cent. protein. Registered in 1915 and 1916.	Two official samples. In accord with guaranty in protein and fat; fiber more than 2 per cent below maximum guaranty. Contained some seeds of wild buckwheat corn cockle, wild rose, charlock, false flax, mustard, ragweed and giant ragweed.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Scribner's Chick Feed. D. & C. E. Scribner Co., Brunswick, Me. Composed of corn, wheat, kaffir corn, oats, millet seed, charcoal, meat meal and fish meal. Contains not more than 12 per cent. crude fiber, and not less than 3 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Scribner's Growing Feed. D. & C. E. Scribner Co., Brunswick, Me. Composed of ground oats, red dog, meat meal, fish scraps, middlings, corn meal. Contains not more than 12 per cent. crude fiber, and not less than 3 per cent. fat and 14 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Scribner's Laying Mash. D. & C. E. Scribner Co., Brunswick, Me. Composed of ground oats, corn meal, hominy, bran, middlings, cottonseed meal, fish scrap and meat meal, alfalfa, bone meal. Contains not more than 12 per cent. crude fiber, and not less than 3 per cent. fat and 18 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Scribner's Scratch Feed. D. & C. E. Scribner Co., Brunswick, Me. Composed of cracked corn, wheat, oats, kaffir corn, India or buckwheat, charcoal. Contains not more than 12 per cent crude fiber, and not less than 3 per cent. fat and 10 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Wentworth Bros. Dry Feed for Growing Chicks. Wentworth Bros., Cornish, Me. Composed of corn meal, wheat middlings, meat scraps, wheat bran, ground oats, charcoal and salt. On 1915 certificate: Contains not more than 7 per cent. crude fiber, and not less than 5 per cent. fat and 18 per cent. protein. On 1916 certificate: Contains not more than 8 per cent crude fiber, and not less than 4 per cent. fat and 18 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Wentworth Bros. Dry Feed for Laying Hens. Wentworth Bros., Cornish, Me. Composed of corn meal, wheat feed flour, wheat bran, gluten, alfalfa meal, meat scraps, oil meal, charcoal and salt. On 1915 certificate: Contains not more than 8½ per cent crude fiber, and not less than 5½ per cent. fat and 20 per cent protein. On 1916 certificate: Contains not more than 9 per cent. crude fiber, and not less than 4 per cent. fat and 20 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Wentworth Bros. Dry Feed for Young Chicks. Wentworth Bros., Cornish. Me. Composed of corn meal, wheat middlings, oat meal, meat scraps, linseed oil meal, charcoal and salt. On 1915 certificate: Contains not more than 5 per cent. crude fiber, and not less than 5 per cent. fat and 16 per cent protein. On 1916 certificate: Contains not more than 8 per cent crude fiber, and not less than 4 per cent. fat and 16 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

ALFALFA MEALS.

Brand, Maker and Guaranties.	Results of Examination.
Red Star Brand Alfalfa Meal. Chas. M. Cox, Co., Boston, Mass. Alfalfa. Contains not more than 29.5 per cent crude fiber, and not less than 1.4 per cent. fat and 16.6 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Alfalfa Meal. Albert Dickinson Co., Chicago, Ill. Alfalfa hay. Contains not more than 35 per cent. crude fiber, and not less than 1 per cent fat and 12 per cent. protein. Registered in 1915 and 1916.	Three official samples. Well in accord with guaranty in protein and fat; more than 2 per cent below maximum guaranty of fiber. One sample contained a few seeds of pigweed.
Alfalfa Meal. Empire State Mills, A. F. Fietz, Munnsville, N. Y. No certificate filed. Claims on label: Contains not more than 25 per cent. crude fiber, and not less than 1.4 per cent fat and 14 per cent protein. Unregistered.	One official sample. Slightly above guaranty in protein and fat; about 5 per cent. above maximum guaranty of fiber.
Alfalfa Meal. Omaha Alfalfa Milling Co., Omaha, Nebr. Contains not more than 30 per cent. crude fiber, and not less than 1 per cent. fat and 12 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Alfalfa. Park & Pollard Co., Boston, Mass. Ground alfalfa hay. Contains not more than 30 per cent. crude fiber, and not less than 1½ per cent. fat and 12 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty in protein and fat; about 2 per cent. below maximum guaranty of fiber. No weed seeds found.
Peters' Lucern Alfalfa Meal. M. C. Peters Mill Co., Omaha, Nebr. Alfalfa hay. Contains not more than 33 per cent crude fiber, and not less than .5 per cent. fat and 12 per cent. protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.

DRIED MEAT AND FISH WASTES.

Ground Meat Scraps. The American Agricultural Chemical Co., New York, and other places. Meat Scraps. Contains not less than 10 per cent fat and 45 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
AGCO. American Glue Co., Boston, Mass. Made from fish by the Lane-Libby Fisheries Company of Vinalhaven, Maine. Contains not more than 1 per cent crude fiber, and not less than 2.5 per cent fat and 50 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Armour's Blood Meal. Armour Fertilizer Works, Chicago, Ill. Dried blood. Contains not more than 2 per cent. crude fiber, and not less than 80 per cent protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.

Feeding Stuffs—Continued.

Brand, Maker and Guaranties.	Results of Examination.
Armour's Granulated Bone. Armour Fertilizer Works, Chicago, Ill. Ground bone. Contains not more than 2 per cent crude fiber, and not less than 5 per cent. fat and 23 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Armour's Meat Meal. Armour Fertilizer Works, Chicago, Ill. Meat residue. Contains not more than 2 per cent. crude fiber, and not less than 6 per cent. fat and 60 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Beach's Star Brand Beef Scraps. Beach Soap Co., Lawrence, Mass. On 1915 certificate: Contains not less than 15 per cent fat and 40 per cent protein. On 1916 certificate: Contains not less than 10 per cent. fat and 40 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Bowker's Ground Meat Scraps. Bowker Fertilizer Co., Boston, Mass. Ground meat scraps. On 1915 certificate: Contains not less than 5 per cent. fat and 40 per cent. protein. On 1916 certificate: Contains not less than 10 per cent. fat and 45 per cent. protein. Registered in 1915 and 1916.	One official sample. Considerably above guaranty.
B. & M. Poultry Food. Burnham & Morrill Co., Portland, Me. Fresh fish trimmings. Contains not less than 1.5 per cent fat and 60 per cent. protein. Not registered in 1915 Registered in 1916.	No dealers' or official samples received.
Dow's Beef Scraps. John C. Dow Co., Boston, Mass. Dried meat scraps. Contains not less than 12 per cent. fat and 43 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Dow's Favorite Poultry Meal. John C. Dow Co., Boston, Mass. Dried meat and bone. Contains not less than 10 per cent. fat and 30 per cent protein. (1915 certificate gives 32 per cent. as minimum protein). Registered in 1915 and 1916.	One official sample. Above guaranty.
J. D. Grant & Sons' Poultry Feed. J. D. Grant & Sons, Bangor, Me. Bone fat and meat scraps. Contains not less than 25.5 per cent. fat and 35.56 per cent. protein. Not registered in 1915. Registered in 1916.	No dealers' or official samples received.
Hinckley Poultry Food. Hinckley Rendering Co., Somerville, Mass. Bone and meat. Contains not less than 8.12 per cent fat and 35.5 per cent protein. Registered in 1915. Not registered in 1916.	No dealers' or official samples received.
Red Star Brand Fish Scrap International Glue Co., Boston, Mass. Fresh fish. Contains not more than 1 per cent crude fiber, and not less than 2 per cent fat and 45 per cent. protein. (1915 certificate gives no fiber guaranty) Registered in 1915 and 1916.	No dealers' or official samples received.

FEEDING STUFFS—Concluded.

BRAND, MAKER AND GUARANTIES.	RESULTS OF EXAMINATION.
Lord's Egg Maker. Lord Bros. Co., Portland, Me. Dry fish meal, Contains not more than 2½ per cent. crude fiber, and not less than 2½ per cent. fat and 45 per cent. protein. (1915 certificate gives 3 per cent. as maximum fiber). Registered in 1915 and 1916.	No dealers' or official samples received.
Poultry Scraps. New England Dressed Meat & Wool Co., Somerville, Mass. Meat scraps and bone meal. Contains not less than 10 per cent. fat and 50 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Blue Ribbon Meat Scraps. Park & Pollard Co., Boston, Mass. Contains not more than 2 per cent crude fiber, and not less than 13 per cent fat and 45 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Portland Bone & Meat Meal. Portland Rendering Co., Portland, Me. Meat and bone. Contains not less than 8 per cent. fat and 35 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Portland Bone Meal. Portland Rendering Co., Portland, Me. Ground bone. Contains not less than 5 per cent fat and 20 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Portland Cracked Bone. Portland Rendering Co., Portland, Me. Ground bone. Contains not less than 5 per cent. fat and 10 per cent protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Portland Poultry Feed Prepared from Cooked Meat and Bone Scraps. Portland Rendering Co., Portland, Me. Meat and bone. Contains not less than 8 per cent. fat and 40 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty.
Whitman & Pratt's Animal Meal. Whitman & Pratt Rendering Co., Lowell, Mass. Ground meat tankage. Contains not less than 10 per cent fat and 33 per cent. protein. Registered in 1915 and 1916.	No dealers' or official samples received.
Whitman & Pratt's Beef Scraps. Whitman & Pratt Rendering Co., Lowell, Mass. Beef scrap and bone. Contains not less than 10 per cent. fat and 45 per cent. protein. Registered in 1915 and 1916.	One official sample. In accord with guaranty.
Whitman & Pratt's Extra Quality Beef Scraps. Whitman & Pratt Rendering Co., Lowell, Mass. Ground beef scraps. Contains not less than 10 per cent fat and 55 per cent. protein. Registered in 1915 and 1916.	No dealers' or official sample received.

STATEMENT BY THE EXECUTIVE OF THE LAW.

A. M. G. Soule, Chief, Bureau of Inspections.

The feeding stuffs inspection for parts of two years, 1915 and 1916, has been pursued with the idea of collecting samples and detecting unregistered goods. The work was actively carried on during this season from November, 1915, until June, 1916, and in the course of inspection most of the stores buying goods from out of the State were visited and many of the wholesale places in Portland, Bangor and Lewiston visited several times.

The total number of feeding stuffs registered for 1915 was five hundred and thirty-eight, while for 1916 thus far they number five hundred and fourteen.

About the usual number of hearings has resulted from the finding of unregistered brands, but in most cases when brought to the attention of the manufacturers, they have taken pains to protect the dealers selling their goods in this State without delay, and the year has been marked by the registration of several new brands of feeds not before sold within the State.

A greater number of samples of cottonseed meal have been found to be deficient than in either of the previous years that the law has been administered by this Department. Some of these cases have been disposed of by new registrations; some by the recommendation that the carload lot be refused by the dealer, which recommendation has been accepted, and in all instances that have warranted, recommendation for prosecution and citations have been made to the Federal Department by virtue of our commission as Collaborating State Official. The cooperative work with the Federal Department in the enforcement of the food law, which embraces in its scope food for animals as well as for human consumption has under its provision made it possible, when a sample of feeding stuff has been found deficient, for the deputy to secure documentary evidence proving interstate shipment of the goods and the case is reported to the Federal authorities. This has added greatly to the efficiency of the inspection work and by this means the blame for the deficiency found in the goods is placed where it is due and not upon the innocent dealer living within the State.

It has again been brought to the attention of the Department that greater care must be taken by the dealers in submitting samples for free analysis. Such samples are solicited and welcomed; it is important, however, that they be taken according to the directions issued by the Department, and the inspectors employed by the Department have been furnished with these blanks for describing these samples with instructions to leave them with the dealers upon whom they call in their course of inspection, and it is hoped that with the coming season a greater number of samples will be received and that pains will be taken to see that the instructions as laid down by the form are exactly followed. This is a special privilege not accorded in some other states, where, if one wishes to determine whether the goods purchased come up to the guaranty, a fee of three dollars—or one dollar for each element—is required by the Department of Agriculture for such analysis.

An important feature to be borne in mind by the feed dealers of the State is that if protection is wanted, only registered goods should be purchased, and an inquiry should be made in all instances from the salesman or from the firm; it is also to be understood that such information is on file at the Department of Agriculture and requests as to whether or not a certain brand is registered for sale in the State are always willingly answered.

November, 1916.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director.

ANALYSTS.

James M. Bartlett
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Official Inspections

80

COMMERCIAL FERTILIZERS, 1916.

Chas. D. Woods.

The Commissioner of Agriculture is the executive of the law regulating the sale of commercial fertilizers in Maine. It is the duty of the Director of the Maine Agricultural Experiment Station to make the analyses of the samples collected by the Commissioner, and to publish the results of the analyses together with the names of the persons from whom the samples were obtained, and such additional information as may seem advisable.

The outlines of the requirements of the law and the explanation of the table begin on page 138. The tabulated results of analyses begin on page 142. The analyses of lime, limestone and gypsum and discussion of results begin on page 192.

Note. All correspondence relative to the inspection laws should be addressed to the Bureau of Inspections, Department of Agriculture, Augusta, Maine.

Outline of the 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 to the Commissioner of Agriculture, Augusta, Maine.

1. *Kind of materials coming under the law.* The law applies to the sale, distribution, transportation, or the offering or exposing for sale, distribution or transportation, any materials used for fertilizing purposes the price of which exceeds $10 per ton, and to lime, marl and wood ashes intended for fertilizing purposes at whatever price they are sold.

2. *The Brand.* Every lot or package shall be plainly marked with:

The number of net pounds in the package.

The name or trade mark under which it is sold.

The name and principal address of the manufacturer or shipper.

The minimum percentage of nitrogen, or its equivalent in ammonia, in available form.

The minimum percentage of available phosphoric acid (soluble and reverted).

The minimum percentage of total phosphoric acid.

The minimum percentage of potash soluble in water.

In the case of lime, marl and wood ashes each package shall, in addition to the above, be plainly marked with:

The minimum and maximum percentage of total lime (calcium oxide).

The minimum and maximum percentage of total magnesia (magnesium oxide).

The minimum and maximum percentage of lime combined as carbonate (calcium carbonate).

The minimum and maximum percentage of magnesium combined as carbonate (magnesium carbonate).

The minimum percentage of lime-sulphur (calcium sulphate) in gypsum or land plaster.

If a fertilizer (including lime, marl and wood ashes) is sold in bulk or put up in packages belonging to the purchaser, upon the request of the purchaser he shall be furnished with a copy of the statements named above.

3. *Manufacturers' certificate.* Before manufacturing, selling or distributing a commercial fertilizer a certified copy of

the statements named in 2 shall be filed with the Commissioner of Agriculture.

4. *Manufacturers' samples.* When the Commissioner of Agriculture shall so request, the manufacturer shall furnish a sealed package containing not less than two pounds of the commercial fertilizer.

5. *Registration fee.* A registration fee is assessed on any brand offered for sale, distribution or transportation in the State as follows: $10 for the nitrogen, $10 for the phosphoric acid, $5 for the potash and $10 for the lime contained or said to be contained in the fertilizer. The filing of the certificate and the payment of the fee is required from only one person for a given brand.

6. *Registration may be refused or canceled.* The Commissioner of Agriculture may refuse to register any commercial fertilizer which bears a name that is misleading or deceptive or which would tend to mislead or deceive as to the materials of which it is composed. The Commissioner of Agriculture also has power to cancel the registration of a fertilizer manufactured, sold, distributed or transported in violation of any of the provisions of the law.

7. *Adulteration.* A fertilizer is adulterated if its weight, composition, quality, strength or purity varies from its fixed guaranty or if it contains any materials deleterious to growing plants.

8. *Misbranding.* A fertilizer is misbranded if; the package or label carries any statement, design or device that is false or misleading in any particular; the container does not carry the statements named in 2; the printed statements attached to the container differ from the statements in the certificate; and if the registration fee has not been paid.

9. *Analysis for correspondents.* A special law provides for the analysis of samples of fertilizers on sale in Maine taken in accordance with the law and the payment of an analysis fee of $10. If the analysis proves to be of public importance the analysis fee will be returned. Otherwise the money will be used in the enforcement of the law. Blanks with full directions will be furnished by the Commissioner of Agriculture on request.

10. *Written guaranty, the dealers' safeguard.* No prosecution will lie against any person handling commercial fertilizers provided he obtains at the time of purchase a written guaranty signed by the person residing in the United States from whom the purchase was made to the effect that the commercial fertilizer is not adulterated or misbranded within the meaning of the Maine law regulating the sale of commercial fertilizers. After a person has been duly notified that an article of commercial fertilizer appears to be adulterated or misbranded the written guaranty will not protect further sales.

11. *Hearing.* The person who is believed to have violated the law regulating the sale of commercial fertilizer will be granted a hearing at which he may appear in person, or by attorney, or by letter. The notice of the hearing will name the time and place of the hearing and a copy of the charge. Failure to appear will not prejudice the case. The hearing will be private and every opportunity will be given for explanation and the establishment of innocence. If the time appointed is not a convenient one, postponement within reasonable limit will be granted.

12. *Penalty.* Violations of the law are punishable by a fine not exceeding one hundred dollars for the first offense and not exceeding two hundred dollars for each subsequent offense.

EXPLANATION OF THE TABLES.

The tables giving the analyses of the samples collected by the Commissioner of Agriculture during the year 1916, follow. The samples were sent to the Station without description other than an identifying number. The data given in the left hand page tables and the guarantees were furnished after the analyses were completed.

The table on the even pages gives the Station number of the sample, the name and residence of the person from whom the sample was obtained and the month the sample was drawn.

The table on the odd pages gives the Station number of the samples and the detailed analyses. By means of the Station numbers the two tables are readily compared.

Under the head of "Nitrogen" in the tables are found seven columns of figures under the following headings.

1. *The nitrogen from nitrates.* In this column is given the percentage of nitrogen present as nitrate. Nitrate nitrogen is wholly and quickly available.

2. *Nitrogen from ammonia salts.* In this column is given the nitrogen from ammonium salts, chiefly sulphate. Ammonia nitrogen is not as quickly available as nitrate nitrogen.

3-4-5. *Organic Nitrogen.* 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 pood 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.

3. *Water soluble organic nitrogen.* This is the soluble nitrogen from organic materials, such as dried blood, dried fish or meat, tankage, cottonseed meal, etc. It dissolves in water and is 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 permanganate of potash. It is quite available.

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 only slowly available.

6. *Total nitrogen found.* 7. *Total nitrogen guaranteed.*

Phosphoric Acid. The table shows the percentages of water soluble, insoluble in weak acid found, and of available and total phosphoric acid found and guaranteed.

Potash. The table shows the percentages of water soluble potash found and guaranteed.

Descriptive List of Fertilizer Samples, 1916.

Station number.	Maker and Brand.	Sample Obtained. From	Sample Obtained. Month.
	AMERICAN AGRICULTURAL CHEM. CO., NEW YORK CITY, N. Y.		
3804	A A Potato Grower, 1916	McLaughlin's Storehouse, Bangor	April
3920	A A Potato Grower, 1916	Jackson & Hall, Belfast	April
4015	A A Potato Grower, 1916	H. J. Shedd, Mattawamkeag	April
3710	Ammoniated Fertilizer A	Listers Agricultural Chemical Works, Portland	March
3851	Ammoniated Fertilizer A	McLaughlin's Storehouse, Bangor	April
3923	Ammoniated Fertilizer A	Jackson & Hall, Belfast	April
3712	Ammoniated Fertilizer AA	Listers Agricultural Chemical Works, Portland	March
3827	Ammoniated Fertilizer AA	McLaughlin's Storehouse, Bangor	April
3903	Ammoniated Fertilizer AA	Jackson & Hall, Belfast	April
3929	Ammoniated Fertilizer AA	Jackson & Hall, Belfast	April
3684	Ammoniated Fertilizer AAA	Henry J. Pullen, Dexter	March
3711	Ammoniated Fertilizer AAA	Listers Agricultural Chemical Works, Portland	March
3775	Ammoniated Fertilizer AAA	R. B. Dunning & Co., Bangor	April
3907	Ammoniated Fertilizer AAA	Jackson & Hall, Belfast	April
4115	Ammoniated Fertilizer AAA	S. G. Otis, Hallowell	May
4118	Ammoniated Fertilizer AAA	C. C. Dunham, Foxcroft	May
3683	Ammoniated Fertilizer AAAA	Henry J. Pullen, Dexter	March
3698	Ammoniated Fertilizer AAAA	Listers Agricultural Chemical Works, Portland	March
3987	Ammoniated Fertilizer AAAA	D. Daigle, Fort Kent	April
4105	Ammoniated Fertilizer AAAA	Jerry Smith, Caribou	May
4116	Ammoniated Fertilizer AAAA	S. G. Otis, Hallowell	May
4119	Ammoniated Fertilizer AAAA	C. C. Dunham, Foxcroft	May
4280	Ammoniated Fertilizer AAAA	R. W. Howe, Auburn	May
3702	Ammoniated Fertilizer 5A	Listers Agricultural Chemical Works, Portland	March

Guaranties and Results of Analysis of Fertilizer Samples, 1916.

Station number.	Nitrogen. Organic. % As nitrate.	% As ammonia.	% As water soluble.	% As active insoluble.*	% As inactive insoluble.	Total. % Found.	% Guaranteed.	Phosphoric Acid. % Soluble.	% Insoluble.	Available. % Found.	% Guaranteed.	Total. % Found.	% Guaranteed.	Potash % Found.	% Guaranteed.	Remarks.
3804	0.88	0.94	0.49	0.64	0.43	3.38	3.70	3.14	1.65	7.25	8.0	8.90	9.0	1.24	1.0	
3920	1.24	1.04	0.49	0.79	0.39	3.95	3.70	3.89	1.61	8.41	8.0	10.02	9.0	1.05	1.0	
4015	–	–	2.38	0.84	0.38	3.60	3.70	4.91	1.91	8.30	8.0	10.21	9.0	1.26	1.0	
3710	0.32	0.18	0.30	0.22	0.17	1.19	0.82	4.77	2.45	10.05	10.0	12.50	11.0	–	–	
3851	0.44	0.12	0.04	0.19	0.14	0.93	0.82	4.94	1.17	10.71	10.0	11.88	11.0	–	–	
3923	0.28	0.08	0.22	0.15	0.12	0.85	0.82	4.94	1.43	10.17	10.0	11.60	11.0	–	–	
3712	0.56	0.25	0.47	0.42	0.14	1.84	1.65	3.35	3.42	8.89	10.0	12.31	11.0	–	–	
3827	0.51	0.28	0.29	0.39	0.18	1.65	1.65	3.08	2.68	8.72	10.0	11.40	11.0	–	–	
3903	0.40	0.62	0.53	0.15	0.12	1.82	1.65	4.80	1.10	9.65	10.0	10.75	11.0	–	–	
3929	0.50	0.22	0.59	0.43	0.15	1.89	1.65	2.97	2.64	8.89	10.0	11.53	11.0	–	–	
3684	0.88	0.27	1.09	0.48	0.21	2.93	2.47	7.38	1.34	10.26	10.0	11.60	11.0	–	–	
3711	0.78	0.50	0.49	0.54	0.20	2.51	2.47	4.75	2.25	9.75	10.0	12.00	11.0	–	–	
3775	0.78	0.64	0.32	0.45	0.35	2.54	2.47	5.17	2.21	9.55	10.0	11.76	11.0	–	–	
3907	0.08	0.78	1.18	0.41	0.19	2.64	2.47	6.06	0.96	11.02	10.0	11.98	11.0	–	–	
4115	0.60	0.78	0.75	0.39	0.19	2.71	2.47	3.88	2.72	9.21	10.0	11.93	11.0	–	–	
4118	0.30	0.74	0.82	0.42	0.18	2.46	2.47	1.55	1.14	10.22	10.0	11.36	11.0	–	–	
3683	1.16	0.33	1.33	0.57	0.39	3.78	3.29	7.62	1.57	10.03	10.0	11.60	11.0	–	–	Moisture 11.7 per cent
3698	1.29	1.13	0.49	0.51	0.23	3.65	3.29	6.94	0.88	10.17	10.0	11.05	11.0	–	–	
3987	1.56	1.20	0.45	0.55	0.35	4.11	3.29	5.66	1.51	9.24	10.0	10.75	11.0	–	–	
4105	1.08	0.86	0.60	0.40	0.43	3.37	3.29	5.68	1.82	10.14	10.0	11.96	11.0	–	–	
4116	1.30	1.22	0.54	0.45	0.15	3.66	3.29	5.38	1.91	9.53	10.0	11.44	11.0	–	–	
4119	0.98	0.74	0.21	0.43	0.18	2.54	3.29	2.04	1.28	10.00	10.0	11.28	11.0	–	–	
4280	1.00	1.20	0.55	0.69	0.24	3.68	3.29	6.89	1.16	10.80	10.0	11.96	11.0	–	–	
3702	1.12	2.03	0.38	0.54	0.23	4.30	4.11	5.73	0.76	8.47	8.0	9.23	9.0	–	–	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained. From	Sample Obtained. Month.
3779	Ammoniated Fertilizer 5A	R. B. Dunning & Co., Bangor	March
3811	Ammoniated Fertilizer 5A	McLaughlin's Storehouse, Bangor	April
3685	Ammoniated Fertilizer VX	Henry J. Pullen, Dexter	March
3697	Ammoniated Fertilizer VX	Listers Agricultural Chemical Works, Portland	March
3970	Ammoniated Fertilizer VX	Daniel B. Gillings, Houlton	April
3988	Ammoniated Fertilizer VX	D. Daigle, Fort Kent	April
4117	Ammoniated Fertilizer VX	S. G. Otis, Hallowell	May
4265	Ammoniated Fertilizer VX	G. C. Lord, Wells	June
3821	Aroostook Complete Manure, 1916	McLaughlin's Storehouse, Bangor	April
3909	Aroostook Complete Manure, 1916	Jackson & Hall, Belfast	April
4009	Aroostook Complete Manure, 1916	Ross Waite, Winn	April
3796	Aroostook Potato Manure, 1916	McLaughlin's Storehouse, Bangor	April
3931	Aroostook Potato Manure, 1916	Jackson & Hall, Belfast	April
3968	Aroostook Potato Manure, 1916	Daniel B. Gillings, Houlton	April
4141	Aroostook Potato Manure, 1916	R. S. Carr, Bowdoin	May
3745	Bradley's Alkaline Bone with Potash	Saco Grain & Milling Co., Saco	March
4229	Bradley's Complete Manure for Corn and Grain, 1916	E. W. Parker, Pownal	May
4239	Bradley's Complete Manure for Corn and Grain, 1916	E. P. Ham, Lewiston	May
4268	Bradley's Complete Manure for Corn and Grain, 1916	Charles S. Smith, Goodwin's Mills	June
3695	Bradley's Complete Manure for Potatoes and Vegetables, 1916	Listers Agricultural Chemical Works, Portland	March
3777	Bradley's Complete Manure for Potatoes and Vegetables, 1916	R. B. Dunning & Co., Bangor	April
3864	Bradley's Complete Manure for Potatoes and Vegetables, 1916	Ralph O'Hara, Harmony	April
4031	Bradley's Complete Manure for Potatoes and Vegetables, 1916	Wm. Wood & Sons, Gardiner	April
4038	Bradley's Complete Manure for Potatoes and Vegetables, 1916	Jones & Co., Winthrop	April

Guaranties and Results of Analysis of Fertilizer Samples, 1916—Continued.

Station number.	Nitrogen. % As nitrate.	Nitrogen. % As ammonia.	Nitrogen, Organic. % As water soluble.	Nitrogen, Organic. % As active insoluble.*	Nitrogen, Organic. % As inactive insoluble.	Nitrogen, Total. % Found.	Nitrogen, Total. % Guaranteed.	Phosphoric Acid. % Soluble.	Phosphoric Acid. % Insoluble.	Phosphoric Acid, Available. % Found.	Phosphoric Acid, Available. % Guaranteed.	Phosphoric Acid, Total. % Found.	Phosphoric Acid, Total. % Guaranteed.	Potash % Found.	Potash % Guaranteed.	Remarks.
3779	0.92	1.84	0.70	0.53	0.25	4.24	4.11	5.47	1.25	8.42	8.0	9.67	9.0	–	–	
3811	0.53	1.81	0.99	0.62	0.20	4.15	4.11	4.88	1.22	8.52	8.0	9.74	9.0	–	–	
3685	1.35	1.24	0.60	0.85	0.26	4.50	4.11	6.81	1.63	10.13	10.0	11.76	11.0	–	–	
3697	1.50	1.40	0.45	0.60	0.31	4.26	4.11	6.91	0.79	9.99	10.0	10.78	11.0	–	–	
3970	0.76	0.96	0.97	1.10	0.43	4.22	4.11	5.79	1.53	10.24	10.0	11.77	11.0	–	–	
3988	1.37	1.46	0.78	0.49	0.20	4.30	4.11	6.71	0.97	10.51	10.0	11.48	11.0	–	–	
4117	1.36	1.48	0.58	0.47	0.12	4.01	4.11	6.44	1.47	10.03	10.0	11.50	11.0	–	–	
4265	1.30	1.12	0.59	0.81	0.34	4.16	4.11	5.15	3.34	9.16	10.0	12.50	11.0	–	–	
3821	0.82	0.66	0.26	0.50	0.25	2.49	2.47	4.48	1.48	8.93	9.0	10.41	10.0	1.05	1.0	
3909	0.68	0.58	0.50	0.70	0.05	2.51	2.47	3.97	1.33	9.12	9.0	10.45	10.0	1.43	1.0	
4009	0.63	0.64	0.45	0.47	0.26	2.45	2.47	4.75	1.45	8.85	9.0	10.30	10.0	1.08	1.0	
3796	1.26	1.04	0.25	0.84	0.33	3.72	3.70	4.32	1.99	7.90	8.0	9.89	9.0	1.14	1.0	
3931	1.60	0.96	–	0.76	0.32	3.56	3.70	4.42	0,63	9.45	8.0	10.08	9.0	1.14	1.0	
3968	0.67	1.08	1.36	0.66	0.04	3.81	3.70	4.82	1.35	8.22	8.0	9.57	9.0	1.04	1.0	
4141	1.36	1.20	0.27	0.69	0.25	3.77	4.11	2.97	1.10	8.95	9.0	10.05	10.0	3.59	4.0	Not registered. Sold direct by company to consumer.
3745	–	–	–	–	–	–	–	6.48	0.66	11.46	11.0	12.12	12.0	2.15	2.0	1915 goods.
4229	1.15	1.28	0.72	0.63	0.08	3.86	3.29	5.23	1.79	8.83	9.0	10.62	10.0	1.18	1.0	
4239	1.18	1.26	0.75	0.42	0.09	3.70	3.29	5.97	1.48	9.16	9.0	10.64	10.0	1.07	1.0	
4268	1.14	1.08	0.53	0.46	0.15	3.36	3.29	6.48	1.68	10.15	9.0	11.83	10.0	1.00	1.0	
3695	1.28	0.90	0.45	0.50	0.22	3.35	3.29	5.09	1.12	9.09	9.0	10.21	10.0	1.18	1.0	
3777	1.20	0.92	0.42	0.63	0.29	3.46	3.29	3.96	1.28	8.64	9.0	9.92	10.0	1.14	1.0	
3864	1.16	0.92	0.53	0.58	0.24	3.43	3.29	4.56	1.15	9.33	9.0	10.48	10.0	1.17	1.0	
4031	0.81	0.93	0.74	0.65	0.24	3.37	3.29	4.78	0.75	9.11	9.0	9.86	10.0	1.04	1.0	
4038	1.02	0.88	0.63	0.48	0.24	3.25	3.29	2.34	1.29	8.41	9.0	9.70	10.0	1.06	1.0	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained.	
		From	Month.
4240	Bradley's Complete Manure for Top Dressing Corn & Grain	David French, East Poland	May
4238	Bradley's Concentrated Flower Food	R. B. Dunning & Co., Bangor	May
3701	Bradley's Corn Phosphate, 1916	Listers Agricultural Chemical Works, Portland	March
3782	Bradley's Corn Phosphate, 1916	R. B. Dunning & Co., Bangor	March
3858	Bradley's Corn Phosphate, 1916	A. M. Brown, Augusta	April
4029	Bradley's Corn Phosphate, 1916	Wm. Wood & Sons, Gardiner	April
4039	Bradley's Corn Phosphate, 1916	Jones & Co., Winthrop	May
3700	Bradley's Eclipse Phosphate, 1916	Listers Agricultural Chemical Works, Portland	March
3781	Bradley's Eclipse Phosphate, 1916	R. B. Dunning & Co., Bangor	March
3794	Bradley's Eclipse Phosphate, 1916	McLaughlin's Storehouse, Bangor	April
3856	Bradley's Eclipse Phosphate, 1916	A. M. Brown, Augusta	April
3928	Bradley's Eclipse Phosphate, 1916	Jackson & Hall, Belfast	April
3829	Bradley's High Grade Potato & Root Special, 1916	McLaughlin's Storehouse, Bangor	April
3835	Bradley's High Grade Potato & Root Special, 1916	McLaughlin's Storehouse, Bangor	April
3746	Bradley's Potato Fertilizer,	Saco Grain & Milling Co., Saco	March
3696	Bradley's Potato Fertilizer, 1916	Listers Agricultural Chemical Works, Portland	March
3855	Bradley's Potato Fertilizer, 1916	A. M. Brown, Augusta	April
3926	Bradley's Potato Fertilizer, 1916	Jackson & Hall, Belfast	April
4032	Bradley's Potato Fertilizer, 1916	Wm. Wood & Sons, Gardiner	April
4036	Bradley's Potato Fertilizer, 1916	Jones & Co., Winthrop	April
3699	Bradley's Potato Manure, 1916	Listers Agricultural Chemical Works, Portland	March
3774	Bradley's Potato Manure, 1916	R. B. Dunning & Co., Bangor	April
3878	Bradley's Potato Manure, 1916	Peter Harmon, Thorndike	April
3919	Bradley's Potato Manure, 1916	Jackson & Hall, Belfast	April

Guaranties and Results of Analysis of Fertilizer Samples, 1916 —Continued.

Station number.	Nitrogen. Organic. % As nitrate.	% As ammonia.	% As water soluble.	% As active insoluble.	% As inactive insoluble.	Total. % Found.	% Guaranteed.	Phosphoric Acid. % Soluble.	% Insoluble.	Available. % Found.	% Guaranteed.	Total. % Found.	% Guaranteed.	Potash % Found.	% Guaranteed.	Remarks.
4240	1.38	1.58	0.58	* 0.47	0.12	4.13	4.11	5.53	1.21	8.69	8.0	9.90	9.0	1.10	1.0	
4238	3.52	–	1.05	–	–	4.57	–	0.53	9.44	6.13	–	15.57	–	–	–	No guarantee on package. Not registered.
3701	0.72	0.45	0.36	0.32	0.16	2.01	1.65	6.52	1.01	10.51	10.0	11.52	11.0	1.18	1.0	Moisture 11.16 per cent.
3782	0.54	0.46	–	–	–	1.75	1.65	5.97	1.28	10.54	10.0	11.82	11.0	1.08	1.0	
3858	0.52	0.22	0.43	0.38	0.21	1.76	1.65	5.50	1.12	10.04	10.0	11.16	11.0	1.03	1.0	
4029	0.58	0.42	0.29	0.43	0.19	1.91	1.65	2.60	1.45	10.03	10.0	11.48	11.0	1.00	1.0	
4039	0.30	0.44	0.57	0.33	0.20	1.84	1.65	5.58	1.03	9.88	10.0	10.91	11.0	1.05	1.0	Moisture 11.53 per cent.
3700	0.45	0.23	0.37	0.27	0.16	1.48	1.23	5.82	1.66	10.41	10.0	12.07	11.0	1.15	1.0	Moisture 11.19 per cent.
3781	0.23	0.35	0.29	0.26	0.11	1.24	1.23	5.93	1.20	10.57	10.0	11.77	11.0	1.02	1.0	
3794	0.44	0.24	0.05	0.24	0.18	1.15	1.23	5.23	1.08	10.10	10.0	11.18	11.0	1.30	1.0	Moisture 11.42 per cent.
3856	0.45	0.24	0.46	0.39	0.18	1.72	1.23	5.10	1.33	9.93	10.0	11.26	11.0	1.22	1.0	
3928	0.14	0.26	0.55	0.25	0.09	1.29	1.23	5.26	0.94	10.34	10.0	11.28	11.0	1.58	1.0	Moisture 12.23 per cent.
3829	0.52	0.43	0.33	0.39	0.17	1.84	1.65	5.57	1.02	10.83	10.0	11.85	11.0	1.05	1.0	Moisture 11.04 per cent.
3835	0.49	0.43	0.22	0.36	0.20	1.70	1.65	5.65	1.20	10.73	10.0	11.93	11.0	2.00	1.0	Moisture 11.62 per cent.
3746	0.45	0.50	0.44	0.55	0.20	2.14	2.08	4.08	1.63	8.23	8.0	9.86	9.0	2.75	3.0	1915 goods.
3696	0.58	0.77	0.23	0.37	0.21	2.16	2.06	5.44	0.96	8.32	8.0	9.28	9.0	1.39	1.0	
3855	0.67	0.45	0.12	0.58	0.15	1.97	2.06	2.23	0.98	8.45	8.0	9.43	9.0	1.38	1.0	Moisture 12.32 per cent.
3926	0.88	0.53	0.16	0.42	0.20	2.19	2.06	3.62	1.07	8.47	8.0	9.54	9.0	0.77	1.0	
4032	0.46	0.76	0.18	0.49	0.27	2.16	2.06	1.39	1.84	8.29	8.0	10.13	9.0	1.18	1.0	
4036	0.66	0.60	0.30	0.40	0.13	2.09	2.06	1.80	1.33	7.95	8.0	9.28	9.0	1.02	1.0	
3699	0.81	0.88	0.43	0.51	0.22	2.85	2.47	6.00	1.00	10.40	9.0	11.40	10.0	1.08	1.0	
3774	0.80	0.64	0.28	0.53	0.18	2.43	2.47	4.40	1.76	8.56	9.0	10.32	10.0	1.08	1.0	
3878	0.88	0.75	0.24	0.57	0.28	2.72	2.47	4.55	0.87	9.69	9.0	10.56	10.0	1.05	1.0	
3919	0.44	0.70	0.70	0.54	0.20	2.58	2.47	4.59	1.06	9.66	9.0	10.72	10.0	1.04	1.0	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained.	
		From	Month.
4143	Bradley's Potato Manure, 1916	C. P. Bates, Bowdoinham	May
3839	Bradley's Special Niagara Phosphate	McLaughlin's Storehouse, Bangor	April
3854	Bradley's Special Niagara Phosphate	A. M. Brown, Augusta	April
3922	Bradley's Special Niagara Phosphate	Jackson & Hall, Belfast	April
4028	Bradley's Special Niagara Phosphate	Wm. Wood & Sons. Gardiner	April
3743	Bradley's XL Super-Phosphate of Lime	Saco Grain & Milling Co., Saco	March
3857	Bradley's XL Super-Phosphate of Lime, 1916	A. M. Brown, Augusta	April
3867	Bradley's XL Super-Phosphate of Lime, 1916	Frank A. Linnell, Harmony	April
3694	Bradley's XL Super-Phosphate of Lime, 1916	Listers Agricultural Chemical Works, Portland	March
4030	Bradley's XL Super-Phosphate of Lime, 1916	Wm. Wood & Sons, Gardiner	April
4040	Bradley's XL Super-Phosphate of Lime, 1916	Jones & Co., Winthrop	April
4130	Clark's Cove Bay State Fertilizer, 1916	Coe-Mortimer Co., Belfast	May
4286	Clark's Cove Bay State Fertilizer, 1916	H. W. Maxwell, Litchfield	June
4282	Clark's Cove Bay State Fertilizer GG, 1916	E. W. Macomber, Auburn	May
4136	Clark's Cove Great Planet A A Manure, 1916	Curtis Durgin, Bangor	May
4016	Clark's Cove Potato Fertilizer, 1916	H. J. Shedd, Mattawamkeag	April
4131	Clark's Cove Potato Manure, 1916	Coe-Mortimer Co., Belfast	May
4137	Clark's Cove Potato Manure, 1916	Curtis Durgin, Bangor	May
3823	Crocker's Ammoniated Corn Phosphate, 1916	McLaughlin's Storehouse, Bangor	April
3915	Crocker's Ammoniated Corn Phosphate, 1916	Jackson & Hall, Belfast	April
3914	Crocker's New Rival Ammoniated Superphosphate. 1916	Jackson & Hall, Belfast	April
3910	Crocker's Potato, Hop & Tobacco Fertilizer, 1916	Jackson & Hall, Belfast	April
3965	Darling's A1 Fertilizer	S. A. Crockett, Houlton	April
3991	Darling's A1 Fertilizer	Fred Daigle, Fort Kent	April

Guaranties and Results of Analysis of Fertilizer Samples, 1916—Continued.

