PUBLIC DOCUMENTS OF MAINE

1914

BEING THE

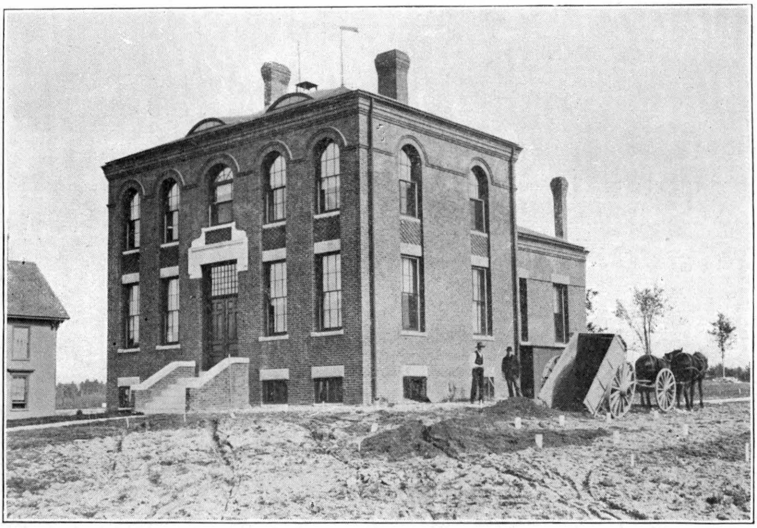
ANNUAL REPORTS

OF THE VARIOUS

Departments and Institutions

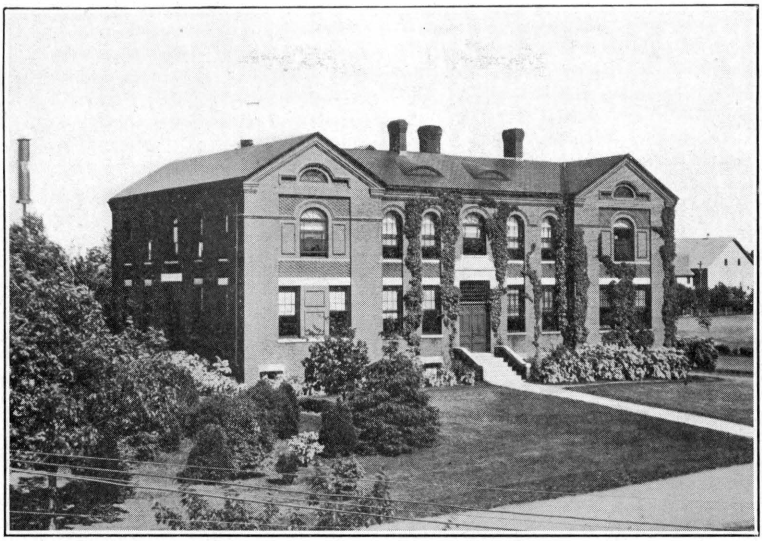
For the Year 1913

VOLUME I.

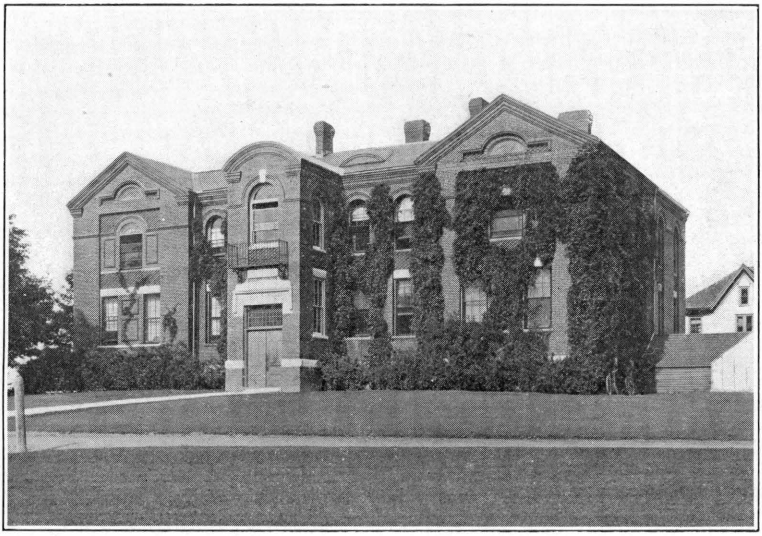


Holmes Hall, 1888.

Holmes Hall, 1899.



Holmes Hall, 1904.



Holmes Hall, 1913.

TWENTY-NINTH ANNUAL REPORT

OF THE

Maine Agricultural Experiment Station

ORONO, MAINE

1913

STATE OF MAINE.

1914

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE

Organization January to June, 1913.

THE STATION COUNCIL.

PRESIDENT ROBERT J. ALEY,	*President*
DIRECTOR CHARLES D. WOODS,	*Secretary*
CHARLES L. JONES, Corinna, FREELAND JONES, Bangor, JOHN M. OAK, Bangor,	*Board of Trustees* *Committee of*
JOHN A. ROBERTS, Norway,	*Commissioners of Agriculture*
EUGENE H. LIBBY, Auburn,	*State Grange*
ROBERT H. GARIDNER, Gardiner,	*State Pomological Society*
RUTILLUS ALDEN, Winthrop,	*State Dairymen's Association*
WILLIAM H. DAVIS, Augusta,	*Maine Livestock Breeders' Association*
WILLIAM G. HUNTON, Readfield,	*Maine Seed Improvement Association*

AND THE HEADS AND ASSOCIATES OF STATION DEPARTMENTS.

THE STATION STAFF.

ADMINISTRATION	CHARLES D. WOODS, Sc. D.,	*Director*
	BLANCHE F. POOLER,	*Clerk*
	GEM M. COOMBS,	*Stenographer*
	JANIE LOGIE FAYLE,	*Stenographer*
BIOLOGY	RAYMOND PEARL, PH. D.,	*Biologist*
	MAYNIE R. CURTIS, A. M.,	*Assistant*
	CLARENCE W. BARBER, B. S.,	*Assistant*
	WALTER ANDERSON,	*Poultryman*
	ESTELLA MORRISON,	*Computer*
CHEMISTRY	JAMES M. BARTLETT, M. S.,	*Chemist*
	HERMAN H. HANSON, M. S.,	*Associate*
	EDWARD E. SAWYER, B. S.,	*Assistant*
	HELEN W. AVERILL, B. S.,	*Assistant*
	ELMER R. TOBEY, B. S.,	*Assistant*
	HARRY C. ALEXANDER,	*Laboratory Assistant*
ENTOMOLOGY	ALICE W. AVERILL,	*Laboratory Assistant*
	EDITH M. PATCH, PH. D.,	*Entomologist*
PLANT PATHOLOGY	WARNER J. MORSE, PH. D.,	*Pathologist*
	CHARLES E. LEWIS, PH. D.,	*Associate*
	MICHAEL SHAPOVALOV, B. A.,	*Assistant*
	VERNON FOLSOM,	*Laboratory Assistant*
HIGHMOOR FARM	WELLINGTON SINCLAIR,	*Superintendent*
	GEORGE A. YEATON,	*Orchardist*
	ROYDEN L. HAMMOND,	*Seed Analyst and Photographer*
	CHARLES S. INMAN,	*Assistant*

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE

Organization July to December, 1913.

THE STATION COUNCIL.

PRESIDENT ROBERT J. ALEY,	*President*
DIRECTOR CHARLES D. WOODS,	*Secretary*
CHARLES L. JONES, Corinna, FREELAND JONES, Bangor, WILLIAM A. MARTIN, Houlton,	*Committee of Board of Trustees*
JOHN A. ROBERTS, Norway,	*Commissioners of Agriculture*
EUGENE H. LIBBY, Auburn,	*State Grange*
ROBERT H. GARIDNER, Gardiner,	*State Pomological Society*
RUTILLUS ALDEN, Winthrop,	*State Dairymen's Association*
WILLIAM H. DAVIS, Augusta,	*Maine Livestock Breeders' Association*
WILLIAM G. HUNTON, Readfield,	*Maine Seed Improvement Association*

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

THE STATION STAFF.

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

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

Agricultural Experiment Station,

Orono, Maine.

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.

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

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

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

Investigations.

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

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

Inspections.

Up to the close of the present year it has 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 will be handled by the Commissioner of Agriculture. The analytical examination of the samples and the publishing the results of the analyses will still be done by the Station. The cost of the inspections is borne by fees and by a state appropriation.

Offices and Laboratories.

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

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

Aroostook Farm.

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

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

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

HIGHMOOR FARM.

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

THE AIM OF THE STATION.

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

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

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

CORRESPONDENCE.

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

Orono, Maine.

Publications.

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

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

BULLETINS ISSUED IN 1913.

No. 209. New Mineral Fertilizer. 12 pages.
No. 210. Spruce Bud Worm and Spruce Leaf Miners. 24 pages, 9 illustrations.
No. 211. Potato Flea Beetle. 20 pages, 8 illustrations.
No. 212. Orchard Spraying Experiments in 1912. 16 pages.
No. 213. Aphid Pests of Maine. II. Willow Family. 28 pages, 36 illustrations.
No. 214. The Biology of Poultry Keeping. 20 pages, 2 illustrations.
No. 215. The Measurement of the Intensity of Inbreeding. 16 pages.
No. 216. Poultry Notes, 1911-13. 28 pages, 8 illustrations.
No. 217. Woolly Aphid of the Apple. 20 pages, 19 illustrations.
No. 218. Tables for Calculating Coefficients of Inbreeding. 12 pages.
No. 219. Comparative Studies of Certain Disease Producing Species of Fusarium. 56 pages, 33 illustrations.

No. 220. Woolly Aphids of the Elm. 40 pages, 24 illustrations.

No. 221. Variations of Fat in Milk. Pedigree System Applied to Guinea-Pigs. Aluminum in Chick Feeds. 20 pages, 6 illustrations.

No. 222. Meteorology, Finances and index. 28 pages, 2 illustrations.

OFFICIAL INSPECTIONS ISSUED IN 1913.

No. 46. Seed Inspection. 12 pages.
No. 47. Fungicide and Insecticide Inspection, 1912. 16 pages.
No. 48. Drugs. 8 pages.
No. 49. Protection of Food Offered for Sale. 8 pages.
No. 50. Feeding Stuff Inspection. 40 pages.
No. 51. Weight of Butter. 16 pages.
No. 52. Seed Inspection. 12 pages.
No. 53. Fertilizer Inspection. 36 pages.
No. 54. Insecticide and Fungicide Inspection, 1913. 8 pages.
No. 55. Clams, Oysters and Scallops. 8 pages.

MISCELLANEOUS PUBLICATIONS ISSUED IN 1913.

No. 464. Fungicide and Insecticide Inspection, Manufacturer's Certificate. 1 page.
No. 465. Feeding Stuff Inspection, Manufacturer's certificate. 1 page.
No. 466. List of Registered Feeding Stuffs. 4 pages.
No. 467. Potato Flea Beetle. 8 pages.
No. 468. Preparation and Use of Lime-Sulphur in Orchard Spraying. 10 pages.
No. 469. Short Weight Butter. 1 page.
No. 470. Newspaper Notice Bulletin 207. 1 page.
No. 471. Methods of Poultry Management at the Maine Agricultural Experiment Station. 78 pages.
No. 472. Newspaper Notice Bulletin 210. 1 page.
No. 473. Newspaper Notice Circular 467. 1 page.
No. 474. Newspaper Notice Circular 468. 1 page.
No. 475. An Act to Provide for Scientific Investigations in Agriculture in Aroostook County. 4 pages.
No. 476. Newspaper Notice Bulletin 212. 1 page.
No. 477. Library Card. 1 page.
No. 478. Newspaper Notice Circular 471. 1 page.
No. 479. Map Highmoor Farm. 1 page.
No. 480. Experiments at Highmoor Farm, 1913. 8 pages.
No. 481. List of Papers from the Biological Laboratory, Vol. I. 8 pages.
No. 482. Aphid Galls of the Poplar. 8 pages.
No. 483. Aphids. 10 pages.
No. 484. Note Regarding the Calculation of Coefficients of Inbreeding. 1 page.

No. 485. Special Report of the Maine Agricultural Experiment Station for the Commissioner of Agriculture for the Year 1912. 48 pages.
No. 486. Blank Record Sheet. 1 page.
No. 487. Blank Record Sheet. 1 page.
No. 488. Summaries of Station Work No. 1. Apple Studies. 20 pages.
No. 489. Newspaper Notice Bulletin 216.
No. 490. Station Publications. 1 page.
No. 491. Available Bulletins and Reports of the Station. 4 pages.

BIOLOGY PUBLICATIONS 1913.

In the numbered series of "Papers from the Biological Laboratory:"
No. 42. Data on Sex Determination in Cattle. By Raymond Pearl and H. M. Parshley. Biol. Bull., Vol. 24, pp. 205-225.
No. 43. Note Regarding the Relation of Age to Fecundity. By Raymond Pearl. Science, N. S., Vol. 37, pp. 226-228.
No. 44. Genetics and Breeding. By Raymond Pearl. Science, N. S., Vol. 37, pp. 539-546.
No. 45. A Biometrical Study of Egg Production in the Domestic Fowl. III. Variation and Correlation in the Physical Characters of the Egg. By Raymond Pearl and Frank M. Surface. U. S. Dept. of Agr., Bureau of Animal Industry, Bull. 110, Pt. III. (In press).
No. 46. The Relative Time of Fertilization of the Ovum and the Sex Ratio in Man. By Raymond Pearl and Redcliffe N. Salaman. American Anthropologist. (In press).
No. 47. A Contribution Towards the Analysis of the Problem of Inbreeding. By Raymond Pearl. American Naturalist, Vol. XLVII, pp. 577-615.
No. 48. The Odd Chromosome in the Spermatogenesis of the Domestic Chicken. By Alice M. Boring and Raymond Pearl. Journ. of Exp., Zool., Vol. 16, pp. 53-83.
No. 49. The Biology of Poultry Keeping. By Raymond Pearl. Me. Agr. Exp. Sta. Ann. Rept. for 1913, pp. 101-120.
No. 50. A Biometrical Study of Egg Production in the Domestic Fowl. IV. Factors Inflencing the Size, Shape, and Physical Constitution of Eggs. By Maynie R. Curtis. (In press.
No. 51. Tables for Calculating Coefficients of Inbreeding. By Raymond Pearl and John Rice Miner. Me. Agr. Exp. Sta., Ann. Rept. for 1913, pp. 191-202.
No. 52. On the Correlation between the Number of Mammae of the Dam and Size of Litter of Mammals. I. Interracial Correlation. By Raymond Pearl. Proc. Soc. for Exp. Biol. and Med., Vol. XI., pp. 27-30.

No. 53. On the Correlation between the Number of Mammmae of the Dam and Size of Litter in Mammals. II. Intraracial Correlation in Swine. By Raymond Pearl. Proc. Soc. for Exp. Biol. and Med., Vol. XI., pp. 31-32.

No. 54. On the Results of Inbreeding a Mendelian Population: A Correction and Extension of Previous Conclusions. By Raymond Pearl. American Naturalist, Vol. XLVIII., pp 57-62.

No. 55. Variation in the Tongue color of Jersey Cattle. By Raymond Pearl. Proc. Soc. for Promotion of Agricultural Science, 1913.

No. 56. Studies on the Physiology of Reproduction in the Domestic Fowl. VI. Double and Triple-Yolked Eggs. By Maynie R. Curtis. Biol. Bull. Vol. XXVI., pp. 55-83.

No. 57. Constants for Normal Variation in the Fat Content of Mixed Milk. By Raymond Pearl. Me. Agr. Exp. Sta., Ann. Rept. for 1913, pp. 299-305.

No. 58. A Pedigree System for Use in Breeding Guinea-Pigs and Rabbits. By Frank M. Surface. Me. Agr. Exp. Sta., Ann. Rept. for 1913, pp. 306-313.

No. 59. On the Ability of Chickens to Digest Small Pieces of Aluminum. By Maynie R. Curtis. Me. Agr. Exp. Sta., Ann. Rept. for 1913, pp. 314-318.

Papers published but not in the numbered series.

a. Methods of Poultry Management at the Maine Agricultural Experiment Station. By Raymond Pearl. Me. Agr. Exp. Sta., Circ. 471, pp. 1-78.

b. The Need for Endowed Agricultural Research. By Raymond Pearl. Science, N. S., Vol. 37, No. 958, pp. 707-709.

c. Note on the Sex Behavior of the Poitou Jacks. By Raymond Pearl. Jour. Animal Behavior, Vol III., No. 4, pp. 297-299.

d. Poultry Notes, 1911-1913. By Raymond Pearl. Me. Agr. Exp. Sta., Bul. 216, pp. 141-168.

e. The Result of Selecting Fluctuating Variation. By Frank M. Surface. Compte-Rend. IVe Conference Internationale de Genétique, pp. 221-236.

f. The Fourth International Genetics Conference. By Frank M. Surface. Amer. Nat., Vol. 47, pp. 646-640.

ENTOMOLOGICAL PAPERS FROM THE MAINE AGRICULTURAL EXPERIMENT STATION, 1913.

Ent. 60. A Note on Two Elm Leaf Aphids. By Edith M. Patch. Journal of Economic Entomology, Vol. 6, No. 3, 1913.

Ent. 61. Insect Notes for 1912. By O. A. Johannsen. Bul. 207 Me. Agr. Exp. Sta. Issued March 14, 1913.

Ent. 62. A Study in Antennal Variation. By Edith M. Patch. Annals Entomological Society of America. Vol. 6, pp. 233-236, Plates 24-27.

Ent. 63. Spruce Bud Worm and Spruce Leaf Miners. By O. A. Johannsen. Bul. No. 210 Me. Agr. Exp. Sta. Issued April 11, 1913.

Ent. 64. Potato Flea-beetle. By O. A. Johannsen. Bul. 211 Me., Agr. Exp. Sta. Issued April 11, 1913.

Ent. 65. Aphid Pests of Maine. Part II. Willow Family. By Edith M. Patch. Bul. 213 Me. Agr. Exp. Sta. Issued July 25, 1913.

Ent. 66. Food Plant Catalogue of the Aphidae of the World. Part II. By Edith M. Patch. Bul. 213 Me. Agr. Exp. Sta. Issued July 25, 1913.

Ent. 67. Woolly Aphid of the Apple. By Edith M. Patch. Bul. 217 Me. Agr. Exp. Sta.

Ent. 68. Woolly Aphids of the Elm. By Edith M. Patch. Bul. 220 Me. Agr. Exp. Sta.

Ent. 69. Food Plant Catalogue of the Aphidae of the World. Part III., By Edith M. Patch. Bul. 220. Me. Agr. Exp. Sta.

Changes in Station Staff in 1913.

April 1, Dr. Charles E. Lewis, Associate Pathologist, resigned to go into farming.

May 1, Mr. Walter Anderson, Poultryman, resigned to go into farming.

May 1, Miss Estella Morrison, Computer, resigned.

July 1, Miss Helen W. Averill, Assistant Chemist, resigned for a year's rest on account of her health.

April 1, Mr. Harold G. Gulliver, B. S. (Cornell) was appointed Scientific Aid in the field experiments at Highmoor Farm.

May 1, Mr. Frank Tenney was appointed Poultryman.

July 1, Miss Hazel F. Marriner, B. A. (Maine) was appointed Clerk in the Biological Department.

September 1, Mr. John Rice Miner, B. A. (Michigan) was appointed Computer in the Biological Department.

HOLMES HALL (EXPERIMENT STATION BUILDING)

The Maine Fertilizer control and Agricultural Experiment Station was established by the Maine legislature of 1885, which appropriated the sum of $5,000 a year for its maintenance. No provision, however, was made for a building for its accommodation. Although it was established as an independent institution, the trustees of the State College offered it quarters. The Board of Managers gladly accepted the offer. A laboratory was provided in Fernald Hall and an office in Wingate Hall—the wooden building, since burned, which stood where the present Wingate Hall is located. This State Station was maintained until the passage by Congress of the Hatch Bill in 1887 placed at the disposal of the University the sum of $15,000 annually for the maintenance of an Agricultural Experiment Station, after which it was discontinued.

The increase in the funds available for the support of a station permitted a considerable increase in the staff of investigation, and a consequent increase in its work, which made increased laboratory and office facilities imperative. To meet this demand, it was decided to erect a new building for the exclusive use of the Station, to be located upon the slight elevation to the east of Coburn Hall, one of the very best sites upon the campus. This building was constructed in 1887. It was built of brick with granite trimmings, and was two stories in height, with a one-story ell. In 1899 the building was enlarged by adding a wing to the south side, thus providing much needed space for food laboratories and the director's office. In the latter was placed the greater part of the station library of about 1,700 volumes.

In accordance with the plan when the building was enlarged in 1899, a wing was added on the north side in 1903. This addition restored the symmetry of the building from the front. The structure thus completed was in the form of a rectangle 46x82 feet with a reentrant angle at the southeast corner. This north wing was used for a time as a recitation room by the College of Agriculture. With the passage of the Adams Act in 1906 the increase in the staff necessitated the Station occupying the whole of the building.

In 1913, still in accordance with the plan adopted in 1899 the reentrant angle left when the addition was built on in 1903 and a two-story front porch were built.

The appearance of the building when first erected and as changed by the subsequent additions is shown in the plates. The arrangement of rooms as they now are is shown in the diagrams on pages xviii-xx. The building is 46x82 feet, two stories high, with a high basement and a large attic.

On the first floor are five chemical laboratories, two entomological laboratories, and two plant pathology laboratories.

On the second floor are four offices, occupied by the director and the administrative assistants; laboratories and offices of the biologists, a seed laboratory, a photographer's laboratory and dark room.

The basement contains two chemical laboratories, three plant pathology laboratories, rooms for the gas generator for the grinding and preparation of samples and for storage.

The large attic is used for the storage of samples, supplies, and extra copies of publications by the Station.

The building is heated by steam, lighted by electricity and supplied with gas.

The total cost of the building was about $23,000.

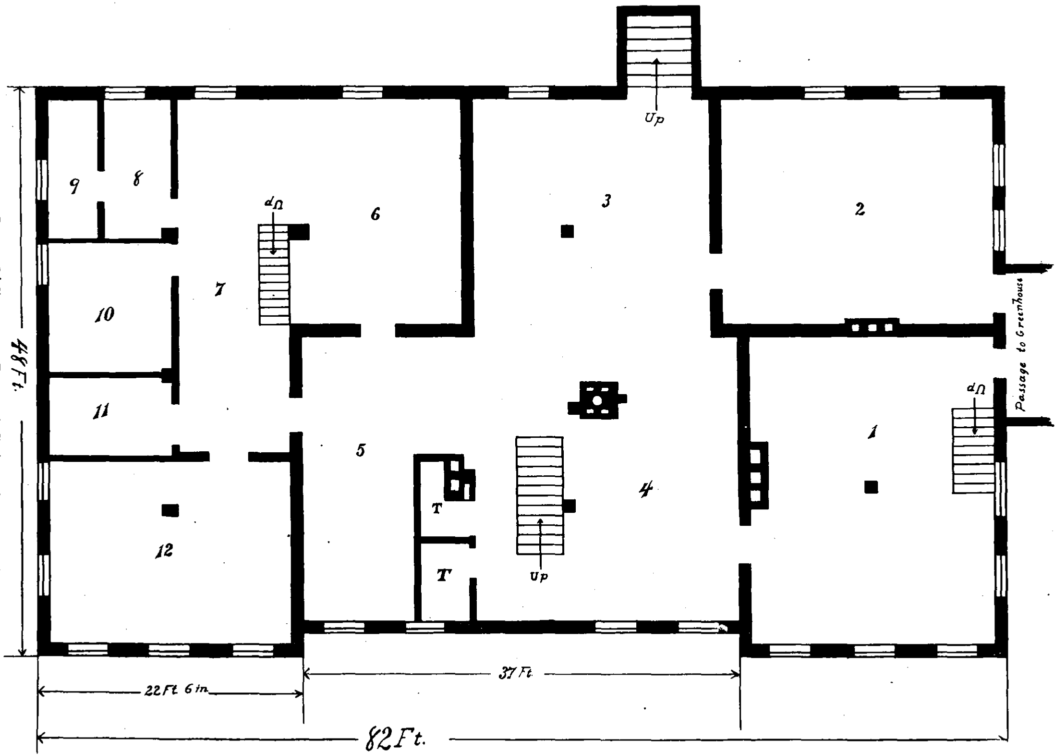
In connection with the basement on the south end of the building is a greenhouse used by the plant pathologists and entomologist.

The increase in the work and force employed in the Station necessitated the removal of the Station library to the University Library in the summer of 1913.

The additions in 1903 gave a dignified building designed and erected for agricultural investigations, and it seemed to the Trustees of the University eminently fitting that it bear the name of one of the most eminent pioneers in agricultural science,—Dr. Ezekiel Holmes. This honor is more deserved since Doctor Holmes nearly 70 years ago urged the entablishment in Aroostook County of a "state experiment farm" and it was largely through his efforts that the Maine Legislature of 1885 established the Maine State College as a separate and independent institution.

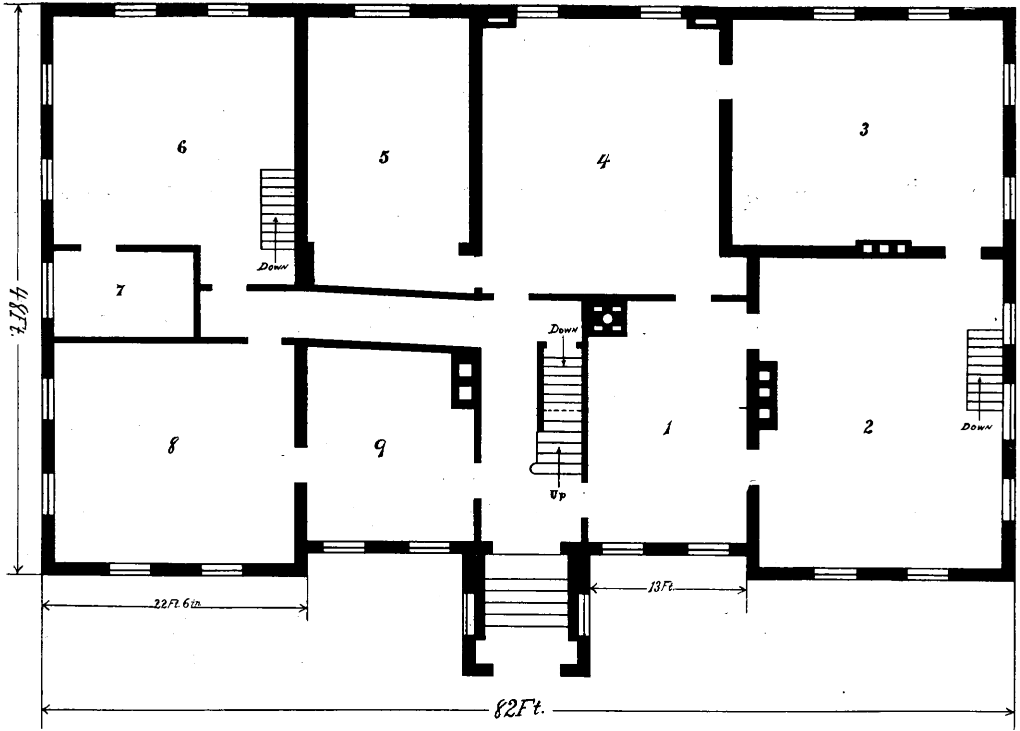
Holmes Hall was formally dedicated on May 25, 1904.

HOLMES HALL, BASEMENT PLAN

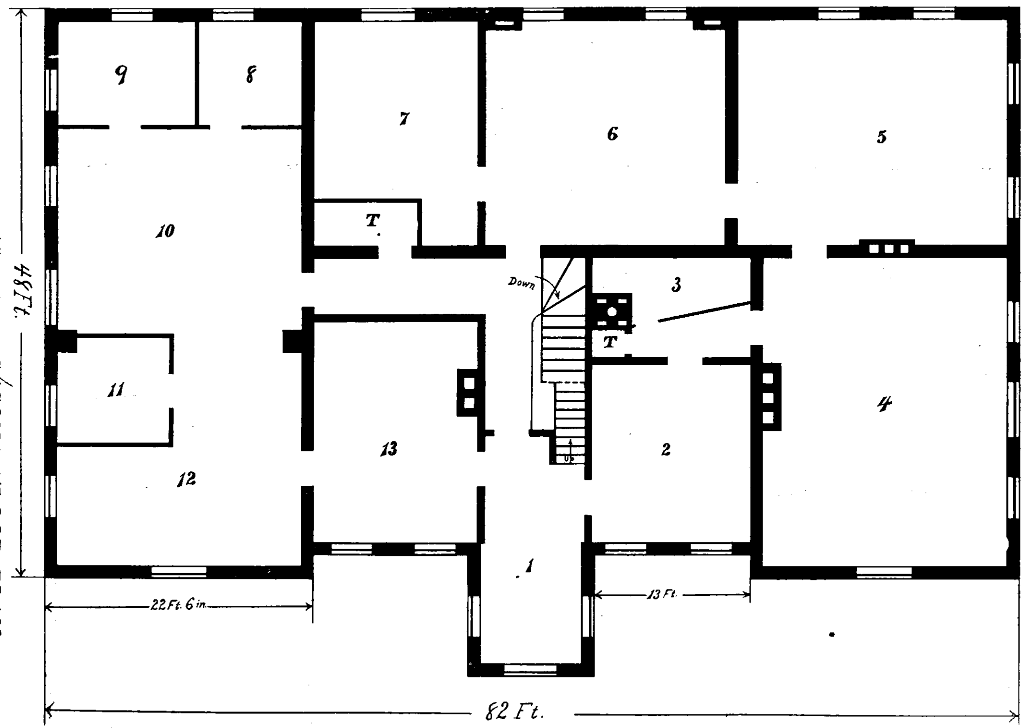


1 to 4 Chemistry 6 to 12 Plant Pathology 5 Gas machine

HOLMES HALL, FIRST FLOOR PLAN



1 to 5 Chemistry 8 and 9 Entomology 6 and 7 Plant Pathology



1 and 3 Photography 2 Seed laboratory 4 to 7 Administration 8 to 13 Biology

HOLMES HALL, SECOND FLOOR PLAN

BULLETIN No. 209.

NEW MINERAL FERTILIZER.*

Chas. D. Woods.

For the past three years a material called at first New England Mineral Fertilizer and later New Mineral Fertilizer has been extensively advertised in New England. This advertising is of the persuasive kind and has led and may lead to still further sales at about three quarters of a cent a pound of a material which in its composition is exactly what they claim it to be, ground rock. It is this likelihood of the money of the farmer going to the coffers of the company for a material that is nearly destitute of available plant food that makes necessary the publication in the following pages of a matter that were it not for the persistent advertising might be disposed of in two pages or less. In their advertising the Company keeps within the existing laws of this State. If a bill aimed against false and misleading advertising that is now being considered by the Maine Legislature should be enacted into law it is possible that something might be done. But that is doubtful, for their advertising is ingenious and guarded. For example, they compare the analysis of the ground rock they call New Mineral Fertilizer with the analysis of a soil that produces good crops and point out the resemblances. They do not dwell upon the differences. They have the same kind of testimonials from users that are so familiar to the reader of patent medicine advertisements. But many have found the use of the goods disappointing with results similar to those here reported. Such instances are not reported in the company's advertisements.

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* This experiment was planned by the writer. The field work was executed under the direction of Mr. Sinclair. The notes were taken by Mr. Bonns.

In 1910 the New England Mineral Fertilizer Company registered New England Mineral Fertilizer in Maine under the fertilizer law. The following is quoted from the annual report of the fertilizer inspection for 1911:*

"NEW ENGLAND MINERAL FERTILIZER.

Occasionally during the past 25 years there have been zealous advocates of the use of ground rock as a fertilizer. Soil is formed by the weathering of rocks by the slow processes of time. Dreamers, and it is to be earnestly hoped their dreams may some time come true, have in their imagination seen the stone walls that encumber so many New England fields converted by mechanical and chemical processes into forms available for the production of fruit, grain, hay, roots and tubers for the food of man and other animals.

In 1909 the American Health Association of Clifton, New Jersey, published a most remarkable 100-page pamphlet entitled "The Fertility of the Soil and Life or Death. A Treatise on the Use of Lava and its Influence on the Evolution of Plants, Animals and Men," by the "Professor of Polaric Nutrition at the Divine Science University." After a number of pages which are apparently designed to befog the mind of the reader, several different brands of lava such as the Mount Pelee Brand, Mount Vesuvius Brand, the Coma Brand, Chimborazo Brand for Trees, the Etna Brand for Sandy Soils, are exploited. In most of the descriptions it is ingeniously suggested that these various brands of lava be used in connection with barnyard manure or else upon rich soils. The Department of Agriculture of the American Health Association were willing to part with these brands for prices varying from $15.00 to $30.00 per ton, f. o. b. Passaic, New Jersey.

In 1910 the New England Mineral Fertilizer and Chemical Company of Boston, Mass., were licensed to sell in Maine New England Mineral Fertilizer which was guaranteed to contain no nitrogen or ammonia, a trace of available phosphoric acid,

* Maine Agricultural Experiment Station, Official Inspections 29. January 1911.

a trace of total phosphoric acid and a trace of potash. When the application for the license was received, the question naturally came up as to whether such a material could be licensed under the fertilizer law of the State. The law applies to "any material used for a fertilizing purpose, the price of which exceeds ten dollars a ton." As this was quoted at $15.00 a ton in carload lots and $17.00 per ton in less than carload lots, it seemed to come within the definition of the law. It will be noted that the goods make no claim for the presence of plant food as obtains in ordinary fertilizing materials, and as is contemplated by the law.

They have apparently issued a good deal of descriptive literature. In these publications considerable reference is made to the work of the "Professor of Polaric Nutrition at the Divine Science University," although he is not given his official title, so far as noted, in the publications of the New England Mineral Fertilizer Company.

There are probably no claims made for the composition of these goods that are not borne out by fact. They do, however, make claims for the performance of this so-called fertilizer many of which are contrary to exact experiments that have been obtained with this class of materials. It is not a new thing to attempt to fertilize land with ground rock. Feldspar which contains a large amount of potash has been used repeatedly in scientific experiments with no substantial results. It is impossible to quote at any length from the absurd literature which is used in advertising these goods. One claim—"No fear of burning the plants with this fertilizer"—is probably correct.

The writer has no knowledge of the sales that were made in Maine in 1910 of these goods with the single exception of a lot which was sold to Mr. A. J. Orf of North Bradford. When Mr. Orf received the goods he wrote to the Experiment Station about having them analyzed. He was informed that no doubt the goods would carry what they claimed to—that is, not any of the ordinary plant food materials, but would contain an abundance of the constituents of rocks quite similar to those present in his field. On receipt of the letter from the Experiment Station Mr. Orf was naturally indignant with the company and wrote them a strong letter. They, however, persuaded him to make a trial of the Mineral Fertilizer and he wrote them in October, enclosing a slip taken from the Bangor Commercial, showing that he had taken the first premium on pumpkins and cucumbers at the Charleston Fair, grown by the use of New England Mineral Fertilizer. Naturally the company were elated at this testimony and sent to the writer a series of letters, including the one which he had written Mr. Orf, which they proposed to publish to show the value of the New England Mineral Fertilizer and the ignorance of Experiment Station people.

On receipt of this communication the writer at once wrote Mr. Orf asking for particulars as to soil, methods of treatment, etc., and also asking the best way to get to his place in order that the land where this marvel was produced might be seen. October 21 Mr. Orf wrote that he grew the pumpkins and took the prize at Charleston. These were grown "on New England Mineral Fertilizer with a light *coat of manure*." He also says: "My potatoes I say nothing about, only ten bushels from two rows 25 rods long." And again: "The company wants me as an agent but I won't swindle the public." Further on he says: "You will see by my letter that it is no use to come up here."

As stated above, it is lawful so far as the fertilizer law is concerned for this company to sell this material under the claims that they do that it is free from nitrogen and contains a trace of the two other constituents of commercial fertilizers that are required by law to be stated on the package. If the fertilizer law were as broad as the food and drug law these goods would be mislabeled if accompanied by such statements as are made in the literature which these people distribute.

In 1910 the Experiment Station had about three acres at Highmoor Farm on which oats were grown without fertilizer. The object of this was to test the natural uniformity of the land and see how well it is suited for plot experiments. It is planned in 1911 to use a part of this field in an experiment to test the Mineral Fertilizer on potatoes and corn. Six-tenths of an acre will be set aside for this purpose and laid out into six plots. Two of these plots will be unfertilized, two will be fertilized with Mineral Fertilizer in accordance with the directions for the particular crop to be obtained from the New England Mineral Fertilizer and Chemical Company, one of the remaining plots will be fertilized at the rate of 1500 to 1800 pounds per acre with a high grade fertilizer, and the other plot will be fertilized at the rate of eight cords of manure and 500 pounds of fertilizer to the acre. One of the unfertilized plots will be planted to sweet corn, the other to potatoes. One of the plots manured with Mineral Fertilizer will be planted to sweet corn, the other to potatoes. The plot with 1500 to 1800 pounds of high grade fertilizer will be planted to potatoes, and the one with manure and fertilizer to sweet corn."

Planning the Experiment.

Prior to the publication of Official Inspections 29 correspondence was begun with the New England Mineral Fertilizer and Chemical Company relative to the experiment outlined in the preceding paragraph. Under date of January 2 the president of the company wrote:

"Yours of the 23rd at hand. We are more than pleased to know that you have concluded to give us a fair show. We shall ship you free of cost whatever amount of fertilizer you desire for this experiment. The same will be identical in analysis with the product which we are to put out the coming season. You stated in your letter that you wished to make an experiment on six plots. All that we ask is that you use an equal number of pounds of our fertilizer in competition with the best fertilizer that you can get on the market."

January 3 the Director of the Maine Agricultural Experiment Station wrote the New England Mineral Fertilizer and Chemical Company as follows:

"Your letter of January 2 is at hand. In the proposed test of Mineral Fertilizer we shall use the equivalent of 360 pounds of a high grade fertilizer carrying 4 per cent nitrogen, 8 per cent of available phosphoric acid and 7 per cent of water soluble potash. We will use the same amount of Mineral Fertilizer or any amount which you will suggest. When you get ready to send the New England Mineral Fertilizer please ship it to the Maine Agricultural Experiment Station, Monmouth, Maine, and notify me at Orono of the shipment. I note your offer that you will furnish this New England Mineral Fertilizer free. We, however, are ready to pay for it. Kindly send bill when the goods go forward to me here at Orono."

February 27, 1911, the president of the New England Mineral Fertilizer and Chemical Company again wrote as follows:

"We are shipping you, as directed, 100 pounds of our Mineral Fertilizer. After reading your very flattering remarks on our fertilizer in Official Inspections 29 we have concluded that it would be advisable for this company to send a representative to see this fertilizer applied. So if you will inform us when you are ready to make your test we will send a man to see the fertilizer put on and we will also send a man at different periods during the season so that we may stand at least a small show of getting fair treatment." Much of the remainder of the letter is personal abuse and the following is the only part which bears upon the proposed experiment as it indicates that they knew when they sent the 100 pounds of fertilizer for the plots exactly what was to be used on the other plots. "It is very self evident from the tests which you lay down in your bulletin which you are going to make with this Mineral Fertilizer and the quantity of what you call high grade fertilizer and the large quantity of stable manure, together with the large amount of chemical fertilizer that you intend putting against this worthless, good for nothing, ground rock which in your judgment is poorer than ordinary dirt, that you are afraid of some of the statements which you have made otherwise you would not wish to corral a large percentage of the fertilizer in your vicinity to dope up your soil for fear that you would be beaten in the coming test which you say you are going to make."

March 7 this letter was acknowledged as follows:

"Your letter of February 27 and 100 pounds of your fertilizer received. I will notify you as far in advance as I can of the time of the experiments with potatoes and corn on which Mineral Fertilizer is to be used will be stated. There will have to be two different plantings, as the potatoes will have to be planted earlier than it is safe to plant corn with us. The farm is open to visitors at all times and you or your representatives will always be welcome."

May 23 the following letter was written to the New England Mineral Fertilizer and Chemical Company:

"I have to leave to day for a week or ten days absence. The plots have been selected for the experiment with the New Englanu Mineral Fertilizer and laid out and full directions have been left relative to the plans with Mr. Bonns, our horticulturist, who is at Highmoor Farm, and Mr. Sinclair, the superintendent of the farm. The plots will probably be planted during my absence, and you will be notified as far in advance as practicable of the exact date when the planting will be done."

All six of the plots were planted on May 30 in the presence of a representative of the company. At that time the representative claimed that not a sufficient amount of Mineral Fertilizer was being used, and this matter was pointed out in a letter from the company under date of June 2.

Under date of June 5 the following letter was sent to the New England Mineral Fertilizer Company:

"Your letter of June 2 is at hand. We will gladly use all the New England Mineral Fertilizer on the plots where we are using it that you desire to be added. When I wrote you December 23, 1910, outlining the experiment I thought that we would make a tenth acre of each plot and, therefore, asked you to send the needed amount of New England Mineral Fertilizer to fertilizer one-tenth of an acre of potatoes and one-tenth of an acre of corn, asking that it be shipped to the Experiment Station at Monmouth. We received from you one bag which contained considerably less than 100 pounds. You did not send any directions for its use but said that you would have a representative present at the time of planting. * * * * * We will add any further amount of your fertilizer on the plots on which it is used that you may wish to send to the Experiment Station at Monmouth. My thought in the letter of December 23 was to have you fertilize the plots which were to be grown with the New England Mineral Fertilizer exactly as you wanted them. In the last sentence of the first paragraph of your letter of June 2 you say 'It seems to me that the test which you are giving our fertilizer is extremely unfair.' I have compared the report of your representative with your letter of December 23 and do not see wherein they differ in any essentials with the exception that the size of the plots was changed to one-twentieth of acre instead of one-tenth of an acre, as originally planned. If the unfairness consists in using a too little amount of the New England Mineral Fertilizer I do not feel that we were to blame for that and we are ready to correct it in any way that you suggest. If there are other particulars in which the experiment seems to you to be unfair I would be glad to have them stated in definite form. I had supposed that the plans of the experiment were agreed to by your company."

Under date of June 8 the company wrote:

"Yours of recent date received, and in answer will say that we doubt very much if it would do any good to put on Mineral Fertilizer this late in the season to the plot of ground in question at the experiment farm unless we had plenty of rain. We note that on Plot D you have used 60 pounds of Armour 4-8-7 in the drill and intend to apply 30 pounds more later, making 90 pounds of what you call high grade fertilizer. Now against this plot you have used only 40 pounds of our Mineral Fertilizer and we think that this is hardly a fair test considering in your estimation that Mineral Fertilizer is poorer than ordinary soil." The letter then proceeds to make similar comparisons on other plots, and concludes: "We think this is a very unfair test. However, it is too late to make any changes and we will have to await the results."

June 10 the company were written as follows:

"Your letter of June 9 is at hand. Frankly I do not like its tenor. It seems to me to be an evasive letter. December 1910 I wrote you outlining the experiment which I planned to put in effect provided you desired to have it carried out. I wrote you at that time exactly how much fertilizer we intended to use on the plots that we were going to fertilizer with commercial fertilizer and farm manure. The experiment was planted exactly as outlined there, with the exception that we used one-twentieth acre plots instead of one-tenth acre plots, as outlined in my letter of December. Relative to the amounts of the Mineral Fertilizer which were to be used, that was left, as you will find in that letter, entirely to your discretion. I told you that there were to be two tenth acre plots. I asked you to furnish Mineral Fertilizer enough for those plots. You sent 100 pounds in a bag which was rather loosely woven so that some of it sifted out in transit. We also took a pint out of the bag for the purpose of chemical analysis. We applied all of the fertilizer which you have sent to the two plots of one-twentieth acre instead of the two plots of one-tenth acre each, as originally planned. If there was not as much Mineral Fertilizer used as you desired upon the plots it seems to me that the fault is entirely with you. We were ready to apply the fertilizer in any amount which you furnished us. As to your contention that it is too late to apply fertilizer at the present time, that is absurd. Corn is just barely pushing through the ground and had made practically no growth as yet. The same is true of the potatoes. You will note that we are planning to add extra fertilizer to the plots which were planted with chemical fertilizer and farm manure."

No reply was received to this letter and on September 8 they were written that in the near future the crops would be ready for harvesting, and that if they cared to send a representative I would be glad to arrange to be there with him. By later correspondence it was arranged that the crops stay in the field and that the representative of the company should be present Wednesday, September 20, at the harvesting of the potatoes and the corn.

At the time when the representative of the New Mineral Fertilizer Company was present at harvesting he said that in his judgment altogether too little Mineral Fertilizer was used, that while he recognized that the company was at fault in this matter it was through their misunderstanding, he supposed. He had nothing to do with the planning of the experiments originally, or the passing upon the experiment as outlined.

It was arranged with him that the results of the present season (1911) should not be published, that we would repeat the experiment on exactly the same land again on 1912, that they were to furnish what Mineral Fertilizer they wanted to be applied either in the fall or in the spring as they deemed best. Under date of October 10 Mr. Yoden, representing the New England Mineral Fertilizer Company wrote: "At the suggestion of Doctor True I am going to ask you if it will be agreeable to you to increase the number of plots in the Mineral Fertilizer experiment. I would like to have you try the experiment on nine plots of potatoes, and the same on corn. Some of these plots we would like to be used with Mineral Fertilizer in connection with stable manure. We will tell you just what amount of manure and fertilizer we would like to have you use if you decide to increase this experiment. If this increase is agreeable to you I will have sent to you the fertilizer necessary, also instructions as to how we would like to have this used. If the experiment cannot be increased I will send you the necessary fertilizer for the two plots where we had the experiment this year."

October 11 the company was written:

"Mr. Yoden's letter of yesterday is at hand. I would be glad if he would outline more in detail the experiments as he would like to have them if we could increase the number of plots from 6 to 18."

No reply was received to this letter and November 1 attention was again called to the letter of October 10. The following letter was written in reply; under date of November 2:

"In answer to your letter of November 1 would say that I would advise that you increase the number of plots to give a more thorough trial of the fertilizer." The letter was signed by Mr. McCrellis, per Mr. Gooch.

November 4 we wrote in reply declining to increase the number of plots but said "Kindly send at your convenience to the Maine Agricultural Experiment Station, Monmouth, Maine, as much of the fertilizer as you wish to have used on two twentieth acre plots, one-twentieth to be planted to corn and the other one-twentieth to be planted to potatoes."

No reply was received to this letter and under date of April 11, 1912, they were again written to reviewing the whole circumstance, asking them to send the fertilizer, and stating: "If I do not hear from you by April 20 I shall consider that we can use the plots that have been reserved for this experiment for other purposes and that you do not wish to continue the experiment."

This was the end of the correspondence with the company.

The Experiment.

The soil in the field selected for this experiment was medium light rocky loam from which all of the stones had been removed. The subsoil was firm and compact and well retentive of moisture. It had been in grass and orchards for a number of years.

It was plowed and kept in clean culture and seeded to oats in 1910 without the addition of any fertilizer whatever. The object was to test the uniformity of the soil and see if it was adapted to a soil test experiment. The yield of oats was about 30 bushels per acre. The part of the field selected for the experiment was divided into six plots, 62 1-2 feet long and 34.8 feet wide, each plot containing 2175 square feet. The field all had a gentle slope towards the west. The soil was as uniform as it was practicable to select. Commencing from the south the plots were numbered, A, B, C, D, E, and F. Corn was grown on Plots A, B, and C, and potatoes on Plots D, E, and F. Plot A. was fertilized with one-fourth cord of manure and 25 pounds of 4-8-7 fertilizer. Plot B was fertilized with 45 pounds of Mineral Fertilizer. Plot C was a check without fertilizer. Plot D had 90 pounds of a 4-8-7 fertilizer, 60 pounds of which was applied at planting and 30 pounds later. Plot E had 43 pounds Mineral Fertilizer. Plot F was a check without fertilizer. The plots were manured and planted on May 30. The corn was about 18 inches in a row and the rows 36 inches apart, 12 rows in each plot, and five kernels to the hill. The potatoes were 12 inches in the row, rows 32 inches apart, with 13 rows to the plot. The corn was cultivated and hoed seven times between June 17 and July 11. The potatoes were cultivated six times between June 16 and July 11 and were sprayed five times between June 30 and August 17.

June 9 the potatoes were coming about equally on all the plots, and the corn was coming slowly. The corn appeared on Plots B and C a day or two earlier than on A. June 15 Plots B and C had slightly better growth and stand than Plot A. July 3 flowering was beginning on all the potato plots. A had a good growth, B and C noticeably less than A, but were about equal. D had a good growth, E and F less than D and about alike. July 13 A had an excellent growth, B and C were alike but less than A by an estimate of 60 per cent. D had excellent growth, E and F similar to the conditions of B and C. July 26 to July 31 A tasselled out and on August 3 and 4 silked. On August 3 and 4 B and C were beginning to show tassel spikes. August 14 B was tasselled out and on August 17 the pollen was ripened.

The yields were as shown in the following table:

Table Showing Yield of Corn.

Plot.	Fertilizer.	Hills.	Plants.	Total crop pounds.	Corn on ear pounds.
A	Manure	364	871	450	284
B	Mineral	412	1253	145	33
C	None	424	1318	175	43

Table Showing Yield of Potatoes.

Plot.	Fertilizer.	Hills.	Merchantable pounds.	Culls pounds.
D	Commercial	499	310	36
E	Mineral	670	210	55
F	None	635	239	46

It will be noted that the plots which contained Mineral Fertilizer yielded in each instance somewhat less than the plots without fertilizer. The differences, however, are too slight to be attributed to the use of the Mineral Fertilizer. The results in this particular experiment, with the amount of fertilizer used show that there was no appreciable beneficial results from the application of Mineral Fertilizer on this soil and with these two crops. The company's claim that not enough Mineral Fertilizer was used may be valid. They, however, were informed of the nature of the experiment and were asked to send the amount of Mineral Fertilizer that they wished to be used on two tenth acre plots. The amount sent was used on two twentieth acre plots. Their failure to send any fertilizer for the repetition of the experiment in 1912 would seem to indicate that they were content with the delay of a year in the publication of the results of this trial and did not care to have their fertilizer tested against commercial manures.

BULLETIN No. 210.

SPRUCE BUDWORM.*

(*Tortrix fumiferana* Clemens.)

O. A. JOHANNSEN.

For the past two or three years the spruce budworm has proved the most serious pest of the spruces in Maine. It appears to be a native of this country for it is here that the species was first described in 1865 and there are accounts of the ravages of an insect believed to be this as early as 1807. It is at present widely distributed over eastern Canada, northern England, New York, Vancouver, and Manitoba. The fact that the insect chiefly attacks the buds and new shoots makes its presence in timber lands a serious problem.

HISTORY AND DISTRIBUTION.

The earliest account we have of the appearance of what is believed to be this insect, is given by Professor Packard in the Fifth Report of the U. S. Entomological commission, p. 835, which reads as follows:

"From Rev. Mr. Kellogg we learned the following interesting facts regarding the appearance of the similar, most probably the same species of caterpillar, even upon the same farm that was ravaged in 1878, early in this century. According to Capt. James Sinnett and Mr. John Jordan, of Harpswell, the spruces of Harpswell and Orr's Islands were destroyed in 1807. Captain Bishop, whose son made the statement to Mr. Kellogg, cut down the dead spruces on these islands and worked

*Papers from the Maine Agricultural Experiment Station: Entomology No. 63.

six weeks boiling the sea water with fuel thus obtained, in order to make salt. This was during the embargo which led to the war of 1812 with Great Britain. It is interesting to note that the budworm in 1878 appeared on the same farm on which the spruces had been destroyed by a worm in 1807, or about 80 years previously."

Of course we do not know that the insect referred to in the foregoing account is the spruce budworm, but it is extremely probable. The first authentic knowledge we have of this species came with a publication of the technical description in 1865 by Mr. Brackenridge Clemens of Easton, Pa., who described it from specimens received from Virginia. In 1869 Mr. C. T. Robinson redescribed a brown variety under the name *Tortrix nigridia* believing it to be an undescribed species. The specimens were obtained from Ohio, Pennsylvania and Massachusetts.