	Nitrogen.							Phosphoric Acid.						Potash		
			Organic.			Total.				Available.		Total.				
Station number.	% As nitrate.	% As ammonia.	% As water soluble.*	% As active insoluble.	% As inactive insoluble.	% Found.	% Guaranteed.	% Soluble.	% Insoluble.	% Found.	% Guaranteed.	% Found.	% Guaranteed.	% Found.	% Guaranteed.	Remarks.
4143	0.50	1.10	0.41	0.42	0.18	2.61	2.47	4.39	1.67	9.51	9.0	11.18	10.0	0.90	1.0	
3839	0.28	0.20	0.11	0.17	0.11	0.87	0.82	4.45	0.89	9.27	8.0	10.16	9.0	1.20	1.0	
3854	0.28	0.14	0.11	0.26	0.13	0.93	0.82	1.44	0.83	8.05	8.0	8.88	9.0	1.38	1.0	
3922	0.23	0.02	0.17	0.14	0.05	0.63	0.82	3.21	0.63	7.25	8.0	7.88	9.0	1.02	1.0	
4028	0.28	0.22	0.18	0.27	0.15	1.10	0.82	0.99	1.28	8.51	8.0	9.79	9.0	1.01	1.0	
3743	0.65	0.54	0.47	0.66	0.20	2.52	2.88	4.34	1.33	9.42	9.0	10.75	11.0	2.06	3.0	1915 goods.
3857	0.98	0.88	0.31	0.52	0.24	2.93	2.47	4.77	1.34	9.31	9.0	10.65	10.0	1.07	1.0	
3867	0.78	0.61	0.30	0.50	0.24	2.43	2.47	5.22	1.42	9.03	9.0	10.45	10.0	1.18	1.0	
3694	0.83	0.68	0.33	0.47	0.16	2.47	2.47	4.53	1.75	8.79	9.0	10.54	10.0	1.08	1.0	Moisture 11.63 per cent.
4030	0.58	0.82	0.78	0.67	0.23	3.08	2.47	3.94	1.17	9.24	9.0	10.41	10.0	1.03	1.0	
4040	1.10	0.82	0.02	0.48	0.22	2.64	2.47	3.37	1.33	9.31	9.0	10.64	10.0	1.06	1.0	
4130	0.78	0.58	0.33	0.57	0.20	2.46	2.47	4.47	1.57	8.64	9.0	10.21	10.0	0.66	1.0	
4286	0.78	0.76	0.27	0.61	0.16	2.58	2.47	4.50	1.39	9.14	9.0	10.53	10.0	1.02	1.0	
4282	0.72	0.66	0.50	0.51	0.16	2.55	1.65	4.47	1.76	9.21	10.0	10.97	11.0	1.02	1.0	
4136	0.48	1.14	1.16	0.67	0.20	3.65	3.29	4.53	1.31	8.91	9.0	10.22	10.0	1.06	1.0	
4016	–	–	1.80	0.53	0.26	2.59	2.06	5.07	1.80	8.25	8.0	10.05	9.0	1.24	1.0	
4131	0.94	0.78	0.37	0.33	0.11	2.53	2.47	5.55	1.05	9.67	9.0	10.72	10.0	1.06	1.0	Moisture 11.12 per cent.
4137	0.54	0.80	0.76	0.40	0.20	2.70	2.47	4.69	0.97	8.68	9.0	9.65	10.0	1.12	1.0	
3823	0.82	0.48	–	0.43	0.18	1.90	2.06	3.86	1.07	7.80	8.0	8.87	9.0	0.95	1.0	
3915	0.50	0.48	0.62	0.44	0.15	2.19	2.06	3.19	1.42	8.23	8.0	9.65	9.0	1.03	1.0	
3914	0.24	0.24	0.25	0.08	0.04	0.85	0.82	5.68	0.97	10.71	10.0	11.68	11.0	1.81	1.0	Moisture 11.01 per cent.
3910	0.64	0.50	0.36	0.41	0.19	2.10	2.06	5.07	1.06	10.04	10.0	11.10	11.0	1.20	1.0	
3965	0.96	1.62	0.71	0.71	0.25	4.25	4.11	6.89	1.28	10.38	10.0	11.66	11.0	–	–	
3991	1.42	1.42	0.63	0.43	0.24	4.14	4.11	6.49	1.21	10.24	10.0	11.45	11.0	–	-	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained. From	Sample Obtained. Month.
4190	Darling's A1 Fertilizer	Philip Brennen, Oakfield	May
4194	Darling's A1 Fertilizer	A. W. Briggs, Monticello	May
3799	Darling's Blood, Bone & Potash, 1916	McLaughlin's Storehouse, Bangor	April
3921	Darling's Blood, Bone & Potash, 1916	Jackson & Hall, Belfast	April
4267	Darling's Blood, Bone & Potash Special	George C. Lord, Wells	June
4277	Dissolved Acid Phosphate	Lee Davis, Webster	May
4241	Fine Ground Bone	A. F. Richardson, Gorham	May
4264	Fine Ground Bone	F. E. Rankin, Wells	June
4127	5-10-0	American Agricultural Chemical Works, Searsport	May
4128	5-10-0	American Agricultural Chemical Works, Searsport	May
4129	5-10-0	American Agricultural Chemical Works, Searsport	May
4082	General Crop Grower, 1916	Fairfield Grain Co., Fairfield	April
4113	Grass & Lawn Top Dressing, 1916	American Agricultural Chemical Works, Portland	May
4133	Grass & Lawn Top Dressing, 1916	Coe-Mortimer Co., Belfast	May
3837	Great Eastern General, 1916	McLaughlin's Storehouse, Bangor	April
3911	Great Eastern General, 1916	Jackson & Hall, Belfast	April
3824	Great Eastern Northern Corn Special, 1916	McLaughlin's Storehouse, Bangor	April
3933	Great Eastern Northern Corn Special, 1916	Jackson & Hall, Belfast	April
3969	Great Eastern Northern Corn Special, 1916	Daniel B. Gillings, Houlton	April
3843	Great Eastern Potato Manure, 1916	McLaughlin's Storehouse, Bangor	April
3932	Great Eastern Potato Manure, 1916	Jackson & Hall, Belfast	April
3798	Great Harvester Potato Manure, 1916	McLaughlin's Storehouse, Bangor	April
3925	Great Harvester Potato Manure, 1916	Jackson & Hall, Belfast	April
4014	Great Harvester Potato Manure, 1916	H. J. Shedd, Mattawamkeag	April

Guaranties and Results of Analysis of Fertilizer Samples, 1916—Continued.

	Nitrogen.							Phosphoric Acid.						Potash		
			Organic.			Total.				Available.		Total.				
Station number.	% As nitrate.	% As ammonia.	% As water soluble.*	% As active insoluble.	% As inactive insoluble.	% Found.	% Guaranteed.	% Soluble.	% Insoluble.	% Found.	% Guaranteed.	% Found.	% Guaranteed.	% Found.	% Guaranteed.	Remarks.
4190	1.44	1.44	0.64	0.50	0.10	4.12	4.11	6.52	1.28	9.88	10.0	11.16	11.0	–	–	
4194	1.54	1.44	0.49	0.60	0.10	4.17	4.11	6.16	1.91	9.75	10.0	11.66	11.0	–	–	
3799	1.18	1.22	0.37	0.79	0.50	4.06	4.11	4.02	1.86	8.12	8.0	9.98	9.0	1.61	1.0	
3921	1.24	1.16	0.54	1.02	0.27	4.23	4.11	4.50	1.88	9.01	8.0	10.89	9.0	1.45	1.0	
4267	1.08	0.38	2.36	0.20	0.19	4.21	4.11	3.88	1.40	9.03	8.0	10.43	9.0	2.85	4.0	1915 goods. Moisture 15.11 per cent.
4277	–	–	–	–	–	–	–	9.06	1.29	13.75	14.0	15.04	–	–	–	
4241	–	–	–	–	–	2.64	2.47	–	–	–	–	23.81	22.9	–	–	
4264	–	–	–	–	–	2.0[illegible]	2.47	–	–	–	–	24.34	22.9	–	–	
4127	2.14	1.13	–	0.48	0.69	4.44	–	6.43	1.66	9.86	–	11.52	–	–	–	Sample from bulk. Used in making 5–10 goods.
4128	–	–	3.63	0.53	0.23	4.39	–	6.54	1.20	9.81	–	11.01	–	–	–	Sample from bulk. Used in making 5–10 goods.
4129	1.36	1.12	0.43	0.85	0.25	4.01	–	5.39	1.53	9.70	–	11.23	–	–	–	Sample from bulk. Used in making 5–10 goods.
4082	0.33	0.64	0.39	0.41	0.19	1.96	1.65	2.36	1.94	8.55	9.0	10.49	10.0	1.02	1.0	
4113	1.12	1.32	0.76	0.47	0.20	3.87	3.70	4.63	1.28	8.42	8.0	9.70	9.0	1.13	1.0	Moisture 11.28 per cent.
4133	1.14	0.98	0.40	0.72	0.39	3.63	3.70	4.50	1.99	8.58	8.0	10.57	9.0	1.31	1.0	
3837	0.08	0.14	0.36	0.17	0.12	0.87	0.82	3.45	0.83	7.80	8.0	8.63	9.0	1.02	1.0	
3911	0.60	0.23	–	0.25	0.09	1.07	0.82	3.72	1.10	8.69	8.0	9.79	9.0	1.16	1.0	
3824	0.70	0.52	0.20	0.39	0.25	2.06	2.06	3.80	1.25	7.97	8.0	9.22	9.0	1.05	1.0	
3933	0.68	0.50	0.57	0.48	0.14	2.37	2.06	3.52	1.35	8.79	8.0	10.14	9.0	0.98	1.0	
3969	0.72	0.54	0.13	0.58	0.12	2.09	2.06	2.27	0.79	8.56	8.0	9.35	9.0	1.27	1.0	
3843	0.38	0.50	0.51	0.41	0.19	1.99	2.06	4.88	1.12	9.81	10.0	10.93	11.0	1.14	1.0	
3932	0.17	0.50	0.83	0.43	0.18	2.11	2.06	4.72	1.05	9.92	10.0	10.97	11.0	1.04	1.0	
3798	1.26	1.30	0.34	0.87	0.39	4.16	4.11	3.99	2.04	7.88	8.0	9.92	9.0	1.24	1.0	
3925	0.79	1.61	0.55	0.78	0.43	4.16	4.11	4.10	1.28	8.19	8.0	9.47	9.0	2.03	1.0	
4014	–	–	2.77	1.13	0.46	4.36	4.11	4.69	1.86	8.06	8.0	9.92	9.0	1.20	1.0	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained. From	Month.
3913	High Grade Acid Phosphate	Jackson & Hall, Belfast	April
3706	High Grade Fertilizer, 1916	Listers Agricultural Chemical Works, Portland	March
3784	High Grade Fertilizer, 1916	R. B. Dunning & Co., Bangor	April
4037	High Grade Fertilizer, 1916	Jones & Co., Winthrop	April
4043	High Grade Fertilizer, 1916	Millard F. Norcross, Winthrop	April
4092	High Grade Fertilizer, 1916	Merrill & Mayo, Waterville	April
3906	Northern Maine Potato Special, 1916	Jackson & Hall, Belfast	April
3912	Northern Maine Potato Special, 1916	Jackson & Hall, Belfast	April
3967	Northern Maine Potato Special, 1916	Daniel B. Gillings, Houlton	April
4052	Northern Maine Potato Special, 1916	Coe-Mortimer Co., Belfast	April
4197	Pacific Dissolved Phosphate and Potash	D. W. Bragdon, North Berwick	May
4226	Pacific High Grade General Fertilizer, 1916	A. K. P. Dresser, W. Pownal	May
4057	Pacific Nobsque Guano	Coe-Mortimer Co., Belfast	April
4058	Pacific Potato Special, 1916	Coe-Mortimer Co., Belfast	April
4196	Pacific Potato Special, 1916	D. W. Bragdon, North Berwick	May
4228	Pacific Potato Special, 1916	A. K. P. Dresser, W. Pownal	May
3853	Packers Union Animal Corn Fertilizer, 1916	McLaughlin's Storehouse, Bangor	April
3908	Packers Union Animal Corn Fertilizer, 1916	Jackson & Hall, Belfast	April
3838	Packers Union Potato Manure, 1916	McLaughlin s Storehouse, Bangor	April
3840	Packers Union Potato Manure, 1916	McLaughlin s Storehouse, Bangor	April
3904	Packers Union Potato Manure, 1916	Jackson & Hall, Belfast	April
3819	Packers Union Universal Fertilizer, 1916	McLaughlin s Storenouse, Bangor	April
3930	Packers Union Universal Fertilizer, 1916	Jackson & Hall, Belfast	April
4224	Quinnipiac Climax Phosphate, 1916	W. H. Pearson Co., W. Falmouth	May

Guaranties and Results of Analysis of Fertilizer Samples, 1916—Continued.

Station number.	Nitrogen. % As nitrate.	% As ammonia.	Organic. % As water soluble.	% As active insoluble.*	% As inactive insoluble.	Total. % Found.	% Guaranteed.	Phosphoric Acid. % Soluble.	% Insoluble.	Available. % Found.	% Guaranteed.	Total. % Found.	% Guaranteed.	Potash % Found.	% Guaranteed.	Remarks.
3913	–	–	–	–	–	–	–	10.02	1.05	16.05	16.0	17.10	17.0	–	–	
3706	0.79	0.63	0.25	0.45	0.26	2.64	2.47	4.75	1.88	9.13	9.0	11.01	10.0	1.12	1.0	
3784	0.72	0.64	0.22	0.46	0.27	2.31	2.47	4.43	1.71	8.72	9.0	10.43	10.0	1.11	1.0	
4037	0.98	0.84	0.12	0.46	0.20	2.60	2.47	3.40	1.34	9.28	9.0	10.62	10.0	1.10	1.0	
4043	0.61	0.65	0.53	0.48	0.23	2.50	2.47	4.27	1.84	8.65	9.0	10.49	10.0	1.00	1.0	
4092	0.72	0.62	0.42	0.54	0.21	2.51	2.47	3.64	2.02	9.54	9.0	11.56	10.0	1.04	1.0	
3906	1.14	0.92	0.45	0.69	0.25	3.45	3.29	5.26	1.06	9.02	9.0	10.08	10.0	1.68	1.0	
3912	1.30	0.98	0.37	0.65	0.23	3.53	3.29	4.99	0.98	9.39	9.0	10.37	10.0	3.34	1.0	
3967	1.04	1.04	0.52	0.75	0.27	3.62	3.29	5.76	1.21	9.28	9.0	10.49	10.0	1.12	1.0	
4052	0.88	0.94	0.65	0.82	0.23	3.52	3.29	4.88	2.26	8.74	9.0	11.00	10.0	0.23	1.0	
4197	–	–	–	–	–	0.09	–	5.52	1.11	9.96	10.0	11.07	11.0	2.09	2.0	
4226	1.38	0.82	0.51	0.69	0.14	3.54	3.29	3.19	1.54	8.70	9.0	10.24	10.0	1.08	1.0	
4057	0.32	0.18	0.29	0.31	0.12	1.22	0.82	0.97	1.38	7.81	8.0	9.19	9.0	1.19	1.0	
4058	0.48	0.50	0.51	0.51	0.14	2.14	2.06	1.63	1.74	7.35	8.0	9.09	9.0	1.04	1.0	
4196	0.74	0.58	0.17	0.50	0.11	2.10	2.06	4.90	1.38	8.19	8.0	9.57	9.0	1.01	1.0	
4228	0.70	0.62	0.37	0.56	0.15	2.40	2.06	2.36	1.99	8.15	8.0	10.14	9.0	2.00	1.0	
3853	0.71	0.39	–	0.31	0.20	1.57	1.64	5.49	0.96	10.73	10.0	11.69	11.0	1.67	1.0	
3908	0.37	0.44	0.52	0.27	0.20	1.80	1.64	4.71	1.01	10.23	10.0	11.24	11.0	1.49	1.0	
3838	0.26	0.08	0.35	0.23	0.18	1.00	2.06	4.21	2.26	9.80	10.0	12.06	11.0	1.22	1.0	
3840	0.70	0.58	0.24	0.41	0.21	2.14	2.06	4.91	1.40	9.83	10.0	11.23	11.0	1.34	1.0	
3904	0.72	0.56	0.25	0.44	0.22	2.19	2.06	5.22	1.53	10.18	10.0	11.71	11.0	1.06	1.0	
3819	0.08	0.22	0.37	0.21	0.10	0.98	0.82	4.64	0.93	9.25	8.0	10.18	9.0	1.07	1.0	
3930	0.24	0.08	0.30	0.15	0.07	0.84	0.82	3.99	1.02	9.46	8.0	10.48	9.0	1.43	1.0	
4224	0.36	0.24	0.17	0.20	0.09	1.06	0.82	3.62	1.33	8.11	8.0	9.44	9.0	1.03	1.0	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained. From	Sample Obtained. Month.
4253	Quinnipiac Climax Phosphate, 1916	C. E. Taylor, Springvale	May
4221	Quinnipiac Corn Manure, 1916	R. P. Greely, Yarmouth	May
4251	Quinnipiac Market Garden Manure, 1916	C. E. Taylor, Springvale	May
4252	Quinnipiac Potato Phosphate, 1916	C. E. Taylor, Springvale	May
4135	Read's Farmers Friend Superphosphate, 1916	Coe-Mortimer Co., Belfast	May
4262	Read's Farmers Friend Superphosphate, 1916	George F. Cheney, Wells	June
4219	Read's Practical Fertilizer, 1916	R. P. Greely, Yarmouth	May
4263	Read's Practical Fertilizer, 1916	George F. Cheney, Wells	June
4220	Read's Vegetable and Vine Fertilizer, 1916	R. P. Greely, Yarmouth	May
4261	Read's Vegetable and Vine Fertilizer, 1916	George F. Cheney, Wells	June
4064	16% Plain Superphosphate	American Agricultural Chemical Co., Searsport	April
4225	Soluble Pacific Guano, 1916	A. F. Sawyer, North Yarmouth	May
4227	Soluble Pacific Guano, 1916	A. K. Dresser, West Pownal	May
4258	Soluble Pacific Guano, 1916	F. Raymond Clark, Eliot	June
4283	Soluble Pacific Guano, 1916	H. J. Wagg, Durham	June
3803	Standard Complete Manure, 1916	McLaughlin s Storehouse, Bangor	April
3703	Standard Fertilizer, 1916	Listers Agricultural Chemical Works, Portland	March
3830	Standard Fertilizer, 1916	McLaughlin's Storehouse, Bangor	April
4266	Standard Fertilizer, 1916	George C. Lord, Wells	June
4083	Standard Guano, 1916	Fairfield Grain Co., Fairfield	April
3707	Standard Special for Potatoes, 1916	Listers Agricultural Chemical Works, Portland	March
3831	Standard Special for Potatoes, 1916	McLaughlin's Storehouse, Bangor	April
3800	Top Dresser, 1916	McLaughlin's Storehouse, Bangor	April
3905	Top Dresser, 1916	Jackson & Hall, Belfast	April

Guaranties and Results of Analysis of Fertilizer Samples, *1916*—Continued.

Station number.	Nitrogen. Organic. % As nitrate.	% As ammonia.	% As water soluble.	% As active insoluble.	% As inactive insoluble.	Nitrogen. Total. % Found.	% Guaranteed.	Phosphoric Acid. % Soluble.	% Insoluble.	Available. % Found.	% Guaranteed.	Total. % Found.	% Guaranteed.	Potash % Found.	% Guaranteed.	Remarks.
				*												
4253	0.36	0.32	0.27	0.27	0.05	1.27	0.82	2.74	1.31	7.70	8.0	9.01	9.0	2.25	1.0	
4221	0.58	0.46	0.17	0.46	0.18	1.85	1.65	2.55	1.81	9.69	10.0	11.50	11.0	1.07	1.0	
4251	1.04	0.98	0.47	0.75	0.23	3.47	3.29	3.46	3.20	8.06	9.0	11.26	10.0	1.14	1.0	
4252	0.74	0.64	0.46	0.55	0.12	2.51	2.06	2.58	1.81	7.73	8.0	9.54	9.0	1.15	1.0	
4135	0.70	0.60	0.40	0.47	0.16	2.33	2.06	3.38	1.03	8.48	8.0	9.51	9.0	1.15	1.0	
4262	0.64	0.56	0.21	0.43	0.46	2.30	2.06	3.73	1.51	7.84	8.0	9.35	9.0	0.98	1.0	
4219	0.24	0.24	0.20	0.26	0.07	1.01	0.82	1.67	1.43	7.90	8.0	9.33	9.0	1.01	1.0	
4263	0.12	0.26	0.49	0.27	–	1.14	0.82	3.01	1.39	8.82	8.0	10.21	9.0	1.01	1.0	
4220	0.78	0.80	0.33	0.55	0.22	2.68	2.47	4.31	1.19	9.48	9.0	10.67	0.0	1.03	1.0	
4261	0.78	0.70	0.50	0.57	0.12	2.67	2.47	3.76	1.45	8.77	9.0	10.22	10.0	1.03	1.0	
4064	–	–	–	–	–	–	–	8.74	1.30	15.58	16.0	16.88	17.0	–	–	
4225	0.44	0.28	0.57	0.43	0.11	1.83	1.65	5.36	1.24	9.89	10.0	11.13	11.0	1.22	1.0	
4227	0.46	0.28	0.63	0.41	0.15	1.93	1.65	5.41	1.28	9.98	10.0	11.26	11.0	1.22	1.0	
4258	0.48	0.52	0.36	0.43	0.05	1.84	1.65	3.35	1.84	9.77	10.0	11.61	11.0	2.34	1.0	
4283	0.60	0.44	0.21	0.33	0.17	1.75	1.65	5.45	1.61	10.70	10.0	12.31	11.0	1.00	1.0	
3803	1.08	1.00	0.40	0.68	0.26	3.42	3.29	4.37	1.24	8.49	9.0	9.73	10.0	1.12	1.0	Goods withdrawn from sale in Maine. Registration not required.
3703	0.58	0.43	0.30	0.27	0.15	1.73	1.65	5.41	1.70	10.20	10.0	11.90	11.0	1.20	1.0	Moisture 11.26 per cent.
3830	0.41	0.39	0.32	0.36	0.19	1.67	1.65	5.04	1.06	10.15	10.0	11.21	11.0	1.09	1.0	
4266	0.58	0.50	0.20	0.47	0.16	1.91	1.65	6.09	1.42	10.11	10.0	11.53	11.0	1.14	1.0	
4083	0.28	0.22	0.18	0.22	0.12	1.02	0.82	2.81	1.05	7.72	8.0	8.77	9.0	1.03	1.0	
3707	0.36	0.81	0.43	0.36	0.17	2.13	2.06	5.52	1.12	7.80	8.0	8.92	9.0	1.24	1.0	
3831	0.62	0.58	0.33	0.45	0.21	2.19	2.06	4.12	1.17	8.46	8.0	9.63	9.0	1.05	1.0	
3800	1.42	1.19	0.10	0.94	0.43	4.08	4.11	4.27	2.09	8.48	8.0	10.57	9.0	0.83	1.0	
3905	1.29	1.09	0.53	0.70	0.39	4.00	4.11	4.40	0.70	8.93	8.0	9.63	9.0	1.04	1.0	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained. From	Sample Obtained. Month.
3704	Williams & Clark Americus Corn Phosphate, 1916	Listers Agricultural Chemical Works, Portland	March
4042	Williams & Clark Americus Corn Phosphate, 1916	Millard F. Norcross, Winthrop	April
3709	Williams & Clark Americus High Grade Special for Potatoes & Root Crops, 1916	Listers Agricultural Chemical Works, Portland	March
3705	Williams & Clark Americus Potato Manure, 1916	Listers Agricultural Chemical Works, Portland	March
4041	Williams & Clark Americus Potato Manure, 1916	Millard F. Norcross, Winthrop	April
3708	Williams & Clark Royal Bone Phosphate, 1916	Listers Agricultural Chemical Works, Portland	March
	ARMOUR FERTILIZER WORKS, CHROME, N. J.		
4110	Armour's Bone Meal Fertilizer	Galt Block Storehouse, Portland	May
4068	Armour's 5-8-2 Fertilizer	Armour Fertilizer Works, Bucksport	April
4173	Armour's 5-8-2 Fertilizer	C. A. Powers, Maplegrove	May
4069	Armour's 5-8-3 Fertilizer	Armour Fertilizer Works, Bucksport	April
4149	Armour's 5-8-3 Fertilizer	Laffaty Real Estate Co., Caribou	May
4159	Armour's 5-8-4 Fertilizer	Peter Casey, Mapleton	May
4172	Armour's 5-8-4 Fertilizer	Clarence A. Powers, Maplegrove	May
3956	Armour's 5-10-0 Fertilizer	Harry Burleigh Storehouse, Houlton	April
4067	Armour's 5-10-0 Fertilizer	Armour Fertilizer Works, Bucksport	April
4102	Armour's 5-10-0 Fertilizer	Galt Block Storehouse, Portland	May
4070	Armour's 4-8-0 Fertilizer	Armour Fertilizer Works, Bucksport	April
4111	Armour's 4-8-0 Fertilizer	Galt Block Storehouse, Portland	May
4208	Armour's 4-8-0 Fertilizer	N. Beauregard & Co., Lewiston	May
4257	Armour's 4-8-0 Fertilizer	G. W. Larrabee, Kennebunk	June
4065	Armour's 4-8-2 Fertilizer	Armour Fertilizer Works, Bucksport	April

Guaranties and Results of Analysis of Fertilizer Samples, 1916—Continued.

Station number.	Nitrogen. % As nitrate.	% As ammonia.	Organic. % As water soluble.	% As active insoluble.	% As inactive insoluble.	Total. % Found.	% Guaranteed.	Phosphoric Acid. % Soluble.	% Insoluble.	Available. % Found.	% Guaranteed.	Total. % Found.	% Guaranteed.	Potash % Found.	% Guaranteed.	Remarks.
3704	0.59	0.56	0.34	*0.26	0.17	1.92	1.65	6.20	1.11	10.42	10.0	11.53	11.0	1.22	1.0	
4042	0.40	0.46	0.22	0.23	0.08	1.39	1.65	5.63	0.89	9.89	10.0	10.78	11.0	1.03	1.0	
3709	0.88	1.08	0.43	0.60	0.32	3.31	3.29	5.76	1.20	9.26	9.0	10.46	10.0	1.35	1.0	
3705	0.63	0.99	0.43	0.46	0.17	2.68	2.06	6.12	1.12	8.80	8.0	9.92	9.0	1.28	1.0	
4041	0.44	0.82	0.23	0.41	0.19	2.09	2.06	4.94	0.76	8.11	8.0	8.87	9.0	1.03	1.0	
3708	0.50	0.29	0.26	0.28	0.21	1.54	1.23	5.50	1.75	10.18	10.0	11.93	11.0	1.16	1.0	Moisture 11.2 per cent.
4110	–	–	–	–	–	2.22	2.47	–	–	–	–	24.34	22.0	–	–	
4068	0.96	0.50	1.03	0.95	0.66	4.10	4.11	5.58	0.82	8.08	8.0	8.90	8.5	2.15	2.0	
4173	0.50	1.28	1.25	0.92	0.15	4.10	4.11	6.49	1.02	8.18	8.0	9.20	8.5	2.14	2.0	
4069	1.76	0.62	0.23	0.76	0.57	3.94	4.11	6.19	0.89	8.26	8.0	9.15	8.5	3.19	3.0	
4149	0.46	0.72	1.26	1.10	0.34	3.88	4.11	6.32	0.66	8.48	8.0	9.14	8.5	3.13	3.0	
4159	1.63	0.04	0.48	1.28	0.44	3.87	4.11	6.35	0.83	7.81	8.0	8.64	8.5	4.00	4.0	Moisture 11.16 per cent.
4172	0.12	2.12	0.32	0.78	0.26	3.60	4.11	5.95	1.28	7.73	8.0	9.01	8.5	6.60	4.0	
3956	1.06	0.99	0.86	0.94	0.43	4.28	4.11	8.33	0.37	10.28	10.0	10.65	10.5	–	–	
4067	1.02	0.92	0.70	0.70	0.65	3.99	4.11	8.23	0.64	9.84	10.0	10.48	10.50	–	–	
4102	1.50	1.06	0.14	0.84	0.51	4.05	4.11	8.69	0.64	9.95	10.0	10.59	10.5	–	–	
4070	1.24	0.64	0.41	0.72	0.41	3.42	3.29	6.43	0.51	8.25	8.0	8.76	8.5	–	–	
4111	0.88	0.60	0.53	0.69	0.38	3.08	3.29	7.56	0.68	9.40	8.0	10.08	8.5	–	–	
4208	1.08	0.80	0.43	0.69	0.40	3.40	3.29	7.38	0.07	8.81	8.0	9.28	8.5	–	–	
4257	0.96	0.80	0.45	0.77	0.34	3.32	3.29	7.19	0.59	8.93	8.0	9.52	8.5	–	–	
4065	1.24	0.84	0.24	0.62	0.46	3.40	3.29	6.46	0.82	8.70	8.0	9.52	8.5	2.08	2.0	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained. From	Sample Obtained. Month.
4106	Armour's 4-8-2 Fertilizer	Laffaty Real Estate Co., Caribou	May
4112	Armour's 4-8-2 Fertilizer	Galt Block Storehouse, Portland	May
4095	Armour's Star Phosphate	Galt Block Storehouse, Portland	May
4256	Armour's 3-8-3 Fertilizer	G. W. Larrabee, Kennebunk	June
4098	Armour's 2-8-1 Fertilizer	Galt Block Storehouse, Portland	May
4148	Armour's 2-8-2 Fertilizer	Laffaty Real Estate Co., Caribou	May
4209	Armour's 2-8-2 Fertilizer	N. Beauregard & Co., Lewiston	May
4249	Armour's 2-8-2 Fertilizer	A. A. Wilson, Springvale	May
4100	Armour's 2-11 Fertilizer	Galt Block Storehouse, Portland	May
4207	Armour's 2-11 Fertilizer	N. Beauregard & Co., Lewiston	May
4250	Armour's 2-11 Fertilizer	A. A. Wilson, Springvale	May
4094	Ground Tankage	Galt Block Storehouse, Portland	May
4096	Nitrate of Soda	Galt Block Storehouse, Portland	May
	BAUGH & SONS CO., BALTIMORE, MD.		
4020	Baugh's Aroostook 5-10-0	Henry Hall, Houlton	April
4019	Baugh's Aroostook 4-8-0	B. F. Ingham, Houlton	April
4151	Baugh's Aroostook 4-10-0	H. B. Kelley Co., Caribou	May
	BOWKER FERTILIZER CO., BOSTON, MASS. & NEW YORK CITY, N. Y.		
3737	Bowker's All Round Fertilizer, 1916	Kendall & Whitney, Portland	March
3817	Bowker's All Round Fertilizer, 1916	McLaughlin's Storehouse, Bangor	April
3891	Bowker's All Round Fertilizer, 1916	Jackson & Hall, Belfast	April
4007	Bowker's All Round Fertilizer, 1916	Allen Hathaway, Winn	April
4004	Bowker's Ammoniated Food for Flowers	Buckley's Drug Store, Bangor	April
4107	Bowker's Ammoniated Food for Flowers	Haskell Implement & Seed Co., Lewiston	May

Guaranties and Results of Analysis of Fertilizer Samples, 1916—Continued.

Station number.	Nitrogen.							Phosphoric Acid.						Potash		Remarks.
	% As nitrate.	% As ammonia.	Organic. % As water soluble.	Organic. % As active insoluble.	Organic. % As inactive insoluble.	Total. % Found.	Total. % Guaranteed.	% Soluble.	% Insoluble.	% Found.	Available. % Guaranteed.	Total. % Found.	% Guaranteed.	% Found.	% Guaranteed.	
4106	1.54	0.84	–	* 0.64	0.33	3.34	3.29	6.57	0.87	8.65	8.0	9.52	8.5	2.19	2.0	
4112	1.20	0.20	0.40	1.13	0.42	3.35	3.29	6.06	0.89	8.54	8.0	9.43	8.5	2.12	2.0	
4095	–	–	–	–	–	–	–	10.94	0.51	13.12	14.0	13.63	14.5	–	–	
4256	0.30	1.24	0.11	0.51	0.18	2.34	2.47	5.73	0.64	7.25	8.0	7.89	8.5	2.77	3.0	1915 goods.
4098	0.63	0.14	0.21	0.31	0.32	1.61	1.65	6.03	0.93	8.27	8.0	9.20	8.5	1.08	1.0	
4148	0.88	0.22	–	0.44	0.21	1.75	1.65	6.25	0.59	8.37	8.0	8.96	8.5	1.98	2.0	
4209	0.46	0.14	0.46	0.55	0.14	1.75	1.65	6.71	0.70	8.44	8.0	9.14	8.5	2.02	2.0	
4249	0.02	0.24	0.90	0.55	0.32	2.03	1.65	6.75	0.66	8.93	8.0	9.59	8.5	2.04	2.0	
4100	0.34	0.26	0.28	0.40	0.37	1.65	1.65	9.09	0.77	11.00	11.0	11.77	11.5	–	–	
4207	0.18	0.12	0.59	0.50	0.25	1.64	1.65	9.15	0.79	11.22	11.0	12.01	11.5	–	–	
4250	0.52	0.08	0.33	0.50	0.32	1.75	1.65	9.38	0.84	11.03	11.0	11.87	11.5	–	–	
4094	–	0.20	3.55	1.74	0.88	6.37	6.58	–	–	–	–	9.78	9.2	–	–	
4096	–	–	–	–	–	14.37	14.81	–	–	–	–	–	–	–	–	
4020	0.04	1.92	0.70	0.71	0.43	3.80	4.12	8.07	1.79	10.30	10.0	12.09	11.0	–	–	
4019	–	2.15	0.43	0.56	0.34	3.14	3.30	5.61	1.76	7.89	8.0	9.65	9.0	–	–	
4151	0.06	2.22	0.50	0.36	0.20	3.34	3.30	8.29	0.78	10.08	10.0	10.86	11.0	–	–	
3737	0.66	0.65	0.39	0.34	0.25	2.29	2.06	4.93	1.71	10.00	10.0	11.71	11.0	1.21	1.0	
3817	1.00	0.63	0.08	0.41	0.27	2.39	2.06	4.59	1.47	9.65	10.0	11.12	11.0	1.03	1.0	
3891	0.66	0.52	0.28	0.38	0.22	2.06	2.06	4.66	1.21	10.19	10.0	11.40	11.0	1.32	1.0	
4007	0.72	0.64	0.28	0.40	0.18	2.22	2.06	6.17	0.93	10.27	10.0	11.20	11.0	1.37	1.0	
4004	2.30	–	0.42	0.04	0.04	2.80	2.47	0.54	1.93	8.15	6.0	10.08	7.0	3.25	2.0	
4107	1.66	–	0.39	0.05	0.02	2.12	2.47	0.41	0.94	7.43	6.0	8.37	7.0	3.24	2.0	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained.	
		From	Month.
3979	Bowker's Blood, Bone & Potash, 1916	S. A. Crockett, Houlton	April
4157	Bowker's Blood, Bone & Potash, 1916	E. W. Fernald, Presque Isle	May
3738	Bowker's Brighton Phosphate	Kendall & Whitney, Portland	March
3818	Bowker's Brighton Phosphate	McLaughlin's Storehouse, Bangor	April
3899	Bowker's Brighton Phosphate	Jackson & Hall, Belfast	April
3739	Bowker's Corn Phosphate, 1916	Kendall & Whitney, Portland	March
3841	Bowker's Corn Phosphate, 1916	McLaughlin's Storehouse, Bangor	April
3890	Bowker's Corn Phosphate, 1916	Jackson & Hall, Belfast	April
4047	Bowker's Corn Phosphate, 1916	Coe-Mortimer Co., Belfast	April
3724	Bowker's Farm & Garden Phosphate, 1916	Kendall & Whitney, Portland	March
3842	Bowker's Farm & Garden Phosphate, 1916	McLaughlin's Storehouse, Bangor	April
3897	Bowker's Farm & Garden Phosphate, 1916	Jackson & Hall, Belfast	April
3733	Bowker's Fresh Ground Bone	Kendall & Whitney, Portland	March
3722	Bowker's Hill & Drill Phosphate, 1916	Kendall & Whitney, Portland	March
3822	Bowker's Hill & Drill Phosphate, 1916	McLaughlin's Storehouse, Bangor	April
3894	Bowker's Hill & Drill Phosphate, 1916	Jackson & Hall, Belfast	April
3744	Bowker's Potato & Vegetable Fertilizer Revised	Saco Grain & Milling Co., Saco	March
3725	Bowker's Potato Phosphate, 1916	Kendall & Whitney, Portland	March
3832	Bowker's Potato Phosphate, 1916	McLaughlin's Storehouse, Bangor	April
3892	Bowker's Potato Phosphate, 1916	Jackson & Hall, Belfast	April
3728	Bowker's Soluble Phosphate	Kendall & Whitney, Portland	March
4246	Bowker's Soluble Phosphate	Kendall & Whitney, Portland	May
3834	Bowker's Superphosphate with Ammonia 1%	McLaughlin's Storehouse, Bangor	April
3896	Bowker's Superphosphate with Ammonia 1%	Jackson & Hall, Belfast	April

Guaranties and Results of Analysis of Fertilizer Samples, 1916 —Continued.

Station number.	Nitrogen. % As nitrate.	% As ammonia.	Organic. % As water soluble.	% As active insoluble.	% As inactive insoluble.	Total. % Found.	% Guaranteed.	Phosphoric Acid. % Soluble.	% Insoluble.	Available. % Found.	% Guaranteed.	Total. % Found.	% Guaranteed.	Potash % Found.	% Guaranteed.	Remarks.
3979	1.62	1.16	0.28	* 0.78	0.40	4.24	4.11	5.01	0.74	8.54	8.0	9.28	9.0	1.12	1.0	
4157	1.42	1.28	0.40	0.77	0.35	4.22	4.11	4.96	0.80	8.21	8.0	9.01	9.0	1.30	1.0	
3738	0.25	–	0.04	0.64	0.02	0.95	0.82	4.10	0.82	8.62	8.0	9.44	9.0	1.11	1.0	
3818	0.30	0.18	0.23	0.22	0.08	1.02	0.82	4.48	0.98	8.97	8.0	9.95	9.0	1.00	1.0	
3899	0.44	0.12	–	0.13	0.13	0.77	0.82	3.99	1.28	8.86	8.0	10.14	9.0	1.66	1.0	
3739	0.48	0.29	0.30	0.20	0.21	1.48	1.65	5.23	1.52	10.22	10.0	11.74	11.0	1.18	1.0	Moisture 11.19 per cent.
3841	0.42	0.50	0.29	0.34	0.20	1.75	1.65	5.18	1.28	10.24	10.0	11.52	11.0	1.16	1.0	
3890	0.66	0.54	0.26	0.41	0.23	2.10	1.65	4.98	1.28	10.46	10.0	11.74	11.0	1.02	1.0	
4047	0.48	0.40	0.27	0.44	0.18	1.77	1.65	2.34	1.91	9.45	10.0	11.36	11.0	1.10	1.0	
3724	0.31	0.52	1.05	0.42	0.22	2.52	1.65	5.84	1.22	9.98	10.0	11.20	11.0	1.06	1.0	
3842	0.51	0.43	0.26	0.34	0.16	1.70	1.65	5.20	1.28	10.01	10.0	11.29	11.0	1.16	1.0	
3897	–	1.10	0.02	0.31	0.18	1.61	1.65	5.30	1.03	10.44	10.0	11.47	11.0	1.85	1.0	
3733	–	–	–	–	–	2.56	2.47	–	–	–	–	23.02	22.9	–	–	
3722	0.90	0.59	0.51	0.59	0.25	2.84	2.49	4.45	1.89	9.07	9.0	10.96	10.0	1.03	1.0	
3822	0.96	0.62	–	0.54	0.23	2.34	2.49	4.35	1.39	8.99	9.0	10.38	10.0	1.05	1.0	
3894	0.57	0.70	0.73	0.53	0.21	2.74	2.49	4.43	1.56	9.14	9.0	10.70	10.0	1.37	1.0	
3744	0.88	1.01	0.31	0.62	0.27	3.09	2.88	5.23	1.19	8.57	8.0	9.76	9.0	4.17	4.0	1915 goods.
3725	0.50	0.38	0.36	0.35	0.11	1.70	1.65	5.63	1.58	10.69	10.0	12.27	11.0	1.16	1.0	Moisture 11.28 per cent.
3832	0.01	0.31	0.70	0.29	0.15	1.46	1.65	4.94	1.06	10.17	10.0	11.23	11.0	1.24	1.0	
3892	0.46	0.44	0.38	0.28	0.27	1.83	1.65	5.58	1.16	10.24	10.0	11.40	11.0	1.47	1.0	
3728	–	–	–	–	–	–	–	9.62	1.07	14.15	14.0	15.22	15.0	–	–	
4246	–	–	–	–	–	–	–	6.99	1.42	13.73	14.0	15.15	15.0	–	–	
3834	0.34	0.08	0.17	0.19	0.11	0.89	0.82	4.51	1.45	9.89	10.0	11.34	11.0	–	–	
3896	0.30	0.06	0.29	0.19	0.18	1.02	0.82	4.78	1.82	10.11	10.0	11.93	11.0	–	–	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained. From	Sample Obtained. Month.
3732	Bowker's Superphosphate with Ammonia 2%	Kendall & Whitney, Portland	March
3836	Bowker's Superphosphate with Ammonia 2%	McLaughlin's Storehouse, Bangor	April
3900	Bowker's Superphosphate with Ammonia 2%	Jackson & Hall, Belfast	April
3736	Bowker's Superphosphate with Ammonia 3%	Kendall & Whitney, Portland	March
3898	Bowker's Superphosphate with Ammonia 3%	Jackson & Hall, Belfast	April
3740	Bowker's Sure Crop Phosphate, 1916	Kendall & Whitney, Portland	March
3833	Bowker's Sure Crop Phosphate, 1916	McLaughlin's Storehouse, Bangor	April
3902	Bowker's Sure Crop Phosphate, 1916	Jackson & Hall, Belfast	April
3980	Bowker's Sure Crop Phosphate, 1916	S. A. Crockett, Houlton	April
3727	Stockbridge Cereal Manure without Potash, 1916	Kendall & Whitney, Portland	March
3893	Stockbridge Cereal Manure without Potash, 1916	Jackson & Hall, Belfast	April
3977	Stockbridge Cereal Manure without Potash, 1916	S. A. Crockett, Houlton	April
4008	Stockbridge Cereal Manure without Potash, 1916	Harry Lewis, Springfield	April
3735	Stockbridge Early Crop Manure, 1916	Kendall & Whitney, Portland	March
3802	Stockbridge Early Crop Manure, 1916	McLaughlin's Storehouse, Bangor	April
3901	Stockbridge Early Crop Manure, 1916	Jackson & Hall, Belfast	April
3721	Stockbridge General Crop Manure, 1916	Kendall & Whitney, Portland	March
3801	Stockbridge General Crop Manure, 1916	McLaughlin's Storehouse, Bangor	April
3895	Stockbridge General Crop Manure, 1916	Jackson & Hall, Belfast	April
3976	Stockbridge General Crop Manure, 1916	S. A. Crockett, Houlton	April
3731	Stockbridge Potato Manure "A" without Potash, 1916	Kendall & Whitney, Portland	March
3849	Stockbridge Potato Manure "A" without Potash, 1916	McLaughlin s Storehouse, Bangor	April
3975	Stockbridge Potato Manure "A" without Potash, 1916	S. A. Crockett, Houlton	April
3990	Stockbridge Potato Manure "A" without Potash, 1916	T. A. St. Johns, Fort Kent	April

Guaranties and Results of Analysis of Fertilizer Samples, 1916 Continued.

Station number.	Nitrogen. % As nitrate.	Nitrogen. % As ammonia.	Nitrogen. Organic. % As water soluble.	Nitrogen. Organic. % As active insoluble.	Nitrogen. Organic. % As inactive insoluble.	Nitrogen. Total. % Found.	Nitrogen. Total. % Guaranteed.	Phosphoric Acid. % Soluble.	Phosphoric Acid. % Insoluble.	Phosphoric Acid. Available. % Found.	Phosphoric Acid. Available. % Guaranteed.	Phosphoric Acid. Total. % Found.	Phosphoric Acid. Total. % Guaranteed.	Potash % Found.	Potash % Guaranteed.	Remarks.
3732	0.54	0.56	0.24	*0.39	0.20	1.93	1.65	5.65	1.07	9.78	10.0	10.85	11.0	–	–	
3836	0.58	0.30	0.17	0.40	0.19	1.66	1.65	2.63	2.35	9.04	10.0	11.39	11.0	–	–	
3900	0.73	0.22	0.10	0.41	0.21	1.67	1.65	3.49	3.02	8.69	10.0	11.71	11.0	–	–	
3736	0.84	0.74	0.44	0.43	0.16	2.61	2.49	6.30	1.17	10.63	10.0	11.80	11.0	–	–	
3898	0.84	0.66	0.51	0.59	0.26	2.86	2.49	4.27	2.28	10.10	10.0	12.38	11.0	–	–	
3740	0.29	0.27	0.29	0.13	0.08	1.06	0.82	5.79	1.49	11.01	10.0	12.50	11.0	1.50	1.0	
3833	0.30	0.12	0.19	0.20	0.12	0.93	0.82	4.51	1.96	10.08	10.0	12.04	11.0	1.14	1.0	Moisture 11.23 per cent.
3902	0.50	0.42	0.24	0.30	0.20	1.66	0.82	4.50	1.34	9.73	10.0	11.07	11.0	1.68	1.0	
3980	0.19	0.26	0.41	0.08	0.07	1.01	0.82	5.36	1.12	10.48	10.0	11.60	11.0	1.02	1.0	Moisture 11.25 per cent.
3727	1.10	1.04	0.65	0.51	0.25	3.55	3.29	6.76	1.44	10.36	10.0	11.80	11.0	–	–	
3893	1.22	0.80	0.44	0.75	0.31	3.52	3.29	4.90	1.67	10.02	10.0	11.69	11.0	–	–	
3977	0.70	1.10	1.09	0.70	0.20	3.79	3.29	5.26	1.29	10.10	10.0	11.39	11.0	–	–	
4008	1.00	0.82	0.51	0.49	0.45	3.27	3.29	4.66	1.89	9.31	10.0	11.20	11.0	–	–	
3735	1.15	1.60	0.52	0.73	0.35	4.35	4.11	4.51	1.17	8.37	8.0	9.54	9.0	1.18	1.0	
3802	1.10	1.34	0.40	0.86	0.36	4.07	4.11	4.34	1.89	8.48	8.0	10.37	9.0	1.09	1.0	
3901	1.03	1.38	0.51	0.80	0.29	4.01	4.11	3.83	1.17	8.02	8.0	9.19	9.0	1.31	1.0	
3721	1.17	0.92	0.77	0.78	0.16	3.80	3.29	5.47	1.22	9.59	9.0	10.81	10.0	1.25	1.0	
3801	0.61	0.96	0.88	0.64	0.35	3.44	3.29	5.10	1.25	8.60	9.0	10.85	10.0	1.14	1.0	
3895	1.00	0.84	0.54	0.69	0.24	3.31	3.29	4.02	1.05	8.93	9.0	9.98	10.0	1.22	1.0	
3976	0.76	0.92	0.95	0.69	0.22	3.54	3.29	5.49	1.05	9.67	9.0	10.72	10.0	1.05	1.0	
3731	1.13	1.64	0.44	0.59	0.14	3.94	4.11	5.66	0.89	8.47	8.0	9.36	9.0	–	–	
3849	1.40	1.10	0.41	0.91	0.32	4.14	4.11	2.44	1.61	8.09	8.0	9.70	9.0	–	–	
3975	1.70	1.36	0.09	0.68	0.39	4.42	4.11	5.41	1.58	9.30	8.0	10.88	9.0	–	–	
3990	0.94	1.44	0.95	0.56	0.19	4.08	4.11	4.86	1.48	8.66	8.0	10.14	9.0	–	–	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained. From	Sample Obtained. Month.
3726	Stockbridge Potato Manure "B" without Potash, 1916	Kendall & Whitney, Portland	March
3848	Stockbridge Potato Manure "B" without Potash, 1916	McLaughlin's Stor ehouse, Bangor	April
3978	Stockbridge Potato Manure "B" without Potash, 1916	S. A. Crockett, Houlton	April
4005	Stockbridge Potato Manure "B without Potash, 1916	John Swasey, Lincoln	April
	E. D. CHITTENDEN CO., BRIDGEPORT, CONN.		
4191	Chittenden's High Grade Potato Fertilizer without Potash	James Dorsey, Ft. Fairfield	May
	COE-MORTIMER CO., NEW YORK CITY, N. Y.		
3887	E. Frank Coe's Aroostook Potato Special	Coe-Mortimer Co., Belfast	April
4152	E. Frank Coe's Aroostook Potato Special	O. K. Story, Washburn	May
3846	E. Frank Coe's Columbian Corn & Potato Fertilizer, 1916	McLaughlin s Storehouse, Bangor	April
3888	E. Frank Coe's Columbian Corn & Potato Fertilizer, 1916	Coe-Mortimer Co., Belfast	April
4076	E. Frank Coe's Columbian Corn & Potato Fertilizer, 1916	A. E. Chase Co., Brooks	April
4073	E. Frank Coe's Columbian Corn & Potato Fertilizer Special	A. E. Chase Co., Brooks	April
3816	E. Frank Coe's Double Strength Potato Manure, 1916	McLaughlin s Storehouse, Bangor	April
3870	E. Frank Coe's Excelsior Potato Fertilizer, 1916	Peter Harmon, Thorndike	April
3974	E. Frank Coe's Excelsior Potato Fertilizer, 1916	McClusky Hardware Co., Houlton	April
3989	E. Frank Coe's Excelsior Potato Fertilizer, 1916	E. C. Cleveland, Ft. Kent	April
4078	E. Frank Coe's Excelsior Potato Fertilizer, 1916	A. E. Chase Co., Brooks	April
4072	E. Frank Coe's Excelsior Potato Fertilizer Special	A. E. Chase Co., Brooks	April
3813	E. Frank Coe's Gold Brand Excelsior Guano, 1916	McLaughlin's Storehouse, Bangor	April
3886	E. Frank Coe's Gold Brand Excelsior Guano, 1916	Coe-Mortimer Co., Belfast	April
3845	E. Frank Coe's High Grade Ammoniated Superphosphate	McLaughlin's Storehouse, Bangor	April

Guaranties and Results of Analysis of Fertilizer Samples, 1916—Continued.

Station number.	Nitrogen. % As nitrate.	Nitrogen. % As ammonia.	Nitrogen. Organic. % As water soluble.	Nitrogen. Organic. % As active insoluble.	Nitrogen. Organic. % As inactive insoluble.	Nitrogen. Total. % Found.	Nitrogen. Total. % Guaranteed.	Phosphoric Acid. % Soluble.	Phosphoric Acid. % Insoluble.	Phosphoric Acid. Available. % Found.	Phosphoric Acid. Available. % Guaranteed.	Phosphoric Acid. Total. % Found.	Phosphoric Acid. Total. % Guaranteed.	Potash % Found.	Potash % Guaranteed.	Remarks.
3726	1.40	1.26	0.56	* 0.63	0.19	4.04	4.11	6.73	1.12	10.30	10.0	11.42	11.0	–	–	
3848	1.43	1.39	0.46	0.58	0.17	4.03	4.11	7.81	1.81	11.14	10.0	12.95	11.0	–	–	
3978	1.29	1.39	1.12	0.51	–	4.25	4.11	6.89	1.28	10.68	10.0	11.96	11.0	–	–	
4005	0.76	1.42	1.30	0.47	0.19	4.14	4.11	6.67	1.38	9.99	10.0	11.37	11.0	–	–	
4191	0.10	2.38	0.26	1.21	0.15	4.10	4.10	9.90	1.44	11.38	10.0	12.82	11.0	–	–	
3887	0.69	1.75	0.58	0.80	0.50	4.32	4.11	4.72	1.22	8.83	8.0	10.05	9.0	–	–	
4152	0.82	1.00	1.70	0.72	0.25	4.49	4.11	4.82	1.66	8.55	8.0	10.21	9.0	–	–	
3846	0.38	0.36	0.25	0.32	0.09	1.40	1.23	5.36	1.10	9.79	10.0	10.89	11.0	1.30	1.0	Moisture 11.38 per cent.
3888	0.38	0.18	0.49	0.31	0.20	1.56	1.23	4.78	1.17	9.84	10.0	11.01	11.0	1.27	1.0	
4076	0.52	0.40	0.26	0.35	0.13	1.66	1.23	3.68	1.47	9.79	10.0	11.26	11.0	1.21	1.0	
4073	0.42	0.26	0.42	0.33	–	1.43	1.23	1.08	1.42	8.72	9.0	10.14	10.0	2.04	2.0	
3816	1.61	0.85	0.33	0.67	0.27	3.73	3.70	3.56	1.35	8.25	8.0	9.60	9.0	1.18	1.0	
3870	1.43	1.45	0.67	0.44	0.15	4.13	4.11	6.92	1.00	10.58	10.0	11.58	11.0	–	–	
3974	0.93	1.36	1.05	0.64	0.22	4.20	4.11	7.07	2.27	10.44	10.0	12.71	11.0	–	–	
3989	0.57	1.43	1.52	0.47	0.25	4.24	4.11	7.67	1.98	11.07	10.0	13.05	11.0	–	–	
4078	1.52	1.36	0.25	0.59	0.35	4.07	4.11	3.43	1.56	9.99	10.0	11.55	11.0	–	–	
4072	1.48	0.60	–	0.57	0.20	2.85	2.88	3.24	1.16	8.01	8.0	9.17	9.0	4.00	4.0	
3813	0.85	0.65	0.22	0.55	0.27	2.54	2.47	3.86	1.53	9.06	9.0	10.59	10.0	1.14	1.0	
3886	0.78	0.94	0.42	0.48	0.22	2.84	2.47	3.62	1.72	9.94	9.0	11.66	10.0	1.09	1.0	
3845	0.20	0.80	1.09	0.28	0.20	2.59	2.47	3.57	1.35	10.09	10.0	11.44	11.0	–	–	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained.	
		From	Month.
4075	E. Frank Coe's High Grade Ammoniated Superphosphate, 1916	A. E. Chase Co., Brooks	April
4126	E. Frank Coe's High Grade Ammoniated Superphosphate, 1916	S. L. Small, Dexter	May
4293	E. Frank Coe's High Grade Soluble Phosphate	John H. Woodard, Minot	June
3881	E. Frank Coe's Morco Top Dresser, 1916	Coe-Mortimer Co., Belfast	April
4179	E. Frank Coe's New Englander Special, 1916	State School for Boys, So. Portland	May
3882	E. Frank Coe's Original Ammoniated Dissolved Phosphate	Coe-Mortimer Co., Belfast	April
3885	E. Frank Coe's Prolific Crop Producer, 1916	Coe-Mortimer Co., Belfast	April
3973	E. Frank Coe's Prolific Crop Producer, 1916	McCluskey Hardware Co., Houlton	April
3985	E. Frank Coe's Prolific Crop Producer, 1916	McIver & Watson, Van Buren	April
4125	E. Frank Coe's Prolific Crop Producer, 1916	S. L. Small, Dexter	May
4051	E. Frank Coe's Red Brand Excelsior Guano, 1916	Coe-Mortimer Co., Belfast	April
4180	E. Frank Coe's Red Brand Excelsior Guano, 1916	State School for Boys, So. Portland	May
4132	E. Frank Coe's Reliable Crop Grower, 1916	Coe-Mortimer Co., Belfast	May
4181	E. Frank Coe's Reliable Crop Grower, 1916	Edward S. Brown, South Portland	May
4182	E. Frank Coe's Reliable Crop Grower, 1916	Gilbert P. Jordan, South Portland	May
4276	E. Frank Coe's Reliable Crop Grower, 1916	Lee Davis, Webster	May
3815	E. Frank Coe's Standard Potato Fertilizer, 1916	McLaughlin's Storehouse, Bangor	April
4077	E. Frank Coe's Standard Potato Fertilizer, 1916	A. E. Chase Co., Brooks	April
4074	E. Frank Coe's Standard Potato Fertilizer Special	A. E. Chase Co., Brooks	April
4278	E. Frank Coe's Universal Fertilizer, 1916	Charles H. Woodard, Minot	May
3883	4-10	Coe-Mortimer Co., Belfast	April
	CONSUMERS CHEMICAL CORPORATION, NEW YORK CITY, N. Y.		
4174	Consumers Pure Sure Potato Manure with 2% Potash	Hopkins Bros., Ft. Fairfield	May

Guaranties and Results of Analysis of Fertilizer Samples, 1916—Continued.

Station number.	Nitrogen: % As nitrate.	Nitrogen: % As ammonia.	Nitrogen: Organic: % As water soluble.	Nitrogen: Organic: % As active insoluble.*	Nitrogen: Organic: % As inactive insoluble.	Nitrogen: Total: % Found.	Nitrogen: Total: % Guaranteed.	Phosphoric Acid: % Soluble.	Phosphoric Acid: % Insoluble.	Phosphoric Acid: Available: % Found.	Phosphoric Acid: Available: % Guaranteed.	Phosphoric Acid: Total: % Found.	Phosphoric Acid: Total: % Guaranteed.	Potash: % Found.	Potash: % Guaranteed.	Remarks.
4075	0.82	0.82	0.41	0.42	0.17	2.64	2.47	3.37	1.48	10.23	10.0	11.71	11.0	–	–	
4126	0.74	0.60	0.58	0.39	0.13	2.44	2.47	5.41	1.29	9.97	10.0	11.26	11.0	–	–	
4293	–	–	–	–	–	–	–	2.55	1.74	14.00	14.0	15.74	15.0	–	–	
3881	1.88	1.38	3.99	0.67	0.35	8.27	8.23	2.58	0.94	5.71	5.0	6.65	6.0	1.30	1.0	
4179	0.56	0.28	0.09	0.24	0.05	1.23	0.82	1.13	1.17	7.52	8.0	8.69	9.0	1.16	1.0	
3882	0.56	0.36	0.38	0.42	0.26	1.98	1.65	3.14	1.86	10.10	10.0	11.96	11.0	–	–	
3885	1.00	1.16	0.68	0.35	0.19	3.38	3.29	7.56	1.81	11.35	10.0	13.16	11.0	–	–	
3973	1.10	0.52	0.81	0.69	0.34	3.46	3.29	7.07	1.22	10.39	10.0	11.61	11.0	–	–	Moisture 11.59 per cent.
3985	0.90	1.06	0.85	0.39	0.15	3.35	3.29	7.54	1.86	11.16	10.0	13.02	11.0	–	–	
4125	0.86	0.72	0.44	0.40	0.15	2.57	3.29	5.84	1.22	9.98	10.0	11.20	11.0	–	–	
4051	1.32	1.14	0.53	0.87	0.25	4.11	4.11	5.26	2.14	8.93	8.0	11.07	9.0	0.21	1.0	
4180	1.92	0.84	0.45	0.67	0.22	4.10	4.11	3.97	1.70	7.61	8.0	9.31	9.0	1.02	1.0	
4132	0.74	0.66	0.49	0.58	0.20	2.67	2.06	1.32	2.40	7.47	8.0	9.87	9.0	0.71	1.0	
4181	0.70	0.56	0.22	0.35	0.32	2.15	2.06	1.55	1.31	7.86	8.0	9.17	9.0	3.05	1.0	
4182	0.74	0.52	0.21	0.55	0.20	2.22	2.06	1.72	1.03	8.11	8.0	9.14	9.0	1.36	1.0	Moisture 15.32 per cent.
4276	0.68	0.60	0.26	0.32	0.24	2.10	2.06	1.93	1.54	8.08	8.0	9.62	9.0	1.00	1.0	
3815	1.27	0.88	0.58	0.43	0.25	3.41	3.29	2.01	1.20	8.98	9.0	10.18	10.0	1.20	1.0	
4077	0.94	1.12	0.48	0.56	0.21	3.31	3.29	4.05	1.25	9.50	9.0	10.75	10.0	0.91	1.0	
4074	1.06	0.94	0.38	0.65	0.25	3.28	3.29	4.55	1.16	8.17	8.0	9.33	9.0	4.06	4.0	
4278	0.40	0.40	0.32	0.33	0.10	1.55	1.65	2.07	1.07	8.24	9.0	9.31	10.0	1.00	1.0	
3883	1.12	1.00	0.40	0.57	0.29	3.38	3.29	6.20	1.31	10.68	10.0	11.99	11.0	–	–	Used in manufacture of 4–10 goods.
4174	1.42	0.12	0.74	0.88	0.97	4.13	4.12	2.09	1.15	8.55	8.0	9.70	9.0	2.49	2.0	Moisture 11.4 per cent.

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained. From	Sample Obtained. Month.
	DARLING & CO., UNION STOCK YARDS, ILL.		
4215	Darling's Fine Ground Bone	Haskell Implement & Seed Co., Lewiston	May
4099	Darling's Pulverized Sheep Manure	Galt Block Storehouse, Portland	May
4213	Darling's Pulverized Sheep Manure	Haskell Implement & Seed Co., Lewiston	May
	DOMINION FERTILIZER CO., LTD., ST. STEPHEN, N. B., CAN.		
4146	Dominion Complete Potato Manure 4–9–1	H. B. Kelley Co., Caribou	May
3940	Dominion General Crop 4–10–0	Jackson & Hall, Belfast	April
4144	Dominion General Crop 4–10–0	H. B. Kelley Co., Caribou	May
4145	Dominion King Brand (5–10)	H. B. Kelley Co., Caribou	May
4150	Dominion Potato Special 5–8	Len. Hobbs, Caribou	May
3939	Dominion Vegetable, Corn & Grain Manure 2–9–1	Jackson & Hall, Belfast	April
	ESSEX FERTILIZER CO., BOSTON, MASS.		
4178	Essex Corn & Vegetable 5–10	E. E. Additon, Leeds	May
4033	Essex Grain, Grass and Potato Fertilizer 1–12	D. H. Maxim, Winthrop	April
3953	Essex High Grade Special 4½–9–1	Harry Burleigh Storehouse, Houlton	April
4193	Essex Manure for Potatoes, Roots & Vegetables 4–10–1	J. B. Williams, Ft. Fairfield	May
4214	Essex Market Garden & Potato Manure 3½–10	Judson Bangs, Sabattus	May
4222	Essex Market Garden & Potato Manure 3½–10	R. P. Greely, Yarmouth	May
3955	Essex Peerless Potato Manure 5–8–4	Harry Burleigh Storehouse, Houlton	April
3952	Essex Potato Grower 5–10	Harry Burleigh Storehouse, Houlton	April
3957	Essex Potato Phosphate for Potatoes and Roots 4–10	Harry Burleigh Storehouse, Houlton	April
4011	Essex Potato Phosphate for Potatoes and Roots 4–10	B. E. Lee, Lee	April
4018	Essex Potato Phosphate for Potatoes and Roots 4–10	A. F. Martin, Mattawamkeag	April
4034	Essex Potato Phosphate for Potatoes and Roots 4–10	D. H. Maxim, Winthrop	April

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Guaranties and Results of Analysis of Fertilizer Samples, 1916—Continued.

	Nitrogen.							Phosphoric Acid.						Potash		
			Organic.			Total.				Available.		Total.				
Station number.	% As nitrate.	% As ammonia.	% As water soluble. *	% As active insoluble.	% As inactive insoluble.	% Found.	% Guaranteed.	% Soluble.	% Insoluble.	% Found.	% Guaranteed.	% Found.	% Guaranteed.	% Found.	% Guaranteed.	Remarks.
4215	–	–	–	–	–	2.01	1.85	–	–	–	–	28.04	28.0	–	–	
4099	0.11	0.22	0.83	0.54	1.37	3.07	2.06	–	–	–	–	3.03	1.0	2.00	1.0	Registered in 1916 as Darling's sheep manure.
4213	0.14	0.34	1.13	0.49	1.11	3.21	2.06	–	–	–	–	1.91	1.0	1.37	1.0	
4146	0.98	0.70	0.26	0.82	0.22	2.98	3.30	7.05	0.82	10.15	9.0	10.97	10.0	0.97	1.0	
3940	0.62	0.20	1.12	1.14	0.44	3.52	3.30	6.19	0.70	10.19	10.0	10.89	11.0	–	–	
4144	1.06	0.32	0.51	1.06	0.43	3.38	3.30	6.67	1.06	9.85	10.0	10.91	11.0	–	–	
4145	0.70	1.20	0.23	1.23	0.37	3.73	4.10	7.86	1.03	10.47	10.0	11.50	11.0	–	–	
4150	1.88	0.30	0.36	1.30	0.30	4.14	4.10	4.82	1.12	8.02	8.0	9.14	9.0	–	–	
3939	0.34	0.06	0.25	0.78	0.38	1.81	1.60	6.68	0.54	9.79	9.0	10.33	10.0	0.85	1.0	
4178	0.34	1.26	1.03	1.24	0.14	4.01	4.10	7.75	1.59	10.28	10.0	11.87	11.0	–	–	
4033	0.04	–	0.42	0.27	0.11	0.84	0.82	6.30	0.69	11.21	12.0	11.90	13.0	–	–	
3953	0.30	1.18	1.02	0.65	0.31	3.46	3.69	7.46	0.79	10.12	9.0	10.91	10.0	1.18	1.0	
4193	0.56	0.64	1.26	0.72	0.15	3.33	3.28	7.29	1.63	9.71	10.0	11.34	11.0	1.22	1.0	
4214	–	0.60	1.12	0.70	0.29	2.71	2.87	7.07	1.07	9.63	10.0	10.70	11.0	–	–	
4222	0.22	0.56	0.93	0.64	0.30	2.65	2.87	6.57	1.53	9.24	10.0	10.77	11.0	–	–	
3955	–	1.94	1.39	0.51	0.21	4.05	4.10	6.00	1.22	8.51	8.0	9.73	9.0	3.96	4.0	
3952	0.24	2.20	0.38	0.94	0.38	4.14	4.10	8.20	0.42	10.65	10.0	11.07	11.0	–	1.0	No potash guaranty on certificate. One per cent. guaranteed on package.
3957	0.22	0.86	1.34	0.73	0.28	3.43	3.28	7.50	1.10	10.16	10.0	11.26	11.0	–	–	
4011	0.58	0.78	0.82	0.74	0.22	3.19	3.28	7.00	2.11	9.37	10.0	11.48	11.0	–	–	
4018	0.36	0.72	1.22	0.71	0.23	3.24	3.28	7.13	1.59	9.26	10.0	10.85	11.0	–	–	
4034	0.58	0.80	0.91	0.76	0.20	3.25	3.28	7.32	1.24	9.46	10.0	10.70	11.0	–	–	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained. From	Sample Obtained. Month.
4035	Essex XXX Fish Fertilizer for all Crops 3-10	D. H. Maxim, Winthrop	April
4223	Essex XXX Fish Fertilizer for all Crops 3-10	R. P. Greely, Yarmouth	May
4254	Essex XXX Fish Fertilizer for all Crops 3-10	C. E. Taylor, Springvale	May
	J. D. GRANT & SONS, BANGOR, MAINE.		
4295	Bone Meal	J. D. Grant & Sons, Bangor	June
	HUBBARD FERTILIZER CO., BALTIMORE, MD.		
4060	Hubbard's Aroostook Gem Fertilizer	Hubbard Fertilizer Co., Searsport	April
4156	Hubbard's Aroostook Gem Fertilizer	E. W. Fernald, Presque Isle	May
4210	Hubbard's Aroostook Gem Fertilizer	Haskell Implement & Seed Co., Lewiston	May
4062	Hubbard's Excelsior Mixture	Hubbard Fertilizer Co., Searsport	April
4211	Hubbard's Excelsior Mixture	Haskell Implement & Seed Co., Lewiston	May
4212	Hubbard's Imperial Guano	Haskell Implement & Seed Co., Lewiston	May
3971	Hubbard's Potato Special	George Benz, Houlton	April
4061	Hubbard's Potato Special	Hubbard Fertilizer Co., Searsport	April
4059	Hubbard's Special Compound	Hubbard Fertilizer Co., Searsport	April
	INTERNATIONAL AGRICULTURAL CHEMICAL CORPORATION, BUFFALO FERTILIZER WORKS, HOULTON, MAINE.		
3944	Buffalo Five-Eight-Naught	Buffalo Fertilizer Works, Houlton	April
3946	Buffalo Five-Eight-One	Buffalo Fertilizer Works, Houlton	April
3686	Buffalo Five-Ten-Naught	A. B. Chase, Dover	March
3687	Buffalo Four-Ten-Naught	A. B. Chase, Dover	March
3941	Buffalo Four-Ten-Naught	Buffalo Fertilizer Works, Houlton	April
3942	Buffalo Five-Ten-Naught	Buffalo Fertilizer Works, Houlton	April

Guaranties and Results of Analysis of Fertilizer Samples, 1916—Continued.

Station number.	Nitrogen. % As nitrate.	% As ammonia.	Organic. % As water soluble.	% As active insoluble.	% As inactive insoluble.	Total. % Found.	% Guaranteed.	Phosphoric Acid. % Soluble.	% Insoluble.	Available. % Found.	% Guaranteed.	Total. % Found.	% Guaranteed.	Potash % Found.	% Guaranteed.	Remarks.
4035	0.29	0.40	0.93	*0.71	0.15	2.48	2.46	6.56	1.61	9.46	10.0	11.07	11.0	–	–	
4223	0.26	0.32	0.98	0.74	0.24	2.54	2.46	6.48	1.61	9.22	10.0	10.83	11.0	–	–	
4254	0.16	0.48	1.20	0.69	0.28	2.81	2.46	7.15	1.57	10.11	10.0	11.68	11.0	–	–	
4295	–	–	–	–	–	3.15	3.00	–	–	–	–	23.70	25.0	–	–	
4060	0.96	1.58	0.47	0.62	0.39	4.02	4.10	6.60	2.63	9.14	10.0	11.77	11.0	–	–	Moisture 11.25 per cent.
4156	0.66	2.04	0.32	0.71	0.32	4.05	4.10	8.41	0.69	10.09	10.0	10.78	11.0	–	–	
4210	–	2.84	0.21	0.69	0.20	3.94	4.10	9.46	1.86	11.23	10.0	13.09	11.0	–	–	
4062	0.04	0.04	0.65	0.33	0.48	1.54	1.64	5.09	2.48	9.29	10.0	11.77	11.0	–	–	
4211	0.08	0.09	0.65	0.40	0.40	1.61	1.64	5.90	2.19	9.80	10.0	11.99	11.0	–	–	
4212	0.26	0.24	0.48	0.62	0.47	2.07	2.45	1.29	1.62	7.41	8.0	9.03	9.0	1.09	1.0	
3971	0.97	1.28	0.45	0.61	0.27	3.58	3.28	1.23	1.81	8.46	9.0	10.27	10.0	1.03	1.0	
4061	0.84	1.76	0.02	0.64	0.34	3.60	3.28	1.40	2.93	7.61	9.0	10.54	10.0	0.89	1.0	Moisture 11.22 per cent.
4059	0.35	1.25	0.76	0.54	0.42	3.32	3.28	6.51	3.36	9.19	9.0	12.55	10.0	–	–	Moisture 11.38 per cent.
3944	1.15	0.97	0.42	0.80	0.74	4.08	4.10	6.86	0.32	9.28	8.0	9.60	9.0	–	–	
3946	2.00	0.63	–	0.98	0.51	4.11	4.10	6.43	0.45	8.80	8.0	9.25	9.0	0.98	1.0	
3686	1.03	0.95	0.18	1.33	0.77	4.26	4.10	8.25	0.76	10.52	10.0	11.28	11.0	–	–	
3657	0.74	0.86	0.42	0.96	0.46	3.44	3.29	8.05	0.68	10.23	10.0	10.91	11.0	–	–	
3941	0.53	0.78	0.61	0.93	0.45	3.30	3.29	8.29	0.38	10.31	10.0	10.69	11.0	–	–	
3942	0.84	0.88	0.74	1.06	0.50	4.02	4.10	8.36	0.51	11.04	10.0	11.55	11.0	–	–	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	MAKER AND BRAND.	SAMPLE OBTAINED.	
		From	Month.
4161	Buffalo Five-Ten-Naught	Bennie Mack, Presque Isle	May
4170	Buffalo Five-Ten-Naught	P. H. Reed, Ft. Fairfield	May
3947	Buffalo Four-Eight-Naught	Buffalo Fertilizer Works, Houlton	April
3945	Buffalo Four-Nine-One	Buffalo Fertilizer Works, Houlton	April
4169	Buffalo Four-Nine-One	P. H. Reed, Ft. Fairfield	May
3949	Buffalo One-Ten-Naught	Buffalo Fertilizer Works, Houlton	April
3950	Buffalo Three-Nine-One	Buffalo Fertilizer Works, Houlton	April
3943	Buffalo Three-Ten-Naught	Buffalo Fert. Works, Houlton	April
3688	Buffalo Two-Nine-One	A. B. Chase, Dover	March
3948	Buffalo Two-Nine-One	Buffalo Fertilizer Works, Houlton	April
	LISTERS AGRICULTURAL CHEMICAL WORKS, NEWARK, N. J.		
3847	Listers Atlas Brand Fertilizer, 1916	McLaughlin's Storehouse, Bangor	April
3717	Listers Bone Meal, 1916	Listers Agricultural Chemical Works, Portland	March
4183	Listers Buyer's Choice Acid Phosphate	J. H. Greene, White Rock	May
3713	Listers Corn & Potato Fertilizer, 1916	Listers Agricultural Chemical Works, Portland	March
3810	Listers Corn & Potato Fertilizer, 1916	McLaughlin's Storehouse, Bangor	April
4235	Listers Excelsior Guano, 1916	C. B. Warren, Sidney	May
3716	Listers High Grade Special for Spring Crops, 1916	Listers Agricultural Chemical Works, Portland	March
3792	Listers High Grade Special for Spring Crops, 1916	McLaughlin's Storehouse, Bangor	April
3714	Listers Potato Manure, 1916	Listers Agricultural Chemical Works, Portland	March
3809	Listers Potato Manure, 1916	McLaughlin's Storehouse, Bangor	April
4247	Listers Plant Food, 1916	Wentworth & Plaisted, Sanford	May
3719	Listers Special Potato Fertilizer, 1916	Listers Agricultural Chemical Works, Portland	March

Guaranties and Results of Analysis of Fertilizer Samples, 1916—Continued.

	Nitrogen.							Phosphoric Acid.						Potash		
			Organic.			Total.				Available.		Total.				
Station number.	% As nitrate.	% As ammonia.	% As water soluble.	% As active insoluble.	% As inactive insoluble.	% Found.	% Guaranteed.	% Soluble.	% Insoluble.	% Found.	% Guaranteed.	% Found.	% Guaranteed.	% Found.	% Guaranteed.	Remarks.
4161	1.02	1.02	0.74	0.74*	0.60	4.12	4.10	7.94	0.70	10.24	10.0	10.94	11.0	–	–	Moisture 11.64 per cent.
4170	1.12	0.98	0.62	0.95	0.38	4.05	4.10	8.58	0.51	10.73	10.0	11.24	11.0	–	–	
3947	–	0.81	1.05	0.93	0.44	3.23	3.29	5.85	0.50	8.00	8.0	8.50	9.0	–	–	
3945	0.12	0.58	1.11	0.90	0.44	3.15	3.29	7.77	0.38	10.27	9.0	10.65	10.0	0.61	1.0	
4169	0.10	0.22	1.58	0.80	0.34	3.04	3.29	6.27	0.64	8.74	9.0	9.38	10.0	0.92	1.0	
3949	0.26	–	0.03	0.35	0.19	0.83	0.80	6.56	0.60	10.05	10.0	10.65	11.0	–	–	
3950	0.72	0.38	0.52	0.83	0.27	2.72	2.46	7.18	0.74	9.36	9.0	10.10	10.0	0.87	1.0	
3943	0.60	0.50	0.27	0.74	0.43	2.54	2.46	8.77	0.28	11.22	10.0	11.50	11.0	–	–	
3688	0.45	0.32	0.32	0.68	0.32	2.09	1.64	8.20	0.56	9.89	9.0	10.45	10.0	1.54	1.0	
3948	0.26	–	0.43	0.66	0.32	1.67	1.64	7.11	0.52	9.50	9.0	10.02	10.0	1.00	1.0	
3847	1.51	1.26	0.26	0.63	0.25	3.91	4.11	5.26	1.80	8.77	8.0	10.57	9.0	–	–	
3717	–	–	–	–	–	2.52	2.47	–	–	–	–	26.00	23.0	–	–	
4183	–	–	0.23	–	–	0.23	–	9.73	1.29	16.03	14.0	17.32	15.0	–	–	
3713	0.61	0.47	0.40	0.38	0.20	2.06	2.06	3.72	1.66	7.83	8.0	9.49	9.0	1.03	1.0	
3810	0.55	0.50	0.35	0.50	0.16	2.06	2.06	3.40	1.12	8.05	8.0	9.17	9.0	1.05	1.0	
4235	0.84	0.64	0.52	0.38	0.23	2.61	2.47	4.66	2.19	9.68	10.0	11.87	11.0	–	–	
3716	0.74	0.50	0.45	0.44	0.16	2.29	2.06	5.45	1.25	10.01	10.0	11.26	11.0	1.18	1.0	Moisture 11 per cent.
3792	0.69	0.53	0.23	0.42	0.20	2.07	2.06	6.22	1.01	10.71	10.0	11.72	11.0	1.14	1.0	
3714	1.31	1.37	0.62	0.81	0.23	4.34	4.11	3.99	1.56	8.52	8.0	10.08	9.0	1.10	1.0	
3809	1.44	1.45	0.08	0.71	0.40	4.08	4.11	4.10	1.57	8.24	8.0	9.81	9.0	1.30	1.0	
4247	0.32	0.18	0.46	0.25	–	1.21	0.82	4.40	2.22	9.30	10.0	11.52	11.0	–	–	
3719	1.30	1.15	0.80	0.75	0.42	4.42	4.11	5.31	1.52	9.91	10.0	11.43	11.0	–	–	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained. From	Sample Obtained. Month.
3954	Listers Special Potato Fertilizer, 1916	Harry Burleigh Storehouse, Houlton	April
4063	Listers Special Potato Fertilizer, 1916	American Agricultural Chemical Co. Works, Belfast	April
3715	Listers Standard Pure Super-Phosphate of Lime, 1916	Listers Agricultural Chemical Works, Portland	March
3808	Listers Standard Pure Super-Phosphate of Lime, 1916	McLaughlin's Storehouse, Bangor	April
3718	Listers Success Fertilizer, 1916	Listers Agricultural Chemical Works, Portland	March
3793	Listers Success Fertilizer, 1916	McLaughlin's Storehouse, Bangor	April
3720	Listers Superior Ammoniated Super-Phosphate, 1916	Listers Agricultural Chemical Works, Portland	March
3850	Listers Superior Ammoniated Super-Phosphate, 1916	McLaughlin s Storehouse, Bangor	April
	LOWELL FERTILIZER CO., BOSTON, MASS.		
3689	Lowell Animal Brand. A High Grade Fertilizer for All Crops, 3½–10	Eastern Grain Co., Corinna	March
3768	Lowell Animal Brand. A High Grade Fertilizer for All Crops 3½–10	Bangor Tallow Co., Bangor	March
3938	Lowell Animal Brand. A High Grade Fertilizer for All Crops 3½–10	Jackson & Hall, Belfast	April
3770	Lowell Bone Fertilizer for Corn, Grain, Grass & Vegetables	Bangor Tallow Co., Bangor	March
4124	Lowell Bone Fertilizer for Corn, Grain, Grass & Vegetables	A. J. McNaughton, Foxcroft	May
3690	Lowell Corn & Vegetable 5–10	Eastern Grain Co., Corinna	March
4123	Lowell Corn & Vegetable 5–10	A. J. McNaughton, Foxcroft	May
4285	Lowell Dissolved Bone & Potash 2-9-2	J. Libby, Litchfield	June
4284	Lowell Dissolved Bone Fertilizer 2–10	J. Libby, Litchfield	June
4218	Lowell Empress Brand for Corn, Potatoes and Grain 1½–10	R. P. Greely, Yarmouth	May
4275	Lowell Empress Brand for Corn, Potatoes and Grain 1½–10	Wm. A. Littlefield, Lisbon	May
3963	Lowell Perfect Potato Brand 5–8–4	Harry Burleigh Storehouse, Houlton	April
3767	Lowell Potato & Vegetable 5–10	Bangor Tallow Co., Bangor	March
3959	Lowell Potato & Vegetable 5–10	Harry Burleigh Storehouse, Houlton	April
4114	Lowell Potato Grower 4–8–4	Weymouth Wool Co., Newport	May

Guaranties and Results of Analysis of Fertilizer Samples, 1916—Continued.