It was not until the late seventies and early eighties that the insect again came into prominence because of the great damage it caused to the spruces along the coast of southwestern Maine. Professor A. S. Packard in the Fifth Report of the Entomological Commission (1890) gives us an excellent account of this outbreak and we can do no better than quoting from his work.

" .... From inquiries and field work carried on in June and July 1883, in different parts of Maine, we have little doubt but that the destruction of spruces and firs along the coast of the State was mainly due to the attacks of this insect.

"The different climatic causes alleged to destroy forest trees in general, would, in the present case, have injured pines and hardwood trees as well as spruces and firs, and the destruction would have been general; whereas the trees have been killed by a caterpillar which is not known to live upon pines nor any trees but spruce, fir, and occasionally the hemlock and larch. Individual trees, or clumps of trees, were attacked, whether in high and exposed situations or in hollows; occasionally from such centers the worms seem to have increased and spread from year to year, until all the trees in localities several square miles in extent were killed. Moreover, as we have seen in the case of the attacks of larch worms, the defoliation of spruces and firs repeated two and perhaps three summers is sufficient to either kill the tree outright, or so weaken it that bark-boring beetles can complete the work of destruction. We are now inclined to the opinion, then, that the Bud Tortrix is the sole or at least the main cause of the destruction of spruces and firs in Cumberland, Sagadahoc and Lincoln Counties, Me., and that by their attacks they render the trees liable to invasion by hosts of bark beetles.

"We next visit Harpswell Neck, and found from our own observation and by inquiry from others that a large proportion of the spruces and firs for a distance of about 10 miles have died within about four years. The pleasure of driving over this picturesque road, with its striking northern harsh and wild scenery and frequent glimpses of Casco Bay, in former years greatly enhanced by riding through bits of deep, dark spruce forests, has been not a little marred by the acres and even square miles of dead spruces, stripped of their dark sea-green foliage, reduced to skeletons, and presenting a ghastly, saddening, and depressing sight, which border the road. And, indeed, one may travel through the spruce forests of the coast from Portland to Rockland and meet with similar sights.

"We visited late in August, in company with A. G. Tenney, Esq., the farm of Mr. William Alexander, passing, before reaching the road leading to his house, an area of several acres from which the spruce growth had been cut off in consequence of their widespread destruction by insects. Mr. Alexander informed us that the spruce trees were, in his opinon, killed by small caterpillars which have been at work for five years, but which were most destructive in 1879. These caterpillars he described as being the young of a small brown moth which laid its eggs in autumn; the caterpillars hatching from them were not inch-worms, but when fully grown the body tapered towards both ends, and were about three-quarters of an inch long, and were most destructive June 20, when they are seen among the buds at the ends of the branches, where they draw the leaves together, eating the buds and not the leaves. He had also seen borers in the trees, but he thought the death of the tree should be attributed to the bud-worms rather than to the borers. As will be seen further on, a number of caterpillars were found by us late this summer feeding upon leaves of the spruce and fir, but the worm observed by Mr. Alexander was probably one of the leaf-rolling caterpillars, a species of the family Tortricidae. A number of spruces and firs with their leaves still on but of a bright red, were observed scattered along the roadside; but no signs of leaf-worms or borers were observed in such trees, although the dead, leafless trees were infested with bark-borers.

"I was informed by the late C. J. Noyes, Esq., of Brunswick, who was a summer resident at Merepoint, that in June and the first week in July, 1878, the spruces and firs were attacked by great numbers of 'little measuring worms, like the currant worm in shape', which eat the buds at the ends of the branches; since 1878 they had mostly disappeared, and in the summer of 1881 he had noticed only four or five.

"From Harpswell Neck we traced dead spruces and firs around to West Bath, where extensive forests had been destroyed and numbers of dead hemlocks were observed, while the wood was attacked and the bark undermined and perforated by Buprestid borers, bark borers, and the pine-weevil (*Pissodes strobi*). We have nowhere seen hemlock trees, which are more exempt than any other coniferous trees from the attacks of insects, so much infested.

"The death and destruction of spruce forests were reported to us at Rockland, Me., and at Calais, Me., the destruction having been observed by Mr. Sewell at the latter town in 1879. From these facts there is good reason to suppose that perhaps a third of the spruce and fir forests from near Portland to Calais have been destroyed by insects, most of the work of destruction having been accomplished four or five years ago, during 1878-79.

"Similar damage has been done at points ten or twelve miles from the sea and in the interior of the State. The injury was especially noticed in North Topsham, near the Bowdoinham line. According to the statements of Mr. Willis, the agent of the Feldspar works in North Topsham, forwarded by Dr. C. A. Packard of Bath, Me., the spruces were in 1879 attacked by borers and also by small caterpillars, 'not measuring worms' (probably like those observed by Mr. Alexander at Harpswell.) The trees thus defoliated leaved out, becoming green again; and in 1880 and 1881 the evil seemed to be diminishing, as has been noticed at other places.

"*Further facts regarding the extent of the ravages of the spruce bud-worm in Maine.*—The following facts regarding the extent of the ravages of this caterpillar on the coast of Maine were gathered during the summer of 1883, and for want of space omitted from the report published in that of the Entomologist of the Department of Agriculture.

"The westernmost locality at which the spruce bud-worm was observed was on Peak's and other islands in Portland Harbor, the spruce not extending in any great quantity west of that city. The spruces about Sebago Lake were also destroyed by this worm or a similar caterpillar, in 1878, as we are informed by Rev. Mr. Kellogg, a Mr. Townsend being his authority. Around the shores of Casco Bay and on many of the islands, especially Birch Island, Orr's Island, Jewell's Island, and Great or Harpswell Island, also on Harpswell Neck, Mere Point, Prince's Point, as well as other peninsulas extending into Casco Bay, wherever the spruces and firs grow thickly, extensive areas of these trees were observed; also similar masses of dead spruce were observed along the Maine Central Railroad, from Portland to Brunswick, and thence to Bath; also on the shores of Cathance River, at and near Bowdoinham, Me. Wherever the fiords or narrow bays and reaches extend inland, in Cumberland and Sagadahoc as well as Lincoln Counties, the spruce and fir forests clothing their shores had been invaded by this destructive caterpillar. Wherever the spruces were abundant on the Kennebec River, below Bath, particularly on the eastern side, at and near Parker's Point, and also at and west of Fort Popham, there were extensive patches of dead spruces. Similar but smaller masses of dead spruce were observed along the steamer route from Bath to Boothbay Harbor, at and to the eastward of Southport; none were observed on Mouse or Squirrel Islands. In the course of a journey, at the end of July, from Brunswick along the coast to Eastport, we were able to ascertain the eastern limits of the ravages of this worm. Several clumps of spruces which had just died were seen on the Knox and Lincoln Railroad before reaching the Wiscasset Station. At Waldoboro, southeast from the station, was an extensive area of dead spruces which presented the same characteristic appearance as in Cumberland County, and for two or three miles beyond Waldoboro there were to be seen large masses of dead spruces and firs. Beyond Warren no dead spruces were to be seen; none were observed about Rockland, Camden, Blue Hill, or the Islands of Penobscot Bay; none on Mount Desert, or on the islands from Mount Desert to East Machias, nor on the road from East Machias to Lubec, although the predominant growth is spruce. No dead spruces were to be seen about Eastport, nor along the railroad from St. Stephen's to Vanceboro and thence to Bangor. From personal observation and inquiry it is safe for us to report that east of the Penobscot River, in eastern Maine, south of Aroostook County, there are no areas of dead spruce. Returning to Brunswick from Bangor, the characteristic patches or large clumps of dead spruce and fir were not seen until we reach a point south of Richmond, and near Bowdoinham, on or near tide-water on the Cathance River. The general absence of any extensive areas of dead spruces around the Rangeley Lakes and the White Mountains has already been referred to in our report. It thus appears that the injury from this worm has been confined, at least south of Aroostook County, to an area on the coast extending from Portland to Warren, and extending but a few miles inland from the sea to tide-water.

"The injury resulting from the attacks of the bud caterpillar are characteristic, as we have stated, the trees dying in masses or clumps of greater or less extent, as if the moths had spread out from different centers before laying their eggs and the caterpillars, hatching, had eaten the buds and leaves, and caused the trees to locally perish. From all we have learned the past season we are now convinced that the spruce bud worm (*Tortrix fumiferana*) is the primary cause of the disease on the coast. As remarked to us by the Rev. Elijah Kellogg, of Harpswell, Me., who has observed the habits of these caterpillars more closely than any one else we have met, where the worms have once devoured the buds the tree is doomed. This, as Mr. Kellogg remarked, is due to the fact that there are in the spruce but a few buds, usually two or three at the end of a twig; if the caterpillar destroy these the tree does not reproduce them until the year following. If any one will examine the buds of the spruce and fir they will see that this must be the case. Hence the case with which the attacks of this caterpillar, when sufficiently abundant, destroy the tree. We have not noticed that the spruce and fir throw out new buds in July and August after such an invasion, the worm disappearing in June. On the other hand, the hackmatack or larch when wholly or partly defoliated by the saw-fly worm (*Nematus*) soon sends out new leaves. By the end of August we have observed such leaves about a quarter of an inch long. In the following spring a larch which has been stripped of its leaves the summer previous will leave out again freely, although the leaves are always considerably, sometimes one-half shorter. Now, if any one will examine the leaf buds of the larch it will be seen that they are far more numerous than in the spruce and fir or other species of the genus *Abies,* being scattered along the twig at intervals of from a line to half an inch apart. Hence the superior vitality of the larch, at least, as regards its power of overcoming or recuperating from the effects of the loss of its leaves in midsummer. Besides this, the bud worm of the spruce and fir is most active and destructive in June, at the time the tree is putting forth its buds, while the hackmatack, which drops its leaves in the autumn, has become wholly leaved out some weeks before the saw-fly worms appear. For these reasons, while the spruce and fir usually die if most of the leaves and buds are eaten after the season's attack, the larch may usually survive the loss of leaves for two seasons in succession.

"In addition to the facts regarding the great abundance of the bud worm we may cite information given us by Prof. L. A. Lee, of Bowdoin College, who observed the bud-worms in June, 1880, upon the spruces at Prince's Point, Brunswick, and had no doubt but that they were sufficient to cause the death *en masse* of these trees. In 1883 we visited the locality, and many of the trees had been cut down for fuel........."

"During the season of 1886 and 1887, as in 1885 no traces of the caterpillars or moths of *Tortrix fumiferana,* formerly so destructive to the firs and spruce, were discovered."

For a period of 25 years there was no reoccurrence of any serious injury caused by this insect, and it was not until about 5 years ago that we again find them beginning to be troublesome. Dr. Fletcher records them from Manitoba in 1907. In July 1909 myriads of the moths were noticed in western New York, many gaining entrance into houses and barns, where the females unable to find a suitable place for the deposition of eggs laid them upon window sills and casements. Thousands found their death in the arc lights of the streets. In Canada, Dr. Hewitt states that in 1909 the larvae were defoliating considerable areas of balsam and spruce in the upper Gatineau region about 100 miles north of Ottawa. They are carried considerable distance by the wind and this method of disposal accounts for the rapid spread of the insect. During the succeeding years the insect has spread over a wide territory covering southeastern Canada east of Lake Huron, southward to the Gulf of St. Lawrence, eastward to Nova Scotia, all of northern New England and northern New York. In Canada there are in addition several infestations in more western localities as in Manitoba and Vancouver, while in the United States in Philadelphia in July 1911 the moths were so abundant that according to the daily papers street car traffic was suspended on one occasion owing to the moths upon the tracks. Dr. W. E. Britton (Twelfth Report, 1912) states "In Connecticut I have never seen them as abundant as they were the past season."

According to the observations of Dr. Packard the infestation of 30 years ago in Maine was practically confined to the coast region westward of the Penobscot river chiefly in Knox, Lincoln, Sagadahoc, and Cumberland Counties. The present outbreak covers a much wider range for we have records of the occurrence of the caterpillars from Aroostook, Penobscot, Piscataquis, Hancock, and Waldo counties. In the vicinity of Castine, on the shores of Penobscot Bay and in the Moosehead lake region the insect was first reported in 1911, and though in all probability it occurred in various localities the previous year no reports were received at this Station of its occurrence in 1910, in Maine. The following extract from a letter of July 5, 1911 received from Mr. E. L. Dean of Greenville Junction gives an idea of the situation in that locality.

"We think the worms have all transformed to pupae, and most of the pupae have hatched into moths which are getting to be very numerous in the woods now. As nearly as we can learn the infested region is from the East Outlet of Moosehead Lake to Township No. 4. Range 6, B. K. P. W. K. P. We have not heard of any of the worms north of Moose River. We cannot say how far south they are, but the center of the infestation seems to be in the vicinity of Parlin Road. The worms have been working on all sizes of spruce and fir trees and we think they have worked more on the fir than on the spruce. The worms have eaten this season's growth and the small trees from which the entire season's growth has been stripped are apparently dead."

HABITS AND DESCRIPTION.

The first intimation that we usually have of the presence of the spruce bud worm is in the late spring or early summer when we see the trees by the roadside as well as in the woods look as if a light fire had passed through them. The little caterpillars feed upon the needles of the new bud or terminal shoots. They gnaw the base of the needles, separating them from the twig, spinning them together by means of the silken thread they secret. The larva thus forms a loose shelter, moving about in the space between the twig and the loosened needles and bud scale, and not, like many leaf-rolling caterpillars, living in a regular tube. The seriousness of the attack of this insect upon the conifers lies in the fact that the caterpillar feeds upon the buds and new growth, not turning its attention to the older growth until the young needles are entirely consumed. A recurrence of the attack for two or three consecutive years in severe infestations would cause the death of the tree.

The trees which are liable to attack are firs, spruces, larch (or tamarack,)* hemlock and white pine. According to observations made by Mr. Wm. C. Woods in the region about Houlton, the firs are most susceptible. In woods where white, red and black spruce occur, the first mentioned is chiefly affected. At Houlton the larches were also injured. Our own observations made in the vicinity of Orono, Castine, east shore of Penobscot Bay and Seal Harbor on Mt. Desert Island confirm those of Mr. Woods. On estates where the Norway spruce is found it vies with the white spruce in susceptibility to attack. The injury to the trees is most conspicuous about the time the larva is full grown, that is about the middle of June in the vicinity of Orono. At this time the fragments of the leaves left by the worms and the frass are quite conspicuous, and at a distance trees which are seriously affected appear as scorched by fire (Fig. 8). Late in the season after the emergence of the moths, winds and rains have removed loose dry leaves and frass so that the tree, unless the old foliage has also been eaten no longer presents so desolate an appearance.

The caterpillar (larva) begins feeding when growth starts in the spring becoming full fed between the first and middle of June. (Fig. 5). They are then about four-fifths of an inch long, of a reddish brown color, and have small light yellow warts on each segment of the body, the sides of the caterpillar are light in color. Sometimes they have a slightly greenish

*Often though erroneously called the Juniper in Maine.

tinge. About the middle of June they transform to brown chrysalids (Fig. 6) inside the loosely made shelters. In a week or ten days the small grayish brown moth (Fig. 7) emerges from the chrysalid dragging the empty case practically out of the larval shelter. The moths may be seen on the wing from the middle of June until toward the latter part of July. Though the moth is prettily marked with brown and black, the scales which adorn the wings are very easily rubbed off so that the insect when caught frequently appears to be of a uniform yellowish gray. Shortly after emergence the moths deposit their peculiar pale green scale like eggs in small oval patches (Fig. 4) on the sides of the needles, and they are not conspicuous. About Orono the eggs were deposited early in July hatching in a week or ten days. By July 27 nearly all egg masses examined were empty. It is said that the larvae feed on the terminal shoots of the branches for a short time before hibernating, and that they pass the winter as a very small caterpillar in a little shelter constructed near the bud. Extended search in the vicinity of Orono, by several experienced observers, and at Castine, Harborside, and Seal Harbor on Mt. Desert Isl., by the writer failed to reveal a trace of the young larvae. As it is certain that the young larvae do hibernate their disappearance this season in these localities seemed almost inexplicable. The only reasonable explanation which we have to offer is that the little caterpillars immediately after emergence were eaten by small spiders which were very abundant upon the spruces and which were seen to feed upon them on several occasions.

DETAILED DESCRIPTIONS OF EGGS, LARVA, PUPA AND ADULT.

Egg. (Fig. 4) Pale green, scale-like, broad, flat, beneath, moderately convex above, oval cylindrical, finely but irregularly granulated. The shell is thin, and at first very soft. Length 0.9 to 1.4 mm.; breadth 0.8 to 1 mm. The patches about 3 mm. in diameter, and composed of as many as thirty eggs. The eggs overlapped each other irregularly, leaving about a third or fourth of the surface of each egg exposed.

"*Larva, first stage.* When first hatched the young caterpillar is uniformly pale peagreen, with a yellowish tint. Head dark brown, but the cervical shield pale amber, with two dark dots on the hinder edge; hairs nearly half as long as the body is thick; length 2.5 mm. At this time the young worms are very active, letting themselves down by a thread as readily as when fully grown.

"*Larva before last molt.* Body not quite so thick as full-fed worm; more uniformly rust-red brown; the piliferous warts duller in color, sometimes not much paler than the rest of the body towards the head, though higher and more distinct towards the end of the body. Head black and prothoracic shield black, the latter pale on front margin; no well-marked, broad, lateral, yellowish-brown band. Length 12 to 13 mm.

"*Larva (full-fed).* Body unusually thick and stout, tapering gradually from the middle to the end, and slightly flattened from above, as usual; head not quite so wide as the body, of the usual form, dark, almost black-brown, but lighter than before the last molt, mouthparts dark, with paler membranous rings at the articulations; antennae with the terminal joint black.

"Prothoracic shield pale brown, paler than the body, with a pair of dark blotches on the hinder edge in the middle, and other scattered, smaller, dark, irregular blotches, of which two are situated in the middle of the front edge, the latter pale whitish. Body rich umber-brown, diffused with olive-green, especially on the sutures; with very conspicuous and showy, large, whitish-yellow, piliferous warts, forming flattened minute tubercles, with a dark center from which the hair arises. On the top of the second and third thoracic segments is a transverse row of four warts on each segment; on the upper side of the abdominal segments are four warts arranged in a short trapezoid; they are far apart transversely, but unusually near together antero-posterior to the body; on the penultimate segment is a median, broad, light-yellowish spot on the hinder edge of the segment; a large, round, convex area, forming the supra-anal plate, from which arise about six fine, long pale-brown hairs. Anal legs spreading, with two or three piliferous callosites; the terminal segment and anal legs concolorous, with an irregular, broad, pale-yellowish lateral band reaching to the prothoracic segment, and slightly tinged with ferruginous. In this band, on the side of each segment, is a pale-whitish, flattened wart, directly in front of and adjoining the spiracle; along the narrow, lateral, fleshy ridge on each segment is a long, narrow, pale-yellowish wart. Beneath dull, livid greenish, with (on each segment) a transverse row of four bright-yellowish warts, concolorous with those above; the two inner ones are minute, the outer ones much larger. Thoracic legs black-brown; the four pairs of abdominal median legs are pale, almost whitish; all the hairs are fine and light-brown in color, and one-half as long as the body is broad. Length 19 mm.

"*Pupa.* Body very thick, the thorax especially unusually swollen; the body, soon after changing, pale horn-colored, striped with brown; antennae and legs dark horn-color or dull tan-brown; wings pale, with the veins dark; the thorax pale horn, spotted with dark tan-brown, with three irregular, dark, dorsal stripes; meso-scutellum and metanotum dark; abdominal segments above, with two rows of stout spines; a lateral row of dark spots, and a medium spot on the two basal segments; similar spots on the succeeding segments lengthened and connecting the lateral spots. Beneath are two irregular rows of diffuse spots; the hinder edge of the segments darkened; the terminal segment uniform dark, shining, tan-brown, ending in a long, stout point, on each side of which are two tightly-curled spines, and two stouter but less curled larger ones at the end, arising from a common base. Length 12 mm.

"*Moth.* A large species, with a stout body and large broad, oblong fore wings; the costa not excavated towards the apex, but full and regularly though slightly curved, the apex being rectangular, head and body umber-brown. Palpi very stout; terminal joint short; fore wings umber-brown, the brown sometimes replaced by rust-red; ground-color bluish-slate; on the inner fourth of the costal edge are four unequal, triangular, brown spots, the second and fourth connecting with an elongated transverse brown patch in the middle of the wing. From a point at or just within the middle of the costa a very oblique, distinct, broad, brown band crosses the wing in a zigzag course, ending at or near the outer third of the internal edge of the wing. This broad band extends out towards or connects with a preapical brown patch on the costa; it also sends an angle inwards behind the median vein, and again another angle outward opposite the inwardly-directed angle. There are often two distinct, costal, whitish dots (sometimes wanting) just before the apex, while the apex itself is brown. There is also a large brown patch in the middle of the wings near the outer edge. There are numerous fine, short, transverse, brown lines dividing the wing into squares or checks, bordered with brown. The bands and short lines are more or less confluent or separate, varying much in this respect. Some females differ in the umber-brown, being bright rust-red, and the clay-blue pale ferruginous brown, while the broad, median, zigzag band is umber-brown on the edges and bright rust-red in the middle, and the wing is covered with an irregular net-work made by the short transverse and longitudinal dark-brown lines inclosing rust-red or smoky-red patches.

"Legs, body, and hind wings glistening unber-brown; tarsi ringed with pale brown. The abdomen of the female is very stout, that of the male ending in a long, distinct, hairy tuft. Described from perfectly fresh specimens, five males, eight females. Length of body, 9 to 10 mm.; of fore wing, 10 to 12 mm.; expanse of wings 19 to 22 mm."

NATURAL CONTROL.

BIRDS.

A correspondent in Ellsworth sent us specimens of the pupae of the spruce bud moth stating that she had observed the purple martin to feed upon them. This very useful bird, once common enough in Maine is now found locally distributed and apparently decreasing in numbers.

SPIDERS.

The part that spiders are evidently taking in holding the spruce budworm in check has already been briefly indicated. Our first observations on this point were made in the laboratory. To study the habits of the young caterpillars of the spruce bud moth we had taken a small balsam fir tree about a foot high, transplanted it into a flower pot and placed upon it, a dozen or more needles collected in the open which had upon them freshly laid eggs of the moth. In due time the eggs hatched but in spite of frequent examination very few small larvae were seen, and these soon disappeared. As the tree was small and kept under close observation in the laboratory the absence of the young larvae puzzled us until we chanced to see a little spider holding in its chelicerae a young larva and sucking it dry. Continued observation showed that the two spiders which were present on the little tree were quite capable of exterminating the several hundred newly hatched little larvae which emerged from the dozen or more egg masses with which the tree had been stocked. Unfortunately these little spiders were lost so that we cannot now say to what species they belonged, excepting, that they looked like members of the family Theridiidae. A few days after these observations were made specimens of small spiders were collected from spruce trees on which egg masses of the spruce budmoth were abundant. These were submitted to Mr. J. H. Emerton so well known for his work upon the spiders of New England, who determined them for us. In the lot were specimens of *Theridion spirale, T, differens, Linyphia phrygiana, Dictyna volupis,* and an immature *Tetragnatha.* On the campus spruces, though egg masses had been easily located, the only young caterpillars seen were a few on July 29 and these were pounced upon by small spiders and devoured, while we stood by, in a manner highly suggesting an explanation of the scarcity of newly hatched caterpillars which was certainly a peculiar sequel to the abundance of the season's moths.

PARASITIC INSECTS.

The parasitic insects which we have found belong to the two orders *Hymenoptera* and *Diptera*. Of the former several different species have been reared by us, of the latter, the only species we have reared is the following.

DIPTERA.

Exorista vulgaris Fallen.

Kongl, Svenska Vetensk, Ak. Handl. XXXI. 1810. Osten Sacken. Canad. Ent. XIX. p. 163 1887. (*hirsuta*.)

Male. Eyes thickly pubescent, front about one and one fourth times as wide as either eye, frontal vitta velvety dark brown with a reddish tinge, about half as wide as the front; vibrissae inserted in level with the oral margin; sides of front silvery as well as the sides of the face, cheeks and the facial depression, cheeks hairy; antennae descending below the level of the lower margin of the eye, the third joint about four times as long as the second, arista thickened to the middle; palpi and proboscis black; frontal bristles descending to below the base of the third antennal joint; orbital bristles wanting. Thorax black, shining, with four more or less distinct pollinose stripes; scutellum black, its apical margin with a paler tinge; pleura pollinose; four post sutural bristles; sterno pleurals three. Abdomen shining black, segments largely white pollinose, second, third and fourth segments bearing discal as well as marginal bristles. Legs black, middle tibiae each with a single bristle on the front side near the middle; hind tibiae outwardly irregularly ciliate with longer and shorter bristles; pulvilli white. Wings hyaline, grayish tinged, apical crossvein slightly incurved at the base; posterior crossvein slightly though distinctly sigmoid curved; halteres brown; calypteres white. Length 7 mm. Bred from pupae brought by Mr. Wm. C. Woods from Houlton. Lot No. 1513.

In the course of a study of the parasites of the spruce budworm in Canada by the Division of Entomology a new species of Tachnid fly was reared in considerable numbers. A description of this species named *Winthemia fumiferanae* is given in the Canadian Entomologist. Vol. 44 pp. 2-3.

HYMENOPTERA.

Pimpla Ontario.

Cresson. Trans. Amer. Ent. Society. Vol. III p. 146.

"*Pimpla Ontario*, Male. Black, shining; face, clypeus, mandibles except tips, palpi, spot on scape beneath, tegulae and apex of scutellum and post-scutellum, white; wings hyaline, iridescent, stigma and veins

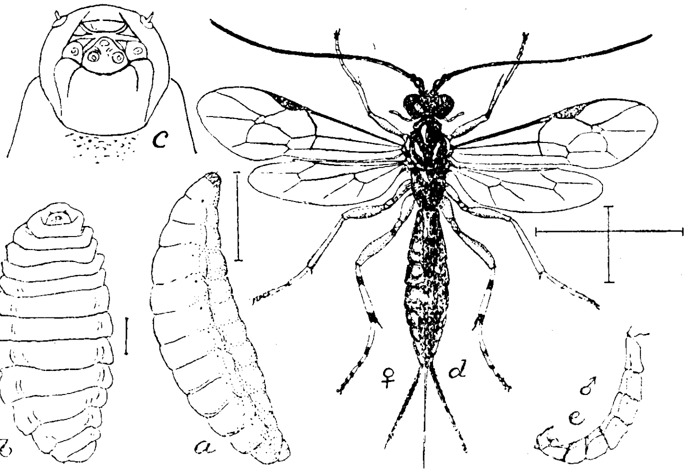

Fig. 1. *Pimpla inquisitor*: *a.* full grown summer larva; *b.* hibernating larva; *c.* mouth parts of larva; *d.* adult female; *e.* abdomen of adult male from sides,— all enlarged. (After Howard. Technical Series No. 5, 1897.)

blackish, the former with a white spot at base, areolet small, 5-angular; legs yellowish-red, four anterior coxae and trochanters beneath white, posterior tibiae and tarsi blackish, with a broad annulus on the former and basal half of first joint of the latter, white; metathorax shining, delicately punctured, with a short pale pubescence, apex rounded; abdomen long, narrow, sub-cylindrical, closely and delicately punctured; antennae long, subrobust and of uniform thickness throughout. Length 5 lines.

Hab. Canada."

This species was bred from specimens sent to us from Greenville Junction in 1911 as well as from material brought by Mr. Wm. C. Woods from Houlton, July, 1912. Lot 1544. It so closely resembles *Pimpla inquisitor* that Fig. 1 will give a good idea of this beneficial insect.

Pimpla conquisitor Say.

Say. American Entomology Vol. II. 1869 p. 689. (*Cryptus.*)

"*C. Conquisitor.* Black; tergum with the posterior margins of the segments white; feet honey-yellow; posterior tibiae and tarsi with black joints.

"Inhabits Indiana.

"Body black, punctured; palpi white; thorax, punctures minute: a longitudinal white line before the wings: metathorax not distinctly punctured on the disk: wings very slightly tinged with dusky; nervures blackish; stigma rather large, with its base and tip whitish; second cubital cellule oblique: tergum densely punctured on every part; segments on their posterior narrow margins white: oviduct about half the length of the abdomen: feet honey-yellow; intermediate and posterior tarsi white, the joints black at their tips; posterior tibiae black, white in the middle.

"Length one-fourth of an inch.

"Resembles *inquisitor* nob., but the posterior margins of the segments of the tergum are white."

This species was bred from the budworm by Professor Fernald years ago.

Apanteles sp. (*Braconidae*) has been reared by us from the spruce budworms which were collected near Orono. Lots 1486, 1509, 1510.

Dr. C. Gordon Hewitt, Dominion Entomologist records rearing a number of species from the budworm in Canada. These have recently been described by H. L. Viereck, in Vol. 42, Proceedings of the United States National Museum. The species are *Apanteles fumiferanae, Meteorus trachynotus, Conoblasta fumiferanae, Phygadeŭon* (*Dirophanes*) *plesius, Epiurus innominatus* and *Mesochorus diversicolor*, of which the first four are from province Quebec, the last two from British Columbia. *Nasonia tortricis* Brues is another Canadian species parasitic on the spruce budworm.

A number of egg masses collected in Orono, late in the summer showed evidence of having been affected by egg parasites, but unfortunately none was reared.

REMEDIAL MEASURES.

In timber lands it would be quite impracticable to adopt measures for the control and eradication of the spruce bud-worm other than in aiding in the spread of the beneficial para-

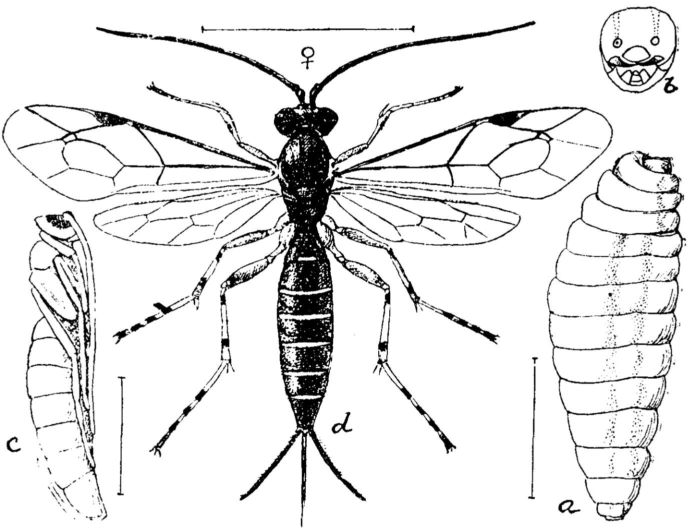

Fig. 2. *Pimpla conquisitor.* *a.* larva; *b.* head of same; *c.* pupa; *d.* adult female,—all enlarged. (After Howard. Technical Series, No. 5, 1897.)

sites. In limited areas, however, as in the case of the protection of ornamental trees of an estate or the young trees in a plantation it would be quite easy to use an arsenical spray which would keep the pest under control. This is rendered all the easier by the fact that we are here dealing with a native insect, which is subject to attack by native parasites and which, if we may judge by its history in the past, will succumb to its natural enemies within a very few years. If we can restrain its activities for a season or two it appears probable that we may not be troubled by it again for decades.

SPRAYING.

As far as we know, little or no effort has been made to check the injury caused by the spruce budworm by spraying, although we see no reason why the insect may not be controlled by the method employed in combating similar species upon other trees. The time when the greatest amount of injury is being done is in the late spring, about the first of June in the vicinity of Orono. To prevent injury to the spruces therefore it will be advisable to begin spraying operations soon after the young shoots open and repeat within a week or ten days. Arsenate of lead applied at the rate of five or six pounds per 100 gallons of water is doubtless the simplest and most reliable remedy.

The question is often asked, what will it cost to spray and what will be the expense involved in the purchase of a suitable equipment? As there are no figures available in regard to spraying for the spruce budworm we must turn to other sources for information. Those given by Professor Herrick in the Journal of Economic Entomology (Vol. 5 page 169) upon spraying for the elm leaf-beetle are recent and as the methods used in combating this insect are similar to those which must be employed against the spruce budworm we will quote directly from Professor Herrick's paper. The part that concerns us reads as follows:

"The first question that presented itself of course, was the matter of apparatus. Our appropriation was not large and it, therefore, became necessary to limit ourselves to reasonably inexpensive and tried outfits. After much correspondence and several interviews with agents, we decided to purchase a Hardie Power Sprayer with a triplex pump, 3 H. P. engine, 200-gallon tank, 12-foot tower, two leads of hose, each 100 feet long and two extension poles, one 20 feet long and the other 12 feet in length, and a Friend Hilly-Orchard outfit with a 3 1-2 H. P. engine, California model pump, 8 foot tower and other equipment like the former outfit. With these outfits, and both gave eminent satisfaction, we were able at all times to maintain 175 to 200 pounds (and over) pressure. One man remained on the tower and with his 20-foot extension pole and Bordeaux Nozzle was able to reach the tops of the very highest trees. The man on the ground ran the engine, drove the team, and sprayed the lower branches. The so-called foreman directed the work, mixed the solutions, attended to breakdowns, climbed trees if necessary, and kept things going in general.

"The first spraying was made from May 16 to May 25, and the second from June 12 to June 22.

"We used 3 lbs. of paste arsenate of lead the first time over the trees and 3 1-2 lbs. to 50 gallons of water the second time.

"A careful and detailed record of the actual cost of spraying 435 trees was kept. Most of these trees were large and all of them stood near the street and near our water supply. It cost $133.37 to spray these trees once or 30.7c per tree. On the average each machine sprayed 36 1-4 trees per day of eight hours, or 4 1-2 trees per hour or a tree about every 13 1-3 minutes. On an average we used approximately 18 1-6 gallons of liquid to each tree.

"A detailed example of a day's work on the largest trees will give even a better idea of the cost of spraying such trees. On June 19th the two machines began on the largest elms on the Campus, namely those from the Library south along each side of Central Avenue. The two machines sprayed 59 of these very large trees. The cost of the men and teams were $17.00, the arsenate of lead $6.61 1-2, the gasoline 35c, total $23.96 1-2, which is an average of 40.6c per tree.

"In all, there are about 530 trees on the University Grounds that were sprayed. About 100 of these were scattered over the steep hillsides west of the buildings and along University and Stewart Avenues. Many of these trees were a mile from our water supply and the majority were scattered and not easy to reach. It cost, exclusive of permanent equipment, $464.90 to spray these trees twice or an average of approximately 88c. each. The scattered trees just mentioned raised the average cost of the whole, quite materially. If all of the trees had stood along streets and reasonably near a water supply the average cost would have fallen I think, below 70c. It took the two machines ten days to make the first spraying and eleven days to make the second. The second spraying was done more thoroughly and there was much more leaf surface to cover. On the other hand, experience had made the men more efficient."

As will be seen the outfits mentioned in the above account are quite similar to those usually used in the spraying of apple orchards which may be purchased, complete with tanks, hose, rods, etc., for from 300 to 400 dollars each. In localities where orchard spraying is practiced it would therefore be a very simple matter to hire an equipment with experienced men to run it.

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TWO SPRUCE LEAF MINERS.

Recurvaria piceaella Kearfott.

Journal N. Y. Ent. Soc. XI . 155. 1903.

Packard Fifth Rept. Ent. Com. 850, 1890 (*Gelechia obliquistrigella* Pack., nec Chambers).

The life history of this species has been described by Mr. W. D. Kearfott in the Journal of the N. Y. Entomological Society. As our own observations confirm those of Mr. Kearfott we will quote his account adding only the new locality reference and dates.

"*The eggs* are laid within a reasonable time after the moth's emergence, in due course the young larvae hatch and begin a very minute mine, which is slowly enlarged until cold weather causes torpidity, and until the earliest sunny and warm spring days, when they desert the old mines and begin new ones (in previous season's leaves) usually farther out or nearer the end of the twig."

"*Larva* .... The head is pale brown, prothoracic shield same but lighter. Skin red on dorsal, lateral and ventral regions, a dark green patch on each abdominal segment, on central dorsal area. On ventral surface of thoracic segments, between each pair of legs is a deep purplish red spot; on segments 5 and 6 there is one such spot on each segment on center line." Length 6 to 7 mm.

"*Pupa.*—Body rather thick, of the usual pale mahogany brown color, the antennae and tips of the wings on the under side reaching to the middle of the fifth abdominal segment. End of the abdomen full and rounded, with about ten unequal, irregularly situated slender bristles, which are slightly curved at the end; besides these there are several fine bristles along the side of the body near the tip. Length 5 mm." (Packard Forest Insects. p. 850).

"*Moth.* Fig. 3. "Head cream-white; antennae with the basal (second) joint white, beyond ringed with white and black. Palpi white, first and second speckled with black, second (longest) joint ocherous at the end; third (last) joint with two black rings of unequal size, the outer the longer; the tip white. Fore wings moderately wide, oblong ovate. Ground color ocherous whitish gray, costal region blackish, base black. A broad oblique band proceeds from the costal edge to the middle of the submedian space, ending in two white spots; there are some whitish scales on the outer edge of the band. Just before the middle of the wing is a broad irregular black band, and beyond it in the submedian space a black spot. A third broad black band crosses the wing, ending on the hind margin and breaking up into three black spots on the hind margin: the band incloses near them two twinned white dots. Near the outer fourth of the wing is a conspicuous white line, sharply bent outwards just behind the middle of the wing; beyond the apex of the angle of the line are several white scales. At the base of the fringe is an oblique line of black scales. The fringe, like the adjoining part of the wing, is of mixed gray ocherous, with back scales. Hind wings rather broad, pointed, pearly slate gray. Legs, including tarsi, banded with black. Expanse of wings, 13 mm. When rubbed the green color of the fore wings becomes paler, and the three oblique black bands are more distinct." (Packard 1890 p. 851.)

"Marking same as *R. thujaella*, except the light shades have an ochreous tone rather than fuscous as in *R. thujaella*. The average size of *R. piceaella* is about one mm. greater than *thujaella*.. Otherwise, the two species are very difficult to separate in the imago state. Alar expanse 9.5 to 11.5 mm." (Kearfott 1903.)

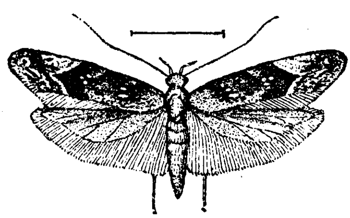


Fig. 3. *Recurvaria piceaella enlarged.* (From Packard 1890 p. 850.)

Professor Packard recorded this species on both red spruce and fir from Peak's Island, Casco Bay, Maine, the moth being on the wing at and soon after the middle of July. Larvae were collected by us from Norway spruce on the Campus of the University of Maine, Orono, Maine, about the middle of May, 1912, associated with the larvae of *Epinotia piceafoliana,* from which they differed by being a little smaller and with body reddish with brown head and shield. The moths emerged late in June. Lot 1493.

Epinotia piceafoliana Kearfott.

Journal N. Y. Entomological Society. XVI. 176, 1908.

About the middle of May 1912, some of the Norway spruces upon the Campus of the University of Maine, at Orono, were found to be affected by the larvae of a small moth. Many of the leaves of the last season's growth were found to be dry and yellow in appearance and more or less appressed to the twig (Fig. 9). A closer examination showed that each of the affected needles was hollowed out and tenanted by a little greenish larva which had gained entrance through a circular hole near the base of the leaf. The mature larva is about 6 mm. long, stout and greenish or yellowish green in color. The head, prothoracic shield and the legs of the thorax are black. When grown they spin a dense white cocoon. This cocoon lies between the needles close to the twig. The moths emerged late in June, though no observations were made upon this, it is probable that the eggs are laid soon after and that the young larvae hibernate within the leaf mines, resuming activity in early spring completing the life cycle, in the same manner as *Recurvaria piceaella*. Mr. Kearfott who first described this species states that the larvae feeds upon the needles of black spruce (*Picea mariana*) at Montclair, N. Y., the moths appearing early in June. The moths have also been taken in Cincinnati, Ohio, the middle of May. Those reared by us in Orono emerged in June.

Moth. "Expanse 9.5 to 10.5 mm.

"Head light gray, tinged with yellowish on top; palpi short, scarcely extending beyond head, tuft small, flattened, the scales at outer end not concealing the short, obtuse outer joint, color gray, shaded with blackish on outside, apical point dusky black; antennae gray; thorax light cinerous gray, with a bronzy median shade; abdomen bronzy black, anal tuft gray-ocherous; legs gray, heavily dusted in front and tarsi ringed with bronzy black.

"Forewing.—Costa nearly straight, slightly curved at base and apex, termen straight and only slightly oblique. Twelve veins, all free, accessory cell large, beginning midway between 10 and 11, outer end opposite 7; internal vein ending opposite 5. Color grayish white, crossed with blackish lines and narrow fasciae. The basal area is defined by a heavier dark dentate line, from inner fourth of costa, curving outwardly to inner third of dorsum; before this are three or four parallel fine dark lines on a gray-white ground, each starting with a blackish costal dot. From middle of costa to before tornus is a narrow dark fascia, interrupted by a white oblique line on middle of cell, below which an obtuse spur of the dark color on the outer edge of fascia. Between this fascia and basal area is a broad fascia of ground color traversed by broken dark lines, and on costa forming two white spots, each usually divided by a blackish dot. Beyond the dark fascia, the apical third is whitish gray, crossed by parallel dark line, starting as black costal dots and separated by four white costal spots. The apex is black and defined below by a white dash through the black terminal line and extending to outer edge of cilia. Ocellus not defined. Cilia dark leaden-gray.

"Hindwing.—Smoky back, cilia dark gray, with a darker basal line. Eight veins, 3 and 4 stalked. Underside both wings dark smoky gray, costal spots repeated on forewing, and the latter grayish white below fold." (Kearfott 1908.)

PARASITES.

We have reared from this insect three different species of hymenopterous parasites, *Porizon sens lat* (June 7 to 12), Lot No. 1483; *Clinocentrus* sp, Lot 1511; and *Microdus* sp., Lot 1512.

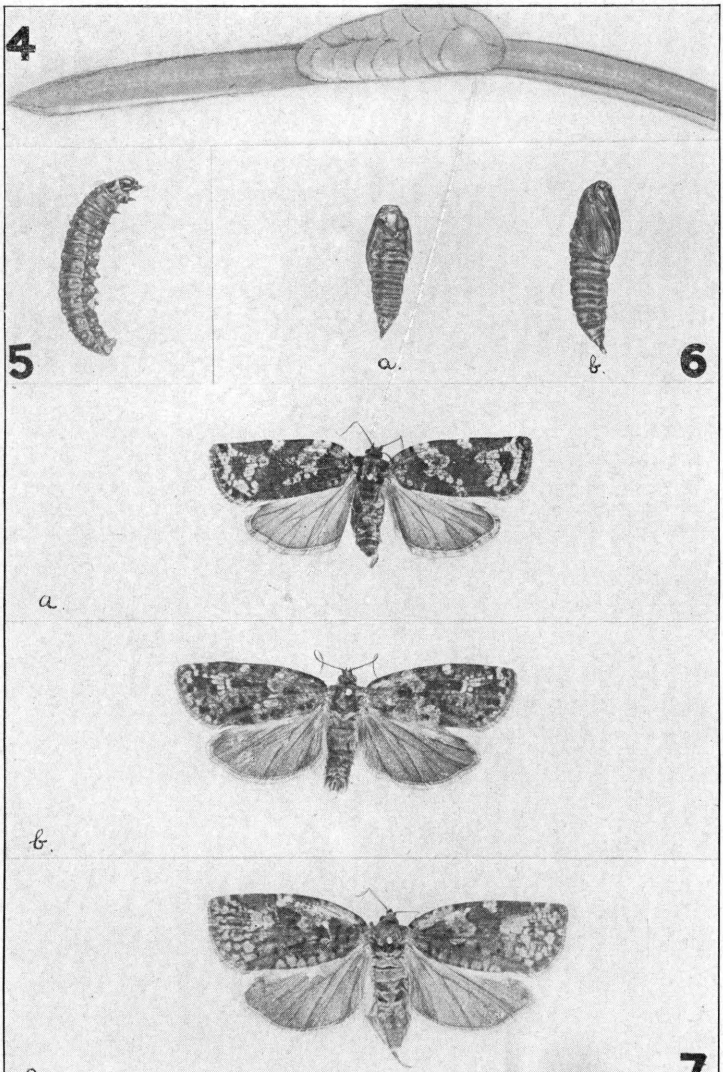
Rhogas Canadensis Cresson.

A specimen of this species was taken at Orono, May 15, 1912, on a Norway spruce twig upon which there were many larvae of *Epinotia piceafoliana,* and it may therefore possibly be a parasite upon it. Mr. Cresson's description of the species reads as follows:

"Female. Black fuscous, opaque; face, mouth, palpi and orbits, dull rufo-testaceous; antennae fuscous; middle lobe of mesothorax, scutellum, most of pleura, spot on each extreme side of metathorax (sometimes wanting), legs, except tibiae and tarsi, and the abdomen beneath, rufo-testaceous; tibiae and tarsi, semi-circular spot at tip of first abdominal segment, and the second and third segments except sides, luteous; apical segment pale fuscous; wings ample, hyaline, iridescent, nervures fuscous; stigma whitish varied with fuscous; metathorax and abdomen finely sculptured. Length 6 mm." Cresson. Trans Amer. Ent. Soc. II. 380. 1869. (*Aleiodes*).

The species was originally recorded from Canada.

This Maine specimen differs from the above description in having a dusky face, yellowish scape, and yellow basal joints of the tarsi. Professor J. C. Bradley compared this specimen with the type at Philadelphia verifying my determination. Lot 1463.



Spruce Budworm. Fig. 4. Egg mass on spruce leaf. Orono, July 16, 1912. Fig. 5. Larva. Fig. 6 *a*, male pupa; *b*, female pupa. Fig. 7. Moth, showing three of many variations in markings;—*a* and *b* were dark gray, and *c* bright brown.

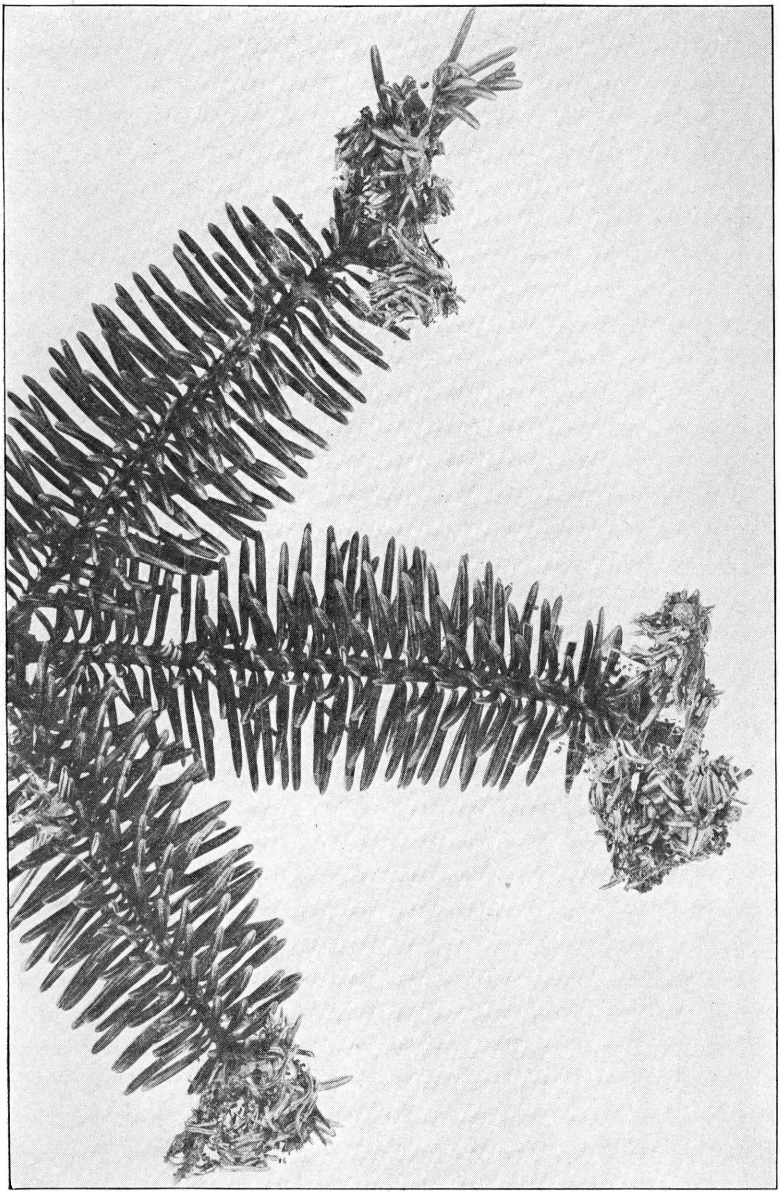


Fig. 8. Work of Budworm on Balsam Fir. Orono, June 11, 1912.

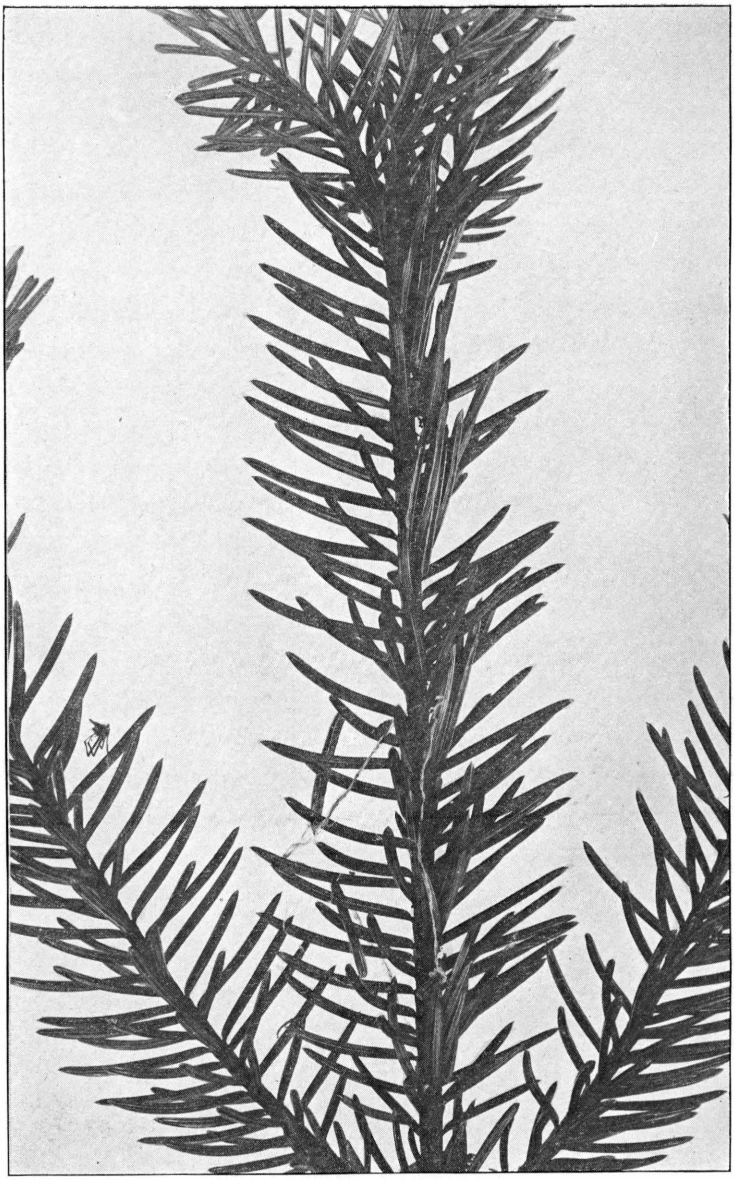


Fig. 9. Work of Leaf-miner on Norway Spruce. Notice area of depressed leaves.

BULLETIN No. 211.

POTATO FLEA-BEETLE*.

O. A. JOHANNSEN.

THE FLEA BEETLE AND EARLY BLIGHT.