Station number.	Nitrogen. % As nitrate.	% As ammonia.	Organic. % As water soluble.	% As active insoluble.*	% As inactive insoluble.	Total. % Found.	% Guaranteed.	Phosphoric Acid. % Soluble.	% Insoluble.	Available. % Found.	% Guaranteed.	Total. % Found.	% Guaranteed.	Potash % Found.	% Guaranteed.	Remarks.
3954	1.32	1.20	0.39	0.86	0.36	4.13	4.11	5.52	0.87	9.94	10.0	10.81	11.0	–	–	
4063	1.34	1.52	0.65	0.56	0.30	4.37	4.11	6.46	1.76	9.63	10.0	11.39	11.0	–	–	
3715	0.76	0.68	0.46	0.45	0.25	2.60	2.47	4.05	1.88	8.82	9.0	10.70	10.0	1.20	1.0	
3808	0.93	0.69	0.29	0.60	0.22	2.73	2.47	4.83	1.11	10.04	9.0	11.15	10.0	1.07	1.0	
3718	0.49	0.32	0.25	0.29	0.17	1.52	1.23	5.81	1.35	10.61	10.0	11.96	11.0	1.10	1.0	Moisture 11.37 per cent.
3793	0.44	0.26	0.06	0.32	0.23	1.31	1.23	5.79	1.03	10.88	10.0	11.91	11.0	1.05	1.0	Moisture 11.21 per cent.
3720	1.04	0.81	0.71	0.65	0.30	3.51	3.29	5.97	1.24	10.34	10.0	11.58	11.0	–	–	
3850	1.38	1.20	0.26	0.47	0.20	3.51	3.29	6.95	1.84	10.35	10.0	12.19	11.0	–	–	
3689	0.39	0.65	1.02	0.72	0.28	3.06	2.87	7.72	0.98	10.11	10.0	11.09	11.0	–	–	
3738	0.40	0.58	0.83	0.75	0.28	2.84	2.86	7.50	0.88	9.96	10.0	10.85	11.0	–	–	
3938	0.40	0.58	0.94	0.59	0.38	2.89	2.87	7.46	0.84	9.96	10.0	10.80	11.0	–	–	
3770	0.46	0.30	0.33	0.65	0.19	1.93	2.05	7.29	1.58	10.22	10.0	11.80	11.0	–	–	
4124	–	0.42	0.94	0.75	0.13	2.24	2.05	6.20	2.02	9.14	10.0	11.16	11.0	–	–	
3690	0.34	1.15	0.88	1.02	0.60	4.00	4.10	7.59	1.74	9.95	10.0	11.69	11.0	–	–	
4123	–	1.88	0.94	0.91	0.38	4.11	4.10	8.49	1.54	10.20	10.0	11.74	11.0	–	–	
4285	0.30	0.06	0.72	0.60	0.17	1.85	1.64	1.23	3.88	7.94	9.0	11.82	10.0	2.23	2.0	1915 goods.
4284	0.08	–	0.70	0.65	0.29	1.72	1.64	6.65	1.30	10.33	10.0	11.63	11.0	–	–	
4218	0.02	–	0.60	0.46	0.13	1.21	1.25	5.79	0.98	9.56	10.0	10.54	11.0	–	–	
4275	0.02	0.08	0.63	0.38	0.13	1.24	1.25	5.89	1.47	9.12	10.0	10.59	11.0	–	–	
3963	0.78	1.94	0.65	0.46	0.20	4.03	4.10	6.01	1.25	8.32	7.0	9.57	8.0	4.25	4.0	
3767	0.30	1.16	0.99	0.89	0.46	3.80	4.10	7.13	1.77	9.63	10.0	11.40	11.0	–	–	
3959	0.31	1.23	2.15	0.97	0.45	4.11	4.10	7.75	1.16	10.26	10.0	11.42	11.0	–	–	
4114	0.26	1.14	0.91	0.77	0.28	3.36	3.29	6.08	0.89	7.95	8.0	8.84	9.0	4.00	4.0	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained.	
		From	Month.
4274	Lowell Potato Grower 4-10-1	Wm. A. Littlefield, Lisbon	May
3765	Lowell Potato Manure 3-10	Bangor Tallow Co., Bangor	March
4122	Lowell Potato Manure 3-10	A. J. McNaughton, Foxcroft	May
3693	Lowell Potato Phosphate 4-10	Eastern Grain Co., Corinna	March
3937	Lowell Potato Phosphate 4-10	Jackson & Hall, Belfast	April
4121	Lowell Potato Phosphate 4-10	A. J. McNaughton, Foxcroft	May
4158	Lowell Superior Fertilizer 4½-8-4	W. P. Stephenson, Presque Isle	May
	MERROW BROS. CO., AUBURN, MAINE.		
4279	Merrow's Bone Meal	Mr. Littlefield, Auburn	May
	MORISON BROS., BANGOR, MAINE.		
3791	Acid Phosphate 16%	Morison Bros., Bangor	April
3788	Morison Bros. Special Potato Fertilizer without Potash	Morison Bros., Bangor	April
3787	Morison Bros. 3-8-2 Fertilizer for All Crops	Morison Bros., Bangor	April
3789	Morison Bros. War Brand Potato Fertilizer	Morison Bros., Bangor	April
3790	Nitrate of Soda 15%	Morison Bros., Bangor	April
	NATIONAL FERTILIZER CO., NEW YORK CITY, N. Y.		
4217	National Aroostook Special Fertilizer, 1916	Irving W. Jones, Palmyra	May
4233	National Complete Root & Grain Fertilizer, 1916	E. L. Chaney, Vassalboro	May
4084	National Eureka Potato Fertilizer, 1916	Farmers Union Grain & Supply Co., Waterville	April
4234	National Eureka Potato Fertilizer, 1916	E. L. Chaney, Vassalboro	May
4216	National Excelsior Potato Fertilizer, 1916	Robert Brooks, No. Newport	May
4023	National Nitrogen Phosphate Mixture No. 2	Tingley, Houlton	April

Guaranties and Results of Analysis of Fertilizer Samples, 1916—Continued.

Station number.	Nitrogen. Organic. % As nitrate.	% As ammonia.	% As water soluble.	% As active insoluble.	% As inactive insoluble.	Total. % Found.	% Guaranteed.	Phosphoric Acid. % Soluble.	% Insoluble.	Available. % Found.	% Guaranteed.	Total. % Found.	% Guaranteed.	Potash % Found.	% Guaranteed.	Remarks.
4274	0.34	1.18	1.30	* 0.77	0.18	3.77	1.23	7.23	1.66	9.87	10.0	11.53	11.0	1.07	1.0	Not registered. Purchased direct from company for personal use.
3765	0.28	0.30	0.82	0.64	0.12	2.16	2.46	7.00	1.37	10.00	10.0	11.37	11.0	–	–	
4122	0.32	0.44	1.04	0.68	0.21	2.69	2.46	6.24	1.58	9.94	10.0	11.52	11.0	–	–	
3693	0.34	0.81	1.26	0.62	0.28	3.31	3.28	7.35	1.30	9.77	10.0	11.07	11.0	–	–	
3937	0.60	0.71	0.47	0.88	0.44	3.10	3.28	7.46	0.69	10.09	10.0	10.78	11.0	–	–	
4121	0.36	1.00	0.90	0.73	0.16	3.15	3.28	6.99	1.11	9.72	10.0	10.83	11.0	–	–	
4158	0.40	1.76	0.57	0.77	0.22	3.72	3.96	7.15	0.54	8.49	8.0	9.03	9.0	4.00	4.0	1915 goods.
4279	–	–	–	–	–	1.49	1.25	–	–	–	–	26.32	28.0	–	–	
3791	–	–	–	–	–	–	–	13.33	0.32	15.93	16.0	16.25	–	–	–	Moisture 13.09 per cent.
3788	1.04	1.42	0.57	0.83	0.21	4.07	4.11	7.51	1.10	10.35	10.0	11.45	–	–	–	
3787	0.40	0.22	0.36	1.06	0.62	2.66	2.46	3.72	1.82	7.59	8.0	9.41	–	2.13	2.0	
3789	0.60	0.72	0.79	0.81	0.43	3.35	3.29	2.95	1.98	7.30	8.0	9.28	–	3.97	4.0	
3790	15.28	–	–	–	–	15.28	15.00	–	–	–	–	–	–	–	–	
4217	1.28	1.20	0.52	0.84	0.23	4.07	4.11	5.30	1.81	9.07	8.0	10.88	9.0	1.17	1.0	
4233	1.08	1.14	0.80	0.35	0.08	3.45	3.29	5.63	1.30	8.72	9.0	10.02	10.0	1.25	1.0	
4084	0.61	0.85	0.40	0.49	0.22	2.57	2.47	3.76	1.72	9.25	9.0	10.97	10.0	1.02	1.0	
4234	0.90	0.72	0.71	0.38	0.12	2.83	2.47	5.95	1.24	9.83	9.0	11.07	10.0	0.98	1.0	
4216	1.34	0.90	0.38	0.69	0.17	3.48	3.29	4.24	1.34	9.15	9.0	10.49	10.0	1.08	1.0	
4023	0.78	0.36	–	0.40	0.20	1.75	1.65	4.05	2.13	9.64	10.0	11.77	11.0	–	–	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained. From	Sample Obtained. Month.
4054	National Nitrogen Phosphate Mixture No. 2	Coe-Mortimer Co., Belfast	April
4134	National Nitrogen Phosphate Mixture No. 3	Coe-Mortimer Co., Belfast	May
4022	National Nitrogen Phosphate Mixture No. 4	Tingley, Houlton	April
4055	National Nitrogen Phosphate Mixture No. 4	Coe-Mortimer Co., Belfast	April
4155	National Nitrogen Phosphate Mixture No. 4	Ben Franklin, Presque Isle	May
4163	National Nitrogen Phosphate Mixture No. 4	O. B. Griffin, Caribou	May
4085	National Nitrogen Phosphate Mixture No. 5	Farmers Union Grain & Supply Co., Waterville	April
4153	National Nitrogen Phosphate Mixture No. 6	I. B. Humphrey, Washburn	May
4154	Natonal Nitrogen Phosphate Mixture No. 6	A. J. Ireland, Mapleton	May
4021	National Nitrogen Phosphate Mixture No. 6	Tingley, Houlton	April
4050	National Potato Phosphate, 1916	Coe-Mortimer Co., Belfast	April
4087	National Potato Phosphate, 1916	Farmers Union Grain & Supply Co., Waterville	April
4053	National Premier Potato Manure, 1916	Coe-Mortimer Co., Belfast	April
4086	National Universal Fertilizer, 1916	Farmers Union Grain & Supply Co., Waterville	April
	NEW ENGLAND FERTILIZER CO., BOSTON, MASS.		
4027	New England Corn & Grain Fertilizer 1½–10	Gray-Hildreth Co., Randolph	April
4259	New England Corn Phosphate for Grain & Vegetables 2½–10	E. Raymond Clark, Eliot	June
3772	New England High Grade Potato Fertilizer 4–10	Bangor Tallow Co., Bangor	March
3934	New England High Grade Potato Fertilizer 4–10	Jackson & Hall, Belfast	April
3960	New England High Grade Potato Fertilizer 4–10	Harry Burleigh Storehouse, Houlton	April
4162	New England High Grade Potato Fertilizer 4–10	O. B. Griffin, Caribou	May
3964	New England High Grade Special 4½-8-4	Harry Burleigh Storehouse, Houlton	April
4281	New England Potato Fertilizer 2–7–4	Arthur W. Sharp, New Gloucester	May
4024	New England Potato Fertilizer 3–10	Gray-Hildreth Co., Randolph	April

Guaranties and Results of Analysis of Fertilizer Samples, 1916—Continued.

Station number.	Nitrogen.							Phosphoric Acid.						Potash		Remarks.
			Organic.			Total.				Available.		Total.				
	% As nitrate.	% As ammonia.	% As water soluble.	% As active insoluble.	% As inactive insoluble.	% Found.	% Guaranteed.	% Soluble.	% Insoluble.	% Found.	% Guaranteed.	% Found.	% Guaranteed.	% Found.	% Guaranteed.	
4054	0.36	0.70	0.75	* 0.36	0.28	2.45	1.65	0.75	2.30	8.16	10.0	10.46	11.0	–	–	
4134	1.12	0.66	0.09	0.61	0.19	2.67	2.47	5.28	1.70	9.43	10.0	11.13	11.0	–	–	
4022	0.93	1.16	0.71	0.55	0.15	3.50	3.29	4.90	2.18	9.18	10.0	11.36	11.0	–	–	
4055	1.06	1.08	0.59	0.45	0.18	3.36	3.29	7.37	2.13	10.23	10.0	12.36	11.0	–	–	
4155	1.06	1.00	0.53	0.70	0.26	3.55	3.29	5.45	1.20	10.00	10.0	11.20	11.0	–	–	
4163	0.96	1.24	0.62	0.48	0.16	3.46	3.29	6.41	1.31	9.78	10.0	11.09	11.0	–	–	
4085	1.47	1.21	0.29	0.87	0.34	4.18	4.11	4.00	1.43	8.83	8.0	10.26	9.0	–	–	
4153	1.66	1.12	0.69	0.46	0.24	4.17	4.11	6.44	1.29	9.92	10.0	11.21	11.0	–	–	
4154	1.12	1.40	0.83	0.57	0.19	4.11	4.11	7.78	2.17	10.62	10.0	12.79	11.0	–	–	
4021	1.66	1.32	0.62	0.62	0.22	4.44	4.11	5.92	2.00	9.61	10.0	11.61	11.0	–	–	
4050	0.99	0.51	–	0.48	0.17	2.03	2.06	1.61	1.66	7.51	8.0	9.17	9.0	1.07	1.0	
4087	0.42	0.60	0.42	0.43	0.23	2.10	2.06	1.85	1.67	7.68	8.0	9.35	9.0	1.05	1.0	
4053	1.22	1.02	0.52	0.82	0.24	3.82	3.70	4.80	2.07	8.60	8.0	10.67	9.0	0.20	1.0	
4086	0.34	0.16	0.25	0.23	0.13	1.11	0.82	1.07	1.49	7.78	8.0	9.27	9.0	1.67	1.0	
4027	0.28	–	0.37	0.33	0.15	1.13	1.23	6.43	1.62	9.27	10.0	10.89	11.0	–	–	
4259	0.04	0.30	0.89	0.76	0.07	2.06	2.06	6.56	1.88	9.40	10.0	11.28	11.0	–	–	
3772	0.30	0.72	1.18	0.62	0.31	3.13	3.28	7.59	1.28	9.68	10.0	10.96	11.0	–	–	
3934	0.30	0.76	1.19	0.79	0.11	3.15	3.28	7.03	1.24	9.53	10.0	10.77	11.0	–	–	
3960	0.32	0.85	1.32	0.83	0.15	3.47	3.28	7.15	1.02	9.83	10.0	10.85	11.0	–	–	
4162	0.56	0.72	0.87	0.68	0.26	3.09	3.28	7.10	1.10	9.19	10.0	10.29	11.0	–	–	
3964	0.46	1.86	0.61	0.65	0.24	3.82	3.69	5.84	1.15	7.77	8.0	8.92	9.0	3.96	4.0	
4281	0.02	0.78	0.39	0.26	0.05	1.50	1.64	5.10	1.07	6.90	7.0	7.97	8.0	3.87	4.0	This analysis not registered for 1916.
4024	0.08	0.48	0.85	0.66	0.39	2.46	2.46	6.25	3.14	9.05	10.0	12.19	11.0	–	–	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number	Maker and Brand.	Sample Obtained. From	Sample Obtained. Month.
3771	New England Potato and Vegetable Manure 5-10	Bangor Tallow Co., Bangor	March
3935	New England Potato and Vegetable Manure 5-10	Jackson & Hall, Belfast	April
3951	New England Potato and Vegetable Manure 5-10	Harry Burleigh Storehouse, Houlton	April
4012	New England Potato and Vegetable Manure 5-10	Winn Farmers Union, Winn	April
4025	New England Standard Phosphate	Gray-Hildreth Co., Randolph	April
3764	New England Superphosphate 3½-10	Bangor Tallow Co., Bangor	March
3936	New England Superphosphate 3½-10	Jackson & Hall, Belfast	April
4026	New England Superphosphate 3½-10	Gray-Hildreth Co., Randolph	April
4260	New England Superphosphate 3½-10	W. A. Pope, Wells Beach	May
	NITRATE AGENCIES CO., NEW YORK CITY, N. Y.		
4177	High Grade Acid Phosphate	C. I. Gilbert, Greene	May
4176	Nitrate of Soda	C. I. Gilbert, Greene	May
	PARMENTOR & POLSEY FERTILIZER CO., BOSTON, MASS.		
4003	P. & P. A A Brand 5-8-1	E. C. Frasier, Fort Kent	April
4192	P. & P. A A Brand 5-8-4	Robert Slipp, Ft. Fairfield	May
3992	P. & P. Aroostook Special 4½-8-4	E. C. Frasier, Fort Kent	April
4002	P. & P. Aroostook Special 4½-9-1	E. C. Frasier, Fort Kent	April
3763	P. & P. Plymouth Rock Brand Fertilizer 3½-10	Bangor Tallow Co., Bangor	March
3766	P. & P. Potato Phosphate 4-10	Bangor Tallow Co., Bangor	March
3958	P. & P. Potato Phosphate 4-10	Harry Burleigh Storehouse, Houlton	April
3773	P. & P. Special Potato Fertilizer 5-10	Bangor Tallow Co., Bangor	March
3986	P. & P. Special Potato Fertilizer 5-10	McIver & Warson, Van Buren	April

Guaranties and Results of Analysis of Fertilizer Samples, 1916—Continued.

Station number.	Nitrogen. % As nitrate.	% As ammonia.	% As water soluble.	Organic. % As active insoluble.	% As inactive insoluble.	Total. % Found.	% Guaranteed.	Phosphoric Acid. % Soluble.	% Insoluble.	Available. % Found.	% Guaranteed.	Total. % Found.	% Guaranteed.	Potash % Found.	% Guaranteed.	Remarks.
3771	0.34	1.10	0.99	0.84*	0.62	3.89	4.10	8.10	1.17	10.79	10.0	11.96	11.0	–	–	
3935	0.54	1.20	0.73	0.95	0.48	3.90	4.10	7.81	1.01	10.86	10.0	11.87	11.0	–	–	
3951	0.11	2.32	0.68	0.90	0.09	4.10	4.10	7.29	1.20	9.69	10.0	10.89	11.0	–	–	
4012	0.04	2.28	0.61	0.95	0.17	4.05	4.10	8.02	1.08	10.21	10.0	11.29	11.0	–	–	
4025	–	–	0.41	0.23	0.18	0.82	0.82	6.11	0.88	11.19	12.0	12.07	13.0	–	–	
3764	0.39	0.59	0.91	0.73	0.23	2.85	2.88	7.24	0.82	10.15	10.0	10.97	11.0	–	–	
3936	0.38	0.54	0.93	0.65	0.28	2.78	2.88	6.97	0.87	9.74	10.0	10.61	11.0	–	–	
4026	0.60	0.60	0.52	0.75	0.22	2.69	2.88	7.08	1.16	9.80	10.0	10.96	11.0	–	–	
4260	0.30	0.56	1.92	–	–	2.78	2.88	6.60	1.89	9.20	10.0	11.09	11.0	–	–	
4177	0.04	–	0.28	–	–	0.32	–	14.28	0.27	16.35	16.0	16.62	–	–	–	
4176	15.26	–	–	–	–	15.26	15.01	–	–	–	–	–	–	–	–	
4003	0.60	1.74	1.09	0.65	0.49	4.59	4.10	7.34	0.82	9.74	8.0	10.56	9.0	1.02	1.0	
4192	0.46	1.28	0.60	1.12	0.35	3.81	4.10	5.55	1.19	8.00	8.0	9.19	9.0	4.25	4.0	
3992	0.44	0.72	1.05	0.85	0.54	3.60	3.69	5.63	0.80	7.38	8.0	8.18	9.0	3.86	4.0	
4002	0.08	1.10	1.58	0.63	0.39	3.78	3.69	7.38	1.38	9.91	9.0	11.29	10.0	1.21	1.0	
3763	0.43	0.59	0.72	0.69	0.27	2.76	2.88	7.45	0.74	10.04	10.0	10.78	11.0	–	–	
3766	0.13	1.01	0.93	0.72	0.35	3.14	3.28	7.30	1.28	9.81	10.0	11.09	11.0	–	–	
3958	0.32	0.86	1.03	0.65	0.27	3.13	3.28	7.53	0.89	10.31	10.0	11.20	11.0	–	–	
3773	0.36	1.16	0.92	1.17	0.28	3.89	4.10	7.97	1.12	10.33	10.0	11.45	11.0	–	–	
3986	0.05	2.15	0.74	0.77	0.24	3.95	4.10	7.91	2.08	9.93	10.0	12.01	11.0	–	–	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained. From	Sample Obtained. Month.
	PORTLAND RENDERING CO., PORTLAND, MAINE.		
3741	Portland Organic Fertilizer. They Double the Dollar. Animal Brand	Portland Rendering Co., Portland	March
3769	Portland Organic Fertilizer. They Double the Dollar. Animal Brand	Bangor Tallow Co., Bangor	March
4189	Portland Organic Fertilizer. They Double the Dollar. Cumberland Garden Manure	A. S. Kneeland, Harrison	May
3742	Portland Organic Fertilizer. They Double the Dollar. Potato Grower	Portland Rendering Co., Portland	March
3761	Portland Organic Fertilize . They Double the Dollar. Potato Grower	Bangor Tallow Co., Bangor	March
3762	Portland Organic Fertilizer. They Double the Dollar. Potato Grower	Bangor Tallow Co., Bangor	March
	PULVERIZED MANURE COMPANY, CHICAGO, ILL.		
3723	Wizard Brand Manure	Kendall & Whitney, Portland	March
	ROGERS & HUBBARD CO., PORTLAND, CONN.		
3996	All Soils—All Crops Phosphate	George E. Bartoll, Freeport	April
4184	Complete Phosphate, 1916	Wales & Hamblen Co., Bridgton	May
4290	Complete Phosphate, 1916	W. P. Shurtleff, Stricklands	May
4287	Corn & General Crops Manure	Geo. W. Pettengil, East Livermore	May
4186	Hubbard's "Bone Base" Soluble Potato Manure	Wales & Hamblen Co., Bridgton	May
4185	Hubbard's Strictly Pure Fine Bone	Wales & Hamblen Co., Bridgton	May
3995	Oats and Top Dressing	George E. Bartoll, Freeport	April
4289	Oats and Top Dressing	George W. Pettengill, East Livermore	May
4288	Potato Phosphate	George W. Pettengill, East Livermore	May
3994	Pure Raw Knuckle Bone Flour	George E. Bartoll, Freeport	April
4291	Pure Raw Knuckle Bone Flour	W. P. Shurtleff, Stricklands	May
3997	Soluble Corn and General Crops Manure	George E. Bartoll, Freeport	April

Guaranties and Results of Analysis of Fertilizer Samples, 1916—Continued.

Station number.	Nitrogen. Organic. % As nitrate.	% As ammonia.	% As water soluble.	% As active insoluble.*	% As inactive insoluble.	Total. % Found.	% Guaranteed.	Phosphoric Acid. % Soluble.	% Insoluble.	Available. % Found.	% Guaranteed.	Total. % Found.	% Guaranteed.	Potash % Found.	% Guaranteed.	Remarks.
3741	0.38	0.68	1.33	0.67	0.21	3.27	2.88	9.06	1.17	11.91	10.0	13.08	11.0	–	–	
3769	0.40	0.92	0.72	0.78	0.47	3.29	2.88	8.87	1.35	11.47	10.0	12.82	11.0	–	–	
4189	0.75	1.71	0.75	1.40	0.20	4.81	4.94	7.37	1.49	9.42	8.0	10.91	9.0	–	–	
3742	0.54	1.04	0.97	0.84	0.84	4.21	4.10	7.34	2.41	11.77	10.0	14.18	11.0	–	–	
3761	0.37	0.83	0.80	0.78	0.49	3.25	4.10	7.32	0.82	9.72	10.0	10.54	11.0	–	–	
3762	0.53	1.10	1.01	0.92	0.27	3.83	4.10	6.73	3.06	11.39	10.0	14.45	11.0	–	–	
3723	–	–	0.58	0.39	1.16	2.13	1.80	–	–	–	1.0	1.48	1.0	3.17	1.0	
3996	1.70	0.10	0.84	0.49	0.18	3.31	3.30	2.19	3.32	5.72	7.0	9.04	9.0	–	–	
4184	0.50	0.00	0.31	0.51	0.15	1.47	1.00	4.99	4.06	8.16	9.0	12.22	11.0	–	–	
4290	0.14	0.06	0.44	0.39	0.11	1.14	1.00	4.85	3.89	8.17	9.0	12.06	11.0	–	–	
4287	1.22	0.16	0.45	0.32	0.29	2.44	2.50	1.98	6.79	7.31	10.0	14.10	12.0	–	–	
4186	1.98	0.24	0.64	1.13	0.23	4.22	4.25	0.73	9.26	8.43	10.0	17.69	16.0	1.04	1.0	
4185	–	–	–	–	–	3.51	3.50	–	–	–	–	22.87	20.0	–	–	
3995	–	–	–	–	–	6.43	6.00	–	–	–	6.0	13.33	12.0	–	–	
4289	3.54	0.14	2.88	0.21	0.22	6.99	6.00	0.40	9.31	4.11	6.0	13.42	12.0	–	–	
4288	0.14	0.08	1.31	0.04	0.49	2.06	2.00	5.28	4.63	11.37	13.0	16.00	15.0	–	–	
3994	–	–	–	–	–	3.55	3.82	–	–	–	–	26.22	24.7	–	–	
4291	–	–	–	–	–	3.73	3.82	–	–	–	–	25.62	24.7	–	–	
3997	1.40	0.12	0.41	0.34	0.31	2.58	2.50	2.12	5.55	8.57	10.0	14.12	12.0	–	–	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained. From	Month.
	F. S. ROYSTER GUANO CO., BALTIMORE, MD.		
4171	Royster's Favorite Compound	B. S. Williams, Ft. Fairfield	May
4201	Royster's Innovation Ammoniated Superphosphate	R. B. Rideout, South Berwick	May
4200	Royster's Penquin Ammoniated Superphosphate	R. B. Rideout, South Berwick	May
	SAGADAHOC FERTILIZER CO., BOWDOINHAM, MAINE.		
3759	Acid Phosphate	Sagadahoc Fertilizer Company, Bowdoinham	March
3758	Nitrate of Soda	Sagadahoc Fertilizer Company, Bowdoinham	March
4273	Sagadahoc B and L Bone, Lime and Potash	J. N. Seaman, Livermore Falls	May
3753	Sagadahoc Dirigo Fertilizer for Grass and Grain	Sagadahoc Fertilizer Company, Bowdoinham	March
3863	Sagadahoc Dirigo Fertilizer for Grass and Grain	Ralph E. Gould, Harmony	April
4205	Sagadahoc Dirigo Fertilizer for Grass and Grain	R. B. Rideout, South Berwick	May
3760	Sagadahoc 5-10-0 Fertilizer	Sagadahoc Fertilizer Company, Bowdoinham	March
4001	Sagadahoc 5-10-0 Fertilizer	H. H. Witherell, Monmouth	April
3757	Sagadahoc 5-10-1 Fertilizer	Sagadahoc Fertilizer Company, Bowdoinham	March
3747	Sagadahoc 4-8-2 Fertilizer	Sagadahoc Fertilizer Company, Bowdoinham	March
3749	Sagadahoc High Grade 2-10-2 Fertilizer	Sagadahoc Fertilizer Company, Bowdoinham	March
3999	Sagadahoc High Grade 2-10-2 Fertilizer	H. H. Witherell, Monmouth	April
4139	Sagadahoc High Grade 2-10-2 Fertilizer	F. S. Adams, Bowdoin	May
4202	Sagadahoc High Grade 2-10-2 Fertilizer	R. B. Rideout, South Berwick	May
4272	Sagadahoc High Grade 2-10-2 Fertilizer	C. G. Bartlett, Livermore Falls	May
3748	Sagadahoc 3-8-4 Fertilizer	Sagadahoc Fertilizer Company, Bowdoinham	March
4140	Sagadahoc 3-8-4 Fertilizer	F. S. Adams, Bowdoin	May
3750	Sagadahoc 3-8-3 Fertilizer	Sagadahoc Fertilizer Company, Bowdoinham	March
3868	Sagadahoc 3-8-3 Fertilizer	Ralph E. Gould, Harmony	April
4000	Sagadahoc 3-8-3 Fertilizer	H. H. Witherell, Monmouth	April
4006	Sagadahoc 3-8-3 Fertilizer	Charles Lowell, Winn	April

Guaranties and Results of Analysis of Fertilizer Samples, 1916—Continued.

	Nitrogen.							Phosphoric Acid.						Potash		
				Organic.		Total.				Available.		Total.				
Station number.	% As nitrate.	% As ammonia.	% As water soluble.	% As active insoluble. *	% As inactive insoluble.	% Found.	% Guaranteed.	% Soluble.	% Insoluble.	% Found.	% Guaranteed.	% Found.	% Guaranteed.	% Found.	% Guaranteed.	Remarks.
4171	0.10	0.96	0.37	0.19	0.06	1.68	1.65	6.27	1.28	9.87	10.0	11.15	10.5	1.69	2.0	1915 goods. Moisture 14.75 per cent.
4201	–	0.96	0.62	0.74	0.17	2.49	2.47	6.19	2.36	9.36	8.0	11.72	8.5	–	–	
4200	0.14	0.62	0.52	0.44	0.09	1.81	1.65	7.26	2.25	10.89	10.0	13.14	10.5	–	–	
3759	–	–	–	–	–	–	–	13.17	0.66	16.71	16.0	17.37	17.0	–	–	
3758	15.9	–	–	–	–	15.90	14.0	–	–	–	–	–	–	–	–	
4273	0.34	–	0.59	0.31	0.11	1.35	1.00	0.29	3.06	3.03	4.0	6.09	7.0	1.16	1.0	
3753	0.16	0.11	0.24	0.45	0.23	1.19	1.00	1.67	2.41	6.52	6.0	8.93	8.0	2.21	1.0	
3863	0.18	0.02	0.17	0.44	0.26	1.09	1.00	1.93	2.42	6.51	6.0	8.93	8.0	1.65	1.0	
4205	0.18	–	0.25	0.56	0.11	1.10	1.00	1.56	2.73	6.52	6.0	9.25	8.0	1.25	1.0	
3760	2.06	0.76	0.54	0.59	0.36	4.31	4.11	4.90	0.60	9.66	10.0	10.26	11.0	–	–	
4001	2.34	0.90	0.05	0.53	0.35	4.17	4.12	4.94	0.68	9.97	10.0	10.65	11.0	–	–	
3757	1.86	1.40	0.44	0.47	0.27	4.44	4.11	5.90	0.54	10.47	10.0	11.01	11.0	1.25	1.0	
3747	1.87	0.56	0.34	0.42	0.18	3.38	3.29	4.12	0.57	8.68	8.0	9.25	9.0	2.00	2.0	
3749	0.85	–	–	0.22	0.68	1.70	1.65	2.54	0.93	10.87	10.0	11.80	11.0	2.41	2.0	
3999	0.58	0.24	0.26	0.49	0.46	2.03	1.65	5.74	0.54	9.25	10.0	9.79	11.0	2.26	2.0	
4139	0.70	0.18	0.42	0.18	0.21	1.69	1.65	1.60	0.89	10.69	10.0	11.58	11.0	2.15	2.0	Moisture 11.13 per cent.
4202	0.40	0.32	0.27	0.45	0.21	1.65	1.65	5.90	0.65	9.81	10.0	10.46	11.0	2.35	2.0	
4272	0.62	0.42	0.64	0.16	0.05	1.89	1.65	4.78	0.74	10.27	10.0	11.01	11.0	2.15	2.0	
3748	0.61	0.56	0.30	0.63	0.45	2.55	2.47	5.65	0.50	9.07	8.0	9.57	9.0	4.75	4.0	
4140	0.74	0.34	0.60	0.73	0.33	2.74	2.47	4.47	0.59	8.34	8.0	8.93	9.0	3.70	4.0	
3750	1.40	0.45	0.39	0.36	0.19	2.79	2.47	3.56	0.64	8.48	8.0	9.12	9.0	3.63	3.0	
3868	1.09	0.51	0.71	0.22	0.17	2.70	2.47	3.25	0.65	8.98	8.0	9.63	9.0	4.11	3.0	
4000	1.78	0.50	0.05	0.29	0.16	2.78	2.47	3.35	1.38	8.73	8.0	10.11	9.0	3.45	3.0	
4006	1.00	0.38	0.47	0.46	0.25	2.56	2.47	2.28	0.66	8.46	8.0	9.12	9.0	2.84	3.0	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained.	
		From	Month.
3751	Sagadahoc 3-10-0 Fertilizer	Sagadahoc Fertilizer Company, Bowdoinham	March
4204	Sagadahoc 3-10-0 Fertilizer	R. B. Rideout, South Berwick	May
3754	Sagadahoc 3-10-1 Fertilizer	Sagadahoc Fertilizer Company, Bowdoinham	March
4206	Sagadahcc 3-10 1 Fertilizer	R. B. Rideout, South Berwick	May
3752	Sagadahoc Special Corn 3-10-3 Fertilizer	Sagadahoc Fertilizer Company, Bowdcinham	March
3862	Sagadahoc Special Corn 3-10-3 Fertilizer	Ralph E. Gould, Harmony	April
3756	Sagadahoc Special Orchard 3-5-1 Fertilizer	Sagadahoc Fertilizer Company, Bowdoinham	March
3755	Sagadahoc Yankee 1-8-1 Fertilizer for All Crops	Sagadahoc Fertilizer Company, Bowdoinham	March
4203	Sagadahoc Yankee 1-8-1 Fertilizer for All Crops	R. B. Rideout, South Berwick	May
	PROF. J. W. SANBORN, GILMANTON, N. H.		
4269	Prof. Sanborn's Chemical Fertilizer for Grass & Grain without Potash	F. G. True, Freeport	May
3982	Prof. Sanborn's Chemical Fertilizer for Potatoes and Corn	E. W. Alexander, Lisbon	April
3993	Prof. Sanborn's Chemical Fertilizer for Potatoes and Corn	E. W. Alexander, Lisbon	April
4270	Prof. Sanborn's Chemical Fertilizer for Potatoes and Corn without Potash	F. G. True, Freeport	May
4271	Prof. Sanborn's Chemical Fertilizer for Use in Hill or Drill without Potash	F. G. True, Freeport	May
	STANDARD GUANO CO., BALTIMORE, MD.		
3869	Farmers Union of Maine Jersey Potato	Peter Harmon, Thorndike	April
4046	Farmers Union of Maine Jersey Potato	Farmers Union, Belfast	April
3866	Farmers Union of Maine Potato Grower	Frank A. Linnell, Harmony	April
3874	Farmers Union of Maine Potato Grower	Peter Harmon, Thorndike	April
3879	Farmers Union of Maine Potato Grower	R. W. Betts, Thorndike	April
3981	Farmers Union of Maine Potato Grower	Albert Mower, Houlton	April
3998	Farmers Union of Maine Potato Grower	Farmers Union Warehouse, Lincoln	April
3873	Farmers Union of Maine Potato King	Peter Harmon, Thorndike	April
4013	Farmers Union of Maine Potato King	Budge & Smith, Mattawamkeag	April

Guaranties and Results of Analysis of Fertilizer Samples, 1916—Continued.

	Nitrogen.							Phosphoric Acid.						Potash		
			Organic.			Total.				Available.		Total.				
Station number.	% As nitrate.	% As ammonia.	% As water soluble.	% As active insoluble.*	% As inactive insoluble.	% Found.	% Guaranteed.	% Soluble.	% Insoluble.	% Found.	% Guaranteed.	% Found.	% Guaranteed.	% Found.	% Guaranteed.	Remarks.
3751	0.83	0.72	0.38	0.37	0.27	2.57	2.47	5.53	0.61	10.76	10.0	11.37	11.0	–	–	
4204	1.26	0.36	0.36	0.35	0.15	2.48	2.47	1.60	0.94	10.45	10.0	11.39	11.0	–		
3754	0.54	0.34	0.31	0.46	0.23	1.88	2.47	4.08	1.48	8.26	10.0	9.74	11.0	1.31	1.0	
4206	1.28	0.22	0.48	0.56	0.21	2.75	2.47	5.55	0.54	9.75	10.0	10.29	11.0	1.30	1.0	
3752	0.97	0.61	0.34	0.35	0.30	2.57	2.47	6.35	0.58	11.00	10.0	11.58	11.0	3.13	3.0	
3862	2.06	0.40	0.15	0.20	0.19	3.00	2.47	5.75	0.65	11.14	10.0	11.79	11.0	3.10	3.0	
3756	1.06	0.63	0.28	0.47	0.20	2.64	2.47	4.16	2.50	8.23	5.0	10.73	10.0	1.98	1.0	
3755	0.32	0.09	0.24	0.32	0.16	0.97	0.82	1.23	0.73	8.84	8.0	9.57	9.0	1.96	1.0	
4203	0.32	–	0.28	0.22	0.16	0.98	0.82	2.06	0.71	8.09	8.0	8.80	9.0	1.30	1.0	
4269	0.72	0.50	1.35	0.96	0.43	3.96	5.80	0.57	6.66	4.66	8.0	11.32	9.0	–	–	
3982	–	–	2.91	0.32	0.15	3.38	3.29	8.00	0.79	9.50	8.0	10.29	9.0	4.20	4.0	1915 goods.
3993	0.10	2.48	0.15	0.37	0.16	3.26	3.20	7.77	0.74	9.42	8.0	10.16	9.0	4.13	4.0	1915 goods.
4270	0.28	0.44	1.49	1.25	0.51	3.97	3.20	0.22	7.49	4.36	8.0	11.85	9.0	–	–	
4271	0.16	0.42	1.11	0.82	0.40	2.91	2.40	0.49	6.71	5.09	8.0	11.80	9.0	–	–	
3869	0.52	1.00	–	0.53	0.26	2.23	2.05	8.53	0.93	11.14	10.0	12.07	10.5	2.46	2.0	
4046	0.04	1.28	0.26	0.53	0.14	2.25	2.05	8.58	1.28	10.94	10.0	12.22	10.5	2.31	2.0	
3866	0.16	2.00	–	0.61	0.49	3.22	3.20	2.60	1.10	8.60	8.0	9.70	8.5	5.04	4.0	
3874	0.07	1.86	0.11	0.80	0.34	3.18	3.20	4.58	1.11	8.62	8.0	9.73	8.5	4.25	4.0	
3879	0.26	1.83	–	0.80	0.34	3.14	3.20	4.48	1.00	8.89	8.0	9.89	8.5	4.32	4.0	
3981	–	–	2.27	0.77	0.46	3.50	3.20	4.74	0.97	8.50	8.0	9.4	8.5	4.45	4.0	
3998	0.02	1.64	0.37	0.78	0.66	3.47	3.20	4.47	1.53	8.15	8.0	9.68	8.5	4.22	4.0	
3873	0.12	1.88	0.08	0.80	0.51	3.39	3.20	1.82	0.88	8.72	8.0	9.60	8.5	7.14	7.0	
4013	–	–	2.81	0.80	0.52	4.13	3.20	2.60	1.35	8.08	8.0	9.43	8.5	7.69	7.0	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Continued.

Station number.	Maker and Brand.	Sample Obtained.	
		From	Month.
4044	Farmers Union of Maine Potato King	Farmers Union, Belfast	April
4166	Farmers Union of Maine Potato King	Potato Growers Association, Houlton	May
3871	Farmers Union of Maine Potato Prize	Peter Harmon, Thorndike	April
3876	Farmers Union of Maine Potato Prize	Peter Harmon, Thorndike	April
3877	Farmers Union of Maine Potato Prize	Peter Harmon, Thorndike	April
3880	Farmers Union of Maine Potato Prize	Ed. W. Downer, Unity	April
	I. P. THOMAS & SON CO., PHILADELPHIA, PA.		
3865	Long Island Special 4-10-0	O. J. Foss, Harmony	April
	TUSCARORA FERTILIZER CO., CHROME, N. J.		
4168	Tuscarora 5-8-2	P. H. Reed, Ft. Fairfield	May
3962	Tuscarora 5-10-0	Harry Burleigh Storehouse, Houlton	April
4160	Tuscarora 5-10-0	George Inman, Mapleton	May
4165	Tuscarora 5-10-0	A. G. Whitcomb, Westfield	May
3860	Tuscarora 4-8-0	Ralph E. Gould, Harmony	April
3861	Tuscarora Standard	Ralph E. Gould, Harmony	April
4071	Tuscarora Standard	Armour Fertilizer Works, Bucksport	April
4164	Tuscarora Standard	A. G. Whitcomb, Westfield	May
	VIRGINIA-CAROLINA CHEMICAL CO., NEW YORK CITY, N. Y.		
4199	V. C. C. Co.'s Ammoniated Bone Phosphate for All Crops	Johnson Bros., North Berwick	May
4243	V. C. C. Co.'s Ammoniated Bone Phosphate for All Crops	M. F. Shackelford, White Rock	May
4089	V. C. C. Co.'s Beef, Blood & Bone BBB with 1% Potash	F. A. Wing, Waterville	April
4237	V. C. C. Co.'s Beef, Blood & Bone BBB with 1% Potash	Brooks Hardware Co., Augusta	May
4245	V. C. C. Co.'s Beef, Blood & Bone BBB with 1% Potash	M. F. Shackelford, White Rock	May
4230	V. C. C. Co.'s Beef, Blood & Bone BBB with 2% Potash	Sam. H. Fitts, Freeport	May

Guaranties and Results of Analysis of Fertilizer Samples, 1916—Continued.

Station number.	Nitrogen. % As nitrate.	Nitrogen. % As ammonia.	Nitrogen. Organic. % As water soluble.	Nitrogen. Organic. % As active insoluble.	Nitrogen. Organic. % As inactive insoluble.	Nitrogen. Total. % Found.	Nitrogen. Total. % Guaranteed.	Phosphoric Acid. % Soluble.	Phosphoric Acid. % Insoluble.	Phosphoric Acid. Available. % Found.	Phosphoric Acid. Available. % Guaranteed.	Phosphoric Acid. Total. % Found.	Phosphoric Acid. Total. % Guaranteed.	Potash % Found.	Potash % Guaranteed.	Remarks.
4044	0.24	2.04	–	0.79*	0.65	3.61	3.20	2.39	1.10	8.23	8.0	9.33	8.5	7.32	7.0	
4166	0.26	1.90	0.22	0.92	0.33	3.63	3.20	2.33	1.12	8.07	8.0	9.19	8.5	7.12	7.0	
3871	0.22	2.47	–	0.51	0.15	3.27	3.28	6.38	0.33	11.65	10.0	11.98	10.5	–	–	
3876	0.05	2.31	0.03	0.57	0.30	3.26	3.28	10.22	0.63	11.78	10.0	12.41	10.5	–	–	
3877	0.16	2.33	0.05	0.53	0.16	3.27	3.28	10.53	0.45	12.09	10.0	12.54	10.5	–	–	
3880	0.12	2.38	0.16	0.50	0.22	3.38	3.28	10.56	0.31	11.62	10.0	11.93	10.5	–	–	
3865	0.04	1.38	0.95	0.78	0.29	3.44	3.25	6.81	2.45	9.23	10.0	11.68	10.5	–	–	
4168	1.64	0.46	0.19	1.13	0.45	3.87	4.11	5.47	0.84	7.90	8.0	8.74	8.5	2.07	2.0	
3962	1.48	1.00	0.48	0.86	0.50	4.32	4.11	8.44	0.34	10.57	10.0	10.91	10.5	–	–	
4160	0.58	1.14	1.31	0.84	0.31	4.18	4.11	9.04	0.33	10.83	10.0	11.16	10.5	–	–	
4165	0.99	0.77	1.21	0.94	0.41	4.32	4.11	8.41	0.63	9.83	10.0	10.46	10.5	–	–	
3860	1.16	0.75	0.43	0.88	0.22	3.44	3.29	6.46	0.40	8.56	8.0	8.96	8.5	–	–	
3861	0.22	0.26	0.67	0.45	0.14	1.74	1.65	6.09	0.48	8.42	8.0	8.90	8.5	2.17	2.0	
4071	0.02	0.30	0.90	0.52	0.15	1.89	1.65	6.49	0.64	8.61	8.0	9.25	8.5	2.02	2.0	
4164	0.62	0.20	0.36	0.49	0.16	1.83	1.65	6.57	0.52	8.28	8.0	8.80	8.5	2.09	2.0	
4199	0.19	0.17	0.96	0.28	0.06	1.66	1.65	4.32	2.96	9.58	10.0	12.54	11.0	–	–	
4243	0.14	0.10	1.18	0.47	0.01	1.90	1.65	2.60	2.18	9.91	10.0	12.09	11.0	–	–	
4089	1.24	0.30	0.54	0.66	0.31	3.05	3.29	0.99	3.52	7.45	8.0	10.97	9.0	1.06	1.0	
4237	0.58	0.28	1.24	0.90	0.35	3.35	2.47	2.55	4.92	5.96	8.0	10.88	9.0	1.04	1.0	
4245	0.40	3.10	0.09	0.27	0.04	3.90	3.29	7.69	2.30	9.66	8.0	11.96	9.0	1.12	1.0	
4230	0.12	2.46	0.39	0.46	0.06	3.49	3.29	9.17	2.35	10.76	8.0	13.11	9.0	2.07	2.0	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

Description of Samples—Concluded.

Station number.	Maker and Brand.	Sample Obtained.	
		From	Month.
4231	V. C. C. Co.'s High Grade Corn and Vegetable Compound with 1% Potash	Sam. H. Fitts, Freeport	May
4236	V. C. C. Co.'s High Grade Corn and Vegetable Compound with 1% Potash	Brooks Hardware Co., Augusta	May
4198	V. C. C. Co.'s Owl Brand Potato Fertilizer	Jackson Bros., North Berwick	May
4242	V. C. C. Co.'s Owl Brand Potato Fertilizer	M. F. Shackelford, White Rock	May
4090	V. C. C. Co.'s Star Brand Potato & Vegetable Compound with 2% Potash	F. A. Wing, Waterville	April
4232	V. C. C. Co.'s Tip Top Top Dresser with 1% Potash	Sam. H. Fitts, Freeport	May
3972	V. C. C. Co.'s 20th Century Potato Manure with 2% Potash	George Benz, Houlton	April
3984	V. C. C. Co.'s 20th Century Potato Manure with 2% Potash	W. F. Paradis, Van Buren	April
4088	V. C. C. Co.'s 20th Century Potato Manure with 2% Potash	F. A. Wing, Waterville	April
4244	V. C. C. Co.'s 20th Century Potato Manure with 2% Potash	M. F. Shackelford, White Rock	May
3872	V. C. C. Co.'s 20th Century Potato Manure without Potash	W. W. Moulton, Thorndike	April
3983	V. C. C. Co.'s 20th Century Potato Manure without Potash	W. F. Paradis, Van Buren	April
4091	V. C. C. Co.'s 20th Century Potato Manure without Potash	F. A. Wing, Waterville	April
4147	V. C. C. Co.'s 20th Century Potato Manure without Potash	Shaw & Mitton, Caribou	May
	WHITMAN & PRATT RENDERING CO., LOWELL, MASS.		
4079	Whitman & Pratt 5-10 Brand	Fairfield Grain Co., Fairfield	April
4248	Whitman & Pratt 5-10 Brand	A. A. Wilson, Springvale	May
3734	Whitman & Pratt Ground Bone	Kendall & Whitney, Portland	March
4097	Whitman & Pratt Ground Bone	Galt Block Storehouse, Portland	May
4255	Whitman & Pratt Special Top Dresser	A. A. Wilson, Springvale	May
4080	Whitman & Pratt 3-10 Brand	Fairfield Grain Co., Fairfield	April
4081	Whitman & Pratt 2½-10 Brand	Fairfield Grain Co., Fairfield	April

Guaranties and Results of Analysis of Fertilizer Samples, 1916—Concluded.

Station number.	Nitrogen. % As nitrate.	Nitrogen. % As ammonia.	Nitrogen. Organic. % As water soluble.	Nitrogen. Organic. % As active insoluble.	Nitrogen. Organic. % As inactive insoluble.	Nitrogen. Total. % Found.	Nitrogen. Total. % Guaranteed.	Phosphoric Acid. % Soluble.	Phosphoric Acid. % Insoluble.	Phosphoric Acid. Available. % Found.	Phosphoric Acid. Available. % Guaranteed.	Phosphoric Acid. Total. % Found.	Phosphoric Acid. Total. % Guaranteed.	Potash % Found.	Potash % Guaranteed.	Remarks.
4231	0.57	0.18	0.83	* 0.85	0.37	2.80	2.47	3.09	5.49	8.45	8.0	13.94	9.0	1.09	1.0	
4236	0.70	0.16	0.77	0.73	0.26	2.62	2.47	2.52	3.37	7.84	8.0	11.21	9.0	1.00	1.0	
4198	0.10	1.26	0.16	0.24	0.04	1.80	1.65	8.17	1.83	10.00	8.0	11.83	9.0	1.00	1.0	
4242	0.10	0.22	0.46	0.77	0.23	1.78	1.65	4.13	2.72	7.93	8.0	10.65	9.0	1.09	1.0	
4090	0.63	1.90	0.22	0.45	0.14	3.34	3.29	8.13	2.19	10.25	8.0	12.44	9.0	2.20	2.0	
4232	2.92	0.06	1.86	1.27	0.42	6.53	5.76	1.99	1.95	5.13	5.0	7.08	6.0	1.00	1.0	
3972	0.84	0.12	1.40	1.37	0.51	4.24	4.12	2.55	0.98	8.96	8.0	9.94	9.0	2.42	2.0	
3984	1.38	0.18	0.78	1.31	0.45	4.10	3.29	2.30	1.28	8.75	8.0	10.03	9.0	2.36	2.0	
4088	1.18	0.22	0.73	1.07	0.41	3.61	4.12	2.46	1.76	8.99	8.0	10.75	9.0	2.19	2.0	Moisture 12.11 per cent.
4244	1.80	0.16	0.42	1.27	0.27	3.92	4.12	3.37	1.56	9.16	8.0	10.72	9.0	2.01	2.0	
3872	–	–	4.04	0.66	0.38	5.08	4.12	7.34	3.61	8.77	10.0	12.38	11.0	–	–	
3983	1.69	0.40	1.32	0.43	0.20	4.04	4.12	5.30	3.25	10.04	10.0	13.29	11.0	–	–	
4091	1.66	0.16	0.77	0.76	0.42	3.77	4.11	4.23	2.46	9.88	10.0	12.34	11.0	–	–	Moisture 12.35 per cent.
4147	1.56	0.40	1.16	0.49	0.19	3.80	4.12	4.91	3.65	9.24	10.0	12.89	11.0	–	–	
4079	0.14	2.26	0.91	0.66	0.10	4.07	4.10	8.18	2.14	10.22	10.0	12.36	11.0	–	–	
4248	0.08	2.12	0.88	0.60	0.39	4.07	4.10	7.86	2.45	9.86	10.0	12.31	11.0	–	–	
3734	–	–	–	–	–	2.76	2.46	–	–	–	–	27.59	22.0	–	–	
4097	–	–	–	–	–	2.42	2.46	–	–	–	–	27.69	22.0	–	–	
4255	0.48	1.82	2.63	1.24	0.63	6.80	5.75	5.63	2.22	7.89	8.0	10.11	12.0	4.30	7.4	1915 goods.
4080	0.02	0.44	1.13	0.53	0.40	2.52	2.46	6.86	2.91	9.07	10.0	11.98	11.0	–	–	
4081	0.04	0.22	1.05	0.59	0.22	2.12	2.05	6.11	2.02	8.70	10.0	10.72	11.0	–	–	

* In high grade organic ammoniates the figures in this column are considerably larger than those in the next column.

LIME, LIMESTONE, AND GYPSUM.

Agricultural lime, limestone and gypsum depend for their agricultural value largely upon the lime which they carry and their freedom from other impurities. Lime in limestone exists as calcium carbonate. When this is burned carbon dioxide is driven off and lime or quick lime (calcium oxide) remains. When exposed to moisture this takes up water and becomes slaked or calcium hydrate. If this material is continued to be exposed to the air it again takes on carbon dioxide from the air and comes back to calcium carbonate similar in chemical composition to the limerock from which it is made, but differing very materially in its mechanical condition.

No. 3730, R-R Land Lime, made by the Rockland-Rockport Lime Co., Rockland, Me., guaranteed to contain 60 to 65 per cent of total lime (calcium oxide) was sampled at Kendall & Whitney's, Portland. It was found to carry 64.08 per cent of lime (calcium oxide) and 3.25 per cent of insoluble matter.

No. 3786, R-R Land Lime, made by the Rockland-Rockport Lime Co., Rockland, Me., guaranteed to contain 60 to 65 per cent of total lime, was sampled at R. B. Dunning & Company's, Bangor, and was found to carry 61.12 per cent of lime (calcium oxide) and 5.08 per cent of insoluble matter.

No. 4010, Pulverized Agricultural Limestone, Dudswell Brand, made by the Dominion Lime Co., Sherbrook, Quebec, guaranteed to carry 52 to 55 per cent of lime, was sampled at the Farmers' Union Storehouse, Lee. It was found to carry 53.48 per cent of lime (calcium oxide) and 4.08 per cent of insoluble matter.

No. 4142, Pulverized Agricultural Limestone, Dudswell Brand, made by the Dominion Lime Co., Sherbrook, Quebec, was guaranteed to carry from 52 to 55 per cent of lime. Sample was taken at N. E. Curtis', Bowdoin, and was found to carry 53.44 per cent of lime (calcium oxide) and 7.03 per cent of insoluble matter.

No. 4109, Agricultural Pownal Limestone, Fine Ground Limestone, made by the Pownal Lime Co., North Pownal, Vt., was guaranteed to carry 45 to 50 per cent of lime. The sample was taken at the Galt Block Storehouse, Portland, and found to carry 46.20 per cent of lime (calcium oxide) and 12.89 per cent of insoluble matter.

No. 3729, R-R Ground Limestone, made by the Rockland-Rockport Lime Co., Rockland, Me., was sampled at Kendall & Whitney's, Portland. The sample as received (No. 3729) carried the label and the guarantees of ground limestone. The goods, however, were not ground limestone but gypsum. The sample contains 22.40 per cent of lime (calcium oxide), equivalent to 68.7 per cent gypsum. The insoluble matter was 4.15 per cent. This sample was probably wrongly marked by the inspector, for, so far as is known at this Station, the Rockland-Rockport Lime Company did not register or offer gypsum for sale in 1916.

No. 4167, Tobique Land Plaster, made by John Stewart, Plaster Rock, N. B., was guaranteed to carry 95 per cent of calcium sulphate (gypsum). The sample was obtained from P. H. Reed, Fort Fairfield, and was found to carry 67.06 per cent of gypsum (calcium sulphate) and 24 per cent of insoluble matter. A rather impure, poor quality gypsum (land plaster).

No. 4294, U. S. Gypsum Plaster, made by the U. S. Gypsum Co., New York City, was guaranteed to carry 73.87 per cent of calcium sulphate. The sample was taken from Sweetser & Cole, Gray, and the inspector stated that he was not sure that it is the U. S. Gypsum brand. Exceedingly good goods, carrying 99.32 per cent of gypsum (calcium sulphate) and 0.85 per cent of insoluble matter.

Discussion of Results of Analyses.

The errors due to the sampling and laboratory examination effect, of course, the results of the analyses as reported. The Station has no control over taking the samples. It rechecks all analyses to reduce the laboratory errors to a minimum. Errors in sampling, due to imperfect methods, improper storage of goods, or other causes cannot be checked up. The larger the number of samples of any one brand examined the better is the measure of the equality of the goods as a whole. But as goods are made in comparatively small batches and from more or less different materials it may be that individual lots of brands showing well on the average may differ materially in composition.

With the best of care, different samples taken from the same goods at the same time and examined by the same analyst will show slightly discordant results. These may be slightly too high or slightly too low. A variation of two-tenths of a per cent in the actual content may occur. That is, the examination of a sample of goods that actually carried 4 per cent nitrogen might show a result as low as 3.8 per cent or as high as 4.2 per cent. Hence when only a single sample is examined variations to these limits are passed, because a case could not be maintained in court. If several samples of the same goods are found to be all or nearly all even slightly low in only one constituent a case could probably be maintained under the fertilizer law, provided the other constituents were not present in sufficient excess to indicate the sample taken did not fairly represent the output.

Nitrogen and particularly potash are the most costly constituents of fertilizers, and in examining the tables special attention should be given to these constituents. In 1916, probably because of the high cost of sulphuric acid, there is an unusual number of samples that are well up in total and somewhat below in available phosphoric acid.

On the whole the fertilizers of 1916 are fairly well up to the guaranty. It is to be remembered, however, that these guarantees are minimum and not average guarantees, and that companies whose goods on the whole run close to their guaranteed analyses may be manufacturing too close to their minimum guarantees for safety to themselves or their customers.

Formerly the lower figure in a guaranty was usually maintained with a good margin for safety. There seems to be a growing tendency on the part of certain companies to manufacture too close to the minimum guaranty. Of course in theory a fertilizer should never fall below the guaranty for that is supposed to be its minimum.

Delay in Publication.

The fertilizer law requires the Director of the Station to "publish the official bulletin giving the results that are deemed of public importance annually in the month of October." The present year the last samples were received from the Commissioner of Agriculture on June 24. The results of the analyses are sent to the Commissioner as fast as they are completed. The last analyses were sent to him September 11. The sampling data were received from him October 7. The tables were completed and forwarded to the public printer October 21.

To set up the type, print, bind and mail as large a book as this requires on the average about ten weeks' time. In order to put the book in the hands of the public in the month of October it would be necessary to have the copy in the hands of the printer early in August. This is not practicable where the data are not supplied to the Station until four weeks after the last analyses are reported. Formerly when the sampling data were furnished the Station with the samples it was possible to prepare the left page tables as soon as all of the samples were received, and the copy for the right page tables could be made before the analyses of the last samples were completed. It was thus possible to send copy to the printer early in August, add the uncompleted results in the first proof, and distribute the book in October.

Analysis of Samples Submitted by Correspondents.

All analyses of commodities coming under the laws of which the Commissioner of Agriculture is the executive are made by the Director of the Station at the request of the Commissioner. There is a special law (Chapter 130, Public Laws of 1911) which provides for the analysis of samples of fertilizers taken by any citizen. It requires the sample to be taken in the presence of a witness from not less than 5 packages in a manner prescribed by the Commissioner of Agriculture. The sample shall be accompanied by an analysis fee of $10. If not more than one sample of the same brand has been analyzed, or if the analysis differs materially from the guaranty, the analysis fee is returned to the sender.

The description of the goods may or may not be sent to the Commissioner as the sender chooses. It is not necessary, as so many seem to think, that the name of the brand and its analysis be sent with the sample. But this information must be given either when the sample is sent or after the analysis is reported to the sender if he wishes the refund.

No samples should be taken without first getting complete directions for sampling. These may be had from the Commissioner of Agriculture, Augusta, or from the Station.

[525-4-16]

University of Maine.

Maine Agricultural Experiment Station

ORONO

CHAS. D. WOODS, Director

APPLE TREE INSECTS OF MAINE

Revised April, 1916.

University of Maine.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director.

APPLE TREE INSECTS OF MAINE.*

EDITH M. PATCH,

O. A. JOHANNSEN.

Before it is possible to combat an insect pest intelligently we must learn something of its habits and of its vulnerable points. When these are known proper remedial measures may then be taken for its extermination or repression. To meet the needs of those who wish to learn something of the commoner injurious insects which affect the apple tree and its fruit this circular has been prepared. It is a compilation largely from the Entomological bulletins and circulars of the Maine Agricultural Experiment Station. We desire to acknowledge the use also of publications of the United States Department of Agriculture and of other sources.

There are very many different species of insects ranging in size from less than 1-50 of an inch to about 8 inches in length. From the United States alone over 30,000 species have been recorded of which over 400 are known to affect in greater or less degree the apple tree or its fruit. Though there are many that are, it must not be supposed that all insects are injurious for by far the larger number are either harmless or actually beneficial. Ruthless destruction of insects by means of trap lanterns and the like is to be deprecated since these methods

*Revised 1916.

are as apt to capture the beneficial and the harmless as the injurious. Poisons, traps, and other repressive measures must be used with caution, and at the right time and place in order to be most effective.

Though technical terms will be avoided in this circular when possible, it may not be out of place here to explain the few which it will be necessary to use in the descriptive matter which is to follow.

Though differing in many particulars all insects possess a segmented body which in the adult stage is arranged in three regions, head, thorax or midbody, and abdomen or hind body. The thorax in the adult is provided with 3 pairs of legs and may be either winged or wingless.

Some insects (e. g, grasshopper) after emerging from the egg gradually increase in size until they reach maturity but without undergoing any abrupt change in external appearance except in the acquisition of wings. Others, however, pass through 4 distinct stages, viz., egg, larva (caterpillar, or grub or maggot), chrysalis or pupa (often enclosed in a cocoon) and the imago or mature insect. After the insect has acquired wings it is mature and no longer increases in size. Thus a small beetle is not the young of a larger one, nor is a small fly the early stage of one of greater magnitude.

Insects are divided into a number of natural groups or orders by which they are known in technical literature and not infrequently in popular accounts also. The *Orthoptera* are four winged; the first pair are thickened and partly overlap when at rest; the second pair are thinner and are folded in plaits like a fan. The mouth parts are formed for biting. To this order belong the cockroaches, crickets and grasshoppers. The *Neuropteroids* include the dragon flies (popularly known as darning needles), May flies, stone flies and the like. The only insects which are rightly called "bugs" are the *Hemiptera,* creatures of various shapes, having jointed beaks adapted for piercing and sucking. Plantlice (figs. 31, 32), scale insects (figs. 3, 4), bed buds, plant bugs (fig. 28), etc., belong to this order. The butterflies and moths, scaly winged insects, are classed as *Lepidoptera.* These are harmless to vegetation in the adult stage, but many species in the larval (caterpillar) stage, then provided with biting mouth parts, are among our most destructive pests. The codling (fig. 40), gypsy, brown-tail and other moths are well known examples. The *Diptera* to which the mosquito, apple maggot (fig. 24), and house or typhoid fly belong, are two-winged when mature. The larva of the mosquito, so common in a rain water barrel, is known as a wriggler. while the corresponding form of the fly is known as a maggot. The plum curculio (figs. 25-27), the apple tree borer (fig. 1, 2), the blundering June beetle, and the potato beetle are members of the *Coleoptera,* insects having hard, shell-like fore wings which meet in a longitudinal line along the middle of the back. Both the larvæ (known as grubs) and the adults have biting mouth parts and in some species are equally concerned in the destruction of plants. Some lady-beetles on the other hand are beneficial because they feed on small injurious insects such as scales and aphids. Ants, bees, wasps, a host of species of minute 4-winged parasitic flies, as well as some injurious saw-flies are members of the order *Hymenoptera,* the adults of which are four winged. The larvæ, most of which are known as grubs or maggots, usually have well developed heads with biting mouth parts and frequently provided with legs.

While the foregoing classification is adopted in most text books, it is more convenient in dealing with the species of the apple to arrange them in accordance with the character of the injury they cause and to this end we will first divide them into 3 primary groups.

A. Injuring root, trunk or branch; borers and sap feeders. Page 3.

AA. Injuring the foliage; biting or sucking insects. Page 13.

AAA. Injuring the fruit; maggots, caterpillars, bugs and beetles. Page 46.

A. INJURING ROOT, TRUNK, OR BRANCH.

a. *Borers in the wood.*

A large white grub about 1 inch long when grown, with brown head; thorax not much thicker than the abdomen. Bores mainly at the base of the trunk. Its presence is indicated by the wood dust it throws out of its burrow. (fig. 1). *Round-headed borers.* Page 4.

A whitish grub about ½ inch long when grown, with flattened thorax about twice as wide as the abdomen. Works on the trunk and large branches. (fig. 2). *Flat-headed borers.* Page 7.

A very small larva which lives in small rounded "shot holes" about 1-16 inch in diameter. Adults are small brown beetles. *Shot-borer beetle.* Page 8.

b. *Scale insects and plantlice.*

Scale about 1-10 inch long on twigs; shaped like oyster shell. (fig. 3). *Oyster-shell scale.* Page 9.

A small circular scale with exuvial spot dark and central. (fig. 4). *San Jose scale.* Page 10.

A small circular grayish scale with exuvial spot a little to one side of the center. *European Fruit-tree scale.* Page 12.

An elongate scale dirty white in color. *Scurfy scale.* Page 12.

A brownish oval scale about the size of half a pea. *European Fruit Lecanium.* Page 12.

Plantlice with white downy secretion; cause wart-like swellings on roots, and also are found on the twigs. (figs. 34, 35). *Woolly aphid.* Page 13.

a. BORERS IN THE WOOD.

Round-Headed Apple-Tree Borer.

(*Saperda candida* Fab.)

Fig. 1; a, larva; b, pupa; c, adult. (After Riley).

The first intimation that the grower usually has of the presence of this borer in his trees is in their retarded growth and the sawdust-like castings, consisting of excrement and gnawings of woody fiber, which the larvæ extrude from the openings into their burrows. This manifestation is usually accompanied by more or less evident discoloration of the bark and, in early spring particularly, by slight exudation of sap.

The parent of this borer is a beautiful beetle, measuring from three-fourths to nearly an inch in length, the male being perceptibly narrower than the female. The legs are gray, the under surface of the body and the head are silvery white, and the upper surface is light yellowish brown with two longitudinal white stripes extending through the thorax and elytra or wing-covers to the tip, as is shown in the accompanying figure 1, *c*.

The larva, when mature measures from three-fourths to a little over an inch in length. It is legless, fleshy, and somewhat grub-like in appearance, cylindrical in form, and light yellow in color. The head is darker.

The pupa, illustrated at *b*, is nearly as long as the adult insect, which it resembles in a superficial manner, the head being bent down toward the breast, and the legs and long antennæ folded upon the ventral surface. Its color is similar to that of the larva.

The beetles make their first appearance of the season late in May or June, according to locality. During the night they come forth from the trunks of the trees in which they have bred, and at this time may be seen in flight.

Soon after their first appearance the sexes mate and eggs are deposited. The female first makes an incision in the bark—probably by means of her mandibles—causing it to split slightly; then, turning head upward, she places an egg under the bark nearly a quarter of an inch from the incision, accompanying the deposition by the extrusion of a "gummy fluid which covers and secures it to its place and usually fills up the aperture. In young trees with tender bark the egg is usually thoroughly hidden, while in older trees it is sometimes so shallowly imbedded as to be readily seen."

The larvæ, soon after hatching, tunnel under the bark and feed on the sap-wood, gradually working their way upward and afterwards downward, usually remaining within a short distance of, or below the surface of, the ground, particularly in young trees. By the end of the second year the larvæ have increased considerably in size and have now penetrated deeper into the solid heart-wood, their burrows being closely packed behind them with castings. The third year the larvæ gnaw outward to the bark, form a pupal cell composed partly of their castings and, with their heads pointing toward the bark, transform to pupæ. With the approach of May and June they cut their way out by means of their powerful manibles and issue through a round hole as mature beetles.

METHODS OF CONTROL.

After borers have once entered a tree there is no better remedy known than to cut them out with a knife or other sharp instrument. Cutting the borers out, unless practiced with the greatest care, is apt to result in injury, and it is far better to prevent the parent insects from depositing their eggs upon the tree. This is not difficult of accomplishment, as oviposition is practically confined to two months in any single locality, usually June and July. The best preventives are impenetrable substances placed about the trunk and various washes of a repellant nature.

For this a few thicknesses of newspaper wrapped rather loosely about the trunk and extending about two feet from the base are all that is necessary. This covering should be tied, by preference with cord, which will readily yield or break with the natural expansion of the tree in its growth, and also be tightly fastened at top and bottom and hilled up with earth so that the beetles cannot obtain access to the tree from below. From the top of this covering upward it is best to use some deterrent alkaline or carbolated wash.

Any one of several washes in general use against boring insects may be used as a deterrent. A good alkaline wash is prepared of soft soap reduced to the consistency of thick paint by the addition of caustic potash or washing soda in solution. A good fish-oil, or whale-oil soap, or common soft soap, is often used, and in some cases any one of these is sufficient to deter the insects from depositing their eggs. The alkaline wash may be carbolated, if desired, by the addition of crude carbolic acid, at the rate of 1 pint to every 10 gallons of the wash. Such a wash not only affords protection against this and other borers, but against scale and fungous diseases at these points, and is, moreover, of positive benefit to the tree. Caustic potash fish-oil soaps are among the best for insecticides.

Clean culture is an important measure as an accumulation of weeds or water-sprouts about the base of the tree constitutes a favorable situation for the females at egg laying time.

Flat-Headed Apple-Tree Borer.

(*Chrysobothris femorata* Fab.)

The adult insect (represented at *c*, fig. 2), measures from a little less to a little more than a half inch in length. It is flattened above, the upper surface of the body is dark metallic brown, and fresh specimens are coated here and there with a powdery gray substance, which is easily rubbed off. The wing-covers are ornamented as shown in the illustration, and underneath, as may be seen when the insect is in flight, the body is a bright metallic greenish blue. The under surface is coppery bronze.

Fig. 2; a, larva; b, pupa; c, adult. (After Riley).

The larva differs greatly from that of the round-headed borer. Its name, flat-headed borer, is derived from the peculiar flat expansion of the second thoracic segment—which is close to the head. In color it is light yellow and in length measures nearly twice that of the mature insect. It habitually rests in a curved position (fig. 2, *a*). The pupa (*b*) shows the form of the future beetle and is of the same yellow color as the larva.

This borer attacks diseased or dying trees by preference, inhabits all parts of a tree from the base of the trunk to the limbs, and is not restricted to fruit trees. In all these respects it differs from the round-headed borer, but agrees with the latter in that it is injurious chiefly to young trees, its injuries being practically confined to newly transplanted nursery stock and to trees which have been weakened through any cause, such as careless pruning, or insufficient nourishment due to poor soil or drought. Infestation may be detected by the discoloration of the bark.

REMEDIES.

The remedies advised for the round-headed borer are also of value and are generally employed against the present species.

It is necessary, however, that deterrent washes should be applied farther up the trunk and to as many branches as can be conveniently reached.

Careful cultural methods.—Careful, clean methods of orchard management are essential as a measure of protection, and involve the cutting out of dead, dying, and injured deciduous forest and shade as well as orchard trees known to be chosen as food by this species. Care should be exercised in transplanting, and especially in pruning; and fertilizers should be used in order that the trees may be thrifty and better able to withstand attack. Proper regard for these measures should give practical exemption from injury.

Shot-Borer.

(*Xyleborus dispar.*)

The female beetles bore into the wood, making deep channels which in small twigs interfere with the circulation of the sap, and the twigs wither, giving the appearance of blight. The holes through the bark are .06 of an inch in diameter and nearly circular, looking like small shot holes.

These beetles feed, both as larvæ and adults, on a peculiar fungus, known as ambrosia, which grows in their burrows. They are sometimes called wood stainers because the fungus blackens the surrounding wood.

When the larvæ are full grown they transform to pupæ in the burrows, and finally emerge as small beetles about one-tenth of an inch long and of a dark brown or nearly black color, with the antennæ and legs of a rusty red. The thorax is short, very convex, rounded and roughened. The wing covers are marked by longitudinal rows of punctures. The hind part of the body slopes abruptly. The beetles leave their burrows in June and July and deposit eggs before August.

REMEDIES.

The trees should be watched during the latter part of June and July and, if blighted twigs or diseased limbs are noticed, examine the branches for small pin holes; if found, the presence of this or some related species may be suspected. Badly infested trees or limbs should at once be cut far enough below the injury to include all the burrows, and burned, to prevent the beetles emerging and attacking new trees. As these beetles live in forest trees, orchards near timber are more liable to become infested.

In some localities good results have been reported from the use of a wash made of 3 gallons of water, 1 gallon of soft soap and ½ pint of carbolic acid, applied in June. The object is to have the liquid soak into the burrow and destroy the fungus upon which the beetles depend for food. Two or three applications at intervals of a few days seem advisable.

b. SCALE INSECTS AND PLANTLICE.

Oyster-Shell Scale.

(*Lepidosaphes ulmi.*)

This scale, which resembles an elongate oyster shell in shape (fig. 3, *b*) has long been known in this country, though believed to be a native of Europe. It is widely distributed and is exceedingly abundant in Maine. Besides seriously injuring apple trees, the twigs of which often densely covered by them, they

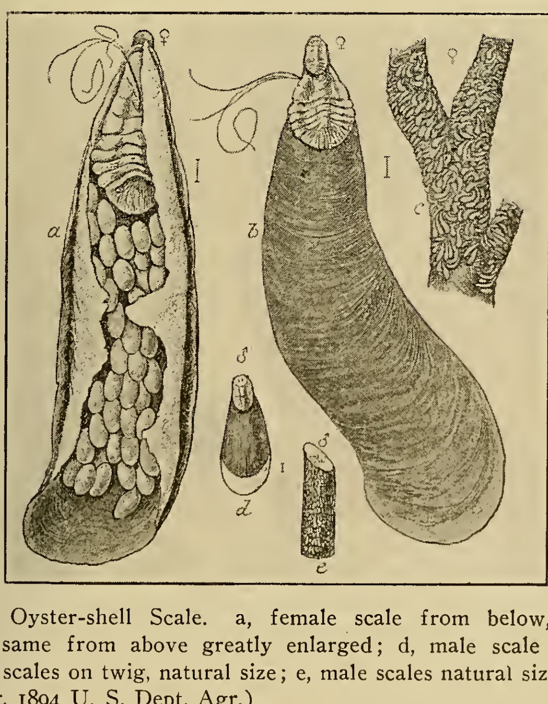

Fig. 3. Oyster-shell Scale. a, female scale from below, showing eggs; b, same from above greatly enlarged; d, male scale enlarged; c, female scales on twig, natural size; e, male scales natural size. (From year book, 1894 U. S. Dept. Agr.)

are found on the pear, plum, currant, dogwood, elm, maple and a number of other trees and shrubs.

In June the eggs hatch, the active young appearing as small white specks which soon attach themselves to new shoots by their beaks. The scale then begins to form, gradually increasing in size. The scale of the female (fig. 3, *a, b, c*) is less than one-eighth of an inch long, narrow, usually curved when not crowded, (fig. 3, *c*) and nearly the same color as the bark upon which it is found. The scale of the male (fig. 3, *d*) is much smaller, less curved and usually not found on fruit trees. As with the San Jose scale the adult male is provided with both wings and legs while the female, remaining under the scale, has neither. A fuller treatment of this insect will be found in Circular No. 121, Bureau of Entomology, which may be obtained upon request from United States Department of Agriculture, Washington, D. C.

REMEDIES.

This insect is quite resistant to the application of most sprays unless it be put on at the time when the young appear, before the formation of the scale. This is about the middle of June, though the exact date cannot be given as it varies with latitude and temperature. As soon as the young larvæ are observed an effective remedy will be found in "Black Leaf 40" tobacco extract, ¾ of a pint in 100 gallons of water, adding 3 pounds of soap to each 50 gallons.

The method of control found most practicable in commercial orchards is the thorough application of lime-sulphur (dormant strength) in the autumn after the leaves fall or in the spring before growth begins.

San Jose Scale.

(*Aspidiotus perniciosus.*)

The San Jose which is one of the worst insect pests of orchards in other states was discovered in the town of Limerick, Maine, in 1909. As there is always a danger of its introduction upon nursery stock from neighboring states, the observation of small circular scales about the diameter of a pin head (fig. 4) upon the twigs of fruit trees should immediately be reported.

FIG. 4. a, female, scale removed; b, cluster of scales; c, female scale; all greatly enlarged. (After Felt.)

The female scale is circular in outline, grayish or blackish in color, and when examined under a lens will be seen to be somewhat raised above the bark especially in the center where there is a little prominence. When the scale is somewhat rubbed the center portion appears yellowish, around which the concentric circles, representing lines of growth, may be seen (fig. 4, *c*). The full grown male scale is elongated, the prominence near one end and the lines of formation eccentric instead of concentric. If the scale be lifted by means of a needle, there will be seen a little yellowish body; the insect proper (fig. 4, *a*). The newly born insect of both sexes possess eyes, legs, antennæ and mouth parts, and crawl about for a few hours upon twigs. When a suitable place is found they settle, insert their long beaks through the bark and begin to suck the plant juice. The scale begins to form even before the young insect becomes fixed, and is at first pale grayish yellow, gradually becoming darker, the central projection usually remaining lighter colored. The insect under the scale now loses legs and antennæ, the female also losing her eyes. Later the male scale assumes an elongate oval shape, and later still, 3 or 4 weeks after birth, it again undergoes a transformation and appears as a mature insect with legs, antennæ, eyes and wings. The female matures in 5 or 6 weeks, remaining fixed in position under the scale, legless and wingless. There are several generations each season.

REMEDIES.

While there are a number of insect parasites which are natural enemies of the scale, chief reliance must be placed upon fumigation and spraying early in the spring before growth begins or in autumn after the leaves fall to keep it under control.

Lime-sulphur washes are to be recommended for sprays, while nursery stock imported from localities known to be infested should be fumigated. Complete directions for spraying will be found in "San Jose Scale and its Control" Circular 124, Bureau of Entomology. This paper may be obtained upon request by addressing "United States Department of Agriculture, Washington, D. C."

European Fruit Tree Scale.

(*Aspidiotus ostreaeformis.*)

The scale of female is circular or broadly oval in outline, dark ashy gray in color with paler margin; sometimes the scale is nearly white. The exuvia is usually not quite central, though nearly so, dark brown, usually naked and glossy.

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 single brooded.

Spraying with lime-sulphur late in the winter or early spring before the appearance of the leaves will control it.

Scurfy Scale.

(*Chionaspis furfura* Fitch.)

The female scales are grayish white and somewhat irregularly pear shaped. The male scale is smaller, snowy white, narrow, and usually straight.

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.

The remedial measures are the same as for the oyster-shell scale.

European Fruit Lecanium.

(*Lecanium corni* Bouché.)

This large soft brown scale occurs in many states on a very large number of shrubs, fruit and shade trees. One or two thorough sprayings with kerosene emulsion, diluted with 4 or 5 parts of water applied when the trees are dormant is recommended in certain localities for this scale.

Woolly Aphid of the Apple.

(*Schizoneura lanigera* Hausmann.)

White masses looking like patches of thick mold often occur on apple trees, especially about pruning wounds or other scars on the trunk and branches and upon water sprouts. Beneath this substance are colonies of rusty colored or purplish brown plantlice known as "wholly aphids" on account of the appearance of white covering which is, however, really composed of waxen filaments.

The species is common in Maine on hawthorn, mountain ash, and Baldwin and some other varieties of apple.

It is one of the migratory aphids and passes part of its life cycle upon the elm, as is explained in the following treatment. It should not however, be confounded with those woolly aphids found upon alder and maple, as the woolly aphid of the apple cannot live upon those trees.

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. 34 and 56.

On the roots its attacks induce enlargements 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. 35.

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, though it may be troublesome then, too. 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 growth of hard fibrous enlargements with the results in a year or two of the death of the rootlets and their ultimate decomposition with subsequent disappearance of the galls and also of the aphids, so that after this stage is reached the cause of the injury is often obscure.

On the trunks the presence of the aphids 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, even when insignificant, is useful as an indication of the probable existence of the aphids 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 aphids, 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. 56.

In August and later, among the wingless ones, winged females appear in abundance. They are little, clear-winged aphids which look nearly black unless carefully examined when the abdomen is found to be dark yellowish red or rusty brown. These are the fall migrants that leave the apple and seek the elm before giving 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 probably 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.

The beak punctures on the rapidly expanding new leaves cause an unevenness of growth which forms a protection for the aphid. By the last of May the earliest of these wingless stem mothers are mature and found in the deformed elm leaves (Fig. 57) producing the next generation.

These nymphs, like the stem mother, are a wingless form and they become fully developed about the tenth of June. Their progeny are the third generation and attain wings. These winged aphids are known as the springs migrants and desert the elm for the apple.

It takes three weeks or slightly more or less, beginning about the twentieth of June, for all the individuals of this third generation to get their growth so that the migration covers a considerable period. The deserted rosette or leaf cluster at this time looks like Fig. 58. During this time these winged aphids may be found alighting on the leaves of apple, mountain ash, and hawthorn. They creep to the under side of the leaf and remain there while they give birth to their progeny (i. e., the fourth generation). These young, before they feed at all, crawl to the stem of the water-shoots, or to some tender place on the bark often near a pruning wound, and there start the colony on the summer host plant. Such a young colony shown in Fig. 56, was on a mountain ash in Orono of which a record was kept during the season of 1912, at the Maine Agricultural Experiment Station.

Preventive and Remedial Measures.

The foregoing account of the habits and characteristics of the woolly aphid will suggest certain measures to control it.

With the knowledge that the source of danger lies in the migrants from the elm leaf, 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 plantlice, such as tobacco decoction, kerosene emulsion, a strong soap wash, 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.

An August spray to kill out colonies before the migrants fly and the hibernating young are produced is particularly desirable.

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 aphids removed.

Some nurseries are said to make a practice of "puddling" roots of infested stock, that is packing mud about the roots to conceal their condition. Before purchasing puddled nursery stock, the buyer should insist that the mud be washed off thoroughly so that the roots are exposed for inspection.

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.

AA. INJURING THE FOLIAGE.

(Divisions a, b, c, d, and e).

a. *Plantlice, small greenish, blackish or reddish lice-like sucking insects.*

Greenish plantlice in colonies causing leaf curl. (fig. 33).
Green apple-aphid. Page 20.

Reddish plantlice in colonies causing leaf curl.
Rosy apple-aphid. Page 20.

b. *Insects feeding freely upon the leaves without a nest and not concealed within leaf or bud.*

A "measuring worm" yellowish white beneath, broad lemon yellow stripe along the side, back with narrow crinkly black lines. *Lime-tree span-worm.* Page 22.

A "measuring worm" or looping caterpillar, when grown about 1 inch long; olive green when young, becoming yellowish or brownish when grown; with brownish longitudinal stripes and white band on sides; under side pale or flesh colored. (figs. 5, 6).

I. With 2 pairs of legs at rear of body.
Spring canker worm. Page 22.

II. With 3 pairs of legs at rear of body.
Fall canker worm. Page 23.

Very large hairless green caterpillar, 4 inches long when grown; body with several red, yellow and blue bead-like tubercles. (fig. 7). *Cecropia caterpillar.* Page 25.

A large black and yellow longitudinally striped caterpillar with yellow neck; very sparsely covered with long soft hairs. (fig. 9). *Yellow-necked caterpillar.* Page 26.

A caterpillar with black, white and yellow longitudinal stripes; head and fourth body segment bright red, with a number of stiff, blunt black spines. (fig. 10).
Red-humped caterpillar. Page 27.

A smooth mottled caterpillar; grayish brown above, gray-green beneath with yellow head. (fig. 55).
Mottled fruit caterpillar. Page 28.