The flea beetle (*Epitrix cucumeris*) is, next to the Colorado potato beetle, the most destructive of the annually recurrent insects on the foliage of the potato in Maine. The insect eats minute holes in the leaf giving it a dotted appearance like a pepper box cover (Fig. 19). Sometimes the damage done by this pest is very marked as was the case of a small unsprayed field in Orono the past year when the plants were entirely killed before July 10. But the danger to the plant is not restricted to what the insect alone can do, for it is generally acknowledged that early blight attacks injured leaves more readily than healthy ones and the punctures made by the insect serve as points of entrance for the germ tubes of the spores of the fungus. The insects themselves are also in all probability active agents in spreading the disease by carrying the spores from plant to plant on their bodies. Early blight is widespread and now very destructive in that it attacks and weakens the plant at a critical period, thus checking the development of the tubers. It is confined to the foliage and is not known to cause rot. Early blight first appears as small brown spots, frequently surrounding flea beetle punctures, scattered over the older leaves. These spots slowly enlarge and frequently become somewhat angular in shape from the fact that they stop on reaching a leaf vein. There is usually a sharp boundary between the healthy green of the leaf and the spot, although a badly spotted leaf will have a decidedly yellow appearance over its entire surface. Close inspection of the early blight spots will usually show concentric lines. Early blight may occur alone or associated with late blight.

*Papers from the Maine Agricultural Experiment Station: Entomology No. 64.

Though so common every year throughout the state, there are still many farmers who are quite unfamiliar with this flea-beetle. This is due to the fact that the insect is so small and active and feeds largely on the underside of the leaves.

HISTORY AND DISTRIBUTION.

In 1807 Illiger published a paper entitled "Portugiesische Käfer" in which he mentions the species *Haltica pubescens* as occurring in Coimbra and Lisbon (Portugal) stating further that he also had the species from North America (Pennsylvania). In 1835 Dr. T. W. Harris records the name *Haltica cucumeris* in his Catalogue of the Insects of Massachusetts. The same author published in 1841 his "Report on the Insects of Massachusetts Injurious to Vegetation" in which he says (p. 103):

"The most destructive species (i. e. of the *Halticini*) in this vicinity is that which attacks the cucumber plant as soon as the latter appears above the ground eating the seed-leaves, and thereby destroying the plant immediately. Supposing this to be an undescribed insect, I formerly named it *Haltica cucumeris,* the cucumber flea-beetle; but Mr. Say subsequently informed me that it was the *pubescens* of Illiger, so named because it is very slightly pubescent or downy." In a later edition Dr. Harris says "Count Dejean, who gave to it the specific name of *fuscula* considered it as distinct from the *pubescens,* and it differs from the descriptions of the latter in the color of its thighs, and in never having the tips and shoulders of the wing-covers yellowish; so that it may still bear the name given to it in my catalogue. It is only one sixteenth of an inch long, of a black color, with clay-yellow antennae and legs, except the hindmost thighs, which are brown. The upper side of the body is covered with punctures, which are arranged in rows on the wing-cases; and there is a deep transverse furrow across the hinder part of the thorax."

Subsequent investigations have shown that the species described by Dr. Harris is distinct from *pubescens* and may therefore rightfully bear the name *cucumeris*. The specimens from Pennsylvania mentioned by Illiger were *cucumeris* and therefore differed from those collected in Portugal. The synonymy now stands as follows:

Epitrix cucumeris Harris. In Catalogue of Insects of Mass., 1835; Rept. on the Insects of Mass., 1841; Journal of Agriculture, I, 103, 1851.

E. fuscula Dejean, Cat'l. 3 ed. 415.

E. nigritula Dejean, olim.

E. pubescens, in part, Illiger's Mag. VI. 58, 1807.

E. seminulum Le Conte. Proc. Ac. Phil. 358. 1861.

Though the adult insect has long been known to entomologists it is only within the last few years that we have learned that the larvae live in the ground feeding on the roots and tubers of the potato and perhaps on related plants. It is true that both Fitch and Riley stated more than 40 years ago that the larva is a leaf miner but it seems that their statements are based upon inference rather than upon actual observations.

Fitch in his Eleventh Report (page 62) says in his discussion of the potato flea-beetle "Having given a full account of the larvae and transformations of this genus in connection with the striped flea-beetle (*Haltica striolata*), it is unnecessary to repeat the same details here." The larva of the striped flea-beetle mines in the leaves of turnips, beets and other plants of the garden according to Fitch's account, and from his statement in the preceding sentence we are led to infer that the larva of *Epitrix cucumeris* also is a leaf miner. There is however nothing in his account in which he states that he actually found the larvae of the potato flea-beetle and we must therefore assume that it was merely a guess on his part.

Riley in his First Annual Report as State Entomologist of Missouri (p. 101, 1869) writes:

"............. The larva feeds internally upon the substance of the leaf, like that of the closely-allied European Flea-beetle of the turnip (*Haltica nemorum*); and, from its near relationship to that insect, we may infer that it goes underground to assume the pupa state, that it passes through all its stages in about a month, and that there are two or three broods of them in the course of the same season."

Though it is definitely stated here that the larva mines in the leaves there is nothing so far as I have been able to discover in Riley's writings showing that this is based on personal observations. A number of entomologists since then have made similar statements but all of their accounts bear evidence of having been copied from the writings of the earlier authors.

Another error, apparently also inherited from the earlier writers, frequently found in the published accounts of these beetles, is the unqualified statement that there are 2 or 3 generations a year. In Maine there is but one generation or at most only a partial second. Mr. F. A. Sirrine's observations made in 1896 in New York are confirmed by our own. He says "As the facts stand there is probably but one brood of the potato flea-beetle a year."

Distribution. The potato flea-beetle has a wide distribution in this country, having been recorded from most of the states from Maine to California. The species is mentioned in the publications of over half of the Agricultural Experiment Stations.

HABITS AND DESCRIPTION.

The hibernating adult beetles emerge from their hiding places under leaves and rubbish during April and May, in this State usually the latter month, and may be found upon plantain, and other weeds, as well as upon the foliage of wild cherry, apple, maple and other trees, where they apparently feed but little if at all at this time for the leaves upon which they are found resting do not bear evidence of feeding punctures. A little later when the young tomato plants are set out, early in June in the vicinity of Orono, the flea-beetles feed upon them, frequently in such numbers as greatly to impair the growth of the plant. From the middle to the last week in June mating pairs are seen. The first eggs the past season at Orono were found on June 26, and none found later than the middle of July. The eggs which were obtained from adults, confined under cheese cloth covered lantern globes set over earth filled flower pots, are laid singly in the ground. The egg (fig. 10) is white in color, elongate ellipsoid in shape, its long diameter about 2 1-2 times the shorter, about .25 mm. long, the surface feebly sculptured. Some potato plants growing in flower pots in breeding cages were "charged" with flea-beetles on July 3. On July 30 full grown larvae and a few pupae were found among the roots of these plants, the larvae mining in the seed potato, the body over half buried within the tuber, the posterior end sticking out at right angles to the surface. The pupae as well as some of the larvae were found free in the earth among the roots.

The larvae (fig. 11) are white, slender, wormlike creatures with distinct dark brown head and yellowish-brown thoracic shield. The head is oval; the mandible subtriangular, the apex with about 4 blunt teeth of which the laterals are smallest (fig.

10, a); the antenna is short, less than half as long as the mandible, subcylindrical, about twice as long as wide; the palpus is stout at base, apical joint conical, nearly as long as the antenna; eyes apparently wanting; setae of head distinct, but few in number. Thorax white, first segment with yellowish brown chitinized dorsal shield, setose. The legs are short, stout, setae few, tarsal claw simple, empodium distinct. Abdomen white, 9 segmented, each segment provided with about 24 setae, the spiracle distinct; ninth segment with rounded apex, unarmed except for the setae. Length about 5 mm.

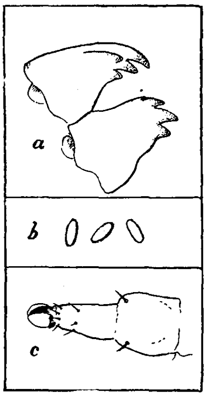


Fig. 10.

Fig. 12.

The pupa (fig. 12) is white, becoming darker when it is ready to transform. A transverse line of several setae is found on each abdominal segment, those on the lateral line longest. Apex of abdomen bifurcate; the forks slender, incurved and sharp. Length 2.2 mm.

During August 1912 larvae and pupae were to be found in the ground among the young tubers but by the end of the first week in September they had all disappeared. About the middle of July the beetles of this generation begin to emerge in Maine, becoming very abundant upon the potato vines and reaching a maximum about the first of September. The first killing frost in September marks the disappearance of the beetles to their places of hibernation. Our own observations are confirmed by those of Sirrine who says that the beetles emerge about July 10 in New York, and by those of Jones who gives July 20 as the date in Vermont.

From the dates given above it will be seen that six or seven weeks must elapse from the time of mating to the maturity of the adults of the next generation so that in this region at least, where we may expect killing frosts about the middle of September, there is time for but one complete generation per year.

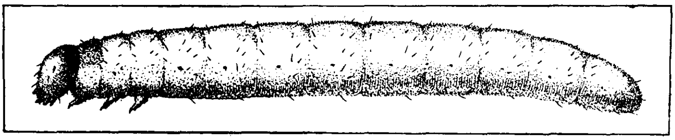


Fig. 11. Larva.

The fact that neither larvae nor pupae were to be found among the roots or tubers after the first week in September, though abundant enough in the same field in similar situations in August, further substantiates this view.

Although in this state, as far as we have been able to ascertain, it is only the adult, which, by its leaf feeding habits, has proved injurious, in New York Messrs. F. A. Sirrine and F. C. Stewart have shown that the larvae are also responsible for seed potato in the ground.

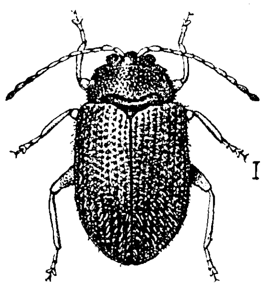


Fig. 13. *Epitrix cucumeris:* adult flea-beetle much enlarged. (From Bulletin U. S. Div. Entomology No. 19.

In New York, the little larvae have been found boring into the tubers, roots, and root stalks of the potato. The wound made by the boring of the grub results in the formation of the some injury to potatoes, namely in causing, what has been termed "pimply" potatoes. So far as our own observations went the past season, the larvae fed only on the fragments of "sliver", but a "pimple" may or may not be produced. In 1894 this trouble was sufficiently common in Eastern Long Island to attract the attention of the farmers. The following year buyers were on the lookout for potatoes thus affected and offered a reduced price for them.

The adult beetle (Fig. 13) is a small insect about one-twelfth of an inch in length with black body and dull yellow legs, and antennae. Its hind legs (Fig 17) are particularly stout and adapted for jumping, hence the name "flea-beetle." It is often called the cucumber flea-beetle because it was originally described as feeding on the cucumber; but this name is rather a misnomer, as the insect feeds by preference upon plants of the family Solanaceae which includes the potato and the tomato.

The genus *Epitrix* to which this insect belongs may be distinguished from its nearest allies by the following characters; very small convex species, bearing on its upper surface short, semierect hairs, sparsely placed over the thorax and arranged in a single row on each interval of the wing covers. The head has an oblique ridge each side extending from the end of the frontal carina to the eye and limited above by an impressed line, the two forming together a broad V. The front angles of the thorax are obliquely truncate with a small tooth behind the truncation. Several species are known from the United States of which three may occur in Maine. The species under consideration differs from its nearest relatives in having the thorax finely but not densely punctate, (Fig. 14) the punctures well separated, the ante basal impression well marked; the striae of the wing covers, especially those nearest the suture, very feeble, the punctures round, not crowded, the upper surface of the body shining piceous. The antennae and legs are reddish yellow, only the femora are darker, somewhat oblong. The thorax is nearly twice as wide as long, slightly wider at the base than the thorax, the umbone rather prominent. Length 1.5 to 2 millimeters (1-16 to 1-12 inch).

HOST PLANTS.

This insect feeds by preference on the members of the *Solanaceae* or Nightshade family embracing the potato (*Solanum tuberosum*), the wonder berry (*S. nigrum var.*), bittersweet or blue bind weed (*S. Dulcamara*) Jerusalem cherry, (*S. Pseudo-Capsicum*), horse nettle (*S. carolinense*), black or common night shade (*S. nigrum*) egg plant (*S. melongena*) tomato (*Lycopersicum esculentum*), Cayenne pepper (Capsicum annuum), ground cherry or husk tomato (*Physalis pubescens*), Petunia (*Petunia nyctaginiflora*), tobacco (*Nicotiana tabacum*), and Jimson or Jamestown weed (*Datura Stramonium.*) Of these the beetle seems to prefer above all others the leaves of the wonder berry.

It has also been recorded as feeding upon leaves of the cucumber, squash, watermelon, muskmelon, bean, corn, radish, turnip, cabbage, sunflower, plantain, beet, spinach, celery, raspberry, apple, sweet potato, rhubarb, and hop.

In order to test the susceptibility of various plants other than those of the nightshade and gourd families to the attack of this insect, a number of flea-beetles, were placed in glass jars, with some leaves, each jar containing but a single species of plant. The beetles were collected at random from a potato field and all subjected to the same conditions. It was found that the leaves of the bean, sunflower, lettuce and the basswood were eaten with evident relish, and that the leaves of Oswega tea, wood sorrel, bluets, hemp nettle, celery, beet and plantain were slightly attacked. In our tests the insects refused to eat the foliage of raspberry, corn, turnip, cabbage, ground ivy, red clover, self heal, evening primrose, maple, dogwood, honey suckle, woodbine, (*Psedera*), twin flower, carrot, arbutus, vaccinium, viburnum, red elder, horse chestnut, dog bane, jewel weed, St. John's wort, wintergreen, violet, ilex, bedstraw, pipsissewa, partridge vine, sarsaparilla, phlox, ash, sumac, and shin leaf.

It will be noted that we were unable to induce the insects to eat the leaves of corn, turnip, cabbage and raspberry, upon which they had previously been recorded, while celery, beet and plantain were but very slightly attacked. It must be said however that in our experiments we used leaves that were full grown. Had new and tender leaves been placed in the jars the results might have been different.

CONTROL.

Parasites. In our own experiments with the flea-beetles we have found no parasites associated with them. In looking over the published accounts we find but two records in which parasites are mentioned.

Professor Forbes in the 21st report of the State Entomologist (p. 117) says "They are sometimes parasitized by a hymenopterous insect, probably one of the *Braconidae*." The other observation is by Dr. Chittenden in Bulletin 19, N. S. Division of Entomology, U. S. Department of Agriculture. He writes —"The flea beetle (i. e. *E. paravula*) as well as *E. cucumeris*, is parasitized while in the adult condition by what is evidently, judging by the larvae, a species of the hymenopterous family Braconidae. Numbers of beetles were collected in order to rear the parasite. Larvae were first observed July 14, but none lived more than a few days after issuing from the beetles. All of the parasitic larvae, as far as could be learned, made their escape from an aperture made at the anal orifice of their host."

Tests of poisons. It has been frequently said that flea-beetles cannot be poisoned. While this of course is not true, it is well known that potato fields sprayed in the usual way for the Colorado potato beetle are not exempt from the attacks of the flea-beetle. Observation has shown that the flea-beetle feeds upon the unsprayed portion of the leaf and appears to avoid the poisoned part. If the upper surface of the leaf is wholly covered with the spray the beetle will feed on the underside, where indeed it usually feeds, by preference.* If some poison mixture could be devised that would prove attractive to the insect it would no doubt solve the problem of flea-beetle control. The successful use of sweetened poisoned bait for the combating the Grape Fidia (*Fidia viticida*) by the entomologists at the New York Experiment station at Geneva has suggested a trial of this method for the potato flea-beetle. The

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*The peculiar feeding habit of the potato flea-beetle has been subject to field observation by Dr. W. J. Morse for eight or ten years both in Vermont and Maine and we can do no better than quote him in this particular:—"The flea-beetles, though they may be present in large numbers and doing much damage, are seldom seen by the potato growers. One reason, of course, is that they are so small. A more important one is that they are almost always found on the *under* sides of the leaves and eat from the under sides, never clear through the leaf, stopping just short of the upper surface. They eat so nearly through that the tissues above dry away leaving a small hole entirely through the leaf. It is certain that bordeaux mixture would be much more effective as a repellant to flea-beetles if it could be applied to the under side of the leaves."

following experiments were made during the summer of 1912, at Orono.

A small field was planted with potatoes and divided into five plots; one of which was sprayed with Bordeaux to which was added three pounds of arsenate of lead, per 50 gallons of spray mixture; the second like the first but with the addition of 2 1-2 quarts of Karo corn syrup per 50 gallons of the spray, the third without bordeaux but using three pounds of arsenate of lead in 50 gallons of water; the fourth as in the third with the addition of 2 1-2 quarts of syrup; the fifth, unsprayed. The potatoes were sprayed at intervals of about two weeks during the season, and put on at the rate of 250 gallons per acre. The conditions under which these experiments were conducted rendered it impossible for us to keep a quantitative record of flea-beetle injury (counts of flea-beetle punctures) but in general it may be said that there was decidedly more flea-beetle injury in in the unsprayed plot than in the sprayed and least injury in the first and second plots which were sprayed with a mixture containing bordeaux. There was no noticeable difference between the plots which were sprayed with the mixture containing the syrup and the corresponding one without it. Had a pure corn syrup been used instead of Karo corn the result might have been different. The difference between the sprayed and the unsprayed plots was much more noticeable during September than earlier in the season.

Some laboratory experiments were also made. A number of beetles were placed in a glass jar with some tender potato leaves thoroughly drenched in an arsenate of lead spray mixture (three pounds in 50 gallons.)

In a second jar Watson's soluble arsenoid (an efficient poison for potato beetles) was used; in the third as in the first but with the addition of Karo corn syrup (2 1-2 quarts per 50 gallons). At the end of 24 hours all the beetles were still alive in the first and second jars, but over 2-3 were dead in the third. All the leaves showed feeding puncture at the conclusion of the test. Though we are scarcely justified from so limited a series of experiments in assuming that the syrup would be serviceable when used on a large scale, nevertheless, the results are interesting and suggestive.

Remedies. The foregoing experiments with Bordeaux mixture have only again demonstrated what has long been known that this fungicide is an excellent flea-beetle repellant. As it is not a poison but a repellant the key note to success in its use lies in thoroughness and frequency of spraying. Professor R. L. Jones formerly of the Vermont Experiment Station was the first to test this remedy and to demonstrate its efficiency.

Although flea-beetles are sometimes abundant in fields which are fairly well sprayed it must be borne in mind that the spray rarely covers the whole leaf and that the beetles attack the unsprayed part. There is, however, another factor which enters and that is that the beetles are much inclined to feed on the underside of the leaf frequently stopping just short of the upper surface. The tissue above dries away and this leaves a small hole through the leaf. As the spray for the most part strikes only the upper surface its effectiveness as a repellant is thus largely nullified. It is certain that bordeaux mixture would be much more effective if it could be applied to the under surface of the leaves. A spraying apparatus so devised that a portion of the spray could be directed upwards against the underside of the leaves would do much towards lessening the damage wrought by flea-beetles and thus also diminish the injury caused by early blight. Director Chas. D. Woods, of this station in a letter published Oct. 19, 1912, upon the subject of "Early Blight and Flea beetles" closes with these words, "One of the projects of the Maine Agricultural Experiment Station for the coming year is the construction of a more efficient potato sprayer and one with the nozzles so arranged, if possible, that they will meet the necessary requirements in the manner of the application of the spray to control early blight and flea-beetles. This may mean, to secure sufficient pressure and volume of spray, the construction of some sort of a gasoline power sprayer for potatoes."

From what has already been said it will be noted that the most effective remedy yet known against flea-beetles is the use of bordeaux mixture. It must be sprayed on so that the vines are well coated, and repeated at frequent intervals, at the rate of 100 or more gallons per acre. If other insects are also present, two pounds of lead arsenate to 50 gallons of the bordeaux, may be added.

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LIST OF INSECTS RECORDED ON POTATO.

EDITH M. PATCH.

This list was compiled from various sources as a part of the General Insect Catalogue used at the Maine Agricultural Experiment Station and the fact that it has proven useful in manuscript is the only excuse offered for its publication. It is a working list and doubtless incomplete. Additions or corrections from anyone kind enough to make them would be appreciated. The references are to accounts where the potato is recorded as a food plant.

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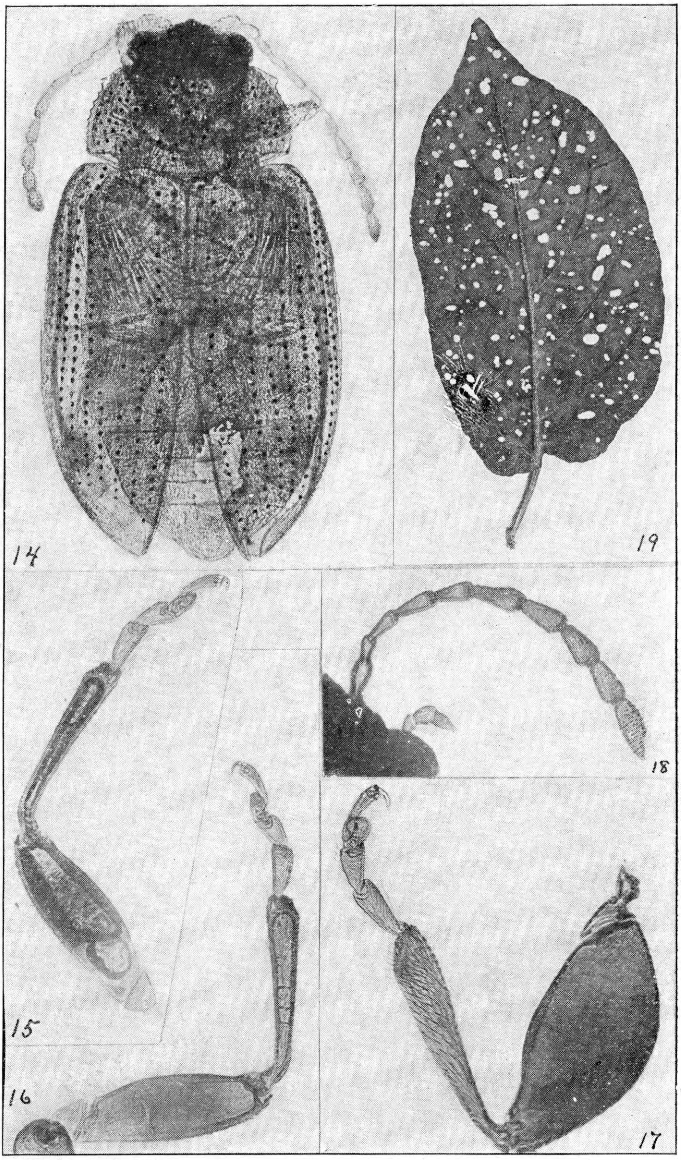

Fig. 14. Potato Flea-beetle, showing punctures. Enlarged. Figs. 15 and 16. Fore and middle legs. Fig. 17. Hind leg. Fig 18. Portion of head showing antenna. Fig. 19. Potato leaf riddled by flea-beetles.

BULLETIN No. 212.

ORCHARD SPRAYING EXPERIMENTS IN 1912.

W. J. MORSE AND G. A. YEATON.

At this Station the first tests of lime-sulphur as a substitute for bordeaux mixture in spraying apple orchards was made in 1908. This was an experiment planned and conducted by the Department of Plant Pathology, the results being reported in Bulletin 164. In this work self-boiled lime-sulphur was prepared by using both hot and cold water and was compared with bordeaux mixture to test its efficiency in the control of apple scab. Five varieties of apples were used, including the Fameuse and the McIntosh, both of which are quite susceptible to scab.

Although three applications of the sprays were made, the first when the leaves were unfolding, the second just after the petals fell, and the third about three weeks later, considerable scab developed on all of the sprayed trees. While the results from the self-boiled lime-sulphur showed that it had materially reduced the amount of scab the bordeaux mixture showed much more efficient control of the disease. However the test was a severe one and 99 per cent of the apples on the unsprayed trees were scabbed.

The same experiment was repeated in 1909 in the same orchard but, on account of weather conditions, that season scab failed to develop even on the unsprayed trees, consequently the results were inconclusive and were not written up for publication. Neither in 1908 nor in 1909 was there any spray injury to be observed on foliage or fruit, even where the bordeaux mixture was used.

Highmoor Farm came under the management of the Maine Agricultural Experiment Station on July 1, 1909, and the orchards, which now consist of over 2300 trees, furnished the

Station for the first time in its history an opportunity to make spraying experiments on a large scale in an orchard entirely under its control. By this time the results of experiments made in other parts of the country indicated that a concentrated mixture of lime and sulphur in water, cooked by artificial heat and then diluted before applying, was the most promising lime-sulphur spray for apple orchards. It was claimed to be more effective than the self-boiled article and entirely free from spray injury, thus, in this respect, being much superior to bordeaux mixture.

Therefore an experiment was planned for 1910 as one of the plant pathology projects for that year in which it was proposed to test the value of artificially boiled or cooked lime-sulphur as an orchard spray, as compared with the self-boiled and with bordeaux mixture. Also it was planned to test the relative efficiency of several commercial brands of concentrated, boiled lime-sulphur as compared with the home-cooked article. With the appointment of Mr. W. W. Bonns as Station Horticulturalist, stationed at Highmoor Farm, the project was transferred to his department. Mr. Bonns carried on two series of experiments, one in 1910 and one in 1911, the results of which were quite fully reported in Bulletins 189 and 198. In the first publication, in addition to giving an account of the results of the experimental work of the season, he reviewed in considerable detail the literature upon the use of lime-sulphur as a summer spray, the use of sulphur and its compounds as fungicides, the question of spray injury from bordeaux mixture, etc. On account of the great demand for Bulletin 189 it was soon out of print. Therefore a summary of the experimental results obtained in 1910 were included in Bulletin 198 with those obtained in 1911.

The apple orchards at Highmoor Farm consist almost entirely of the Ben Davis and Baldwin varieties. The entire orchards were sprayed once late in June 1909 with bordeaux mixture and arsenate of lead, largely to control leaf-eating insects, just as soon as it was found that the purchasing committee had decided to buy this farm. So far as known this was the first time the trees, which were then in a much neglected, half-starved condition, had ever been sprayed. In 1910 all but the experimental plots received three applications of bordeaux mixture and arsenate of lead. During both seasons much damage from spray injury resulted to both foliage and fruit, particularly on the Ben Davis. Since 1910 the main orchards have been sprayed yearly with home-cooked lime-sulphur and with uniform success as far as spray injury was concerned.

On account of weather conditions no real severe test of lime-sulphur as a means of control of apple scab was experienced until the present year, although the data secured in 1910 were sufficiently conclusive for practical purposes with regard to certain questions under consideration. The artificially cooked lime-sulphur gave that year, as a rule, much better results as to scab control than did the self-boiled article. The results in 1910 were also slightly in its favor in this respect when compared with bordeaux mixture. The commercial brands of concentrated lime-sulphur were, during that season, somewhat more effective than the home-cooked material, but this advantage was not considered sufficient to offset the greater cost of the former for large orchards.

With regard to injury to foliage and fruit all of the lime-sulphur sprays proved to be much more satisfactory than bordeaux mixture, although one proprietary spray, the name of which indicated that it was some sort of a sulphur compound, produced much greater spray injury than did bordeaux mixture. However, in these orchards of over 2300 trees, mostly Ben Davis and Baldwin, wherever bordeaux mixture has been used during the past four years the resulting injury to foliage and fruit has, as a rule, more than offset the benefits derived from fungus control. It will be seen later that during 1912, while the foliage escaped, much russeting was produced on the fruit. On the other hand, properly made and properly applied lime-sulphur has produced practically no foliage injury and very little russeting of the fruit could be attributed to it. At the same time when applied at the proper time, particularly in the experiments to be described in this bulletin, it was quite effective in the control of the apple scab fungus on both foliage and fruit.

While it has been shown conclusively in these experiments and those conducted elsewhere that lime-sulphur is a much safer spray to use on those varieties of apples like the Ben Davis which are very susceptible to spray injury, there are certain varieties of apples which are not injured or are but slightly injured by bordeaux mixture. Moreover the work of Stewart and his associates of the New York Station has shown that lime-sulphur not only is far inferior to bordeaux mixture as an agent to control the late blight and other potato leaf-diseases, but it is apparently positively detrimental to the potato.* Therefore it seemed justifiable to plan a series of experiments extending over a number of years in which the relative efficiency of bordeaux mixture and lime-sulphur as a spray for apple orchards could be tested under a variety of seasonal weather conditions. While the reports are everywhere quite favorable to lime-sulphur, as an orchard spray the data so far accumulated are not sufficiently varied and complete to draw final conclusions. If bordeaux mixture is more effective or even equally effective in scab control there is no reason for the orchardist who experiences no injury from it upon the varieties which he grows to discard it in favor of lime-sulphur.

Certain writers, a summary of whose work Mr. Bonns gave in Bulletin 198 have noted the fungicidal value of lead arsenate.† Therefore the experiments for 1911 were so planned as to include a test of the fungicidal value of lead arsenate, further comparisons of the fungicidal value of bordeaux mixture and home-cooked lime-sulphur, and a test of different dilutions of lime-sulphur to determine which is the most satisfactory strength to use, both with regard to control of scab and freedom from spray injury. The variety used for making these tests in all cases being the Ben Davis.

On account of weather conditions being unfavorable to the growth of the fungus practically no scab developed in the orchards in 1911 so that from that standpoint no data of value was secured. In fact on account of the failure of scab to develop the only clear-cut result of the experimental spraying of that year was with regards russeting the fruit. Where bordeaux

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* Stewart, F. C. and French, G. T., Lime-Sulphur vs. Bordeaux Mixture as a Spray for Potatoes. Bul. N. Y. Agr. Exp. Sta. 347, 1911. Munn, M. T., Lime Sulphur vs. Bordeaux Mixture as a Spray for Potatoes II. Bul. N. Y. Agr. Exp. Sta. 352, 1912.

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

Wait, M. B. Experiments on the Apple with Some New and Little Known Fungicides, Cir. U. S. D. A. Bu. Pl. Ind. 58, 1910.

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

mixture was used over 70 per cent of the apples were so affected while on the other plots this was not over 2 per cent in any case and the amount was fairly uniform, regardless of the kind and strength of the spray.

The 1912 Experiments.

In 1912 the apple spraying experiments were again transferred to the Department of Plant Pathology. When the first two applications of the spray were applied in the experiments which will be described the Station pathologist was on a leave of absence, otherwise an unsprayed check-plot would have been saved for comparison. That part of the work which was primarily concerned with the fungicidal value of the different sprays was an exact duplicate of that carried out the season before, but as has already been pointed out the weather conditions of the summer of 1912 were much more favorable to the test.

In this experiment there were used 139 Ben Davis trees, about twenty-five years old and which constituted a block at one corner of the most thrifty orchard on the farm. This is the same block of trees which was used in 1910 and 1911 experiments. Previous to 1909 this orchard, like the others on the farm, had been much neglected, although it showed some evidence of previous cultivation and had also been used for a sheep pasture in recent years. For the past three years it has been well fertilized and has been thoroughly cultivated each year. It is now in a quite thrifty condition. The block was divided into six different plots.

Plot A was sprayed with arsenate of lead 4 pounds in 50 gallons of water.

Plot B was sprayed with home-cooked lime-sulphur, 27° Beaumé density 2 gallons, in water sufficient to make 50 gallons. This was called the "one-fifth stronger" plot as the spray carried 20 per cent more of the concentrate than is commonly recommended.

Plot C or the "standard dilution" plot was sprayed with 1 2-3 gallons of the same lime-sulphur concentrate, diluted with water to make 50 gallons. This is the same dilution as is used on the general orchards on the farm.

Plot D was called the "one-fourth weaker" plot as only 1 1-4 gallons or 25 per cent less of the concentrate than in Plot C was used to each 50 gallons of the spray.

Plot E was sprayed with 2 pounds of arsenate of lead in 50 gallons of water.

Plot F was sprayed with a 3-3-50 bordeaux mixture.

Two pounds of arsenate of lead were added to the spray in each case on plots B, C, D and F. All of the sprays were applied with a gasoline power sprayer outfit, using two leads of hose at a time at about 150 pounds pressure. Care was taken to thoroughly wash out both the tank and the pump after using each different kind of spray, before putting in the next. The relative position of the plots and the number of trees in each are best shown in the following plan.

PLAN OF EXPERIMENT.

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

A. 9 trees, arsenate of lead 4 lbs. to 50 gallons.
B. 35 trees, lime-sulphur 2 gallons in 50, 2 lbs. arsenate of lead.
C. 36 trees, lime-sulphur $1\frac{2}{3}$ gallons in 50, 2 lbs. arsenate of lead.
D. 35 trees, lime-sulphur $1\frac{1}{4}$ gallons in 50, 2 lbs. arsenate of lead.
E. 12 trees, arsenate of lead 2 lbs. to 50 gallons.
F. 12 trees, 3–3–50 bordeaux mixture, 2 lbs. arsenate of lead.

As originally planned three applications of the sprays were to be made, the first just as the blossoms were showing pink, the second after the petals fell and the third about three weeks later. The early part of the season was very wet and for several days before the first application should have been made it rained almost constantly. Partly on this account and partly on account of a misunderstanding on the part of those in charge of the work at that time the first application of the sprays on the experimental plots was delayed so long that the blossoms opened before it could be applied. Fortunately, on the orchard adjoining the plot, where exactly similar conditions existed with regards soil, age, variety and condition of the trees, this first application was made just before the blossoms opened. Hence this furnished opportunity to select a plot of trees sprayed three times with standard dilution lime-sulphur and where the applications were made at the proper dates as was intended in the original experiment. As will be seen later the results from this block of trees furnished an excellent demonstration, when compared with the other experimental plots, of the value of a fungicidal spray for apple scab when applied just before the blossoms open. This plot will be referred to as Plot G.

Plots A to F inclusive were sprayed first on June 5 and again on July 1. Plot G was sprayed on May 24, June 5 and July 1.

Effect of the Sprays on the Foliage.

The experimental plots were under the constant observation of the orchardist, Mr. Yeaton, and were frequently visited by Dr. Lewis, the associate pathologist, and the writer during the season.

On June 5 there was no evidence of scab in any of the orchards. On plot G where the first application of lime-sulphur was made on May 24 there was no evidence of spray injury although an occasional leaf showed scorching at the margin.

Plot A, 4 pounds of arsenate of lead with no fungicide, showed a small amount of scab on the leaves of all of the trees, some leaves being quite badly affected on the first of July. No spray injury was noted at that time. By the middle of July the scab had not developed much more but there was by this time abundance of spray injury on the leaves. By August first the foliage still plainly showed the effects of spray injury but the evidences of scab on the leaves had largely disappeared. A record was also kept on the appearance and development of scab on the fruit on this and other plots but this will be discussed under another heading.

Plot B, sprayed with 2 gallons of lime-sulphur and 2 pounds of arsenate of lead diluted to 50 gallons, showed a quite general infestation of scab on the leaves by July 1. However, while some of the leaves on all of the trees in this plot were attacked, the infestation was, on the whole, recorded as slight as compared with plots C. D. and E. By the middle of July there was not much evidence of farther development of scab, but some spray injury was plainly evident on the foliage. This was, however, frequently plainly associated with scab spots and suggested that it might be analogous to arsenical injury on potato leaves which have been injured by flea beetles. A given amount of Paris green or other arsenical may be used on potato plants with perfect safety so long as the epidermis of the leaves is unbroken. On the other hand, if a considerable number of flea-beetle punctures are present in the leaves arsenical injury is quite likely to result, the severity of the injury varying with the number of punctures.

By August 1 the evidence of scab infestation on this plot had largely disappeared and no increase of the amount of spray injury on the foliage was observed during the remainder of the season.

Plot C sprayed with 1 2-3 gallons of lime-sulphur and 2 pounds of arsenate of lead diluted to 50 gallons. Detailed records made of the amount of scab on the leaves of the individual trees in this plot at various times during the season showed relatively more scab was present than on plot B, where the "one-fifth stronger" dilution of lime-sulphur was used. On the other hand very little leaf-spot or spray injury was observed on plot C.

Plot D, sprayed with 1 1-4 gallons of lime-sulphur and 2 pounds of arsenate of lead diluted to 50 gallons. Much more scab was observed on this than on any of the other lime-sulphur plots. Judging from the appearance of the leaves alone, and in comparison with plot E the two applications of this weaker dilution of lime-sulphur failed to exert any restraining influence on the development of the scab fungus whatever, although it will show later that it did reduce somewhat the amount of scab on the fruit.

Plot E, sprayed with 2 pounds of arsenate of lead in 50 gallons of water. With the exception of plot D this showed the greatest development of scab on the foliage of any. In this connection it should be noted that there was a decidedly less amount of scab on the leaves of the trees in plot A where double the amount of arsenate of lead was used without any lime-sulphur. In fact on the last mentioned, considering plot E as a check, the control of scab on the foliage was fully equal to that on the "standard dilution" plot and nearly equal to that on the "one-fifth stronger" plot.

Plot F, sprayed with a 3-3-50 bordeaux mixture. During the present season if final conclusions were to be based on the effects on the leaves alone bordeaux mixture showed much better results than lime-sulphur. However the final record of the percentages of perfect and imperfect fruit, which are given later, tell a somewhat different story. On plot F, where bordeaux mixture and arsenate of lead was used there was almost perfect control of scab on the foliage and no spray injury of the leaves was observed. On the other hand very severe spray injury to the leaves was experienced on the same variety in previous years.

Plot G, sprayed with "standard dilution" lime-sulphur the same as plot C, except that it received an application on May 24, just before the flower buds opened. On this plot throughout the season the control of scab on the leaves was all that could be asked for, and little or no spray injury was apparent.

Effect of the Sprays on the Fruit.

Notes and observations were made and records kept of the development of scab and the appearance of russeting on the fruit during the season. These records do not give any additional information which is of material value and which is not indicated by the condition of the fruit at the time of harvesting, therefore they are omitted.

The fruit on the trees on the experimental plots under consideration averaged about 3 barrels per tree, giving on the entire area over 400 barrels. So far as could be observed the condition of the fruit on the different trees in each plot was fairly uniform, therefore it seemed to be an unnecessary expenditure of time and labor to attempt to sort and count the entire quantity. For the purpose of obtaining the necessary data the entire crop on 6 trees in each plot was picked separately, placed in barrels and taken to the packing shed for sorting. In all plots except A, E, and F, where this was impossible, the 6 trees constituted one of the rows nearest the center of the plot. The amount of fruit actually used and counted to obtain the data recorded in the following table amounted to about 20 barrels per plot or treatment. In some cases it ran over this and in others, notably in plot G, it was somewhat less than 20 barrels.

It will be noted in the table that in plot E the percentages total slightly more than 100 while in plot F they amount to considerably more than this. This is accounted for by the fact that in some cases, particularly in plot F the same apples were both scabbed and russeted.

RESULTS OF THE FUNGICIDE EXPERIMENTS ON THE FRUIT.

Plot.	TREATMENT.	Total No. of apples.	Number smooth.	Number scabby.	Number russeted.	*Per cent. of perfect apples.	*Per cent. of scabby apples.	*Per cent. of russeted apples.
A	Arsenate of lead 4 lbs.—water 50 gallons..................	10,507	7,132	2,660	715	67.8	25.3	6.8
B	Lime-sulphur 2 gals.—arsenate of lead 2 lbs.—water 48 gals......................	10,298	7,409	2,520	369	71.8	24.4	3.5
C	Lime-sulphur 1⅔ gals.—arsenate of lead 2 lbs.—water 48⅓ gals.	9,312	4,727	4,439	146	50.7	47.6	1.5
D	Lime-sulphur 1¼ gals.—arsenate of lead 2 lbs.—water 48¾ gals.	9,513	3,450	5,835	228	36.2	60.9	2.3
E	Arsenate of lead 2 lbs.—water 50 gals....................	9,935	1,859	8,044	52	18.7	80.6	2.3
F	Bordeaux mixture 3-3-50—arsenate of lead 2 lbs...........	9,363	5,959	3,048	3,404	63.6	32.5	35.3
G	Lime-sulphur 1⅔ gals.—arsenate of lead 2 lbs.—water 48⅓ gals.†	6,733	5,985	95	650	88.8	1.4	9.6

* The per cents. do not total 100 as in some instances a considerable number of the same apples were both scabby and russeted.

† Like plot C except that an application was made just before the flower buds opened.

Discussion of Results.

As has already been mentioned the original plan of the experiment called for an application of the various sprays when the flower buds began to show pink, or before they opened. The failure to do this greatly lessened the value of the data which it was planned to obtain. Fortunately, however, this omitted spray was applied to the adjoining orchard from which plot G was taken. As a result certain other data were obtained which are doubtless of more practical value than that originally desired.

Efficiency of the first spray application. Perhaps the most striking thing about the results secured is with regards the value of the spray applied before the blossoms opened as compared with the two following applications. This is shown by the figures obtained on plots C and G. The treatment on these two plots being exactly alike except that on C the first spraying was omitted. In one case only about 50 per cent of perfect apples were obtained and nearly all of the remainder of the fruit was scabbed. In the other nearly 90 per cent of the fruit was sound and perfect and less than 1.5 per cent was scabby. It is true that on the last plot nearly 10 per cent were classed as russeted but this figure is somewhat misleading as the russeting was, as a rule, very slight. Very few of these so-called russeted apples would have to be sold for less than a No. 2 grade.

The general conclusion was that, under the existing weather conditions of the past season, where the first spraying was omitted the profits derived from the two following sprayings paid little more than the cost of application. This statement should not be taken as implying that these are not important or advising that they should be omitted, but as pointing out the great importance of the first spraying, applied at the proper time. The more complete knowledge of the life history of the scab fungus which has been gained in recent years coincides with these experimental results.

The fungus passes the winter on fallen leaves under the trees. In early spring on these leaves of the season before it matures within a capsule an entirely different type of spore from that which leads to the propagation and spread of the fungus during the following summer. These sac spores are thrown out in the spring in large numbers, are carried to the leaves of the lower branches of the trees, and there serve as centers of infection as soon as they have germinated and have begun to produce a diseased area. This period of ejection of the sac spores lasts but for a comparatively short time and then the danger from them is largely past. Consequently if a fungicidal spray is applied to the trees when these spores are being matured and thrown off, or at least before they have germinated and infected the leaves and parts of the young blossom buds, a large proportion of the potential possibilities of scab infestation for the coming season will be eliminated at the start. If, on the other hand, the first application is too long delayed and infection has occurred no amount of later spraying will absolutely control the disease although it may do much to prevent its spread to uninfected fruit and leaves.

That two applications of standard dilution lime-sulphur did materially check the development of scab is plainly shown in comparing plots C and E where the former gave 32 per cent more perfect apples than the latter. On the other hand plot G, sprayed three times, gave a like increase of over 70 per cent. This much greater efficiency in disease control is very evidently due to the prevention of the early spring infection from the sac spores produced on the old leaves under the trees.

Dilution of lime-sulphur. The fact that only two applications were made to the different plots of which the different dilutions of lime-sulphur were tested detracts from the value of the data obtained. While too sweeping conclusions should not be drawn from them, the results taken for their face value are fairly suggestive. The "one-fifth stronger" dilution was decidedly more efficient in scab control than was the "standard dilution" and produced but little more russeting of the fruit. This did, as has been previously noted, produce some slight leaf injury. Judging from this season's experience and that of the year before it would seem that a 27° Baumé lime-sulphur can be used at the rate of two gallons to 48 of water with comparative safety on varieties like the Ben Davis which are very susceptible to spray injury. Judging from the results of the present season alone this stronger dilution is much more efficient than the standard dilution in scab control—possibly sufficiently so to warrant its use in commercial spraying. However this is a matter which requires more confirmatory evidence.

The "one-fourth weaker" dilution on plot D proved to be entirely inefficient in scab control and doubtless what gains there were did not pay the cost of spraying. While it is very likely that much better results would have been obtained if another application of this spray had been made earlier it is not felt that the results are sufficiently encouraging to warrant following it farther another year.

Lime-sulphur vs. bordeaux mixture. The percentage of perfect apples obtained from the plot sprayed with bordeaux mixture exceeded that produced on those plots sprayed with lime-sulphur the same number of times with the exception of plot B where the strongest lime-sulphur spray was used. Here again, however, the figures do not tell the whole story. Strange as it may seem, practically all of the scabbed apples on the bordeaux sprayed plot were also among the russeted. However, very few of the apples on this plot were very badly affected with scab. On the other hand the scabbed apples on the lime-sulphur sprayed plots were, as a rule, somewhat more seriously affected. While the slightly scabbed apples on the bordeaux plot would doubtless keep in storage better than the slightly more severely attacked fruit on the lime sulphur plots the latter fruit on account of its freedom from spray injury or russeting would bring a higher market price.

Arsenate of lead as a fungicide. Another very striking fact in connection with results obtained was the apparent effectiveness of heavy applications of arsenate of lead in the control of apple scab as is shown by a comparison of the per cent of scabby apples recorded from plots A and E. In one case where 4 pounds of arsenate of lead to 50 gallons of water was used with no other material added as a fungicide only a little over 25 per cent of the fruit was scabbed while in the other case where only half as much arsenate of lead was applied over 80 per cent of the apples were scabby. Moreover it will be seen on reference to the table that where the 4 pounds of arsenate of lead was used alone the percentage of perfect apples obtained was greater than on all other plots which received the same number of applications except B, where the stronger dilution of lime-sulphur was used.

It was in connection with these comparisons that the lack of an unsprayed check-plot was most apparent. Apparently when plots A and C are compared, 4 pounds of arsenate of lead were decidedly more effective in scab control than standard dilution lime-sulphur plus 2 pounds of arsenate of lead. If 4 pounds of arsenate of lead exerts so decided a fungicidal effect, is it not possible that the amount of scab on plot E, sprayed with 2 pounds of arsenate of lead alone, is considerably less than would have developed on an unsprayed plot? If such is the case its use as a check plot does not measure the true fungicidal value of sprays used on the other plots. Similarly how much of the fungicidal value of lime-sulphur combined with arsenate of lead is due to the presence of the last named material? There is one outside factor which may have exerted an influence on the apparent effectiveness as a fungicide of the heavy application of arsenate of lead. As is illustrated on p — the nine trees in this plot were at the corner of the orchard and were thus much better exposed to the sunlight than those on the other plots. However it does not seem that this location with regards light is sufficient to account for the recorded differences.

Experiments with Different Arsenicals in Combination with Lime-Sulphur.

The ordinary arsenate of lead paste commonly used for orchard spraying is a very variable substance. Some lots as purchased may be quite soft and carry a considerable percentage of water. Other lots, sometimes from the same manufacturer, are received in the form of a rather dry, sticky paste. This variation in composition may cause considerable variation in the amount of arsenate of lead actually used in the spray no matter how careful the user is to accurately weigh the quantity taken. Also considerable difficulty is frequently experienced in disolving the arsenate of lead paste, particularly that which has partially dried out, so that it will mix thoroughly and well with the spray. Certain manufacturers are now selling a dry arsenate of lead in powder form which dissolves readily and quickly in water and which, if not adulterated, should always carry the same amount of poison pound for pound. Arsenite of zinc is also being sold as a substitute for arsenate of lead.

While the use of these substances as a substitute for the ordinary form of arsenate of lead as an insecticide is primarily a problem of economic entomology, their effects upon foliage and fruit, injurious or otherwise, are matters which concern the pathologist. Therefore an experiment was conducted, with the object in view of determining whether or not these substitutes produce injurious effects, in which the ordinary form of arsenate of lead paste was compared with the dried or powdered arsenate of lead and the arsenite of zinc.

For this Ben Davis trees were used in blocks of 36 trees each. The records were taken on the fruit from one row of 6 trees near the center of the plot as was the case in the fungicide experiments. So far as could be observed none of the insecticides, all of which were used in connection with standard dilution lime-sulphur, produced any appreciable injury to the foliage. Three pounds of arsenate of lead paste, 1 1-2 pounds of the dry arsenate of lead and one pound of arsenite of zinc were used with each 50 gallons of the lime-sulphur spray. The following gives in tabular form the condition of the fruit when harvested.

RESULTS OF THE INSECTICIDE EXPERIMENTS ON THE FRUIT.

TREATMENT.	Total No. of apples.	Number sound.	Number wormy.	Number russeted.	Per cent. of sound apples.
Arsenate of lead paste	6733	6080	3	650	90
Arsenate of lead dry	3594	3383	2	209	94
Arsenite of zinc	5790	5485	5	300	93

In the above table the term "sound" is used to include all apples which were not attacked by insects and were not russeted. In this experiment no account was made of scabby fruit.

Discussion of Results.

The results set forth in the above table are so self-evident that very little discussion is necessary. It will be seen that with regards insect control the three different insecticides produced almost exactly identical results. It may be said in this connection that not one of the apples classed as "wormy" was attacked by the codlin-moth but by the lesser apple worm. It will also be seen on comparing the per cents of sound fruit that the two substitutes produced even better results with regard to russeting than did the arsenate of lead paste, although these differences are probably within the limits of experimental error. So far as can be judged from the data obtained by this one experiment dry arsenate of lead and arsenate of zinc are fully as effective and are as safe to use as arsenate of lead paste. The results of the experiment, were on the whole so satisfactory, both with regards insect control and ease in mixing with the spray liquid, that dry arsenate of lead will be used on all the orchards at Highmoor Farm in 1913.

BULLETIN No. 213.

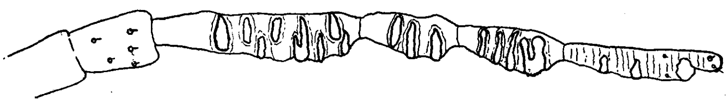
APHID PESTS OF MAINE. PART II.*

EDITH M. PATCH.

WILLOW FAMILY.

It is interesting to note that the aphides attacking willows and poplars are restricted to comparatively few genera. Many of the species are troublesome on shade and ornamental trees. The complete life cycle of certain gall forming species of the poplar is not yet known, but with *Pemphigus betae* (Gillette 1912) traced to the cottonwood for its winter host we have a stimulus for ascertaining whether the poplar serves as alternate host for other species of economic importance to vegetation outside of the willow family itself.

Pemphigus populimonilis Riley. The galls of this species are so familiar and characteristic with their bead like rows of cells each containing a single occupant, that *populimonilis* has been free from synonymic difficulties. Fig. 47.



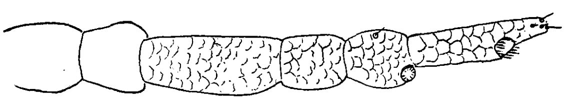


Fig. 20. *P. populimonilis.* Antenna of spring migrant.
Fig. 21. Antenna of pupa drawn to same scale as Fig. 20.

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* Papers from the Maine Agricultural Experiment Station: Entomology No. 65.

Alate viviparous female,—Spring migrant. From late July until mid-August this form can be found winged and solitary in the gall which it is now ready to desert. Fig. 20 shows the antenna of this form and Fig. 46 D. the wing. Fig. 21 is a drawing of the antenna of the pupa, the joints IV and V of which are typically rather short and bulging, and VI longer, narrower and with nearly parallel margins.

Apterous viviparous female,—Stem mother. This form has not previously been recorded. I first took it in 1905 and have met with it since though the galls of the progeny so far outnumber those of the stem mother that many occur to one containing the apterous parent. Sometimes the stem mother is present in one of a chain of galls containing pupae, but often she is found in a single gall separate from those occurring in a chain but not differing from them in structure or appearance,—at least there is not enough difference so that those containing the stem mother can readily be separated without examining the insect itself.

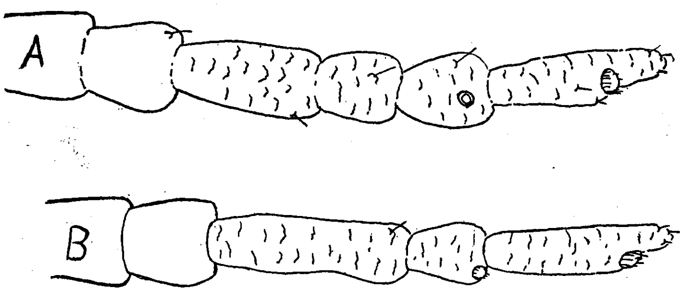


Fig. 22. *P. populimonilis.* Antenna of stem-mother.

The antenna of this form (Fig. 22) is ordinarily 6-jointed though sometimes, as is often the case with stem mothers of allied species, there is some irregularity in the development of the antenna and it appears with 5 joints. The joints have the same rotundity as in the pupa, a character accentuated by the shortness of IV and V which are literally about as broad as they are long.