Smooth light yellowish or apple green caterpillars with cream-colored stripe down middle of back and along each side. *Green fruit-worms.* Page 29.

Smooth greenish caterpillar 1½ inches long when grown, with various colored blotches and marks on the back. (fig. 11). *Saddled prominent.* Page 30.

Very small smooth greenish yellow caterpillars (½ inch or less), feeding upon upper surface of leaf. (fig. 14).
Apple-leaf Bucculatrix. Page 32.

Hairy caterpillar with four white humps of hair on the back, and black pencils of hair on head and tail. (fig. 15).

I. Head red. *White-marked tussock.* Page 33.

II. Head black. *Antique tussock.* Page 33.

Hairy caterpillar; ground color bluish with a single line of white dots on the back. (fig. 16).
Forest tent caterpillar. Page 35.

Hairy caterpillar, ground color brownish, with broken white stripes on each side when full grown; the young are in winter nests, they are brownish with 2 reddish dots on back. *Brown-tail.* Page 36.

Hairy caterpillar, ground color dusky; with 2 rows of red spots and 2 rows of blue spots along back and with dim yellowish stripe between them. *Gypsy.* Page 41.

Hairy caterpillars, when grown with long pencils of hairs at each end; when young only sparsely hairy.

I. Body white, black spotted, hair gray or white, with spreading tufts of white hairs and decorated down the back with a row of 8 black tufts. (fig. 17). *Hickory tiger.* Page 42.

II. Body black, body hair yellow; more or less black at ends. *Spotted tiger.* Page 42.

Hairy caterpillars with soft hairy lappets low on the sides; a black band between joints 3 and 4 which shows when walking; warts on joint 3. *Velleda lappet.* Page 44.

A long-legged yellowish brown beetle feeding on the foliage. (fig. 18). *Rose chafer.* Page 44.

c. *Caterpillars living in web nests or cases in spring or summer, or concealed in folded leaf or bud.*

Dusky yellowish, hairy caterpillar usually with broad dark stripe along middle of back; body hairs long and dark; in colonies. (fig. 19). *Fall web worm.* Page 47

Hairy caterpillar, ground color bluish, white stripe along middle of the back; in colonies. *Orchard tent-caterpillar.* Page 48.

Small bud-feeding caterpillar, with head and top of next segment black, body brownish. *Bud moth.* Page 50.

Small smooth olive greenish or brownish caterpillar, with yellow head, black dot on each side of segment behind the head; lives in folded leaf in fall. (fig. 22). *Leaf sewer.* Page 51.

Caterpillar living in small cigar-shaped case (or from fall to early spring a curved case) about ¼ inch long. (fig. 23). *Cigar case bearer.* Page 52.

d. *Conspicuous winter stages. Egg masses, cocoons, etc.*

A small clump of dried leaves firmly tied together with silk, fastened to the twig, concealing small dark living caterpillars within. (fig. 38). *Brown-tail moth nest.* Page 36.

A large spindle-shaped cocoon upon the twigs with a single large brown pupa within. (fig. 37). *Cecropia cocoon.* Page 25.

A flat, oval, tan-colored, felt-like mass attached to tree trunks, old boards and all kinds of rubbish. *Gypsy moth egg mass.* Page 41.

A band of eggs encircling a twig.

I. Egg mass with rounded ends. (fig. 36).

Orchard tent-caterpillar eggs. Page 48.

II. With square ends.

Forest tent-caterpillar eggs. Page 35.

Eggs adhering to a grayish cocoon; cocoon enclosing a brownish empty pupal skin. (fig. 39).

Antique tussock. Page 33.

A whitish frothy mass enclosing several layers of eggs adhering to a grayish cocoon, with empty pupal skin within.

White-marked tussock. Page 33.

e. *Microscopic creatures* causing reddish spots on the leaves more or less blister-like beneath. *Blister mite.* Page 53.

a. PLANTLICE.

Besides the woolly aphid which does its chief damage to the apple roots, several species of aphids attack the leaves, fruit and tender stems. These are minute insects about $\frac{1}{8}$ of an inch long. They pierce the tissue of the shoots with their beaks and suck the sap or infest the leaves causing them to curl, or become sickly. When they attack the growing fruit the apples are dwarfed and puckered, and often rendered unmarketable. Some species of these pass their whole life upon the apple while others spend part of the year on other plants. But as all the important species return to the apple twigs to lay eggs in the fall and as they resemble one another closely, both in appearance and manner of injury, it is not necessary to discuss more than two species here.

Aphids are frequently attended by ants which are attracted by honey dew, a sweet secretion of the aphids, and the presence of ants about the apple leaves is a pretty certain sign of aphid infestation.

Lady beetles (figs. 52, 53) both in the adult and larval stage feed greedily upon aphids and should not be mistaken for injurious insects. Syrphus maggots also are among the most beneficial insects in the State in this respect, as they destroy aphids in great numbers.

Green Apple Aphid.

(*Aphis pomi* De G.)

The body is pear-shaped, the colors being yellowish green, greenish, or darker, varying considerably in detailed markings and in the several generations.

Winter eggs (fig. 30) are deposited by the sexual females in the fall. They hatch in the spring, and, like the species next considered, the aphids developing from them cause a curling of the leaves. The green apple aphid infests the apple throughout the year. Upon the hatching of the winter eggs in spring a succession of agamic generations is produced, the earlier ones, except the first, with numerous winged individuals which migrate to other trees and establish new colonies.

Rosy Apple Aphid.

(*Aphis sorbi* Kaltenbach.)

The rosy apple aphid is readily distinguished from the preceding by its larger size, rounder body, and usually rosy color, which, however, may vary from salmon to tan or even to slaty gray or black, the body being covered with a whitish pulverulence.

Winter eggs are deposited in the autumn by sexual females, and more often on the trunk and larger limbs than with the other species mentioned. They hatch in spring as the apple leaves are pushing out, and the young aphids infest the young leaves and later the tender shoots and foliage, the latter thus becoming usually badly curled. Three generations from the egg are said to occur on the apple in the spring, many individuals of the second and third generations developing wings and migrating to other trees and to other host plants. After the third generation the apple is deserted by the insects until fall, when the return migrants appear and give rise to the true sexual forms, the females depositing eggs as described.

METHODS OF CONTROL.

Pruning.—As has been stated, the aphids under consideration pass the winter in the egg stage on the apple, the eggs being deposited more or less promiscuously over the more nearly terminal twigs (fig. 30). With young trees especially, which are seen to be heavily stocked with the eggs, the latter may be in part removed during the work of pruning, and the prunings should be collected and burned.

The insects in the egg condition are frequently distributed on nursery stock; therefore, if in planting trees this stock be well pruned and the prunings destroyed, the establishment of the aphids in young orchards may be often prevented or delayed.

Winter spraying for destruction of eggs.—When lime-sulphur is used for scale insects, some of the aphid eggs are incidentally destroyed. Experiments in certain localities on old trees where the rough bark affords protection, however, would indicate that a winter spray applied for the eggs alone is hardly warranted by results obtained.

Spring and summer treatments.—Effective work in controlling these insects may be done in the spring just after they have hatched from eggs and have collected on the tips of the buds showing green and while the buds are compact and before the aphids have an opportunity to seek the protection of unfolding foliage but are exposed on the surface of the buds. Trees seen to be badly infested at this time should be thoroughly sprayed, taking pains to wet as completely as possible all parts of the buds, twigs, and branches. However thoroughly the work may be done, some of the "lice" may escape destruction. A subsequent treatment in the course of a week should usually be made, especially if the first application is seen to have been unsatisfactory.

After the foliage is well out and more or less distorted from the presence of the aphids, effective spraying is quite difficult, since many of the insects are on the inner surface of the curled leaves. Much can be done however with high pressure and a drive nozzle.

Spray mixtures.—The lime-sulphur wash for the destruction of winter eggs is made according to the usual formula for the wash.

After the trees are in foliage, a more dilute contact insecticide must be employed, as black leaf 40 or other good tobacco decoction, kerosene emulsion, or whale-oil soap. Since aphids secure their food by sucking up sap from within the plant, none of the arsenical poisons would be effective.

b. INSECTS FEEDING FREELY UPON THE LEAVES WITHOUT A NEST AND NOT CONCEALED WITHIN LEAF OR BUD.

Lime-Tree Span-Worm.

(*Erannis tiliaria* Harris.)

Not uncommon on apple trees in Maine is this "loop worm" with a dull red head, body yellowish white beneath a broad lemon yellow stripe along the side and a yellow back with about 10 fine crinkly black lines running lengthwise.

This caterpillar is common upon the lime-tree or basswood, and will also feed upon the foliage of the apple, elm, and certain forest trees.

Upon the apple this species is often associated with the fall canker worm, which it resembles very much in its life history. It seems to remain and do damage when the fall canker worm has disappeared. When full grown, about the middle of June, they usually let themselves down by a silken thread, enter the ground about five or six inches and form a little oblong cell, within which they change to the chrysalis state. In October or November, (sometimes not until the following spring), the moths appear. The wingless females climb the trees or other objects where they meet the winged males, mate and soon deposit the eggs in flattened masses, usually upon the branches of the trees they have infested as larvæ.

REMEDIES.

The life history of this species is so nearly like that of the fall canker-worm that the remedies suggested for that insect are applicable to this. It is not so serious a pest as the canker-worm, but is capable of doing much injury to the foliage of apple trees, nevertheless.

Canker Worms.

1. SPRING CANKER-WORM.

(*Paleacrita vernata.*)

The male moths of this species have rather large, thin, silky wings, about one inch across when spread. The general color is bluish gray. A well defined row or band of light markings near the outer margin of the front wings, and three darker, irregular bands, across the same wings, together with the slightly lighter color and absence of markings on the hind wings, are characteristic features. The inconspicuous female moths are wingless and, because of this fact, the spread of the species is very slow, occurring mainly by the transportation of nursery stock infested with eggs.

The moths usually emerge from the ground early in the spring—about April, or farther south in March—and the females climb up the trunks of trees to deposit eggs. The eggs, which are shaped something like hens' eggs and are about the size of fly specks, are deposited in irregular masses, usually partially concealed by loose pieces of bark. They hatch about the time the leaves unfold; the time varying with the locality and the season. The larvæ are "measuring worms" with 2 pairs of legs at the hind end of body (fig. 5). The young larvæ

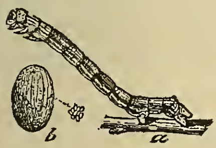

Fig. 5. a, larva, showing the two pairs of posterior legs; b, single egg, much enlarged. (After Riley).

are voracious feeders and they grow rapidly, usually attaining full size in from three to four weeks from the time of hatching. Upon reaching full size they drop to the ground, burrowing beneath the surface to a depth of two to five inches. Here each one forms a cell, lined with silk which it spins, and soon transforms to the chrysalis stage, where it remains until the following spring, when the adult moth emerges as before.

II. FALL CANKER-WORM.

(*Alsophila pometaria.*)

The fall canker-worm so closely resembles the other species as to be frequently mistaken for it. For all practical purposes they may be considered together, but the fall canker-worm is more distinctively a northern insect. As in the other species, the female moth is wingless, but in this species she lacks the hairiness which characterizes the other. The male moth has two light bands across the front wings instead of the single one of the preceding, and the rear wings are slightly shaded. The larvæ of this species also, besides having three pairs of legs under the hind end of the body, as shown in figure 6, have a broad, dark stripe along the back, as opposed to the narrow markings of the other species. The eggs, which are slightly larger than in the previous species, somewhat resemble small flower pots and are attached to the bark, in exposed situations, in masses of from 60 to 200, placed side by side as seen in figure 6, *e*. The eggs highly magnified, are shown in figure 6 *a*.

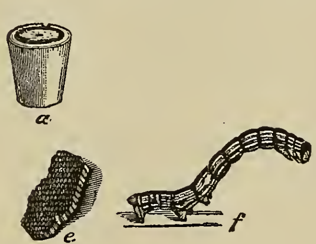

Fig. 6. a, single egg, much enlarged; e, egg mass; f, larva, showing the three pairs of posterior legs. (After Riley).

The eggs are deposited in fall or early winter (sometimes in mild winters as late as March). They hatch about the same time as those of the other species and the larvæ act in a similar manner, entering the ground about the same time. Instead of forming a cell lined with silk, however, this species spins a tough cocoon, and the moths come forth and begin laying eggs in October and November.

HOW TO FIGHT CANKER-WORMS.

One of the surest preventive measures is to place a band of tarred or other heavy paper about the tree in March and smear it with tree tanglefoot, thus preventing the ascent of the female moths and the deposit of eggs. A band 6 or 8 inches wide is sufficient and all roughnesses beneath it should be filled with cotton. If the fall canker-worm is present, of course the treatment must begin in October. If the trees are already attacked, jarring the limbs will cause many of the worms to spin a thread and drop to the ground. If the band of tanglefoot is in place they will be unable to return to the attack and may be destroyed.

Perhaps the best way of fighting this pest, however, is by spraying with arsenate of lead, giving one application just before the blossoms open and a second after the petals fall.

CECROPIA MOTH.

(*Samia cecropia.*)

The large gray or brown cocoon of the Cecropia moth is frequently found attached to the twigs of trees (fig. 37).

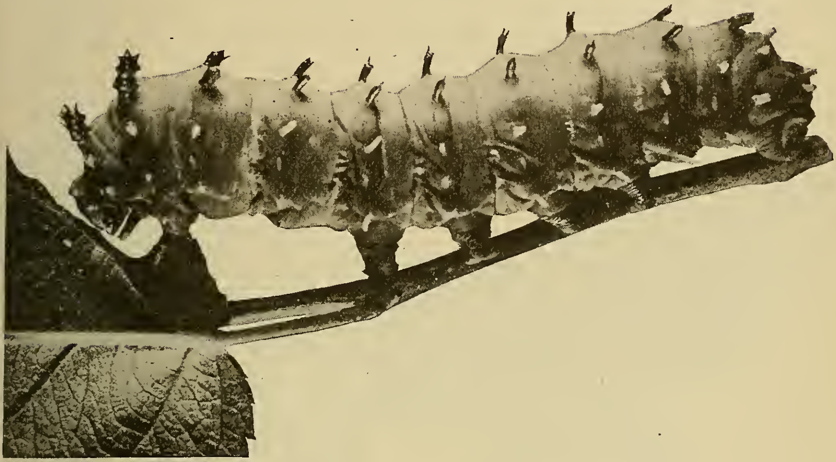

FIG. 7. (From Me. Agr. Exp. Sta. Circular).

These are spun late in August or September by a green caterpillar about four inches long. The body of the caterpillar is ornate with colored bead-like tubercles, the two pairs nearest the head being red with black spines, and the other dorsal tubercles smaller and yellow. Along the sides of the body the tubercles are bluish. (fig. 7).

After the cocoon is spun the caterpillar changes to the pupa, a dark brown object which may be found by opening one of the cocoons during the winter.

In the spring the insect breaks open the brown pupal skin and emerges from the cocoon as the adult insect, the largest moth in the state and one of the most beautiful. Its expanded wings measure about five and one half inches. In color the wings are brownish with a border of gray and submarginal lines of white and red. The form of the markings is better represented by the accompanying illustration than by a description.

The caterpillar is well attended by insect parasites and is devoured by birds. In this State it has not occurred to a troublesome extent and need not be feared as a pest, although it feeds on apple and various forest trees. No remedies usually seem necessary. If the caterpillars are found upon a small tree which they are likely to injure, hand picking will prove effectual.

Those who find the Cecropia cocoons during the winter are often interested to save them in a warm room for the sake of observing the beautiful moth which emerges (fig. 8).

Fig. 8. (From Me. Agr. Exp. Sta. Circular).

Yellow-Necked Caterpillar.

(*Datana ministra.*)

During the late summer the yellow-necked caterpillar is a common orchard pest in Maine.

The moth is tannish brown in color with head and the part of the thorax nearest the head a rich chestnut brown. Several dark brown lines cross the fore wings transversely. The hind wings are pale buff. The female moth deposits about 100 eggs in a cluster on a leaf.

The caterpillars which hatch from these eggs, attain their full growth in 5 or 6 weeks. They are then about two inches long. The head is black and the segment just back of the head is orange colored, a character which gives rise to the popular name "yellow-neck." The body is striped longitudinally with alternate yellow and black lines. Soft white hairs occur over the whole body but are too thin to be especially noticeable (fig. 9). Like the red-humped caterpillar, these caterpillars are clustered together both while feeding and when at rest. The caterpillars when at rest assume a characteristic and peculiar position on the branch with both extremities of the body raised. When alarmed they jerk their heads and tails in an irritated manner.

Fig. 9. (After Holland).

The full grown caterpillars bury themselves in the earth a few inches below the surface, where they transform into brown pupæ, unprotected by any cocoon. They remain in the earth all winter and emerge about the middle of the next summer, when they are transformed to the moth, or mature insect.

REMEDIES.

As in the case of the red-humped caterpillar, gathering the caterpillars by hand is the simplest remedy and perhaps the only one which it is necessary to recommend. The caterpillars are gregarious and the whole brood is easily removed from the tree and destroyed. Arsenical sprays will kill them, and may sometimes be a convenient means of combating them.

Red-Humped Caterpillar.

(*Œdemasia concinna.*)

During August, September and October, the red-humped caterpillar is one of the most troublesome orchard caterpillars in the State. Many correspondents reported that entire orchards of young trees were stripped of their foliage, except for the mid ribs of the leaves, before the presence of the pest had been discovered.

Fig. 10. (From Me. Agr. Exp. Sta. Circular).

The mature insect is an inconspicuous brown moth with wing expanse of slightly more than one inch. The female deposits eggs on the under side of a leaf in a cluster, usually during July. The young caterpillars, which soon hatch from these eggs, feed upon the tender tissues of the under side of the leaf, not attacking at first the upper surface. When they become larger they devour the whole leaf except the mid rib. They move in flocks, an entire brood feeding together and remaining in a cluster when resting. In the caterpillar or larval stage this insect is readily recognized. The body of the full grown caterpillar is marked with fine longitudinal stripes of black, white and yellow, and short black spines occur in rows. The head is bright red and the first segment of the abdomen, which is conspicuously humped, is of the same color (fig. 10). The caterpillars reach their full growth (about $1\frac{1}{4}$ inches) from August to late October. When full grown, they descend to the ground and hide under leaves or other rubbish and make a glassy transparent cocoon, within which they pass their pupal period. They remain in the cocoon all winter and emerge the following season as mature moths.

REMEDIES.

The red-humped caterpillars are not especially difficult to combat if a watch is kept for the colonies while they are young. As they are gregarious, it is a simple matter to clip off the small twig containing the whole brood of little caterpillars, or to crush them with an old cloth. When they are larger they can often be dislodged by jarring the branch and destroyed on the ground. Arsenical sprays will kill them.

Mottled Fruit Caterpillar.

(*Crocigrapha normani.*)

The eggs are laid in a mass flatly attached to the leaf. They hatch in mid-June in Maine. The larva is a smooth, hairless caterpillar, $1\frac{1}{2}$ inches long when full grown. Its head is shiny yellow with one dark blotch on each lobe. Its body is mottled grayish brown above, and pale grayish green beneath. The legs are pale. This caterpillar feeds both upon the foliage and the fruit. (fig. 55). The pupal stage is passed in the ground. It is a glistening brown object about $\frac{3}{4}$ inch long. The mature insect is a brownish moth expanding about $1\frac{1}{2}$ inches.

REMEDIES.

Arsenical sprays applied for other species will control this one also. As this caterpillar is very readily dislodged, jarring the tree and killing the insect on the ground is a convenient combative measure.

Green Fruit-Worms.

Xylina antennata Walker, *X. laticinerea* Grote, *X. grotei* Riley.

These three insects resemble each other so closely in appearance and habit that they can be treated under one heading. In the larval stage light yellowish or pale green caterpillars with cream colored stripes lengthwise their bodies, attaining from one to one and a half inches in length when full grown. When young they feed upon the leaves and buds and when they are about half grown they attack the green fruit in June while it is still small, eating into it much as does the mottled fruit caterpillar shown in Fig. 55. When full grown, late in June or early in July, they bury themselves in the earth where their pupal stage of about 3 months is passed. At the close of this transforming rest they emerge as moths which hibernate in the adult stage, laying their eggs the next spring on the bark.

MEANS OF CONTROL.

When the green fruit-worms are young and feeding on the buds and newly opened leaves, an arsenical spray or dilute lime-sulphur solution should destroy them. Later when they begin feeding on the fruit it is very difficult to kill them with poison.

Saddled Prominent.

Heterocampa guttivitta (Walker).

This species is well known in Maine because it has been excessively destructive to orchard and forest trees during some seasons. The full grown caterpillar is about 1½ inches long; body green usually, with reddish brown markings on the back, smooth and hairless (fig. 11). The mature insect is a moth expanding about 2 inches, ground color olive-greenish ashen with cream white patches and black markings (figs. 12, 13).

For Maine the saddled prominent has but one brood. The moths emerge in greatest numbers late in May and early in June. Oviposition begins soon after mating which occurs the first night after emergence. The eggs hatch in about 9 days and the larvæ become full grown in 5 weeks (or more according to weather conditions and food supply). During this time they molt four times. The full grown larvæ enter the ground for pupation. In Maine pupation takes place from mid July to late August, the majority of larvæ burying late in July. They pass the winter in the pupal stage, under the leaf mold, and the moths emerge in the spring.

The eggs are deposited singly by the female which in captivity applies the eggs to both sides of the leaf. From the reason that the *tops* of the trees are stripped first and then the lower branches it is to be concluded that the moths by preference deposit the eggs upon the upper leaves. Perhaps the same tendency to fly high may account in part for the fact that the hillside forests are in general more largely attacked than the lowlands.

The full grown larva drops or climbs to the ground and constructs a cell in the earth or under the leaves at a distance of 1 to 3 inches below the surface. This cell is oval and is lined by a thin spinning of silk.

The insect after remaining in the pupal stage all winter emerges with the warm spring days.

FIG. 11. (After Packard).

FIG. 12. Male. FIG. 13. Female.

(FIG. 12 and 13 from Me. Ag. Exp. Sta. Bul. 161).

COMBATIVE MEASURES.

For the orchard or shade trees there are several practical measures which have proven successful the past season in preventing serious injury from the saddled prominent.

Spraying.—This species is susceptible to arsenical poisons and the caterpillars readily died on apple trees which were thoroughly sprayed. Arsenate of lead will kill these caterpillars and should be applied as soon as they begin appreciable work. Applications from the middle to the last of June would probably get all these caterpillars which hatched upon the trees. In case a migration to an orchard from an infested forest growth is feared, the orchard should be sprayed as soon as the caterpillars begin to travel in search of fresh food; or if trees not already attacked are banded with a sticky substance, as for canker worms, the ascent of caterpillars up the trunk will effectually be prevented.

Jarring and banding.—The saddled prominents are readily shaken from the branches. The cool of the morning is the most propitious time for jarring. The caterpillars once dislodged, their reclimbing can be prevented by banding.

A material useful for this purpose is sold under the name of Tree Tanglefoot. This substance consists principally of resin softened by the admixture of suitable oils. It is quite similar to that used in the manufacture of adhesive fly-paper, and is very effective in checking the ascent of caterpillars when applied on bands of heavy paper to the trunks of trees. Where the number of caterpillars jarred from the trees is excessive it is expedient to kill them. A hand spray charged with kerosene or gasoline is a useful means to this end.

Fowls and Pigs.—Hens will devour these caterpillars greedily and if given the range of an orchard will eat great numbers of the caterpillars which drop to the ground or descend to pupate.

Pigs pastured in an orchard will, by rooting up and eating the pupæ, prevent great numbers of saddled prominents and other moths from emerging and depositing eggs for the following season.

Apple-Leaf Bucculatrix.

(*Bucculatrix pomifoliella.*)

The larva of this insect is about one-fourth inch long when mature, cylindrical, tapering at both ends. Joints of the body rounded and prominent, color dark yellowish, with a greenish tinge and reddish shades on the anterior segments. The larvæ are active and when disturbed suspend themselves by a silken thread.

The cocoon is dirty white, slender, about one-fourth inch long, ribbed longitudinally by about six prominent ridges, oblong, tapering at both ends, flattened on the side to which it is attached. Usually fastened to the twigs and branches in groups. (fig. 14).

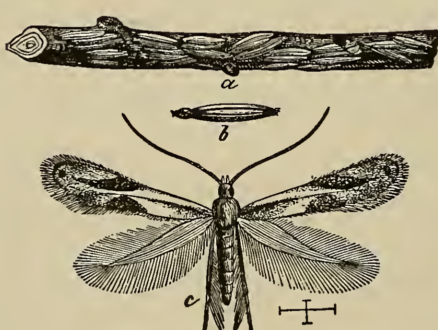

Fig. 14. (After Riley).

The small moth has only about one-fourth inch expanse of wings. Fore wings whitish, tinged with pale yellow and dusky brown. (fig. 14).

This insect spends the winter in the pupa state in the cocoon, usually attached to the twigs and branches of the host plant. About the time the leaves unfold, the moths come forth and lay their eggs upon the tender foliage. The larvæ are full grown in July.

In September or October the cocoons in which the pupæ spend the winter are formed. The larvæ feed externally upon the foliage, the upper epidermis and pulp eaten away in patches, the veins and lower epidermis intact.

REMEDIES.

Jar the trees when the larvæ are full grown and they will suspend themselves by threads and can be swept down by a broom and killed by hot water or crushed.

Apply sprays of kerosene emulsion or lime-sulphur wash in winter, to the branches that bear the cocoons.

Spray with arsenical poisons as for other leaf-eating insects in summer when the caterpillars are feeding.

Tussock Moths.

I. WHITE-MARKED TUSSOCK (*Hemerocampa leucostigma*).

II. ANTIQUE TUSSOCK (*Notolophus antiqua*).

The conspicuous white egg masses of these moths are deposited late in the summer or in the fall upon the cocoons from which the female moths emerge. As the hairy cocoons are commonly attached to the rough bark, or twigs of trees the caterpillars infest, the egg-masses are readily found at any time after the leaves have fallen. The eggs which the white-marked tussock deposits are covered with a white frothy substance which becomes brittle upon exposure to the air. The antique tussock does not protect its eggs in this manner but leaves them uncovered upon the cocoon (fig. 39).

The caterpillars which emerge from these eggs in the spring are most grotesque in appearance. The caterpillar of the white-marked tussock moth when full grown has a shiny coral red head beyond which extend two stiff pencils of black hairs directed forward like horns. A single pencil of similar construction supplies the other end of the body with a tail. Upon the middle of the back, starting a little behind the head, is a

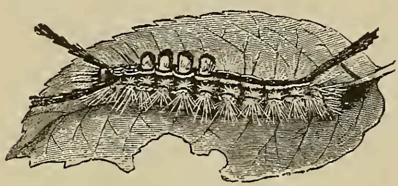

Fig. 15. (After Riley).

row of four regular tufts of soft whitish hairs which resemble small paint brushes neatly trimmed off at the tip. In a line with these but nearer the tail occur two little bright red tubercles (fig. 15). The full grown antique tussock caterpillar resembles closely the species just described. Its head, however, is jet black and it has an additional pair of black pencils, similar to though shorter than the horns, projecting from the sides of the body, which is lacking in the caterpillar of the white-marked tussock.

After feeding for four or five weeks the caterpillar becomes full grown and spins a rough cocoon of silk with which it mixes the hairs that have decorated its body. These cocoons are usually formed upon the bark or in the angles of twigs. Often a leaf is attached to the mass.

In about two weeks the adult insects emerge from the cocoons. The males are winged, the white-marked tussock having gray wings which expand nearly one and one-half inches and the antique tussock having smaller brown wings. The female moths of these two species are not readily distinguishable. They never acquire wings and their distended bodies are practically little more than animated sacs of eggs. The females being unable to fly and their bodies being too heavy for their slender legs to drag about, cling to the cocoons from which they emerge and soon after mating deposit about 300 eggs in a mass upon the cocoon.

REMEDIAL MEASURES.

The white egg masses deposited on the cocoons remain on the trees all winter. These are readily seen and can be removed and burned. Cocoons of the tussock not covered with eggs should not be disturbed as they are either the empty cocoons of males or cocoons containing parasites. If the cocoons are empty they can do no harm and if they contain parasites, these insect enemies of the tussock should be allowed to develop.

The fact that the females cannot fly makes this pest easily controlled locally, for the orchardist need not especially fear his neighbor's infested trees.

The caterpillars are susceptible to arsenical sprays and this means of combating them is sometimes necessary where the winter collecting has been neglected or when the tussocks appear in destructive numbers upon shade trees.

Forest Tent Caterpillar.

(*Malacosoma disstria.*)

The eggs of this insect are deposited in a belt encircling a small twig, about 200 in each mass. These egg masses resemble those of the orchard tent caterpillar, except that they are more nearly square at the ends. A glistening varnish-like protective substance is deposited with the eggs which renders the mass more readily seen in the sun.

The colonies of young larvæ do not construct tents as do the orchard tent caterpillar, but they are usually massed during dark or rainy weather.

The caterpillars resemble the orchard tent caterpillars, the most striking difference being that the cream colored line along the back is broken into a line of dots in the forest tent caterpillar while with the orchard tent caterpillar this line is unbroken. They grow to be about two inches long.

The full grown caterpillar constructs a filmy outer cocoon with an inner firm cell which it soaks with a yellow discharge drying to a pale yellow powder. These cocoons are often attached to buildings.

Moth.—In from 10 to 14 days after spinning the cocoon the adult insect emerges. This yellowish brown moth resembles that of the orchard tent caterpillar closely but the transverse bands on the wings are darker than the ground work of the wings instead of paler as with the other species. It is not practicable to combat the insect in this stage.

REMEDIAL MEASURES.

Arsenical sprays applied early in the season will satisfactorily dispose of this pest and for orchard or shade trees protected in this manner no other means are necessary. It is their custom to congregate in great masses on the trunks of the trees while they molt their skins. Here they may be destroyed by a stiff broom dipped in kerosene or swept into a pail of water and kerosene.

When not congregated for molting the older caterpillars when not feeding stretch out motionless along the branches or trunk and are difficult to see, especially as they are likely to choose the upper side of the branch.

However, it is not necessary to wait for the molting periods in order to combat the older caterpillars on trees which have not been protected by spraying. These caterpillars drop downward when disturbed. This habit leads to the suggestion that by a combination of jaring and banding much injury may be prevented. After the caterpillars are jarred from the tree the trunks of trees are painted with a band of "tanglefoot" such as is used against the gypsy caterpillar to prevent their ascending.

The egg-rings can be removed and burned at pruning time as they are easy to see.

Fig. 16. Forest Tent Caterpillar. (From Me. Ag. Ex. Sta Circular).

Brown-Tail Moth.

(*Euproctis chrysorrhœa.*)

The caterpillars of the brown-tail moth are capable of ruining orchard, shade and many woodland trees. They are also a dreaded nuisance because the caterpillar hairs break off, and on coming in contact with the human skin, cause extreme irritation and often illness.

So serious a pest should be known by every one in the State, because although extermination of this insect may not be possible, much practical and effectual work can be done in holding it in check and reducing its numbers so that damage to orchard and shade trees may be very slight.

The moths, expanding from one and one-fourth to one and three-fourths inches, are white except for the abdomen, which is tinged with brown and tipped with a tuft of brown hairs. This tuft is small and dark in the male, but the large golden-brown tuft in the female is conspicuous enough to be the most striking characteristic of the moth, and has won for this insect its descriptive name of "brown-tail." These moths are on the wing in July, and unlike some closely related pests, the brown-tail females as well as the males are strong fliers. They are active at night, and as lights have an attraction for them, they sometimes fly a long way toward a lighted district.

The female usually selects a leaf near the tip of the branch on which to deposit from one hundred and fifty to three hundred eggs. Some of the brown hairs from the abdominal tuft adhere to the egg-mass and give it the appearance of a brown felt lump.

By the middle of August most of the eggs are hatched and the young caterpillars spin a slight web over the leaf near the egg cluster. When they have eaten all but the skeleton of the first leaf, they draw another into the web and repeat the process at intervals during the late summer. They feed slowly, however, and spend so much time spinning their web that they do comparatively little damage to the trees in fall, and they are still very small (about one-fourth of an inch in length) when cold weather comes on.

The winter nests.—(Fig. 38). In the fall the young caterpillars weave additional layers of silk about their retreat, fastening it securely to the branch by the web, and pass the winter thus in colonies of one hundred and fifty to three hundred in a single nest. This is a very unusual yet most commendable habit in a caterpillar pest, for they can be killed, hundreds at a time, simply by burning the nests in which the colonies hibernate. The nests, composed of leaves, bound firmly together by a silken web, are varied in shape. In spite of the superficial variety the essential characteristics of the brown-tail moth nests are soon learned, and even anyone unfamiliar with the nest can make himself perfectly certain if he will cut carefully into the nest. *If the structure contains one or more silken cells filled with tiny living caterpillars it is the winter nest of the brown-tail moth.*

Early in the spring the young caterpillars emerge from their winter nests and feed upon the opening leaf buds. Until about the middle of June they feed greedily upon the leaves, completely stripping the trees where they are numerous. When full grown the caterpillars are about one and one-half inches long. They are dark brown with a sprinkling of orange. Long fine reddish-brown hairs cover the body, and a row of conspicuous white hairs run along each side. Like the caterpillars of the tussock and gypsy moths, they bear bright red tubercles on the top of the sixth and seventh abdominal segments.

Poisonous qualities of the caterpillars.—Were the caterpillars to be feared only for their ravages upon orchard and other trees, the situation would be alarming enough, but not less serious is the physical discomfort experienced by people living in infested districts. When the minutely barbed hairs of the caterpillar come in contact with the skin they cause an eruption similar to and in many cases worse than ivy poisoning. These hairs are brittle and where the caterpillars are numerous few people are likely to escape, as the caterpillars drop from the branches and creep about, even entering houses. Direct contact with the insects themselves is not necessary, however, for when the caterpillars shed their skins the molts are blown about, widely scattering the barbed hairs.

The caterpillars are usually full grown in June. They then spin loose cocoons, attached commonly to leaves, though sometimes other shelter is sought. Within these they transform to brown pupæ about three-fourths of an inch long. From the first to the twentieth of July the moths with pure white wings and brown-tipped abdomens emerge from these cocoons to deposit eggs for the next generation of caterpillars.

REMEDIAL MEASURES.

Destruction of breeding places.—Old and worthless orchard trees, wild cherry tangles and other susceptible trees in infested regions should be cleared away, thus lessening the labor of direct search for the destruction of winter nests, by eliminating likely breeding places.

Cutting and burning the winter nests.—This has been the most important of the direct remedies because it is cheap and, if thoroughly done, a sufficient protection against the ravages of this pest. The webs and leaves that compose the nest are woven tightly to the tips of the branches and hang there like dead leaves all winter. With so many months for inspection there is no excuse for harboring the hibernating caterpillars on shade or orchard trees.

PROTECTING THE PARASITES.

The United States government has at a great expense and a tremendous amount of painstaking labor imported, bred and liberated many parasitic enemies of the brown-tail and gypsy moths, six or more species of which hibernate during the winter in the winter nests of the brown-tail moth.

Any one in Maine collecting the winter nests of this pest can have a share in the work of preserving and distribution of the beneficial parasites at the expense of very little trouble if he so desires.

The method of destroying the brown-tail nests in midwinter while effective in killing the caterpillar, also destroys 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 nests should be removed from the orchard or shade trees during the winter but should be held and kept under outdoor conditions until the first warm days of spring when both parasites and caterpillars become active. 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 tree tanglefoot, or some similar sticky preparation so that the emerging caterpillars can be caught in their attempt to escape. It might be well to tie a wad of cloth around the outside of the barrel in a band and keep this sticky with tree tanglefoot.

This method of dealing with the nests while destroying the caterpillars gives at the same time a chance for the parasites to fly away and continue their natural depredations on the brown-tail moths. The parasite, a small shiny, dark, four winged fly about 3-16 of an inch in length, could fly off unharmed if the tanglefoot is not placed in the upper rim of the barrel. It is suggested that these barrels be placed in the vicinity of woodlots in which browntail nests are known to be present.

Gathering and burning the eggmasses.—During the July flight and the egg laying period the conspicuous brown egg masses can be removed by picking the infested leaves and burning them. No other treatment for very small trees would be necessary.

Spraying.—In August when the newly hatched caterpillars are young they can readily be killed as they are at this time especially susceptible to the poison. Some years the browntail caterpillars feed late into the fall, many becoming half grown and working about the fruit as well as the leaves. This experience leads us to emphasize the need of an August spray for this pest for while the species normally forms its winter nest while tiny and before it has fed more than a few weeks this habit has many exceptions and the late feeding on trees in fruit is a serious menace on account of the poisonous hairs shed by the caterpillars. It is less satisfactory to spray in the spring as the caterpillars if numerous eat the tender leaves as fast as they unfold. Then, too, the leaves are constantly expanding in the spring, and fresh unpoisoned leaf surface is exposed soon after a spray has been applied. Thus one August spray will do what it would take several applications to accomplish in the spring. The older caterpillars in the spring are less susceptible to sprays.

There is, however, no excuse for an orchardist having brown-tail caterpillars on his trees in the spring because even if he neglects the August spray he has all winter in which to gather the nests.

Although there is nothing spectacular in collecting inactive egg masses, August spraying, or gathering winter nests, we should not lose sight of the fact that a single egg mass or a single winter nest means from 150 to 350 moths on the wing next July, and that one August spray in the fall for a tree with 1000 egg masses, no uncommon occurrence in thickly infested regions, prevents 300,000 moths more or less, taking flight the next season.

Gypsy Moth.

(*Porthetria dispar.*)

Unlike the brown-tail moth, the gypsy moth winters in the egg stage. Although winged, the female gypsy moth does not fly, but deposits the eggs in any convenient place to which it can crawl. The egg masses are most commonly attached to the bark of trees but they are also found in such places as under edges of stones, beneath fence rails, on buildings, and in old cans and rubbish. The eggs are laid in July and August in a mass of 400 to 500. They are covered with tan colored hairs from the body of the female moth, and form an irregular oval mass. As the eggs do not hatch until about May 1, eight months at least are available for their destruction.

The young larvæ or young caterpillars are dark in color and well furnished with dark hairs. The full-grown larva is between 2 and 3 inches long, dark brown or sooty in color, with two rows of red spots and two rows of blue spots along the back, and with a yellowish but rather dim stripe between them. The body generally is clothed with long hairs, and sometimes reaches the length of 3 inches.

The larvæ usually become full grown about the 1st of July, and then transform to pupæ. The pupæ are found in the same situations as those we described for the egg clusters, but are found also in the foliage of trees and shrubs.

The male moth is brownish yellow in color, sometimes having a greenish brown tinge; it has a slender body, well-feathered antennæ, and a wing expanse of about an inch and a half. The forewings are marked with wavy zigzag darker lines. It flies actively all day as well as by night.

The female moth is nearly white, with slender black antennæ, each of the forewings marked with three or four zigzag, transverse, dark lines, and the outer border of both pairs of wings with a series of black dots. The body of the female is so heavy as to prevent flight.

REMEDIAL MEASURES.

Killing the Eggs.—No single method of destruction against the gypsy moth is more effective than killing the eggs. The egg masses, wherever accessible, can be destroyed from August to May by soaking them thoroughly with crude coal-tar creosote to which a little lamp black is added as a marker. The creosote may be applied with a small swab or paint brush. It is not safe to attempt to remove the eggmasses as they crumble apart when touched and some of the eggs are thus scattered and left to hatch unharmed.

The caterpillar when very young can be controlled by a spray of arsenate of lead, 10 pounds in 100 gallons of water. If the caterpillars are half grown 15 pounds may be required.

Tiger Moths.

I. HICKORY TIGER MOTH (*Halisidota caryæ*).

II. SPOTTED TIGER MOTH (*Halisidota maculata*).

These two closely related insects are so similar in habits and are so commonly associated in Maine orchards that they may be discussed together.

The hickory tiger caterpillars are, when full grown, covered with spreading tufts of white hairs and decorated down the back with a row of 8 black tufts. The fourth and tenth segments each bear two long slender pencils of black hair.

The caterpillar of the spotted tiger moth is yellow and black, these colors occurring in widely variable proportions. Sometimes the whole body is covered with yellow hairs in which case there is a row of 8 tufts of black along the back as with the hickory tiger. Often, however, both ends of the caterpillar are covered with black hairs with scattering pencils of white and the yellow hairs are limited to the central portion of the body. Both the hickory tiger and spotted tiger caterpillars have jet black heads and legs.

The young tiger caterpillars are only sparsely supplied with hairs and bear very little resemblance to the fuzzy full grown ones. They are gregarious when young and at first their presence may be detected by skeletonized leaves but later the colony scatters and the caterpillars feed separately, eating the whole leaf substance. If they are disturbed they curl up like a hedgehog and drop to the ground. The hairs are easily brushed from the body of these caterpillars and cause, upon contact with sensitive skin, an irritating itching sensation.

FIG. 17. Caterpillar of hickory tiger moth. (From Me. Agr. Ex. Sta. Circular).