Collection data for this species are as follows: 46-05. *Populus balsamifera.* Aug. 15, 1905. Veazie, Me. Several stem mothers taken singly in galls but these were dead either from parasitic insect or fungous attack. Winged form and pupæ were present in other galls, and a species of *Chaitophorus* was populating galls deserted by this *Pemphigus*.

86-06. *Populus balsamifera*. July 26, 1906. Veazie, Me. A single winged specimen in each small gall except where the gall was already vacated or occupied by a syrphus maggot.

81-09. *Populus balsamifera*. July 22-27, 1909. Veazie, Me. Galls very numerous. A single leaf was found bearing 65 galls. Four stem mothers, numerous pupæ and winged migrants still in galls,—each solitary.

99-12. *Populus balsamifera*. July 18, 1912. Veazie, Me. Galls numerous each containing a single insect in pupal stage.

Pemphigus gravicornis n. sp. For the past three years the pseudo-galls of this species have been common on *Populus balsamifera*. The affected leaves are folded lengthwise along the midrib and their margins are applied together at their ventral surfaces. The whole leaf except at the margin is swollen into a large sac or pocket which is filled with aphides. Fig. 53. This gall resembles that of *populiconduplifolii* but the two aphides are readily separated on antennal characters. So far as my observations go the galls of *gravicornis* occur on leaves anywhere on the tree while those of *populiconduplifolii* are on terminal leaves only.

Winged viviparous form.—Spring migrant, with antennal joints III, IV, V heavily charged with large irregular sensoria giving them a knurled appearance; and VI very slender and ordinarily without sensoria except the usual one at base of spur, though one or more others may be present. Fig. 23.

Fig. 23. *P. gravicornis*. Antenna of spring migrant.

The wings are delicate and the veins faint. Fig. 46 H. No description has been made of the living specimens, but the peculiar antennæ will serve to distinguish this species.

Collection data are as follows:

87-06 July 26, 1906. Veazie, Me.; 26-11 July 7, 1911, Orono, Me.; 98-12 July 18, 1912, Veazie, Me. Pupæ and migrants were taken but no stem mothers in these collections. The deserted galls are frequently appropriated by colonies of *Chaitophorus*.

Pemphigus populiconduplifolius Cowen. The galls of this species resembles that of *gravicornis* closely. Fig. 52. Sometimes galls of this species instead of being folded along the midrib are all on one side of the midrib in which case they are elevated above the level of the surface, and like those of gravicornis the ventral surface of the leaves forms the inside of the gall. Galls are pale green tinged with red and have a swollen appearance. The terminal leaves are those ordinarily attacked.

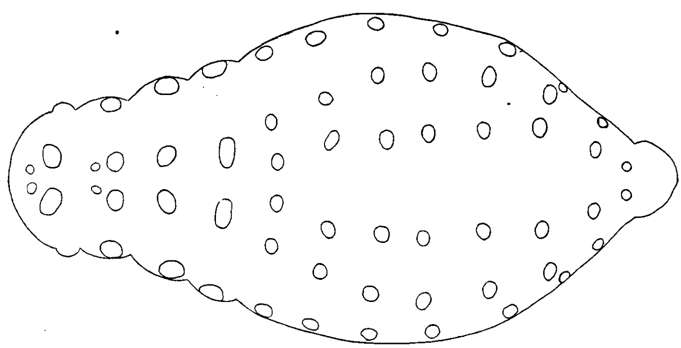


Fig. 24. *P. populiconduplifolius.* Wax gland areas of stem-mother.

Apterous viviparous female,—Stem mother. The wax gland areas of this form are shown in Fig. 24 and the antenna in Fig. 26. This insect is globular, dark greenish blue and woolly.

Winged viviparous form,—spring migrant. The antenna of this form is shown in Fig. 25 and the wing in Fig. 46 c.

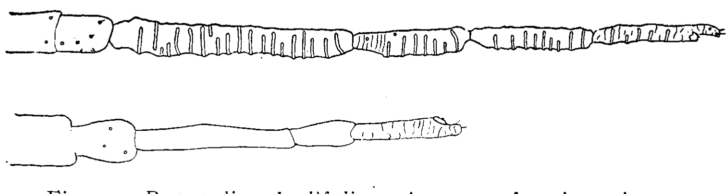


Fig. 25. *P. populiconduplifolius.* Antenna of spring migrant.
Fig. 26. Antenna of stem-mother.

Collection data are as follows:—23-06 (in part) June 14, 1906. Stem mothers; 37-10 June 29, 1910, Veazie, Me. Pupæ numerous and some migrants just winging; 46-10, 47-10, July 5, 1910, Veazie. One stem mother and numerous pupæ and winged forms. 91-12, a single stem mother in each gall with several nymphs, Orono Campus. 110-12, July 15, 1912, Orono, same tree as 91-12 and probably some of the same lot. Winged forms numerous. *Populus balsamifera.*

Pemphigus populicaulis Fitch. This species is structurally very close to *bursarius*. A few of the galls are shown in Figs. 49, 50, and 51. As will be noticed these are formed near the midrib and may be at the base of the leaf or elsewhere along the midrib, the opening being sometimes on the ventral (Fig. 49) and sometimes on the dorsal surface (Fig. 51). The galls vary considerably in size and in shape though they are more or less globular. This species is common on *Populus balsamifera* in this vicinity.

Winged viviparous female,—spring migrant. The wing of this form is shown in Fig. 46 I. and the antenna in Fig. 27. It will be noticed that joint VI is as heavily annulated as the other joints. I have specimens from Minnesota and Texas which accord with the Maine material and the figures of California specimens (Essig 1912) show the same characters as typical.

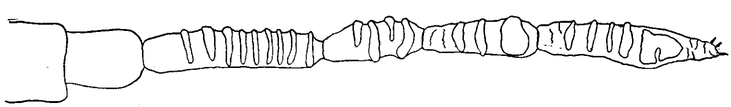


Fig. 27. *P. populicaulis.* Antenna of spring migrant.

Collection data are as follows:—23-11, Orono, July 6, 191: Winged forms in galls.

101-12, July 18, 1912, Veazie. Galls on stem at base of leaf (Fig. 50) causing a twist in the stem. Opening on the ventral side. Galls are more or less pinkish and some are decidedly reddish.

102-12 Veazie, July 18, 1912, galls on ventral side of leaf opening on dorsal surface, greenish or occasionally pinkish. They measured from half an inch to three-quarters of an inch along the mid-rib. Fig. 51.

103-12, Veazie, July 18, 1912. Pinkish galls along the midrib on the dorsal side opening on the ventral surface. Fig. 49.

Pemphigus bursarius Linn? A species closely allied to, if not identical with *bursarius* of Europe (Tullgren 1909) is common on poplar here. The life cycle is not ascertained but breeding tests for an alternate host are planned. The antenna and wing are represented by figures 28 and 46 B.

Fig. 28. *P. bursarius.* Antenna of spring migrant.

The gall is found on the petiole of the leaf in the form of irregular swellings of varied size, anywhere from near the base of the leaf to the extreme proximal end of the petiole. Gall causes curve in the petiole or sometimes a confused twist where two or three galls are crowded close together. Galls are also sometimes found on the new growth twig itself. The opening is a rather lip like slit usually transverse to the petiole. Fig. 48.

Collection data are as follows:—

60-06, and 65-10, July 7 and 10, 1906. Irregular globular galls on petiole containing winged forms and pupæ.

64-06, July 10, 1906. Irregular globular galls on new growth twigs of *Populus.*

28-11, Orono Campus. *Populus deltoides* Marsh (var. Carolina poplar) July 12, 1911. Galls contained stem mother, small nymphs, pupæ and winged migrants.

Chaitophorus populicola Thomas. This well marked species does not seem to be confused with other American species either in our literature or collections. Common in Maine on Cottonwood, American Aspen (*P. tremuloides*) and Balsam Poplar (*P. balsamifera*).

Alate viviparous form. General color a varnished black. Antenna black with III paler. Sensoria as shown in figure 29. Abdomen black, hirsute with cornicles yellow. Wing veins black and heavily shadowed, shadow broader at tip of veins especially with the two discoidals where it broadens to a dark V. Fig. 46 K.

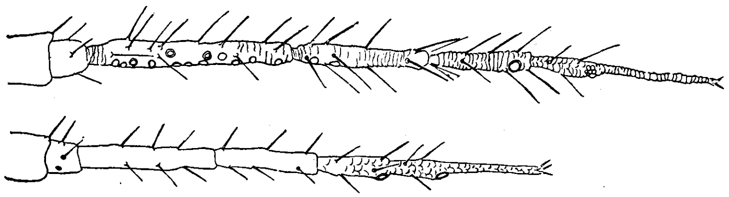


Fig. 29. *C. populicola.* Antenna of alate female.
Fig. 30. Antenna of apterous female.

Apterous viviparous form. Head and antenna black with III pale. Abdomen black dorsally and highly polished, ventral side paler and brownish. Cornicles light almost white. The progeny of these are reddish brown with a distinct yellowish λ the stem of which extends to front of head, the fork coming on the abdomen and being much more distinct than the stem. Another yellow spot at caudal part of abdomen, and cornicles are very pale. Body mottled with black specks. Antenna brownish with III pale. Fig. 30. Legs brown.

Collection data as follows:—

47-04, Orono, June 23, 1904. Dark apterous females and nymphs on Aspen Poplar.

47-05, Veazie, Aug. 15, 1905. Balsam Poplar.

33-06, June 18, 1906. Both winged and apterous viviparous females on Balsam Poplar.

59-06, July 3, 1906. Both apterous and winged viviparous females and pupæ on Aspen Poplar.

93-06, August 3, 1906. Both apterous and winged viviparous females on Aspen Poplar.

13-08, June 19, 1908, Veazie. Winged and apterous viviparous females, pupæ and nymphs on leaves and tender shoots of Balsam Poplar.

39-08, Veazie, July 10, 1908. Winged viviparous females and nymphs on leaves and tender shoots of Balsam Poplar.

40-10, Veazie, June 29, 1910. Winged viviparous female and her progeny on ventral side of Balsam Poplar leaf.

41-10, Veazie, June 29, 1910. Winged and apterous females and nymphs on Aspen Poplar.

56-10, Orono, July 12, 1910. Winged and apterous females and nymphs on Balsam Poplar.

70-10, Veazie, July 21, 1910. On leaves and petioles. Apterous females very dark,—some entirely black except for a yellow mark on cephalic portion of abdomen and whitish yellow cornicles,—others yellowish brown as usual. Newly dropped nymphs orange yellow. Winged forms also present.

71-10, Veazie, July 21, 1910. On leaves and petioles of Aspen Poplar. Alate females and small dark apterous females.

5-11, Orono, July 14, 1911. On petioles and new growth twigs of cottonwood. Alate viviparous female.

96-12, Veazie, July 18, 1912. Apterous and alate females, on Balsam Poplar leaves and also in galls of *Pemphigus gravicornis*.

Chaitophorus delicata n. sp. A tiny species which I had not seen before and which appears to be undescribed was collected from the leaf of Aspen Poplar (*P. tremuloides*) by Mr. William C. Woods last summer.

The apterous females, nymphs and pupæ, were all a pellucid water white with a vivid green mark on prothorax, a transverse green stripe on first abdominal segment, and a green blotch in the region of the white cornicles more or less connecting them. Fig. 31 shows the relative length of the antennal joints.

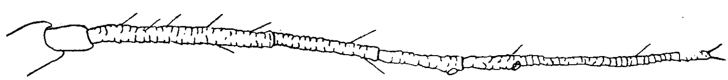


Fig. 31. *C. delicata.* Antenna of apterous female.

No winged forms were obtained.

Collection data as follows:—

104-12, Veazie, July 18, 1912. Leaf of Aspen Poplar. A small collection of apterous females, nymphs and pupæ.

119-12, Orono, July 29, 1912. A small collection from ventral leaf of Aspen Poplar. Apterous females, nymphs and one pupa.

Chaitophorus viminalis Monell? Until the life cycle of this species with careful detailed descriptions of the successive generations has been worked out by some one I refrain from definitely attributing Maine collections to either *viminalis* or *nigrae* as at present I am too much confused to contribute any aid to the situation. What I take to be *viminalis* has two successive generations of apterous forms which are so different in appearance that they might easily be mistaken for two distinct species and it would not be strange if this aphid has already been described under several names.

My color notes on collection 30-06, Veazie, June 15, 1906, *Salix* may be of interest in this connection. The apterous viviparous female had dorsal surface blackish with single well defined yellowish green streak extending from front of head to style,—streak very narrow through head but broadening in the central surface of body to an ovate space, narrowing again toward tip of abdomen. Cornicles yellow, style yellowish green, whole ventral surface greenish yellow. The apterous aphides that the form just described give birth to are uniform pale yellowish green with two vivid green longitudinal lines on the abdomen.

The alate viviparous females of this species present at the same date (June 15) have head and thorax black and abdomen black with greenish yellow lateral margin, cornicles dark, ventral abdomen greenish yellow. The wing (Fig. 46 E) is uniformily smoky dark with slender brown veins and brown stigma. For antennæ see Figs. 32 and 33.

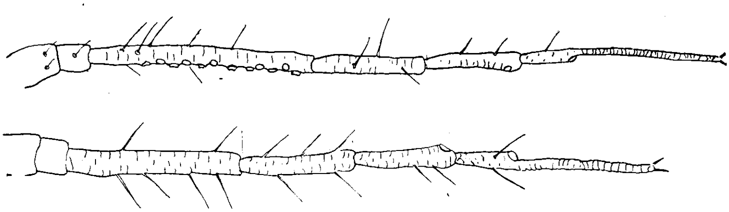


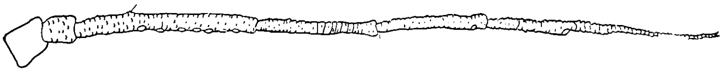
Fig. 32. *C. viminalis.* Antenna of alate female.
Fig. 33. Antenna of apterous female.

There are other species of *Chaitophorus* on *Salix* in Maine but my notes are not sufficient to record.

Aphis salicicola Thomas, I have taken only twice. It is characterized by long cylindrical cornicles, a style proportionately long, and the short branch of Media (Fig. 46 L). The relative length of the antennal segments are shown in Fig. 34. Antennal III has a single row of about seven rather faint sensoria. Fig. 35 shows the cornicle drawn to the same scale as the antenna.

36-04. Apterous and alate viviparous females collected from *Salix,* Orono, June 14, 1904.

88-12. Apterous viviparous females, *Salix,* Orono, July 16, 1912.



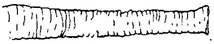


Fig. 34. *A. salicicola.* Antenna of alate female.
Fig. 35. Cornicle of same.

Aphis populifoliae Davis. Speckled Poplar Aphid. This remarkable species found usually on the upper surface of poplar leaves was described by Mr. Davis under the name of *Aphis populifoliae* (Fitch) in June, Econ. Ent. Vol. 3, 1910, p. 489.

The alate viviparous female has the following characters. Head black; no frontal tubercles; antenna with from about 20 to 30 sensoria on III, and few or none on IV relative length of joints shown in Fig. 36; eyes black; beak black, extends to between 2nd and 3rd coxæ; prothorax black, lateral tubercles prominent; shape and venation of wings as usual for *Macrosiphum,* Fig. 46 G, veins and stigma black; legs with femora black, tibiæ pale proximal 2-3 and black distal 1-3, tarsi black; abdomen black or reddish black with snow white pulverulent spots on dorsum arranged in transverse rows of one row per segment, venter slightly powdered; cornicles long cylindrical slightly swollen near base and black; style ensiform and upturned.

The apterous viviparous female is in general appearance black spotted with white. Head black, antenna (Fig. 38) black except proximal III which is very pale; sensoria present on III; eyes black; prothorax black with 2 white dorsal dots, tubercles present; thorax brownish black; legs with femora mostly dark proximally pale, tibiæ mostly pale, distally dark, tarsi black; abdomen brownish black with white pulverulent spots and venter pulverulent; cornicles long, black, cylindrical, slightly swollen near base. Fig. 39 shows cornicle drawn to the same scale as Fig. 38.

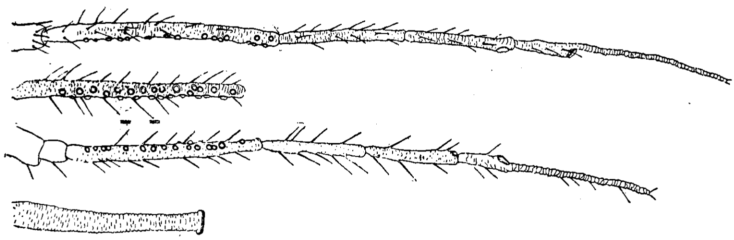


Fig. 36. *A. populifoliae.* Antenna of alate female. Fig. 37. Joint III of same from another individual. Fig. 38. Antenna of apterous female. Fig. 39. Cornicle of same.

Habitat of this species on new growth twigs but especially on dorsal surface of leaves causing a slight longitudinal curl upward. Found on *Populus balsamifera, P. tremuloides,* and certain other species of *Populus.*

Collection data: 58-06. One apterous viviparous female with progeny on dorsal leaf. Two alate viviparous females with progeny on dorsal leaves. *Populus balsamifera* and *P. tremuloides* July 3, 1906.

20-08. Apterous viviparous females and progeny. *Populus* sp. Orono, June 22, 1908.

36-08. A mass of this black and white species with a black and white larva of a lady beetle made one of the prettiest "coloration" schemes I have ever seen. *Populus* sp. terminal leaves and tender shoots. Orono, July 9, 1908.

70-08. Winged viviparous female and pupæ on balsam poplar (tender growth of water sprout). Orono, Aug. 25, 1908.

58-10. Apterous viviparous females and progeny on dorsal surface of leaves of *Populus balsamifera* causing a very slight upward curl of leaf. Orono, river bank, July 12, 1910.

77-10. Apterous and alate viviparous females, nymphs and pupæ on *P. balsamifera* on dorsal surface of leaves causing slight curl upward. Orono, river bank, July 23, 1910.

95-12. Apterous and alate viviparous females and nymphs on dorsal surface of leaves of balsam poplar turning the edges of edge and more or less crumple. Also present in galls of *Pemphigus gravicornis,* Veazie Sand Bank, July 18, 1912.

106-12. Alate and apterous viviparous females and nymphs on dorsal surface of leaves of balsam poplar turning the edges slightly upward. Veazie, July 18, 1912.

Macrosiphum laevigatae Essig. In 1910 a colony of *Macrosiphum* was collected on the campus here at Orono since described from California as *laevigatae.* They were found on the ventral side of the tender tip leaves of willows at the rear of campus heating plant. Only apterous viviparous females and nymphs were taken that season, collection 78-10, but July 16, 1912, winged forms were found on *Salix* at Orono, collection 87-12.

The apterous viviparous female has a light greenish yellow head; antennæ (Fig. 40) with I, II, and III except articulation pale, and IV-VI black, III with 3 to 5 inconspicuous sensoria near base; eyes black, thorax, abdomen almost white with greenish yellow tinge and with a vivid green longitudinal line extending from prothorax to the fifth or sixth segment of abdomen where it sometimes stops abruptly; cornicles longer than antennal III, concolorous at base and dusky at tip which is distinctly though irregularly reticulated for a distance equaling about one-ninth the length of cornicle, the basal eight-ninths being comparatively smooth (Fig. 42); style concolorous with abdomen. There is a minute lateral abdominal tubercle just cephalad the base of the cornicle.

The winged viviparous female has about 10 delicate sensoria on basal half of antennal III. Fig. 41, drawn to the same scale as Fig. 42.

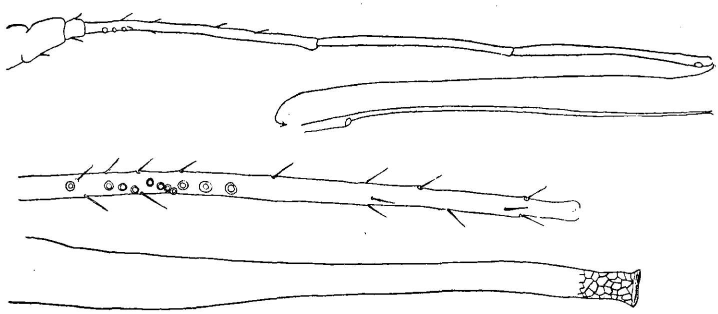


Fig. 40. *M. laevigatae.* Antenna of apterous female. Fig. 41. Joint III of antenna of alate female. Fig. 42. Cornicle of apterous female.

Melanoxantherium bicolor Oestlund. A species which I take to be *bicolor* is not uncommon here on Balsam Poplar.

Apterous viviparous female. Head reddish brown. Eyes black. Antenna with proximal part dingy yellow and distal part black. Spur much longer than basal VI. Prothorax and thorax reddish brown, lateral tubercles prominent. Fig. 44 A. Legs with femora dingy yellow and tibiæ and tarsi black. Abdomen dark mottled reddish brown with pale inconspicuous median dorsal line, lateral tubercles prominent. Cornicles light dingy yellow like femora and longer and more slender than in *smithiae*. (51-10). *Pupa* colored like the apterous female.

Alate viviparous female. Head reddish brown. Antenna (Fig. 43) with spur much longer than basal VI. Prothorax reddish brown, lateral tubercles prominent, Fig. 44 A. Thorax reddish brown. Wings with pale slender veins and light brown stigma. Legs with brownish yellow femora and tibiæ tipped with black, tarsi black. Abdomen reddish brown, cornicles light, dull brownish yellow. Fig. 45 A. Only a slight indication of a median dorsal line toward tip of abdomen. The young progeny of this form have a median grayish dorsal line the whole length of the body. (34-06).

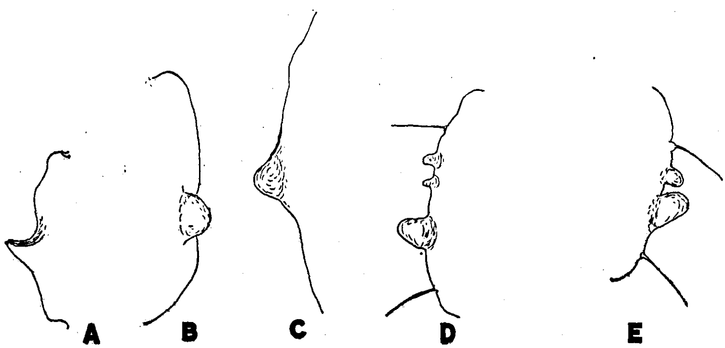


Fig. 44. *Melanoxantherium.* Prothoracic tubercles all drawn to the same scale. A, *bicolor,* apterous viviparous; B, *saliciti,* alate viviparous; C, *smithiae,* alate viviparous; D and E, *salicis,* apterous viviparous.

Collection data:—4-04 (in part). Orono, May 26, 1904. Winged specimens of both this species and *smithiae* were fairly abundant resting on the upper side of cultivated currant leaves.

They had probably merely alighted there as a resting place as no nymphs were present. The currants were not adjacent to willows, though willows were not far distant.

34-06, Veazie, June 19, 1906. Winged form on *Populus balsamifera.*

51-10, Veazie, July 7, 1910. Balsam Poplar. Apterous and alate females and pupæ.

Melanoxantherium salicti Harris. A species which I have taken for *salicti* was collected in Maine on willow in 1906. Head slaty black, not glistening, antenna black except at base. III with about 22 sensoria irregularly placed (Fig. 43, B.). Eyes black. Prothorax black, lateral tubercles present. Fig. 44, B. Thorax black with scutel lobe brownish, wings hyaline with pale brown veins and stigma the color of veins, legs with femora bright yellow, tibiae yellowish with dark distal tip, tarsi black. Abdomen black with bright yellow cornicles which are shaped much as in the foregoing species. (Fig. 45 B).

Predominating color slate-black with orange yellow legs and cornicles. There is the faintest suggestion of a light mid-dorsal line. (25-06). Orono, June 16, 1906. Willow twig.

Nymphs (half grown progeny of foregoing). Predominating color dark reddish brown with conspicuous median dorsal line of grayish white extending from front of head to cauda. Ventral surface slightly powdery gray. Antenna light, clear, with distal end dark. Legs with femora light clear, slightly yellowish, tibiæ dusky, and tarsi black. Cornicles yellow. 26-06. Orono, June 16, 1906. Willow twig.

Melanoxantherium smithiae Monell. A dusky reddish species with hyaline wings, and pale pulverulent longitudinal median line on abdomen, cornicles orange, shorter and more bulging than in the three species preceding, accords with named specimens of *smithiae* kindly given me by Mr. Monell. Figs. 43 C, 44 C and 45C, D. On *Populus,* migrating to *Salix* early in June.

Collection data for this species are as follows:

4-04 (in part). Mixed collection of *bicolor* and *smithiae.* Winged forms resting on cultivated currant (probably alighted there temporarily only). Twelve taken in one hour. No progeny present. May 26, 1904. Orono.

15-04. Winged females. Willow. May 26, 1904, Orono.

66-04 and 67-04. Heavy infestation of winged and apterous females on willow in front of Experiment Station Building Sept. 9, 1904. This species proved such an annoyance to people using the building that the willows were removed.

6-07. Specimens received from Caribou, Maine, June 17, 1907, with the complaint that "they cover a limb and suck the bark until it is dead and peels off." On Carolina Poplars and Aspen trees.

64-10. Apterous viviparous females and nymphs on *Salix*, near Campus Greenhouse, new growth twig, Orono, July 18-25, 1910.

95-10. Apterous viviparous females and nymphs numerous along *Salix* stem. Orono, Aug. 18, 1910.

126-10. Winged and apterous viviparous females numerous on same willows from which 64-10 were collected. Sept. 15, 1910.

26-13. Orono *Populus*. June 2, 1913. Pupæ, and migrants ready for flight.

35-13. Orono, June 5, 1913. *Salix*. Migrants occurring singly with young.

Melanoxantherium antennatum n. sp. This remarkable species I have not met since 1908, and only the apterous oviparous females were seen at that time. However, this form is so distinctive it seems unnecessary to wait longer for the winged forms before presenting a brief description.

The apterous oviparous female has a blackish head with black eyes; antenna blackish and with but 4 joints, III with single terminal circular sensorium; (Fig. 43 D) prothorax greenish brown; tubercle lacking or inconspicuous; entire leg black; abdomen hirsute; incrassate clavate cornicles black upon a yellow spot; (Fig. 45 E) dorsal surface of body with a general dark greenish brown coat or blackish; ventral surface greenish yellow. Ventro-lateral margin of abdomen with the appearance of a longitudinal roll.