They feed until they are nearly one and one-half inches in length and then they leave the trees and seek suitable shelter for their cocoons, the sides of buildings often being selected. The cocoons are oval, snug little objects less than an inch long and are composed almost entirely of the hairs which have covered the caterpillars, closely felted together. Within the cocoon the insect remains all winter—as short, thick, rather blunt brown pupæ.

The winged moths emerge from the cocoons in June and deposit their egg clusters upon some suitable food plant. The hickory tiger moth is pale buff. The fore wings are thickly sprinkled with little brown dots and set with irregular yellowish white spots. The hind wings are unmarked. The spotted tiger moth resembles the related species closely, but the spots are variable in size and number.

REMEDIAL MEASURES.

Arsenical sprays will poison these caterpillars. However, where trees are carefully watched, the colonies of the tiger caterpillars could be easily removed by hand while they are young and congregated together. Sometimes, too, it is possible to get rid of them by jarring them off on to a sheet. Where they form cocoons along the edges of clapboards and in other crannies about buildings, much can be done by sweeping down the cocoons and destroying them.

Velleda Lappet Moth.

(*Tolype velleda.*)

The larva of this insect is remarkable for having on each side of each segment a little lappet or flat lobe; from these many long hairs are given out, forming a fringe to the body. It is bluish gray, with many faint longitudinal lines; and across the back of the last thoracic segment there is a narrow velvety black band. When at rest the body of the larva is flattened, and the fringes on the sides are closely applied to the surface of the limb. The larva is full grown during July. The cocoon is brownish gray, and is usually attached to a branch of the tree. The body of the moth is milk white with a large blackish spot on the middle of its back, the wings are a soft bluish gray crossed by white lines. The moths have an expanse of wing ranging from 1¼ to 2 inches.

REMEDIAL MEASURES.

It is rarely necessary to apply repressive measures. Arsenical sprays will control these insects, if abundant enough to prove troublesome.

Rose-Chafer.

(*Macrodactylus subspinosus* Fab.)

The rose-chafer (fig. 18), a long-legged beetle of a light yellowish brown color, and about a third of an inch in length, appears in June, the date varying somewhat according to locality and season, and the beetles mate and begin feeding soon after they emerge from the ground. For from four to six weeks after their appearance they continue feeding, almost constantly paired. The female deposits her eggs singly, from twenty-four to thirty-six in number, a few inches beneath the surface of the earth, and in about two or three weeks' time they hatch and the young larvæ or grubs begin feeding on such tender rootlets, preferably of grass, as are in reach. In autumn they have reached maturity. They are yellowish white in color, with a pale brown head. Late in autumn they descend lower into the earth, beyond the reach of frost, and in early spring they ascend, and each grub forms a little earthen cell in which it passes the winter. Later in the spring, in April or early May, they transform to pupæ, and in from two to four weeks afterwards the beetles emerge, dig their way out of the ground, and the destructive work is renewed. A single generation of the species is produced in a year, and about three weeks is the average duration of life for an individual insect.

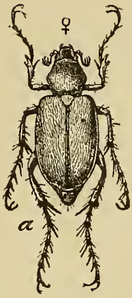

FIG. 18. (After U. S. Div. of Entomology).

The beetles do not confine their ravages to any particular portion of a plant, but consume blossoms, leaves, fruit, and all alike (fig. 41, 42). Whole orchards are often devastated, and the fruit crop of large sections of country destroyed. It is no uncommon sight to see every young apple on a tree completely covered and obscured from view by a sprawling, struggling mass of beetles.

REMEDIES.

The rose-chafer is one of our worst insect enemies to combat successfully.

The beetles are said to dislike ordinary arsenical sprays and avoid sprayed foliage. Experiments in New York, however, resulted in killing the beetles with a spray of 8 pounds of arsenate of lead to 100 gallons of water sweetened with 2 gallons of molasses, as this proved attractive and was readily eaten.

They may be jarred from trees on to sheets saturated with kerosene, but these methods are tedious and must be practiced daily in early morning or toward sundown to be effective.

Small orchards may be protected, at least from the first arriving hordes of the chafers, by planting about them early flowering plants that particularly attract the beetles. Spiræas, Deutzias, Andromeda, magnolias, blackberries, and white roses are especially useful as counter-attractives. The beetles swarm on the flowers of these plants in preference to many varieties of fruits, and when thus massed in great numbers, their destruction by the use of collectors or other mechanical means is greatly facilitated. All ground which might serve as a breeding place and which it is possible so to treat, should be plowed and harrowed early in May for the destruction of the larvæ or pupæ.

c. CATERPILLARS LIVING IN WEB NESTS WHILE THE TREE IS IN LEAF, OR MORE OR LESS CONCEALED IN FOLDED LEAF OR BUD.

Fall Web Worm.

(*Hyphantria cunea.*)

Fig. 19. (After Riley).

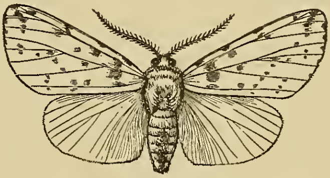

Fig. 20. (After Howard).

The mature insect is a moth with a wing expanse of about $1\frac{1}{2}$ inches. It varies much in coloration but the most common form is white or slightly fulvous with white wings. The wings may be pure white or dotted with black and brown. In the spring the moths emerge from the cocoons in which they have passed the winter and the female deposits eggs upon a leaf in May or June. Each moth lays about 400 eggs from which hatch minute caterpillars in 10 days or more according to weather conditions. These caterpillars remain together and cover themselves with a small silken web. As they grow, more and more leaves are drawn into the web which may in time include the leaves of several small branches or all upon a large branch. Such webs sometimes attain dimensions of several feet and are conspicuous and unsightly masses.

If they are so numerous on one tree that the food supply gives out they leave the web and seek other trees. Otherwise they remain until they are full grown (a little more than an inch in length), when they drop to the ground and seek a place where they may make cocoons. Recesses which attract them for this purpose are crevices in bark, spaces under boards or door steps, or near the surface of the ground in rubbish. These insects pupate within thin, almost transparent cocoons and remain in them all winter, emerging as mature moths in the spring.

REMEDIAL MEASURES.

Trees well protected with arsenical sprays will not need other treatment for fall web worm, for the poisoned leaves will be drawn into the web for food. In many cases the simplest means for combating them is to keep close watch upon the trees and clip off and burn the web when it is still small. Even the full sized web can be pruned off from trees not valuable, but in the orchard there is, of course, no excuse for allowing them to remain until large branches are involved in the web. The web may be effectually drenched with a strong washing powder solution or kerosene emulsion, during the day when the greatest number of caterpillars are within.

Orchard Tent Caterpillar.

(*Malacosoma americana.*)

Encircling the twig of apple, plum, and wild cherry trees is frequently found a glistening brown mass about three-fourths of an inch in length (fig. 36).

From such an egg cluster hatch in the spring from two hundred to three hundred caterpillars, which live in a colony and construct a whitish tent-like web in the angle of two convenient branches. It is the habit of the tent caterpillars to pass their time when not feeding, particularly at night and during cold or stormy weather, within the tent which they enlarge as their own rapid increase in size calls for more room. During the warm sunny hours of the day they leave their protection and feed voraciously, defoliating the branches in the vicinity of the tents. One colony is enough to denude a young tree or several large branches of an old tree.

The tent which is at first a delicate filmy silken web becomes by the time the caterpillars are full grown a structure two feet or more in length, unsightly with the accumulation of molted skins and other rubbish.

The full grown caterpillar is nearly two inches long. It is slender, dark, and velvety with numerous soft golden brown hairs upon the body. A white stripe marks the middle of the back, while the sides are streaked irregularly with white or yellow. Along each side of the dorsal white line is a row of transverse pale blue spots.

After feeding for four or five weeks the caterpillars leave the tree in search of a sheltered place for their cocoons, a crevice in the bark, the eaves of buildings, or rubbish piles, proving attractive for this purpose. The cocoon is an elongated oval with the outer silk delicate and loosely woven and the inner part firmer and close. The inner cell is painted on the inside with a thick yellow liquid which soaks through the cocoon and soon dries to a yellow powder.

The insect remains in the cocoon from two to three weeks, when it emerges as a brown moth expanding about one and one-half inches. The fore wings are crossed obliquely by two pale lines. The general color of the moth varies from buff to reddish brown in different individuals.

FIG. 21. Female moth photographed in resting position, slightly enlarged.

REMEDIES.

This insect is so easy to combat that its presence to any great extent in an orchard is due largely to negligence. During the bright days of winter and spring the egg-rings are readily detected on young twigs as their varnished surfaces glisten in the sun. These should be removed and burned at pruning time.

Since the caterpillars often congregate in their tents at night and usually during stormy weather they can frequently be destroyed, the whole colony at once, by soaking the tent with kerosene emulsion, or soap or washing powder suds. This may be applied by a swab attached to a pole, any time when the whole family is "at home."

Arsenical sprays will kill the caterpillars and may be applied to the branches near the tents. Trees sprayed early in the spring for the bud moth and other early caterpillars will be sufficiently protected against the tent caterpillar also.

Bud Moth.

(*Tmetocera ocellana.*)

This is probaly one of the worst pests to apple orchards in Maine. It works in the unfolding flower and leaf buds of orchard trees, often doing great damage to the crop, besides attacking nursery stock and young trees.

The half grown, brown hibernating caterpillars usually emerge from winter quarters about the time the buds begin to expand, their first appearance depending on the advance of the season, and ranging over two or three weeks. When they are out early, they gnaw into the buds. If the buds are open they crawl inside. They attack both flower and leaf buds, fastening the parts together with silken threads forming a nest, within which they feed upon the enclosed tender flower or leaf parts. They do not confine their depredations to a single leaf or flower in the bud, but increase the injury done by sampling nearly all. They sometimes bore down the stems a few inches, killing the terminal shoots. The bud attacked turns brown, making the nest conspicuous. The caterpillars feed mostly at night for 6 or 7 weeks and moult 3 times. When full grown the caterpillar forms a tube out of leaves, which it lines with thin, closely woven silk, and within it soon changes to the pupa. In about 10 days the pupa works its way nearly out of the tube by the hooks on its back. The skin splits open and the moth appears. The moths are on the wing during the latter part of June and the first of July. They fly mostly at night, resting on the trees during the day time, when they may be easily recognized by the white bands on the ash colored wings. The moth has a wing expanse of 3-5 of an inch. They live 2 or 3 weeks, during which time they mate and the eggs are laid. The eggs, which resemble small fish scales, are laid singly or in clusters, mostly at night, on the under side of the leaves. The eggs hatch in 7 to 10 days. The young larvæ feed upon the epidermis of the leaf, forming a silken tube for protection. After the fourth moult, which occurs the last of August or the first of September, or before the leaves fall, they leave the silken tubes and form a silken winter home (*hibernaculum*) on the smaller twigs near the buds, in which they spend the winter. The appearance of the hibernating larva in the spring completes the cycle of life.

REMEDIES.

Pull off and burn the withered clusters of leaves containing the caterpillars and chrysalids early in spring. Spray with arsenate of lead when the flower clusters first appear and again just before the blossoms open. A third spray just after the blossoms drop is sometimes necessary.

Leaf Sewer.

(*Ancylis nubeculana.*)

The leaf is folded along the mid rib, the two sides being brought together, the caterpillar constructing its nest within (fig. 22). The winter is passed in the larval condition in the folded leaves which lie on the ground. In April the larvæ transform to pupæ and about 10 days later the moths begin to appear, laying eggs in June. The caterpillar is about $\frac{1}{2}$ inch in length when full grown, yellowish green, with yellow head, and horny shield on the next segment a little darker, with a black dot on each side. On each of the remaining segments there are some pale, shiny, raised dots (tubercles) from every one of which arises usually a single hair.

Fig. 22. (From Me. Ag. Exp. Sta. Bul. 177).

In the perfect state this insect is a small white moth with brown markings with an expanse of wings of about $\frac{3}{4}$ inch.

REMEDIES.

When the injury to the tree is serious the fallen leaves may be raked up and burned in the autumn to restrict the development of the moth the following season.

Well cultivated orchards have little to fear from this insect.

THE CIGAR CASE-BEARER.

(*Coleophora fletcherella.*)

The caterpillars infest mainly the leaves, but in the spring they may also be found on the buds and the young fruits. The full grown caterpillar is reddish orange and averages 1-5 of an inch in length. The case, as it is made in the fall, is a minute flattened curved structure composed of portions of the upper and lower skins of the leaf. In the spring a second case (fig. 23) is made, which is longer, cylindrical or cigar-shaped, in which the larva pupates. The adult insect which emerges from the pupa during June and July is a small, steel gray moth expanding less than ½ an inch.

FIG. 23. (After Slingerland).

REMEDIES.

This insect can be kept in check by arsenical sprays, the first to be applied as soon as the cases are noticed on the opening buds. A second and perhaps a third application may be necessary at intervals of 4 to 7 days on badly infested trees.

Leaf Blister Mite.

(*Eriophyes pyri.*)

Nearly 20 per cent of the inquiries which reached the Department of Entomology of the Maine Agricultural Experiment Station from about the middle of July to the middle of August concerned the work of the leaf blister mite on apple. For the most part this work was not unnaturally mistaken by the people collecting it for some fungus disease, as the blotches on the leaves resemble somewhat the injury caused by leaf-spot fungi. The mites themselves are so small that they are invisible to the unaided eye, and although they can be seen as moving specks with a good hand lens, it takes a microscope to give any real idea of their appearance.

They are not insects in the true sense of that term, but belong to the same class of animals as the spiders. They are whitish elongate little creatures about 1-125 inch in length and live within the tissue of the leaf, developing their colonies there within the blister or "gall" which the irritation of their presence causes. In winter they seek the protection of the scales in the leaf buds.

They are, indeed, among the smallest animal forms which attack our crops, but they frequently occur in such abundant colonies that the damage they do to the leaf is very conspicuous. This injury may first be noticed in spring when it appears as reddish or yellowish green raised spots or blisters on the leaves; but it is not until much later in the season that it attracts general attention, and by this time the blister spots are brown, giving the leaves a diseased appearance. If the attack is severe the foliage is likely to fall prematurely and dropping of the fruit sometimes results.

There is no remedial measure applicable at the time of the year when the damage is apparent and by winter the work as well as the mite being out of sight, the trouble is likely also to be out of the mind of the orchardist.

The leaf blister mite, however, yields readily to treatment either by miscible oils and home-made oil emulsions or lime-sulphur. Trees sprayed with lime-sulphur for other purposes do not need especial treatment for the blister mite. When this remedy is applied for the blister mite alone a dilution of one part to ten of water is sufficient when the concentrated solution tests 31 degrees Beaume. This insecticide may be applied either in the fall after the leaves have fallen or in the spring anytime before growth starts. The reason that a dormant spray is effective is that the adult mites hibernate under the bud scales, and a thorough spray, which should coat the tree completely, will kill them, thus preventing their injury the following season. When once reduced in numbers, the mites do not ordinarily gain ground rapidly and control measures are not required every year. The orchardist himself can judge as to when the damage is severe enough to make treatment advisable, if care is taken to ascertain whether the leaf injury is due to mites, leaf-spot fungi or spray injury.

Spraying for the leaf blister mite has passed the experimental stage and the satisfactory results of this treatment have been demonstrated many times in large commercial orchards. Judging from the appreciative letters of thanks received by this Station from people who used lime-sulphur at our recommendation, this spray evidently is as efficient under Maine conditions as elsewhere. The leaf blister mite is widely spread and seriously abundant here and any earnest orchardist who has had a heavy infestation of this pest during the summer just past would do well to give it the attention of a thorough spray as a part of his fall or early spring calendar as an assurance of better conditions next year.

AAA. INSECTS ON OR IN THE FRUIT.

(Divisions a, b, c, and d.)

a. *Caterpillars with 3 pairs of thoracic and several abdominal legs.*

Full grown caterpillar less than ½ inch long, with an anal fork, mining in the fruit. The anal fork can only be seen with a high power microscope, the larva being slightly compressed between cover glass and slide.
1. *Lesser apple worm.* Page 55.

Full grown caterpillar nearly ¾ inch long without an anal fork, mining in the fruit. (fig. 40).
2. *Codling moth.* Page 55.

Full grown mottled caterpillar, 1½ inches long eating into the fruit. *Mottled fruit caterpillar.* Page 28.

Smooth light yellowish or apple green caterpillars with cream-colored stripe down middle of back and along each side.
Green fruit-worms. Page 29.

b. *Legless maggots or grubs.*

Very small slender white maggots mining in the flesh of the apple leaving brownish tracks.

3. *Apple maggot or railroad worm.* Page 57.

A small white grub mining in the very small wind falls in early summer (fig. 25). 4. *Plum curculio.* Page 60.

c. *Mature insects.*

A gnarled blackish snout beetle with dusky reddish markings, puncturing the fruit. (fig. 27).

4. *Plum curculio.* Page 60.

A flat yellowish mottled bug with slender beak; ovipositing in and deforming the fruit. (fig. 28).

5. *Tarnished plant bug.* Page 62.

A long legged yellowish brown beetle feeding on fruit. (fig. 18). *Rose chafer.* Page 44.

d. *Plantlice.* Colonies of reddish or green aphids feeding on the small fruit, dwarfing and puckering it.

Aphis sorbi. Page 20.
Aphis pomi. Page 20.

Lesser Apple Worm.

(*Enarmonia prunivora.*)

The larva feeds upon the apple in a manner similar to that of the codling moth, for which it is doubtless frequently mistaken. Besides by its smaller size the larva may be distinguished from that of the codling moth by the presence of the anal fork. The adult moth expands about $\frac{5}{8}$ of an inch across the wing. The ground color of the front wings is black, with patches of pale rusty red, of gray, and of yellowish white and steel blue oblique lines. The hind wings are dusky gray at the base, shading to black at the apex.

REMEDIES.

The insect may be combated by the spray used against the codling moth.

The Codling Moth.

(*Carpocapsa pomonella* L.)

The codling moth passes the winter in the larval stage in silken cocoons in cracks and holes in the trees and in houses where apples have been stored. In the spring these larvæ change to pupæ, and the moths emerge about a month after the apple is in blossom.

The moth (fig. 40, *a*) varies somewhat in size, but the maximum spread of its wings is about three-fourths of an inch. The front wings are of a brownish gray color and are crossed with lines of gray scales, giving them the appearance of watered silk. At the tips of the wings there is a large brown spot, in which are many scales of bronze or gold. The hind wings are grayish brown in color. The moth lays her eggs, a few days after emergence, on the leaves of apple or other food plant, or on the fruit. A majority of the eggs of the first generation are laid on the leaves, while the greater part of those of the second generation are laid upon the fruit.

A large number of the larvæ which hatch from eggs deposited on the leaves eat small portions of the leaves before finding fruit. The larva, living most of its life within the fruit, throws out through its entrance hole, which it enlarges from time to time, or through its exit hole in the side of the fruit, the characteristic mass of frass or excrement which is the sign of infestation.

The larvæ have some difficulty in entering the smooth sides of the fruit, and about 80 per cent of the first generation enter by way of the calyx, while the majority of the second generation enter at the sides, especially where the fruits are touching.

Before entering the young apple the larva feeds, as noted, on the leaves, but also for a day or two within the partial concealment formed by the calyx or blossom end of the apple. During several days, therefore, the little apple worms feed externally, both before they enter the calyx and within the latter, and the object of spraying is to insure their being poisoned by thoroughly coating in advance, with an arsenical mixture, the leaves, and especially the blossom end of every fruit, before the shutting up of the lobes of the calyx. Most of the larvæ enter the calyx after it is closed, and are then beyond the reach of any poison later applied.

The pinkish larva lives in the fruit about twenty days, and grows to a length of about five-eighths of an inch (fig. 40) when, being full fed, it makes a tunnel to the outside of the fruit, the entrance of which is filled with frass and silk. When ready to leave the apple this plug is pushed out. The larva then crawls out and immediately seeks a place in which to spin its cocoon.

Cocoons have been observed in the following places: In holes and cracks in the trunks and branches of the trees; under rough bark; in the fruits (though rarely); in the cracks in the ground around the tree; on or between the clods among the fallen fruit; under bands or anything else resting on or against the tree; in cracks and angles of the walls and roof of the building in which apples are stored; under shingles of buildings near apple trees; in fence posts and under pickets of nearby fences; in paper or other rubbish on the ground; and in various other places. The cocoons of the first generation are composed entirely of silk, while in those of the second generation are incorporated bits of wood and bark. The larvæ inside the cocoons transform into pupæ in about six days from the time of spinning the cocoon.

In about twenty days from the spinning of the cocoon the pupal skin splits and the moth emerges (fig. 40, *a*), lays its eggs, and gives rise to another generation.

MEASURES USED AGAINST THE CODLING MOTH.

An arsenical spray immediately after the blossoms have fallen should be used and repeated 7 to 10 days later, but before the calyx lobes have closed. Use burlap bands on trunks, killing all codling caterpillars under them every 10 days from July 1 to August 15, and once later before winter. Where spraying is properly done, banding is probably not necessary.

Apple Maggot or Railroad Worm.

(*Rhagoletis pomonella.*)

The adult stage of the apple maggot is a fly, a little smaller than the house-fly and readily distinguished by four dark irregular bands across the wings; these are found in the apple orchards from about July first until frost. During this time the females are employed laying eggs, by piercing the skin of the apple with a sting-like ovipositor and leaving at each incision one egg buried in the pulp. Each female is capable of laying at least three or four hundred eggs.

From these eggs hatch apple maggots which tunnel through the pulp where they feed until full grown. The maggots are small, plump, white objects without legs and with head so ill defined that it is difficult to find it at all. The mouth parts are reduced to a pair of rasping hooks. The apple maggot works in soft discolored mushy trails anywhere in the pulp. The trails of the apple maggot never contain little round sawdust-like pellets. Often their tunnels lie directly beneath the skin of the apple, showing through in the light colored varieties as dark trailing tracks which have won for the apple maggot the popular name of railroad worm (fig. 44). *But, though the maggot frequently comes near the surface of the apple, it never breaks through the skin until it is through feeding and is thus always protected, a circumstance which shows clearly that it is of no use to try to destroy this pest by spraying.*

When the eggs are laid, the apples are young and hard and for some time the maggots grow very slowly. At this stage the tunnels are very inconspicuous and the maggots themselves are not likely to be detected except by careful search. As the apple matures, the maggot makes more and more headway and is frequently full grown by the time the apple is ripe (fig. 43). Moreover the presence of the maggots seem to hasten the development of the apples and much of the infested fruit comes to the ground as windfalls. *This is the reason so much stress is laid on the destruction of windfalls to get rid of the maggot.*

Since the flies are so long on the wing and lay their eggs over such an extended time the full grown maggots are found at different periods. The first eggs are laid naturally in the early fruit and accordingly as soon as August tenth full grown maggots have been recorded in Early Harvests. On the other hand, some of the later maggots, from eggs laid in harder winter varieties, do not acquire their full size until late in the fall or winter. These are the maggots that are stored with the fruit.

The full grown maggots bore out of the windfalls and bury themselves an inch or less in the ground. Or, if they are in gathered fruit where they cannot find a suitable burying ground, they creep away beneath some protecting object instead. Soon after leaving the apple (sometimes the transformation takes place within the apple but not often) the maggots shrink a little in length and bulge a little in thickness, the skin at the same time growing tougher and slightly darker. The insect is known in this form as the pupa, and rests in this stage all winter. With the return of summer a second transformation takes place when the tough skin which has covered the pupa all winter is broken open by the adult insect (a fly with dark bands on its wings) which has developed inside the pupal case. This mature fly spends its life laying eggs in the flesh of young apples, thus starting a new generation of apple maggots.

The maggot, pupa, and adult fly are shown in the accompanying illustration, enlarged about 3 times. (Fig. 24).

Maggot. Fly. Pupa.

Fig. 24.

The apple maggot enlarged 3 times.

PREVENTIVE MEASURES.

As pointed out here, it is useless to try to poison the growing maggots as they are within and protected by the apple. It is also evident that if the maggots contained in windfalls and picked fruit are destroyed one year there will be no trouble to fear from them the next. Of course it is highly improbable that even by the greatest vigilance, every maggot could be thus destroyed. But when it is considered that each maggot left to its own devices has a chance of becoming a fly capable of laying at least three hundred eggs, and that each maggot undestroyed this year may mean three or four hundred next year, the importance of killing as many as possible is evident. If the apple maggots, as do many insects, all developed about the same time, the problem would be much simpler, but as full grown maggots are found in apples from before the middle of August until into the winter, the watch for them must extend over several months.

If enough hogs or sheep to eat the windfalls are kept under infested trees from the second week in August until the fruit is finally gathered, all the maggots in windfalls will be got rid of. Of course the same results, as far as destroying the maggot is concerned, can be obtained by having windfalls faithfully gathered during this time and fed to stock, or made into cider.

In one orchard where the main crop is not sweet fruit, a plan of baiting for the apple fruit fly has proven successful. A few Tolman sweet trees are grown in the orchard as traps. The flies deposit the majority of eggs in these sweet apples by preference, and the other fruit is saved to a great extent. All of the Tolman sweet apples, in this case, are gathered and destroyed.

Recent experiments in New York, Canada and Maine indicate that the adult flies may be killed by arsenical sprays during the time they are feeding about the trees before they begin to deposit eggs. Sweetening the poison with molasses makes it more attractive. It is perhaps too soon to advise any one formula at this time. Further literature concerning the matter may be had upon application to the Director of this Station.

Plum Curculio.

(*Conotrachelus nenuphar.*)

At about the time in early spring when vegetation resumes activity and buds begin to push, curculios, which have hibernated under rubbish on the ground, under the rough bark of trees and in other secure hiding places, emerge from concealment and seek the fruit plants upon which they feed and breed. About the time the trees bloom, mating begins and as soon as the young fruit enlarges the deposition of eggs begins. Apples no larger than small peas often bear from 1 to 3 of the characteristic crescent marks made by the curculio. These punctures as well as those made by the adult beetle in feeding cause a serious deformation of the fruit (fig. 45). The deposition of eggs goes on most rapidly during the month of June, but continues through July and August, gradually growing less and less as the beetles die. The majority of the beetles of this generation do not live beyond the month of July, but a few may survive until September, or in rare instances until late fall. During the season both males and females feed upon the same fruits in which eggs are deposited, making small, usually cylindrical punctures. The eggs hatch in from 4 to 6 days and the young larvæ start tortuous burrows through the fruit. Development of the larvæ causes the fruit to fall within a few days. In about 20 days the larvæ mature, cease feeding, bore out of the fruit, and at once enter the ground where they complete their transformations and in about 28 days emerge as perfect beetles. (figs. 25, 26, 27). The newly emerged beetles usually remain quiet for a day or two, allowing the body wall, beak and jaws to harden; then they fly into the trees and begin feeding upon the fruit. Beetles of this new generation do not (except possibly in rare cases) pair and no eggs are laid during this first season. The fruit is freely punctured for feeding purposes and the amount of this work increases as the season advances. It is this feeding of the new generation that causes the greatest injury to the fruit crop. (fig. 45.) Feeding continues as long as fruit remains upon the trees. Late in the fall the beetles leave the trees and hide away in secure places for the long winter period of hibernation. Such in brief is the life history of the plum curculio.

Another curculio known as the *Apple curculio* is smoother and has a longer snout. This species has not been recorded from Maine.

REMEDIAL MEASURES.

Destruction of fallen fruit is one of the chief means of combating this pest. Where hogs are pastured in the orchard with a view to devouring apple maggots in fallen fruit the curculios would be incidentally disposed of. The recommendations that fallen fruit be destroyed commonly conveys no idea of the first fallen apples. The mind turns to the tangible fruits of midsummer and fall, and where the recommendation is followed the small apples the size of peas that fall in early summer are entirely ignored. The same small apples are, however, an important factor, and should be considered in any systematic attempt to control the ravages of the plum curculio.

FIG. 25. Larva (enlarged). FIG. 27. Adult (enlarged).
FIG. 26. Pupa (enlarged).

It does not seem possible for an apple one-fourth inch or less in diameter to supply nourishment enough to bring a larva to full maturity, but it has been learned that larvæ can and do develop in just such apples. To gather them in a large orchard would be impracticable, but if clean culture is practiced they and the larvæ they contain could be largely destroyed by use of the disk harrow or some other tool that would chop them up or bury them. If the ground is clean and the orchard sufficiently open, so that the sun can shine upon the apples as they lie upon the ground, nothing further is necessary, because direct sunlight upon the apples will kill the contained larvæ. Superficial tillage of the surface soil can be commended as an effective method of attacking curculio. This tillage should be carried on continuously or at frequent intervals for a period of from 30 to 40 days, during which the great bulk of the new crop of plum curculios is in the ground. The object of tillage is to turn the pupæ out, kill some in the process, and expose the rest to the elements and to birds and insects that prey upon them.

Arsenate of lead sprays are said to be of use in poisoning the adult beetles.

Tarnished Plant-Bug.

(*Lygus pratensis.*)

This insect is a very destructive one, and injuriously affects a large number of cultivated plants. It passes the winter in the perfect state, taking shelter among rubbish, or in other convenient hiding places, and early in May, as soon as vegetation starts, it begins its depredations.

These insects are partial to the unopened buds, piercing them from the outside and sucking them nearly dry, which causes them to become withered and blackened. Sometimes a whole branch will be thus affected, being first stunted, then withering and finally dying. This insect also causes serious deformation of the fruit both by feeding and egg-laying punctures. Early in the morning these plant-bugs are in a sluggish condition, and may be found hidden in the expanding leaves; but as the day advances and the temperature rises, they become active, and when approached dodge quickly about from place to place, drop to the ground, or else take wing and fly away. In common with most true bugs, they have when handled a disagreeable odor. In the course of two or three weeks they disappear, or cease to be sufficiently injurious to attract attention.

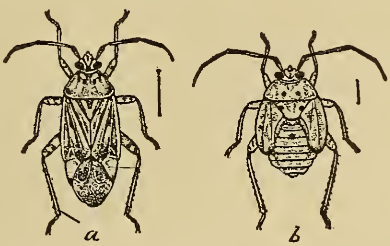

FIG. 28. (After Chittenden). Enlarged.

The mature bug (fig. 28 *a*) is about one-fifth of an inch long, and exceedingly variable in color and markings, ranging from a dull brown to a greenish or yellowish brown. In a typical specimen the head is yellowish, with three narrow reddish stripes; the beak is about one-third the length of the body, and is folded upon the breast when not in use. The prothorax has a yellow margin and several longitudinal yellowish lines; behind the prothorax, upon the scutellum, is a yellow V-shaped mark; the wings are dusky brown, with a pale cuneus and black point at the apex; the legs are dull yellow. The immature insects are greenish; if a little older they possess a pair of round black dots on the back of the thorax, another pair on the scutellum, and a single dot on the abdomen.

COMBATIVE MEASURES.

Since these insects hibernate among rubbish of all kinds, clean culture is very important. By clean culture is understood the removal of all litter from fence corners, so as to take away the shelters in which the insect winters. When they appear in spring the plants upon which they are should be shaken early in the morning, while the bugs are still in a torpid condition, making them fall upon a sheet underneath, and then destroying them. As soon as it becomes warm the insects are exceedingly active, and so swift in all their motions that they cannot be captured.

The young can be killed with tobacco extract but this is not effective against the adults. No really satisfactory means of control is yet known for this pest.

BENEFICIAL INSECTS.

(Adapted from Packard.)

In a great variety of ways certain insects are helpful to man, and are especially efficacious either in insuring his crops or in destroying those insects which would otherwise devour them.

Pollenizers of Fruit trees.—A very important part in the production of abundant crops of fruit is played by bees and other honey- or nectar-gatherers, and pollen-feeding insects. It is now generally acknowledged that bees, especially the honey-bee, act as "marriage-priests" in the fertilization of flowers, conveying pollen from flower to flower, and thus insuring the "setting" of the fruit. Many wasps, as well as butterflies and moths, species of pollen-eating beetles, thrips, and other insects, by unconsciously bearing pollen from distant flowers, prevent too close in-and-in breeding. Indeed, as Goethe said, flowers and insects were made for each other. Many plants would not bear seeds did not insects fertilize them. Insects are in the first place attracted to flowers by their sweet scent and bright colors, and it is claimed that the lines and circles on the corolla of certain flowers guide them to the nectary; though we do not see why the scent is not in the main sufficient for this purpose. According to Sir John Lubbock, "The visits of insects are of great importance to plants in transferring the pollen from the stamens to the pistil. In many plants the stamens and pistil are situated in separate flowers; and even in those cases where they are contained in the same flower, self-fertilization is often rendered difficult or impossible; sometimes by the relative position of the stamens and pistil, sometimes by their not coming to maturity at the same time. Under these circumstances the transference of the pollen from the stamens to the pistil is effected in various ways. In some species the pollen is carried by the action of the wind; in some few cases, by birds; but in the majority, this important object is secured by the visits of insects, and the whole organization of such flowers is adapted to this purpose."

Parasitic Insects (Ichneumons and Tachinæ).—While insectivorous birds accomplish much towards reducing the numbers of injurious insects, they often as likely as not eat the beneficial as well as the destructive kinds. Without doubt the leading factor in preventing the undue increase of noxious insects are the parasitic kinds belonging to certain dipterous and hymenopterous families.

An ichneumon-fly (figs. 46-49) lays its eggs either on the outside of the caterpillar or bores under its skin inserting an egg within the body. The larva of the ichneumon upon hatching works its way into the interior of the host. Here it does not injure the muscles, nerves, or the vital parts of the caterpillar, but apparently simply lies motionless in the body-cavity, absorbing the blood of its host.

Tachina (*Senometopia*) *militaris* has been observed by Riley to lay from one to six eggs on the skin of the army-worm, "fastening them by an insoluble cement on the upper surface of the two or three first rings of the body." The young maggots on hatching penetrate within the body of the caterpillar, and, lying among the internal organs, absorb the blood of their host, causing it finally to weaken and die. Sometimes but a single maggot lives in its host. Many grasshoppers as well as caterpillars are destroyed by them.

Insectivorous Insects.—There are very many carnivorous kinds which devour insects entire. Such are the ground-beetles (fig. 51), water-beetles, the larvæ of Tenebrionids and of lady-beetles (Coccinella) (figs. 52, 53), and those of the lace-winged flies (Chrysopa) which prey on aphids, though the maggots of the Syrphus flies are more abundant and efficacious as aphid destroyers in Maine.

Practical Application.—When the life of an injurious insect is carefully studied, it is frequently found that the pest can be combated by breeding and distributing its natural parasitic and predaceous enemies. For a most remarkable example of such an undertaking it is only necessary to mention the work of the U. S. Government and Massachusetts against the Gypsy Moth. For current accounts of this work the reader is referred to the Annual Reports of the Mass. State Forester, and publications of the U. S. Bureau of Entomology.

GENERAL TREATMENT FOR APPLE ORCHARDS.

While the enemies of the apple are numerous and varied, by far the larger part of them may readily be held in check by spraying with the more common insecticides and fungicides, and often, by a combination of materials, several enemies may be met with one application. There should, however, be a definite purpose in view for every application. The mere fact of spraying is not enough. It is important that the orchardist know *why* and *how,* and *when* to spray or otherwise combat his enemies. Beneficial insects should be recognized when seen, and should be protected and encouraged. Certain diseases may be controlled by spraying; in other cases diseased parts must be removed and burned.

The time of spraying will depend upon the purpose in view, but in *no case* should spraying be done when the plants are in full bloom. Spraying at this time will often interfere with the fertilization of the flowers, and consequently reduce the crop of fruit, while there is much needless destruction of bees and other insects which work upon the flowers.

The treatment of apple trees at various times during the season and the purpose of the same may be briefly stated as follows:

A. Lime-sulphur (dormant or winter strength) before buds begin to swell in the spring. To destroy blister mite, oyster shell, San Jose, and other scales, and aphid eggs. Under same conditions this may assist in holding scab and other fungous diseases in check.

B. Tanglefoot smeared on bands of heavy paper about the trunks of trees. In March for spring canker-worm; in October for fall canker-worm and lime-tree span-worm. At any time when migration of hungry caterpillars from devastated forest trees is feared.

C. Blackleaf 40, ½ pint to 50 gallons water, when buds show green but are still compact. To destroy aphids when newly hatched and assembled on the tips of the buds before the leaves unfold to afford protection. This time of spraying with nicotine solution recommended as the most important single aphid spray by the New York Agricultural Experiment Station, Geneva, N. Y. Bulletin No. 402. This can be combined with lime-sulphur.

D. Summer dilution lime-sulphur containing 2 to 3 pounds of arsenate of lead paste (1 to 1½ pounds of the dry powder) to 50 gallons, just as the blossom buds are showing pink. To combat bud-moth, brown-tail moth, canker-worms, fruit worms, tent-caterpillars, apple scab, leaf-spot, and fruit rot. If plantlice are prevalent add Blackleaf 40, ½ pint to 50 gallons.

E. Repeat D as soon as the flower petals have fallen, for the same pests and the codling moth.

F. Repeat D again about two and not over three weeks after the application E.

G. If the season is very wet and favorable to the development of apple scab, or black rot is troublesome, later applications of the summer dilution lime-sulphur may be required. In these arsenate of lead may be omitted unless caterpillars or other leaf eating insects are present.

H. August spray for brown-tail moth caterpillars. Arsenate of lead applied just as the eggs are hatching. This is the most important spray for this pest and if thoroughly applied precludes the necessity of other treatment for this insect. This will combat also tussock caterpillars, fall web-worm, red-humped caterpillars, yellow-necked caterpillars, and caterpillars of the tiger moths.

* * * * * * * * * *

In Nova Scotia where conditions are similar to those in Maine Britton and Sanders (Spray Calendar for Nova Scotia Apple Orchards for 1916) have recommended an additional early summer dilution of lime-sulphur application combined with arsenate of lead "when leaves about blossom clusters are showing green. For canker-worm defer this spray for a few days." To combat bud-moth, brown-tail moth, tent-caterpillar, canker-worm and apple scab. If aphids are present add Blackleaf 40 ½ pint to 50 gallons of water.

Culture.

If the *curculio* and the *apple maggot* are present practice clean cultivation, beginning in June if the curculio is present. Cultivation also destroys the moths which pass their pupal stage in the ground.

Gathering Windfalls.

As both the larva of the curculio and of the maggot are found in the small apples and later leave these to pupate in the earth, it is highly important to rake up frequently all windfalls and destroy them. This means not only the larger apples but even those which are no larger than a pea. Where sheep or hogs are pastured in an orchard the trouble of gathering windfalls by hand is avoided.

Fungous Enemies.

Fungi can be successfully combated only before the plants are attacked. The more important fungous diseases of the apple in Maine which may be controlled wholly or in part by spraying are: scab; black, brown, pink, and bitter, rot; fly-speck and sooty blotch of the fruit; leaf spot; and various forms of limb canker.

Materials Used in Fighting Apple Enemies.

CAUTION: *The following formulas are for use on the apple. In many cases they are not adapted for more tender plants. Keep all poisons carefully labelled and out of the reach of children and animals.*

LEAD ARSENATE.

Lead Arsenate paste	2 to 3 pounds
Water	50 gallons

Arsenate of lead acts slower as a poison than Paris green. It has the advantage, however, of remaining longer in suspension in water, of not burning the foliage and of adhering better than Paris green. Make a smooth thin paste with the poison and a little water and add the remainder of the water and stir thoroughly. When the dry powder instead of the paste is used but ½ the weight of lead arsenate indicated above is required. This is strong enough for caterpillars while they are young. When half grown or larger certain species are very resistant and 6 to 7 pounds of the paste (3 to 3½ of the dry powder) to 50 gallons of water are then required.

KEROSENE EMULSION.

Fish-oil soap	½ pound
Boiling water (soft)	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 forcibly 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% emulsion). This is the strength ordinarily used for the destruction of sucking insects upon plants. For larger or small 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.

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.

*Refuse from cigar factories.

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 manufactrued 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 proportion 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 800 parts of water. Some have been successful with 1 part to 1000 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 a 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 aphids. For this purpose 1 pound of stone lime, slaked and strained into 50 gallons of tobacco extract as prepared for application, is sufficient.

When other plant enemies besides aphids are present "Combination sprays" are frequently successfully applied. Self-boiled lime-sulphur (8-8-50 cold) may be used adding 1-70 of its volume of *Black Leaf*. On the same basis *Black Leaf* may be combined with Bordeaux (5-5-50) or with lead arsenate or with both together when foes combine against one kind of plant.

LIME-SULPHUR.

Directions for this remedy are given in a publication issued by this Station entitled "The Preparation and Use of Lime-Sulphur in Orchard Spraying." This can be secured by request.

When lime-sulphur is used with any nicotine solution for a combination spray, omit the soap which is often added to tobacco decoctions.

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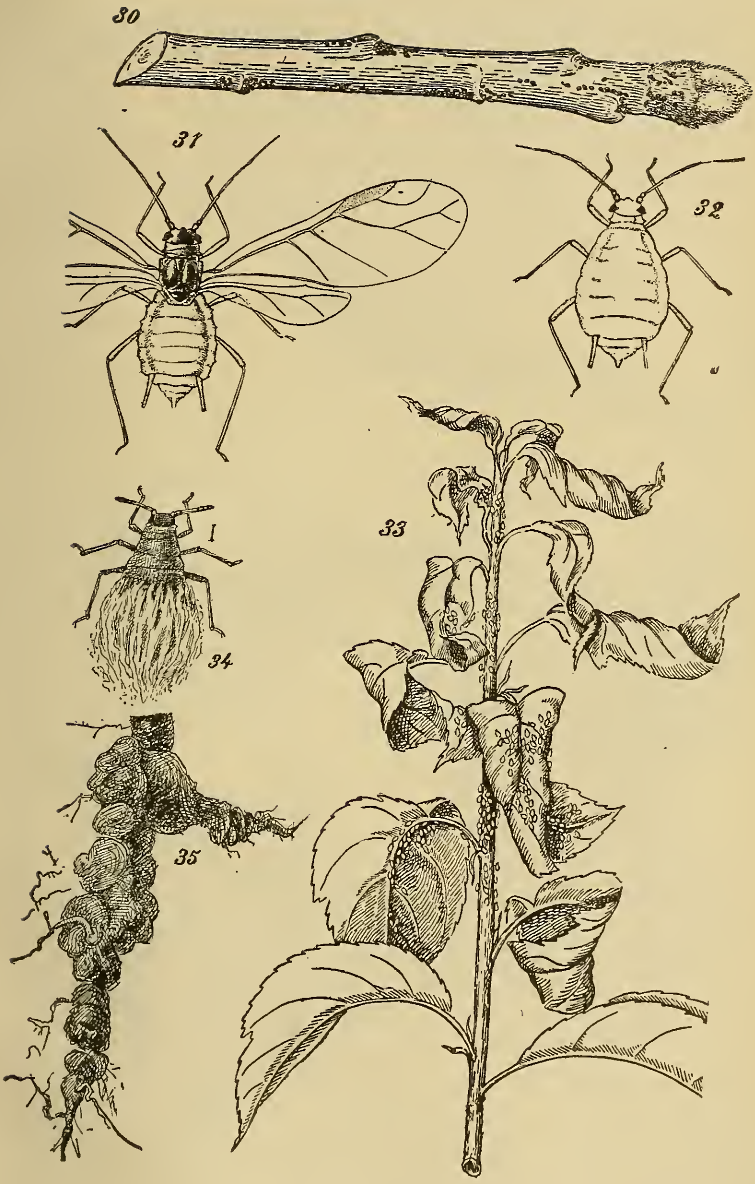
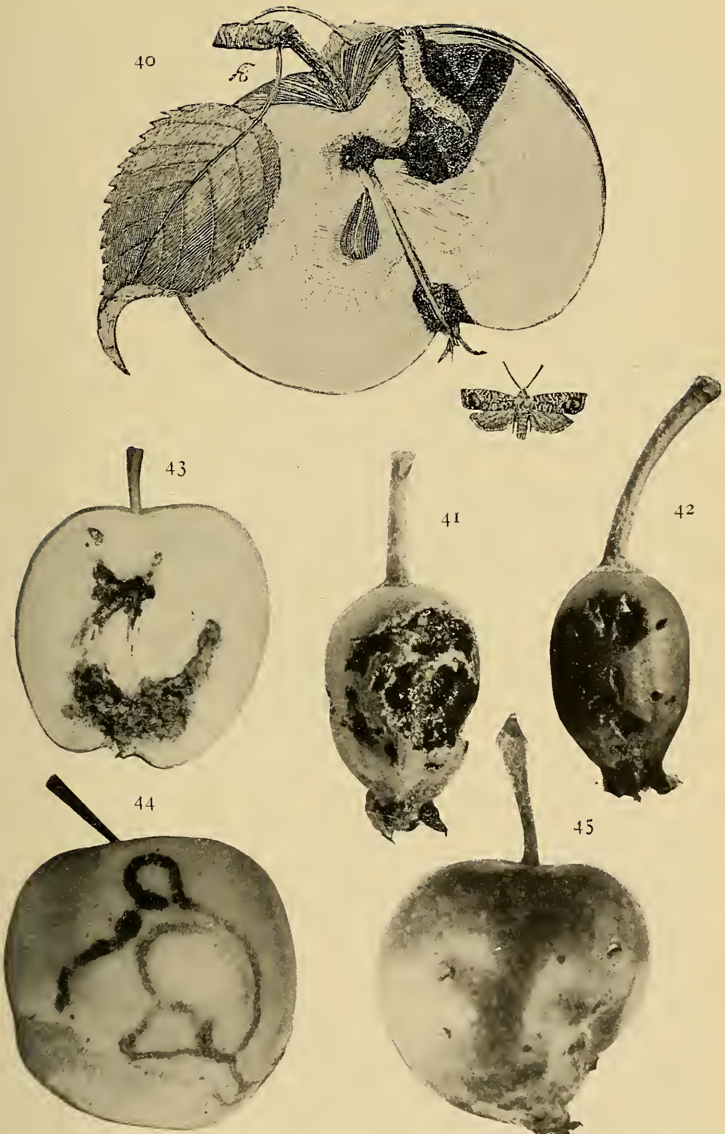


APPLE APHIDS AND WORK.

FIGS. 30-33 Green apple-aphis; 30, Winter eggs; 31, Winged form; 32, Wingless form; 33, Leaf curl caused by Apple-aphis; 34, Woolly aphid, wingless form; 35, Knotty root caused by Woolly aphid.
(FIGS. 30-33 after Quaintance; 34, 35 after Marlatt).

WINTER STAGES

Photographed from Maine specimens. Fig. 36, Eggs from which Tent Caterpillars hatch. Fig 37, Cocoon of Cecropia Moth. Fig 38, Winter nest of Brown-tail Moth. Fig. 39, Eggs of the Antique Tussock Moth on cocoon.



APPLES INJURED BY INSECTS

Fig. 40. Codling Moth (*after Lodeman*). Figs. 41, 42, Apples eaten by Rose Chafer (photographed July, 1907). Fig. 43, Section of apple showing work of apple maggot (photographed Oct., 1907). Fig. 44. Hightop with characteristic trail of apple maggot (photographed Sept., 1903). Fig 45, apple deformed by apple curculio photographed July 11, 1907).

BENEFICIAL INSECTS

Figs. 46-49, *Ichneumon sublatus*, parasites bred from pupae of Saddled Prominent. Fig. 50, Parasitized specimens of young Red-humped Caterpillars attached to apple leaf and parasites *(Limneria guignardi)* which emerged from them. Photographed August 29, 1906. Fig. 51, Beetle *(Calosoma)* feeding on Sadd'ed Prominent (Bul. 161 Maine Agr. Exp. Sta.) Fig. 52, 53, Lady Beetles, adult and larva, which feed on aphids *(After Marlatt.)* Fig. 54. *Podisus modestus*, a bug stabbing the Saddled Prominent (From Bul. 161 Maine Agr. Exp. Sta)

Fig. 55. Mottled Fruit Caterpillar *(Crocigrapha normani)*. Photographed July 10, 1907.

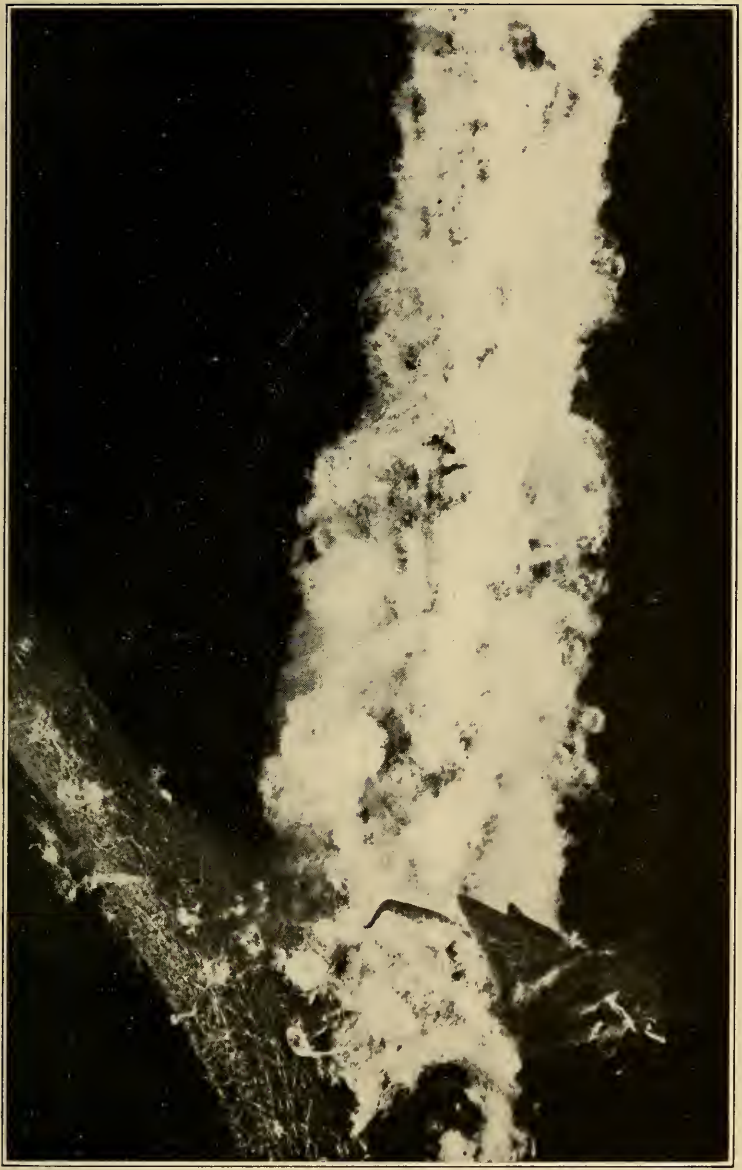


FIG. 56. Nymphs of the Woolly Aphid, *Schizoneura lanigera* on water shoot of mountain ash, *Pyrus americana*,—the immediate progeny of migrants from elm leaf rosette. Photographed at Orono, June 28, 1912. Enlarged.

FIG. 57. Young rosette photographed June 6, 1913. Small picture at right. FIG. 58. Old rosette photographed July 17, 1913. Work of Woolly Aphid of apple on elm leaves. See page 14.

[531-12-16]

University of Maine.

MAINE

AGRICULTURAL EXPERIMENT STATION

ORONO, MAINE.

CHAS. D. WOODS, Director.

POTATO GROWING AND POTATO DISEASES FROM MAINE TO CALIFORNIA.

Through the efforts of the United States Department of Agriculture an arrangement was made whereby Doctor Otto Appel, the leading authority on potato diseases in Germany, made a tour of inspection of the leading potato growing sections of the northern and western states in the summer of 1914. Doctor Appel was accompanied by Doctor W. A. Orton and Professor William Stuart of the Bureau of Plant Industry and by Director T. C. Johnson of the Virginia Truck Experiment Station. For a considerable part of the journey from Michigan to California another foreign plant pathologist of international reputation, Doctor Johanna Westerdijk, was a member of the party. The leading pathologists and potato specialists in each section visited did all in their power to make the visit to their territory instructive and profitable. Thus, through the benefit of the knowledge and experience of many leading experts from abroad and in this country, it was possible in a relatively short time to secure a large amount of reliable, first-hand knowledge of potato growing and potato diseases, under a variety of conditions, which could hardly be obtained in any other way.

Therefore, as Director of this Station, it seemed wise to comply with the request of Secretary Houston that our plant pathologist be detailed to accompany the party during the entire trip. The following pages represent a partial report of Doctor Morse's observations from Maine to California, presented at the annual meeting of the Maine Seed Improvement Association at Lewiston, December, 1915, and are a reprint (with slight changes) of pp. 265-282 of the Report of the Commissioner of Agriculture, State of Maine, 1916.

While the Station has found the data secured as the result of this inspection trip to be of much value in the study of local potato disease problems it is not probable that any considerable part of it will be used in any of the regular bulletins. It has, therefore, seemed advisable to reprint the article for general distribution to the mailing list within the State.

CHAS. D. WOODS,
Director.

POTATO GROWING AND POTATO DISEASES FROM MAINE TO CALIFORNIA.

W. J. Morse.

With the rapid development of transportation facilities, both at home and abroad, entirely new and often dangerous disease problems have arisen to confront the potato grower. Some of these potato troubles a generation ago, or even a decade or two ago, we knew but vaguely, or only by reputation. Some we had never even heard of in this country. Yes, more than that, what is undoubtedly the most dangerous and destructive potato disease yet discovered, was unknown till 1896 when it was first reported from Hungary. This is the wart disease or potato canker. In 13 years it had crossed the Atlantic Ocean and was present in Newfoundland. In the meantime it has become widely distributed in England, Ireland, Scotland and Wales, and has been found in Germany as well. So far as known it has never reached the mainland of North America.

Powdery scab, while undoubtedly first observed about 75 years ago, has only recently come into prominence. Now it is widely scattered, particularly in the British Empire. England apparently has been very generous in passing the disease along to her colonies, but recently some of them, more especially Canada, have taken matters into their own hands, and quarantined against her. The distribution of powdery scab in Maine points strongly to the conclusion that Canada is the original source of the major part of the powdery scab infection in this state. The same thing is true of the other infected regions of the United States. Following the discovery of the disease in Maine, it was next found in the two most northern counties of New York. Next came the information that it was present in the states of Washington and Oregon and in British Columbia to the north of them. Now within a month comes the information that it is quite widely distributed in the northeastern part of Minnesota along the Canadian line. All this, taken together with the fact that powdery scab is quite widely scattered in Canada, makes a strong case against that country. However, before we accuse her of being the entire cause and source of our troubles, one very important fact which we did not know at first, should be taken into consideration. It now looks as though powdery scab is a disease, the distribution of which is quite definitely limited by climatic and soil conditions. It may be, and there is considerable reason for believing this to be a fact, that in America it will only develop in the cooler, moister climate of Canada and along the very northern border of the United States. There is no doubt that thousands of bushels of potatoes infected with the disease have in recent years been used in the South for seed, yet a most careful search has failed to reveal any in the crops they have produced there except a few tubers at or near Hastings, Florida. It has not been found in the southern part of our own state even, except in the extreme southeast where the summers are usually relatively cool and wet. Its absence from the remainder of the state can hardly be claimed to be due entirely to freedom from contagion. It seems almost beyond belief that infected potatoes have not been planted from time to time in that part of Maine which is now thought to be and apparently is free from the disease.

Blackleg is another undesirable emigrant which Europe, especially England, passed along to us by way of Canada. We have evidence also in certain instances of direct importations of blackleg and powdery scab from European countries. Undoubtedly such importations were numerous in the years just previous to the time when the potato quarantine became effective. In the fall of 1913 I found powdery scab abundant in some European shipments of potatoes which arrived in Boston, and the same condition was found by the Government pathologists when they looked into the situation both in Boston and in New York City.

Blackleg was first reported in America in 1906 but it had apparently been recognized in Canada a few years previous to this. Undoubtedly it occurred in Maine some years before it was recognized and described by myself the first year I was here, or in 1907.

Within our own country several important developments in the potato industry have taken place during recent years. Potato growing as a late winter and early summer crop has come to be an industry of considerable magnitude in certain southern states. Under their climatic conditions potatoes rapidly deteriorate and it is necessary to secure new seed each year from the north. Maine leads in furnishing this seed but New York, Michigan, Wisconsin and Minnesota are important factors in the trade and are bidding for it in every way possible. Since Maine potatoes are shipped largely to all the important potato growing sections from Texas north to New Jersey and Long Island, we enter into competition with all of these states at one point or another. In addition other northern states, Vermont for example, where the potato is a less important crop, ship seed south to a certain extent. It will be seen then that any potato disease which gains a foothold in any northern locality stands a much greater chance of being widely distributed throughout the country than ever before.

Dr. W. A. Orton of the United States Department of Agriculture, being familiar with all these conditions in various parts of the country and in Europe and realizing their importance to the future development of the potato industry in America, conceived the idea of inviting Geheimrat, Dr. Otto Appel, the leading authority on potato diseases in Germany, to come to this country and make a survey of the more important northern and western potato growing areas during the summer of 1914. It was my good fortune to be a member of the party which accompanied Dr. Appel on this trip from Maine to California.

In every state we visited we were joined by the plant pathologists, horticulturists, agronomists and county experts or extension representatives of the various agricultural colleges and experiment stations. At each stop we were met by from several to 50 or more practical potato growers who generously provided automobiles for transportation, whereby we were enabled to visit all the potato fields we had time to see while in that vicinity. They often carried us a hundred miles or more along the route of our journey by that means. From Maine to California in about two months we covered some 14,000 miles, 1,200 of which were by automobile. Our itinerary was so planned to make as much of our railroad travel as possible at night or on Sunday, therefore it will be seen that we spent a good share of the day, six days in the week, during this time in potato fields.

Rain interfered with our plans but one day and then we attempted to work for we had crossed the whole state of Minnesota, to the edge of North Dakota to have a single day in this region.

Previous to this trip I thought I had some pretty well defined ideas as to what constitutes a good potato soil. Before I got back I decided that I knew nothing about it. In Michigan the Danish farmers were growing excellent crops of potatoes, with the help of clover and cows, on what was once largely pure sand, and formerly covered with white pine—land so poor that American farmers would not settle on it. In certain parts of central Wisconsin the Germans and Swedes were doing even better with what at first appeared to be a somewhat similar soil. When we reached the famous Red River Valley of northern Minnesota on the rainy day mentioned we found the potato soil was a sticky, black prairie gumbo, so sticky and slippery, in fact, that after the first mile or two with the automobile provided, some of us refused to ride farther and got out and walked the rest of the way in the rain.

In Idaho they are growing potatoes, second to none in the country, without fertilizer on land which, before the water was turned on, would grow nothing but sage brush and jack rabbits. Much of this soil came from disintegrated lava, for underlying this section is solid lava rock at a depth of from 3 to 30 feet. On the so-called tule lands of the deltas of the San Joaquin and Sacramento river valleys in California, Japanese and Chinese are growing thousands of acres of potatoes, also without fertilization, the yields on the best of which running from 350 to 550 bushels per acre.

In describing our trip I shall omit all reference to conditions in our own state which are familiar to you, except to describe certain phases of the potato disease situation which apply to Maine or are related to what I shall discuss farther on.

We have recently come to the conclusion that in Maine we have entirely overlooked in the past one type of disease which sometimes does considerable damage in the southern and central parts of the state but which, apparently, is of less importance in Aroostook county. I refer to the so-called Rhizoctonia disease of the potato. The name comes from the fungus which is said to cause it, but it is sometimes spoken of as the "little potato disease." This, however, as it occurs in Maine, describes only one phase of it.

Everyone who prepares potatoes for the table is familiar with the little black or brown spots which sometimes appear on the tubers and which look like hard, superficial particles of dirt which will not wash off. They are not dirt at all, but compact masses of fungous threads, or the over-wintering stage of a fungus which is as common as pebbles in New England potato soils. Except that when it appears in quantity and thus makes the surface of the tuber more or less unsightly I had always felt that it was of no economic importance in New England. Our recent experiences with this fungus as a cause of disease of potatoes have led us to conclusions quite the contrary.

Soon after the potatoes are planted the fungus begins to grow and, often in central and southern Maine, attacks the young sprouts and kills them before they come up. The stalks, however, may get some distance above ground before being killed. Again, cases have been observed where fully 90 per cent of the plants were attacked sufficiently to produce a practical failure of the crop so far as merchantable tubers were concerned and very little evidence of disease could be seen by looking at the tops. All through the season they appeared to the average observer to be perfectly healthy above ground and gave promise of an abundant harvest, but they suddenly died when dry weather came on in August, when the tubers were about half grown. In such cases it is a very insidious type of disease. The fungus frequently attacks the underground, tuber-bearing stolons, cutting them off after the young potatoes have formed, or before they obtain much size, thus bringing about the production of a large number of small potatoes in a hill; hence the name, "little potato disease."

There are a number of disease conditions, mainly characterized by the appearance of the parts of the plants above ground, some of which are quite distinct while others appear to grade into each other, and which are partly parasitic in nature and partly of unknown origin. In Maine, with one exception, these are by no means as common nor as destructive as they are in the Middle West, Rocky Mountain and Pacific Coast states. However, since those of a parasitic nature, and most of those which so far have been found to be non-parasitic, appear to be carried with the tubers, and tubers from diseased hills usually produce more seriously affected plants than those from which they came, a wise Maine grower will not temporize with them. He will eliminate the diseased plants as soon as they appear in his fields and before they begin to set tubers. If the disease occurs in his fields to such an extent that this practice is impossible, he will dispose of the entire crop and endeavor to secure seed for his next year's planting from fields which showed none of these troubles.

These leaf and stem troubles are known variously as wilt, leaf-roll, curly dwarf, rosette, mosaic, etc. Mosaic is the only one which occurs to any extent in Maine. Of the two leading varieties grown it is almost entirely confined to the Green Mountain, practically none being seen on the Irish Cobbler.

Mosaic is characterized by more or less wrinkled, irregular, distorted foliage of a variegated color. The leaves are variously spotted and mottled with a lighter green, giving a calico effect. No definite parasite has been found associated with it. It certainly indicates a weakness of the seed, and should be eliminated wherever it occurs.

Potato wilt, wherever found, is undoubtedly of a parasitic nature. Apparently a similar type of disease may be caused by two different types of fungi. This is not particularly important to us, but it is important from the standpoint of the practical grower to know that potato wilt is carried by the seed tubers and that once in the soil the fungus which causes the disease may persist there for an undetermined time. So far we have seen very little of it in Maine and it is much less prevalent here than in any other of the leading potato growing states visited.

While wilt may appear earlier it does not usually show up in a striking manner till about blossoming time or later. In the earlier stages the affected plants may be lighter green, and later even take on a yellowish appearance. The lower leaves begin to die first, and thus it is often overlooked by the average observer. His attention is usually attracted by the premature death of the plants, following a wilting or withering of the upper leaves.

If the stems of potatoes affected in this manner are cut off close to the surface of the ground, either above or below, but more especially the underground portions, it will be seen that they show a ring of discolored or browned tissue a little way below the surface. This is in the region of the water conducting system and undoubtedly the wilting and death of the plant is due to the clogging of the conducting vessels, thus shutting off its water supply.

The fungus also attacks the roots and tubers. In my experience such tubers as have already formed at the time of the examination of plainly diseased plants usually show some signs of infection at the stem end. This may be indeed slight, just at the junction of the stem and tuber, or it may appear in the form of a distinct brownish ring a little below the surface of the potato, and extending some distance from the stem end. The small amount of wilt observed in Maine, while the general effects are similar, appears to be of a slightly diffeient type than that described, in that the growth of the fungus, and the resulting browning of the stem may extend up for considerable distances, often into the leaf stalks. The wilting characteristics are more pronounced, for the plants will often suddenly wilt and die without much previous signs of disease. Regardless of the cause, potatoes from plants so affected should never be used for seed purposes.

We frequently find in Maine a potato trouble where the diseased tubers might be mistaken for those affected with the wilt fungus. Here the tissues, usually confined to that portion outside the vascular ring, show a peculiar mottled browning, or irregular netted appearance. This has been given the name of net-necrosis. There is no evidence that it is of a parasitic nature, but it may indicate a constitutional weakness, therefore tubers so affected should not be used for seed. Even the browning of the vascular ring, in our experience, does not always indicate the presence of a parasite that we can discover, but all these things do indicate a weakness of the tuber.*

Potato leaf-roll, a disease which has been receiving considerable attention in Germany during the past few years, has only

*Experimental work conducted after this article was written, but before publication, has shown conclusively that planting tubers affected with net-necrosis results in a material reduction in yield.

recently been recognized in this country. It may have been present for a much longer time before the characters which differentiate it from similar troubles were recognized and pointed out. In view of the experience of European growers with this malady, and in view of the fact that Doctor Appel says that what they call leaf-roll in Germany is identical with a trouble which is associated with and apparently has become an important factor in reducing the yields in certain central and western states, notably in some of the irrigated sections of Colorado and Utah, it is important that Maine potato growers become familiar with the characteristics of the disease and be on their guard against it.

After seeing field after field having plants affected in this manner and seeing them in the presence of Doctor Appel, who is probably the best authority on this subject, I am thoroughly convinced that there is such a thing as leaf-roll. I am also just as thoroughly convinced that there are at least one or two other types of foliage troubles which simulate this and grade into it in appearance, and which at times it is impossible for even the most expert to differentiate by simply looking at the tops alone. This, however, has little real significance to the practical man. He should look upon *any* abnormal type of potato plant as something which should not be tolerated in his field, and should not use for seed purposes tubers produced by such plants.

In this connection and at this point I wish to introduce for the sake of emphasis, a general observation with regard to tuber-borne potato diseases, and this includes nearly all the more important potato troubles. The practical potato grower does not need to be a trained pathologist in order to avoid these difficulties. It is not even necessary for him to be able to distinguish all of these various diseases, although it is often an advantage to be able to do so. It does not take a very keen observer to tell an abnormal or diseased potato plant or tuber from a perfect one. If only sound, healthy and perfect potatoes, grown from healthy plants, are used for seed and then disinfected by one of the regular recognized means before planting, many of our potato troubles would vanish. For example, powdery scab could have been kept out of Maine in this way without the potato growers knowing the difference between it and common scab. Yes, without knowing that such a thing as powdery scab existed.

Potato leaf-roll, as its name implies, is characterized by a conspicuous upward rolling or curling of the leaflets on their mid-ribs. The leaves assume a more upright position than is normal. A striking characteristic of the disease is the change in the color of the leaves. This is a yellowing, frequently associated with a reddening or purpling. I was by no means always satisfied that much of what was pronounced to be leaf-roll, even by the experts of the party, always occurred entirely independent of other disease producing factors. After a certain amount of familiarity with the disease was acquired, two important characteristics were observed, which, if present, tended to eliminate any doubt which existed. One of these was the appearance of the reddish and purplish colors in the curled leaves, and the other was the almost entire failure of the affected plants to set tubers. I know of no other potato disease where these characters are of constant occurrence together.

Plants affected with leaf-roll are more or less stunted in appearance. They appear much longer lived than those attacked by wilt, and may live as long as the healthy plants in the same field. Apparently it is a non-parasitic trouble, though in some cases it has been maintained that it is caused by fungi. Leaf-roll is carried by the seed tubers, hence those produced by diseased plants should not be used for seed purposes.

Although fields have been reported in Maine as carrying as high as 100 per cent of the disease, I personally have seen almost none of what I should call true leaf-roll in this state. I have, however, seen a trouble of similar appearance associated with Rhizoctonia injury which might easily be mistaken for it.

Plants affected with what is known as curly dwarf have every appearance that the name implies. The whole plant is dwarfed and more compact than normal and has a peculiar crinkled foliage. An important characteristic of the disease is that the stems and leaf petioles are distinctly brittle as compared with those of normal plants. As compared with leaf-roll the leaves curl downward rather than upward. Occasionally a plant showing this trouble is seen in Maine, often associated with the mosaic disease. The cause of curly dwarf is also unknown.

I have now described the more important potato diseases which we met in our trip across the continent and have stated something as to their occurrence in Maine. I now wish to make a brief comparison with disease conditions farther west and to tell you something about potato growing in the states visited.

While we spent a part of one day in western Vermont, our real potato disease studies after leaving Maine began in New York. Entering the state at Plattsburg on Lake Champlain we proceeded westward through Clinton and Franklin counties to Malone and from there to Rochester. From Rochester we first worked eastward to Geneva and then westward to Buffalo.

In northern New York, with few exceptions, the fields were not equal to the average in Aroostook. There was much less blackleg, but Rhizoctonia, wilt, leaf-roll and similar diseases were much in evidence. The mosaic disease, as in Maine, was particularly common on the Green Mountains. It is interesting to note that we did not see this disease again on this trip, but I have recently been told that this year it appeared over much of the territory covered.

In northern New York very little commercial fertilizer is used in comparison with Maine, particularly Aroostook. Some cases were found where from 400 to 700 pounds per acre were applied, but usually it was from 200 to 300 pounds. In some towns around Plattsburg they were using stable manure shipped from Montreal, costing $12 for a carload of 43 tons with 75 cents a ton for freight added. To one accustomed to the close planting practiced in northern Maine there seemed to be a big waste of land here, for it is common to plant three feet apart in checks. In some sections visited on the trip, I believe in Michigan, the hills in a few fields were 40 x 40 inches.

In western New York, in Ontario, Livingston and Munroe counties, we saw a district of considerable importance as a seed growing area. At that time this was not at its best on account of having experienced a long drouth. This made the effects of Rhizoctonia and wilt very prominent.

Members of the party visited some of the important potato growing centers in both the upper and lower peninsula of Michigan. Near Port Huron in St. Clair county, where the soil is a sandy loam, some leaf-roll, wilt and Rhizoctonia injury were observed. The last two mentioned were particularly bad on a few fields.

The colony of Danish potato growers already mentioned is located not far from Grand Rapids. They have a light, sandy soil, formerly heavily wooded with white pine. The lumbermen left it a barren waste of stumps and drifting sand, with little or no vegetation. In fact, the stumps of many of the pines are still there, but they are now utilized by their present owners for fencing. You can go for miles and miles in this section and see no other fences than those made of pine stumps tipped over on the side with roots attached. The results which these Danes have accomplished since they came there 20 or 30 years ago are little short of marvelous, and this has all been brought about by a system of farm management which includes the growing of livestock, clover and potatoes. General farming is practiced but dairying appears to be the leading industry. Clover and potatoes are the chief crops, nearly every farmer growing from five to ten acres of the latter. Some diseases were found here but these were not serious.

The potato industry is being developed in the northern peninsula of Michigan in the vicinity of Houghton. This locality appears to be especially adapted to the raising of seed, and as yet it is quite free from disease.

Wisconsin, already a leading potato state, has wonderful possibilities ahead in the line of development. Wisconsin, like Maine, has really not yet begun to raise potatoes and has a much greater unused area to the northward, adapted to this purpose, than Maine. The potato soils of northern Wisconsin are not, according to my observations and from what I can learn, equal to those of northern Maine. The most of our observations in Wisconsin on this trip were made in Waupaca, Portage and Chippewa counties in the central and somewhat north of the central part of the state.

The soils in these sections are somewhat sandy, but not so much so as in Michigan. They are underlaid by a clay subsoil 10 or 15 inches down, making them of much greater water holding capacity than one would first suspect. They have one advantage over Aroostook county in that corn can be grown there, thus making dairying a profitable adjunct to potato raising as well as increasing the range of revenue producing crops.

Apparently stable manure is the chief source of fertilization, although some commercial fertilizer is used in amounts varying from 150 to 400 pounds per acre. They plant rather late, sometimes as late as the middle or last of June. The reported yields run from 150 to 200 bushels per acre. Undoubtedly by adopting Maine methods this could be increased largely. While there are some exceptions, potatoes are planted in checks 3 x 3 feet and practically level culture is followed. Though some wilt, leaf-roll and Rhizoctonia injury were observed, the Wisconsin potatoes as far as seen were very healthy.

Our observations in Minnesota were confined to the region around Minneapolis and St. Paul and that section of the Red River Valley near Morehead, or across the river from Fargo, North Dakota. It would be unfair to make sweeping statements based on such limited observations but, so far as I saw them, conditions here were not up to my expectations.

Large amounts of wilt and Rhizoctonia injury were observed around St. Paul, and practically all the plants on certain of the fields were characterized by Dr. Appel as having leaf-roll or the beginning stages of it. In the single day spent at Morehead, rain largely interfered with the inspection work, but so far as could be seen wilt, and Rhizoctonia injury, particularly the former, were very common.

Several days were spent in Colorado, which was the next state visited. Most of the potatoes that we saw in Colorado, Utah and Idaho are raised under irrigation and the soil is naturally fertile. As a rule the altitude is such as to produce a relatively cool climate and the almost continuous sunlight experienced during the growing season is favorable to starch formation and growth. Drouth need not be feared, and the equally disastrous results of excessive rainfall, followed by late blight and rot, which is the case with us in Maine, are also eliminated.

On general principles one would say that conditions for potato growing are ideal, but in Colorado we have one of the most striking instances of disease development leading to practical failure of the crop, even under these apparently favorable conditions. The same thing is beginning to show up in certain parts of Utah.

What is known as the Greeley district, not far from Denver, has been one of the most important potato growing districts of Colorado. This district, which at one time was one of the most noted in the United States, is only about 20 miles long and 12 to 15 miles broad at the point of greatest width. Potato growing began here about 1870 and was uniformly successful up to a little less than a dozen years ago when the whole industry began to go to pieces. One potato grower told me that in 1904 they shipped 14,000 cars within a radius of 15 miles of Greeley. This dropped to 8,000 cars in 1910, and in 1911 only 200 cars were shipped. Others set this last figure at 600 cars. In a few seasons potato growing changed from an important industry to one of little account. Conditions were a little better last year, but were still bad enough then. A recent report from there indicates that the crop of the present season makes them more hopeful.

The strangest part of this slump in the industry at Greeley is that no two people appear to agree as to the cause of the trouble, and they have some very keen, up-to-date men among the potato growers there. There is certainly evidence enough of disease to account for many of the difficulties experienced, for leaf-roll, wilt and Rhizoctonia were almost universally present in a marked degree in the summer of 1914.

Large crops of alfalfa are produced, and potatoes are grown on alfalfa sod. This, of course, tends to increase the nitrogen content of the soil, which latter is claimed by some to be deficient in phosphorus. There is a strong probability that some of the trouble may be due to an unbalanced condition of the food materials in the soil, but I could learn of no attempt being made to discover this, or to use any form of commercial fertilizer to correct it if it does exist. Sugar beets are also grown to a considerable extent, and some growers maintain that the trouble with potatoes began coincidentally with the introduction of sugar beets. What the connection is between the two, if any, they are unable to state.

At Carbondale, Colorado, on the other side of the Continental Divide, and not far from Leadville, conditions are quite different from those at Greeley. It is true that the industry here is more limited and is of more recent development. In the case of one large concern, at least, I do not believe that they will ever have to go through the Greeley experience. It is owned and personally managed by two business men, and I have yet to see a case anywhere in the United States where men engaged in a line of applied agriculture have made such a thorough study of all phases of their business. They have made use of every scrap of scientific and practical information they can obtain, so far as it was applicable to their conditions. These men are farming to make money and not to spend it. When I state that they spent $60,000 for their water supply alone it will be seen that they are engaged in no small undertaking. They have between 2,000 and 3,000 acres of land and something over 1,000 of this is under cultivation. I was told that not an acre of this is for sale.

I never saw finer looking potatoes than theirs. By careful selection they have largely eliminated disease, undesirable, irregular types of tubers and low yielding strains, so that their average yields are something remarkable. In selection their aim has not been to increase their yields by growing big tubers, but to propagate only those strains which give a maximum number of tubers per hill of uniform table size. While they set apart each season certain land planted with carefully selected tubers in which to raise their own seed for the coming year they are not in the seed business. Practically all their crop goes as table stock. Being business men you would expect them to look for a special market where good prices may be had and they have. Most of their potatoes go to high class hotels and city clubs. In fact, they supply one of the leading clubs in New York City.

It is interesting to note that in this part of Colorado we saw the first cases of blackleg after leaving northern New York, although it is known to occur in most of the sections visited.

Certain parts of Utah are having experiences similar to those mentioned for the Greeley district of Colorado. We saw considerable of the territory around Salt Lake City and from there north through Ogden, Brigham and Logan to the Idaho line. As a rule, the potatoes seemed to be in a rather unsatisfactory condition. An interesting development in the west is that it is by no means uncommon for private concerns to establish laboratories and employ pathologists of their own. The American Smelting and Refining Company has done this at Salt Lake City. One of the objects of this laboratory is to find out the cause of recent, local potato failures, and devise remedies.

Very few easterners think of Idaho as a potato growing state, but the irrigated lands which are now being opened up or have been opened up in Idaho during the last ten or twelve years are, so far, nothing short of a potato grower's paradise. Probably nowhere else in the country can so large yields of first-class potatoes be obtained at so little expense. In average yields per acre Idaho is rapidly coming to the front, and unless some disaster like that which occurred in the Greeley district of Colorado overtakes them it would not be surprising if they took the lead in the country in yields per acre before many years.

This all agrees with what the land agent and promoter tells you. There is, however, one more thing which he forgets to tell you. While southern Idaho can and does produce cheaply some of the largest crops of most excellent potatoes, the people to eat them are located hundreds of miles away. Either way you go you must haul the crop long distances over high mountain ranges, and much of the profit goes to the railroads. It will be a long time before the industry in a large way will become very profitable here, unless some method is devised to utilize the crop locally in such a manner that it will net a fair price. At present they do not have starch factories or other industries to take care of the culls and excess crop.

While blackleg, wilt, leaf-roll and the Rhizoctonia disease were all found, nearly a week's study of the situation in southern Idaho indicated that, so far, these diseases have been of very little importance there.

One farm visited at Twin Falls, Idaho, was of particular interest to me, since I found the blackleg disease there. A few years ago I was called to visit a potato field in Piscataquis county where blackleg was common. This was on a farm where the disease had never appeared before. The field was planted with seed grown on the Twin Falls, Idaho, farm. The Idaho grower got it from a man in Carbondale, Colorado, who imported the original seed from Scotland. Undoubtedly the disease came all the way from Scotland to Maine with the seed tubers by this round-about way, and all within five years. It is a very good illustration of how some importations of infected seed may result in a wide distribution of a tuber-borne potato disease in a very short time.

Visits were made to northern Idaho, and various parts of Oregon and Washington. Although more or less seed is grown, particularly in the latter state for California planting, no especially large potato districts were visited.

With one exception, no particularly interesting development of potato diseases was observed, sufficient to require special mention. Near Tacoma, Washington, at a substation of the Washington Agricultural Experiment Station, was found what is apparently an undescribed leaf trouble. This had already been observed in 1913 and 1914 on some potatoes that the United States Department of Agriculture brought to Maine for some of their breeding work. I have also found a few affected plants in Maine fields this season. It is characterized by a peculiar browning or streaking of the under sides of the leaves or leaf petioles along the line of the veins or midrib. It has been called, for the want of a better name, the "streak disease." It has the appearance of a bacterial trouble, but, as yet, no bacteria have been isolated from the diseased plants which are capable of causing the disease upon inoculation.

Regarding California, the last state to be taken up, I will confine what I have to say to telling you something about the potato industry of the deltas of the San Joaquin and Sacramento rivers, near Stockton, the county-seat of San Joaquin county. This area, sometimes spoken of as the "tule lands," consists of some 250,000 acres of very fertile peat soil.

The lands lie mostly at or near sea level and are made up of the more or less decomposed roots and decayed remains of the tule or giant bulrush and other marsh plants to which has been added the sediment deposited by the river. The marshes are reclaimed by throwing up levees by means of great dredges along the banks of rivers and sloughs to exclude the tidal and flood waters. During the growing season the water is kept at the required level by means of ditches and pumps. Additional water needed for irrigation during the summer months is brought over the levees by siphons or through by means of head gates. Various crops are grown, but potatoes, of which there are annually planted some 40,000 or 50,000 acres, is the principal one.

These lands, like many others in California, are divided into large holdings, frequently dating back to the original Spanish grants. As a rule, they are not farmed by their owners, but are rented mostly to Japanese growers, and the work is done largely by Japanese and Chinese laborers, who live in camps in the fields. The largest potato grower in the United States is one of these Japs, who has planted as high as 6,000 or 7,000 acres a year. Land rental is high, often amounting to $30 or $40 per acre per year. Consequently the grower has absolutely no interest in the land itself, except to get all he can out of it as long as it pays him. Then he moves on to fresh land which is constantly being reclaimed.

For the first three years after reclamation the lands are cropped with potatoes every year. Then it is barley alternating with potatoes until great reductions in the yields of the latter crop make it no longer profitable. If this system is persisted in, yields which, in the beginning, run from 350 to 550 bushels per acre, drop to as low as 60 bushels per acre. As far as I could learn absolutely no fertilizer is applied and the diseased or cull potatoes are left on the ground as a source of infection to future crops.

The effects of leaving culls on the ground are even worse than they would be in a more rigorous climate. On account of the mild winters on the deltas the cull potatoes produce a large volunteer crop in the barley so there is a continuous growth of potatoes on the land from year to year. Thus diseases, once introduced, have abundant opportunity to live over and increase. The tenants move from camp to camp from year to year and carry their seed with them. In fact, no better method could be devised to propagate and spread potato diseases in this region.

As might be expected, wilt and Rhizoctonia are rampant. A Government expert on the ground estimated that the losses from the latter amounted to at least a million dollars in the delta region in 1913. In the mild climate of California a secondary trouble follows the wilt and materially adds to the losses from this cause. This is known as the "jelley end" rot and is caused by other fungi and bacteria which gain entrance through the lesions produced by the wilt fungus.

In addition, they have two interesting animal pests, the tuber moth and the nematode or eel worm. The former makes large tunnels or channels in the flesh of the tuber, while the latter attacks the surface, giving it an uneven, knotty appearance. Apparently the tuber moth is not so likely to attack the potatoes in the moist soils of the deltas, before they are dug, as in the dryer situations. One case was reported where only one or two per cent of the crop was attacked when dug, but several days after, 90 per cent of the culls left on the same field were attacked by the tuber moth.