103-08. Apterous oviparous females and eggs received from E. No. Yarmouth, Maine, Oct. 31, 1908, with the statement "we find a great many of these insects on and in a pump which stands beneath an old willow."

104-08. Apterous oviparous females received from Cherryfield, Maine, Nov. 4, 1908.

Melanoxantherium salicis Linn. This black bodied aphid with conspicuous white spots, brilliant cornicles and heavily veined wings is a striking contrast to the allied but more subdued species of this genus.

Alate viviparous female. Head blackish; antenna (Fig. 43 E) with I, II, III brown, others blackish, III with about 14 sensoria in irregular row, base and spur of VI subequal; eyes black; prothorax blackish with prominent lateral tubercle; thorax with lobes all uniform black; wings with very heavy black veins, anal vein heaviest; legs with femora and tibiæ brown with points dark, tarsi black; abdomen greenish or brownish black with white median line composed of dots and with 4 white spots cephalad the cornicles in a row bordered by smaller ones and a large white spot at base caudad of cornicle; cornicles brilliant orange, long large bulging and with very little flare at opening, about as in the apterous form.

The young progeny of the alate viviparous females are dull greenish with bright orange cornicles and white markings arranged as in the parent.

Apterous viviparous female. The antenna (Fig. 43 F) with sensoria on III, but fewer than in the alate form. The cornicles are bright orange, long, large, bulging, constricted at tip with a very slight flare. (Fig. 45 F). The lateral tubercles of prothorax and abdomen are very large and conspicuous. In Maine collections the number and arrangement of those on the prothorax seem subject to variation. There is always one large prominent one but one or two others may be present. (Fig. 44 D and 44 E).

Collection data: 49-06. June 28, 1906. Alate viviparous females and nymphs on *Salix* along branches more than 1-4 inch in diameter.

8-08, Orono, June 16, 1908, on trunks and branches of *Salix* in gregarious colonies.

12-10. May 16, 1910. Gregarious along stem of *Salix*, Orono. Apterous viviparous females just mature not yet with progeny. Body black, cornicles bright orange.

16-10. May 18, 1910. Nymphs. First instar with 4-jointed antennæ and beak reaching beyond tip of abdomen. Second instar with 4-jointed antenna and beak extending beyond 3rd coxa. Third instar with 5-jointed antenna. June 6, winged forms rapidly developing from colonies near base of main willow trunk.

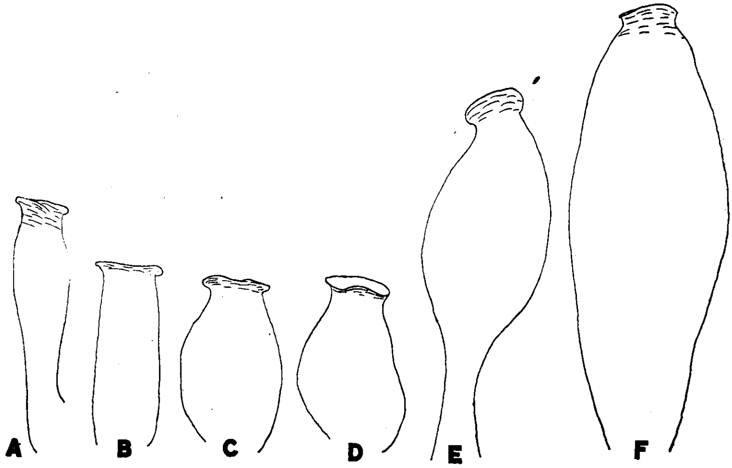


Fig. 45. *Melanoxantherium* cornicles all drawn to the same scale. A, *bicolor,* alate viviparous; B, *salicti,* alate viviparous; C and D, *smithiae,* alate and apterous viviparous; E, *antennatum* apterous oviparous; F, *salicis* apterous viviparous.

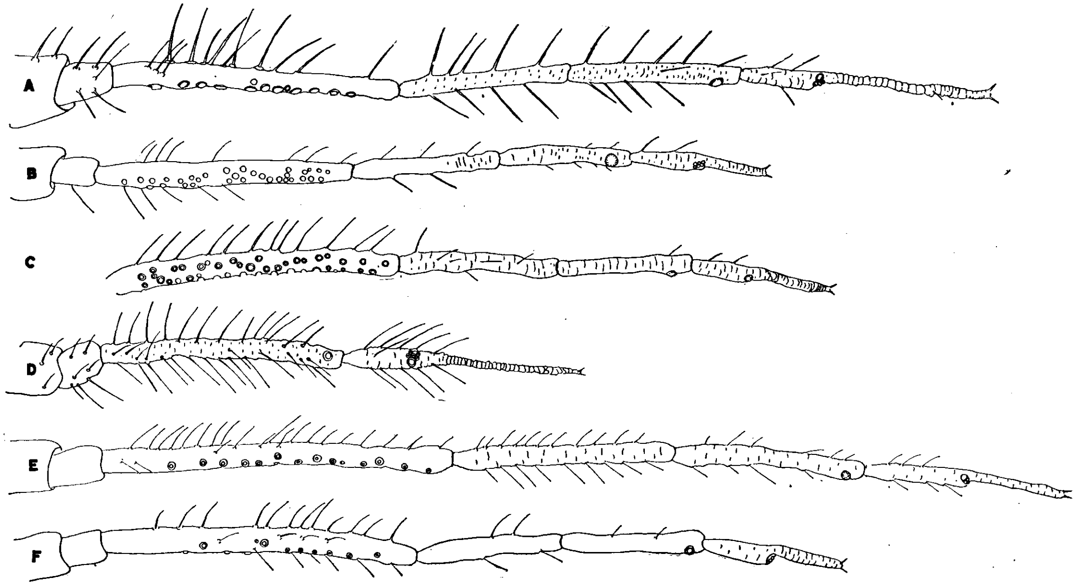


Fig. 43. Antennæ of *Melanoxantherium,* all drawn to the same scale. A, *bicolor,* alate viviparous; B, *salicti,* alate viviparous; C, *smithiae,* alate viviparous; D, *antennatum,* apterous oviparous; E, *salicis,* alate. viviparous; F. *salicis.* apterous viviparous.

APHID CONTROL.

Shade or ornamental trees can be protected frequently from serious aphid attacks by keeping watch from year to year. This is especially desirable while trees are young. Later it is more difficult, but the damage is not usually as serious on large well established trees.

From small or isolated trees the galls of gall forming species can sometimes be collected by hand before the aphides leave them. thus lessening the trouble in that vicinity for another year.

Species inhabiting the trunk of large branches can be destroyed in great numbers by using a brush dipped in any of the spray solutions ordinarily used for aphides.

Tips of branches bearing leaves which have been curled by aphides can be dipped into a tobacco decoction long enough for the solution to penetrate. Such a method as this is of course only applicable for a few treasured plants or small trees.

In recent years tobacco extracts have rapidly taken the place of other sprays for aphides, and well informed apple growers are using them almost to the exclusion of other insecticides. It should be remembered that this is a contact insecticide and kills only the insects actually touched. It is, therefore, necessary to be very thorough in the spraying

Formula—Tobacco Decoction.

Tobacco stems or tobacco dust................	2 pounds.
Water	4 gallons.

Put the tobacco in the water, enough to cover, which may be either cold or hot. Place over the fire and when the water has reached the boiling point, remove some of the fire and allow the water to simply *simmer* for fully one hour, when the liquid is ready to be drained off, diluted to the above proportions and applied. Boiling violently drives off the nicotine.

If whole-leaf tobacco is used, prepare as above, using one pound of tobacco to each four gallons of water.

No lime or other alkaline substance should be added to the tobacco *while cooking.* Apply at once or within a few days after making, if possible.

Certain reliable extracts such as *"Black Leaf," "Black Leaf 40,"* and *"Nikoteen"* are on the market and can be secured through local druggists. The Black Leaf preparations are manufactured by *The Kentucky Tobacco Product Company,* Louisville, Ky., and are carried by the Collins Hardware Company, 97 Friend St., Boston, Mass. *Nikoteen* is manufactured by The Nicotine Manufacturing Company, St. Louis, Mo., and can be secured from Joseph Brick & Sons, 47-54 N. Market St., Boston, Mass.

Directions for use come with the products. There is nothing to do in the preparation of these extracts except to stir the contents of the can before pouring out any quantity for dilution. In most cases one gallon of the *Black Leaf* will be found sufficient for each seventy gallons of water. But if in the treatment of any louse this does not seem sufficient it may be used in 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.

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.

FOOD PLANT CATALOGUE OF THE APHIDAE OF THE WORLD.

PART II.*

EDITH M. PATCH.

SALICACEAE. WILLOW FAMILY.

POPULUS. Poplar. Aspen.

P. alba L. (canescens). White Poplar, Silver-leaved Poplar.
Chaitophorus populi (Linn.) Pass. (Myzaegirus Amyot), (Arctaphis populi Walker). Buckton, 2, p. 142.
Cladobius populae Kalt. (Aphis) Macchiati, 1883, p. 260.
Guercioja populi Del Guercio. Mordwilko, 1908, p. 361 (9).
Lachnus longirostris Fab? Passerini, 1860, p. 38.
Lachnus longirostris Fab. Kaltenbach, 1874, p. 92.
Lachnus longirostris Pass. Kaltenbach, 1874, p. 562.
Pachypappa vesicalis Koch. Cholodkovsky, 1901, p. 293.
Schizoneura tremulae DeGeer. Kaltenbach, 1874, p. 561.

P. angustifolia James (laevigata).
Chaitophorus populicola Thomas. Hunter, 1901, p. 88.
Pemphigus populi-monilis Riley. Cowen, 1895, p. 116.

P. balsamifera L. Balsam Poplar, Tacamahac (1911).
Aphis populifoliae Davis, 1910. Patch, 1913, Bul. 213, p. 82.
Chaitophorus populicola Thomas. Patch, 1913, Bul. 213, p. 78.
Melanoxantherium bicolor Oestlund. Patch, 1913, Bul. 213, p. 85.
Pemphigus balsamiferae Williams. Williams, 1910 (1911), p. 8.
Pemphigus gravicornis Patch. Patch, 1913, Bul. 213, p. 75.
Pemphigus popularius Fitch. Jackson, 1908, p. 191.
Pemphigus populicaulis Fitch. Jackson, 1908, p. 193.
Pemphigus populiconduplifolius Cowen. Gillette, 1909a, p. 355. Patch, 1913, Bul. 213, p. 76.
Pemphigus populiglobuli Fitch. Jackson, 1908, p. 197.
Pemphigus populimonilis Riley. Essig, 1912, p. 707. Patch, 1913, Bul. 213, p. 73.
Pemphigus populiramulorum Riley. Jackson, 1908, p. 209.
Pemphigus populitransversus Riley. Jackson, 1908, p. 207.
Pemphigus populivenae Fitch. Jackson, 1908, p. 195.
Stagona vesicalis Rudow. Rudow, 1875, p. 249.

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* Papers from the Maine Agricultural Experiment Station: Entomology No. 66. For Part I see Bulletin 202.

P. berolinensis.

Pemphigus bursarius L. (lactucarius Pass) (pyriformis Licht.) Tullgren, 1909, p. 122.

P. canadensis.

Pemphigus filaginis Boyer. (gnaphalii Kalt) (prociphilus gnaphalii Koch) (Pachypappa marsupialis Koch) (ovato-oblongus Kessler). Tullgren, 1909, p. 136.

P. candicans Ait. Balm-of-Gilead.

Aphis candicans Fitch. Monell, 1879, p. 26.

Chaitophorus candicans Thomas. Hunter, 1901, p. 87.

Melanoxanthus salicis Linn. Cowen, 1895, p. 117.

P. deltoides Marsh. (monilifera) (angulata) Cotton-wood, Necklace Poplar.

Arctaphis sp. Cooley, 1912, p. 89. "New Aphis of Cottonwoods."

Chaitophorus populicola Thomas. 1879, p. 104.

Chaitophorus populifolia Fitch (stevensis Sanborn). Sanborn, 1904, p. 36 and 1906, p. 225.

Chaitophorus populifoliae (Fitch). Hunter, 1901, p. 88.

Melanoxantherium salicti Harris. Weed, 1891, p. 290.

Pemphigus betae Doane. Gillette, 1912, (24th Rept. Exp. Sta.) p. 28. "On Cottonwood."

Pemphigus bursarius Linn? Patch, 1913, Bul. 213, p. 78.

Pemphigus oestlundi Cockerell, 1906, p. 34.

Pemphigus populicaulis Fitch. Sanborn, 1904, p. 20.

Pemphigus populicaulis Fitch. Jackson, 1908, p. 193.

Pemphigus populiconduplifolius Cowen. Jackson, 1908, p. 217.

Pemphigus populitransversus Riley. Sanborn, 1904, p. 22.

Pemphigus populitransversus Riley. Jackson, 1908, p. 207.

Pemphigus pseudobyrsa Walsh. Jackson, 1908, p. 199.

Phylloxera popularia Pergande. Pergande, 1904b, p. 266. (In galls of Pemphigus transversus Riley).

Phylloxera prolifera Oestlund. Oestlund, 1887, p. 17. (In galls of Pemphigus populicaulis Fitch).

P. Fremonti S. Wats.

Chaitophorus populicola Thomas. Williams, 1891, p. 9.

Melanoxanthus salicti (Harris). Williams, 1891, p. 9.

Mordwilkoja oestlundi (Cockerell) (Pemphigus vagabundus Walsh) Davis, 1911, p. 4.

Pemphigus populicaulis Fitch. Williams, 1891, p. 9.

Pemphigus populimonilis Riley. Davidson, 1910, p. 374.

Pemphigus populiramulorum Riley. Jackson, 1908, p. 209.

Pemphigus populitransversus Riley. Williams, 1891, p. 9.

Pemphigus pseudobyrsa (Walsh). Williams, 1891, p. 9.

Phylloxera prolifera Oestlund. Williams, 1891, p. 9.

Thomasia populifoliae (Fitch). Essig, 1912a, p. 716.

P. grandidentata Michx. Large-toothed Aspen.

Aphis populifoliae Fitch. Thomas, 1879, p. 102.

Aphis (*Dactynus*) *populus-grandidentata* Raf. Rafinesque, 1818.

Chaitophorus populi (Linn). Hunter, 1901, p. 88.
Chaitophorus populifoliae (Fitch) "= C. populi (Linn.)?" Oestlund, 1887, p. 39.

P. nigra L. Black Poplar.
Anuraphis populi Del Guercio. Del Guercio, 1909 (1910). Redia VII, p. 298.
Aphis populi L. Kaltenbach, 1874, p. 561.
Chaitophorus leucomelas Koch. Passerini, 1863, p. 58.
Chaitophorus leucomelas Koch., Pass. Buckton, 2, p. 135.
Chaitophorus lyratus Ferrari. Del Guercio, 1900, p. 119.
Chaitophorus nassonowi Mordwilko. Mordwilko, 1899, p. 410.
Chaitophorus populi (Linn) Pass. (Myzaegirus Amyot) (Arctaphis populi Walker). Buckton, 2, p. 142.
Chaitophorus versicolor Koch (Aphis populi var. Kalt) Ferrari, 1872, p. 76.
Lachnus viminalis Boyer. (Aphis). Ferrari, 1872, p. 80.
Pemphigus affinis Kalt. (Thecabius populneus Koch). Passerini, 1863, p. 74.
Pemphigus bursarius (L.) Kalt. Kaltenbach, 1874, p. 561.
Pemphigus bursarius Hartig. (Eriosoma populi Mosley) (Aphioides bursaria Rondani). Buckton, 3, p. 118.
Pemphigus filaginis Boyer (gnaphalii Kalt.) (Prociphilus gnaphalii Koch) (Pachypappa marsupialis Koch). (ovato-oblongus Kessler). Tullgren, 1909, p. 136.
Pemphigus spirothecae Koch (affinis Koch) (Puceron de peuplier Reaumur). Buckton, 3, p. 122.
Pemphigus spyrothecae Pass. Passerini, 1860, p. 39.
Pemphigus tortuosus Rudow. Rudow, 1875, p. 248.
Pemphigus vesicarius Pass. Passerini, 1863, p. 76.
Stomaphis bobretzkyi Mordwilko. Mordwilko, 1899, p. 411.
Stomaphis longirostris (Fab.). Del Guercio, 1907 (1908) Redia V, p. 344.
Thecabius populneus Koch. Koch, p. 295.
Thecabius populneus Koch. Kaltenbach, 1874, p. 562.

P. pyramidalis Salisb. (italica Duroi) (dilatata), Lombardy Poplar.
Chaitophorus leucomelas Koch. Kessler, 1882, p. 37.
Chaitophorus nassonowi Mordwilko. Mordwilko, 1899, p. 410.
Chaitophorus populeus (Kalt.) (Lachnus punctatus Burm?) (Cladobius populeus Koch). Buckton, 2, p. 137.
Chaitophorus populi (Linn). Pass. (Myzaegirus Amyot) (Arctaphis populi Walker). Buckton, 2, p. 142.
Cladobius populea Kalt. (Aphis.) Ferrari, 1872, p. 76.
Drepanosiphum smaragdinum Koch. Koch, p. 205.
Drepanosiphum (Aphis) tiliae Koch. Kaltenbach, 1874, p. 561.
Pemphigus affinis Kalt. Kaltenbach, 1874, p. 561.
Pemphigus bursarius Linn. Reaum (Aphis). Ferrari, 1872, p. 83.
Pemphigus bursarius Hartig (Eriosoma populi Mosley) (Aphioides bursaria Rondani). Buckton, 3, p. 118.

Pemphigus filaginis Boy de Fonsc. (gnaphalii Kalt.) (Prociphilus gnaphalii Koch.) (Pachypappa marsupialis Koch) (ovato-oblongus Kessler). Tullgren, 1909, p. 136.
Pemphigus glandiformis Rudow. Rudow, 1875, p. 247.
Pemphigus populicaulis Fitch. Jackson, 1908, p. 193.
Pemphigus protospirae Licht. Tullgren, 1909, p. 155.
Pemphigus spirothecae Pass. (affinis Koch). Tullgren, 1909, p. 161.

P. tremula L.

Aphis populi tremulae Ascanius. Hagen, p. 449.
Asiphum populi (Fab.) Koch. Koch, p. 246.
Asiphum tremulae DG. Tullgren, 1909, p. 66.
Chaitophorus populi (Linn.) Pass. (Myzaegirus Amyot) (Arctaphis populi Walker). Buckton, 2, p. 142.
Chaitophorus populi (Linn.) (Ch. tremulae Koch). Koch, p. 9.
Chaitophorus versicolor Koch. Passerini Flora.
Pachypappa lactea Tull. Tullgren, 1909, p. 72.

P. tremuloides Michx. (trepida). American aspen.

Aphis populifoliae Davis, 1910. Patch, 1913, Bul. 213, p. 82.
Aphis (Dactynus) populus-trepida Raf. Rafinesque, 1818.
Chaitophorus bruneri Williams. Williams, 1910, (1911), p. 26.
Chaitophorus delicata Patch. Patch, 1913, Bul. 213, p. 80.
Chaitophorus populicola Thomas. Gillette, 1909a, p. 388. Patch, 1913, Bul. 213, p. 78.
Cladobius beulahensis Cockerell. Cockerell, 1904, p. 263.
Pemphigus populicaulis Fitch. Hunter, 1901, p. 78.
Pemphigus? rileyi Stebbins. Stebbins, 1910, p. 9.

P. trichocarpa Torr. & Gray.

Chaitophorus populicola Thos. (?). Essig, 1909, p. 98.
Chaitophorus salicicola Essig. Essig, 1911b, p. 534.
Eichochaitophorus populifolii Essig. Essig, 1912a, p. 715.
Pemphigus populicaulis Fitch. Essig, 1912a, p. 712.
Pemphigus populimonilis Riley. Gillette, 1909a, p. 356.
Pemphigus populitransversus Riley. Davidson, 1910, p. 372.

P. sp.

Aphis populi-albae Boyer. Lichtenstein, La Flore.
Byrsocrypta vagabunda Walsh. Walsh, 1862, p. 306. (migrants "on various forest trees").
Chaitophorus albus Mordwilko. Mordwilko, 1899 (1901), p. 410.
Chaitophorus populifoliae Fitch. Davidson, 1910, p. 375.
Cladobius longirostris Mordwilko. Mordwilko, 1899, (1901), p. 414.
Cladobius rufulus Davidson. Davidson, 1910, p. 375.
Lachnus longistigma Monell. Sanborn, 1904, p. 31.
Pemphigus borealis Tullgren. Tullgren, 1909, p. 146.
Pemphigus immunis Buckton. Buckton, 1896, p. 51.
Pemphigus infaustus Ferrari. Lichtenstein, 1885 ("var. de P. spirothecae Pass.").

Pemphigus lichtensteini Tull. Tullgren 1909, p. 151.
Pemphigus napaeus Buckton. Buckton, 1896, p. 50.
Pemphigus oestlundi Cockerell. (P. vagabundus (Walsh) of authors). Oestlund, 1887, p. 22. Cockerell, 1906, p. 34.
Pemphigus populi Courchet. Courchet, 1881, p. 46.
Pemphigus populicaulis Fitch (betae Doane?). Clarke, 1903, p. 248.
Pemphigus spiriformis Licht. Zoölogical Record, 1886, p. 319 (misprint for pyriformis).
Pemphigus tortuosus Rudow. Lichtenstein, La Flore.
Pemphigus varsoviensis Mordwilko. Mordwilko, 1899, p. 411.
Schizoneura passerinii Signoret. Lichtenstein, La Flore.
Schizoneura populi Gillette. Gillette, 1901, p. 1.
Thecabius (*Pemphigus*) *affinis* Kalt. (ranunculi Kalt.). Tullgren, 1909, p. 110.

SALIX. Willow.

S. acuminata.

Lachnus viminalis (Boyer) Pass. (salicis Shaw?) (salicis Curtis?) (saligna Walker). Buckton, 3, p. 57.

S. alba L. (vitellina) White Willow.

Aphis populea Kalt. (Lachnus punctatus Burmeister). Kaltenbach, 1843, p. 117.
Aphis populea Kalt. Kaltenbach, 1874, p. 561.
Aphis salicis Linn. Kaltenbach, 1874, p. 586.
Chaitophorus saliceti Schrank (Aphis). Macchiati, 1883, p. 261.
Chaitophorus salicti Schrank (Aphis). Ferrari, 1872, p. 77.
Chaitophorus smitheae Monell. Monell, 1879, p. 32.
Chaitophorus viminalis Monell (?). Weed, 1888, p. 133.
Chaitophorus vitellinae Schrank (Aphis). Ferrari, 1872, p. 76.
Cladobius populae Kalt (Aphis). Macchiati, 1883, p. 260.
Cladobius steinheili Mordwilko. Mordwilko, 1899, p. 350. (? on Salix alba).
Lachnus longirostris Fab? (Aphis). Ferrari, 1872, p. 81.
Lachnus longirostris Fab. Kaltenbach, 1874, p. 92.
Lachnus longirostris Pass. Kaltenbach, 1874, p. 562.
Lachnus viminalis Boyer. Kaltenbach, 1874, p. 585. Del Guercio, 1907 (1908). Redia V, p. 345.
Melanoxanthus salicis (Linn.). Williams, 1891, p. 27.
Melanoxanthus smithiae Monell. Williams, 1891. p. 27.
Myzus ribis Linn. et auct (Aphis). Ferrari, 1872, p. 62.
Siphocoryne capreae (Fab.) Pass. (pastinacae L.) (A. aegopodii Scop) (R. capreae Koch) (R. cicutae Koch) (A umbellatarum Koch). Passerini, 1863. p. 52.
Stomaphis longirostris (Fab.) (Aphis Fab.) (Phylloxera Boyer) (Lachnus Passerini) Del Guercio, 1907 (1908) Redia V, pp. 259, 344.

S. amygdaloides Anders. Peach-leaved Willow.
Aphis salicicola (Thomas). Cowen, 1895, p. 121.

S. babylonica L. (annularis) Weeping Willow.
Aphis capreae Fab. (A. aegopodii Scop.). Kaltenbach, 1843, p. 109.
Aphis saliceti Kalt. Passerini, 1863, p. 37.
Aphis vitellinae Schrank. Kaltenbach, 1874, p. 585.
Chaitophorus viminalis Monell (?). Weed, 1888, p. 133.
Rhopalosiphum salicis Monell. Monell, 1879, p. 27.

S. laevigata Bebb.
Chaitophorus salicicola Essig. Essig, 1911b, p. 534.
Fullawaya saliciradicis Essig. Essig, 1912a, p. 716.
Macrosiphum laevigatae Essig. Essig, 1911b, p. 549.
Micrella monelli Essig. Essig, 1912a, p. 715.
Symdobius salicicorticis Essig. Essig, 1912a, p. 715.

S. lapponum L.
Chaetophorus salicivorus Passerini. Schouteden, 1906a, p. 213.

S. lasiolepis Benth.
Micrella monelli Essig. Essig, 1912a, p. 715.

S. longifolia M. (interior) Sand Bar Willow.
Chaitophorus nigrae Oestlund. Cowen, 1895, p. 117.
Melanoxanthus salicis (Linn.). Williams, 1891, p. 27.

S. lucida Muhl. Shining Willow.
Chaitophorus viminalis Monell (?). Weed, 1888, p. 133.
Melanoxanthus salicis (Linn.). Williams, 1891, p. 27.
Siphocoryne (*Rhopalosiphum*) *salicis* (Monell). Oestlund, 1887, p. 70.

S. macrostachya Nutt.
Symdobius macrostachyae Essig. Essig, 1912a, p. 715.
Thomasia crucis Essig. Essig, 1912a, p. 716.

S. nigra Marsh. Black Willow.
Chaitophorus nigrae Oestlund. Oestlund, 1887, p. 40.
Rhopalosiphum salicis Monell. Monell, 1879, p. 27.

S. nigricans Sm.
Chaitophorus capreae Koch. Buckton, 2, p. 136.
Chaitophorus salicti (Schrank) Pass. Passerini, 1863, p. 60.
Cladobius populea (Kalt.) Koch. Passerini, 1863, p. 56.

S. purpurea L. Purple Willow.
Chaitophorus salicivora Walker? Passerini, 1860, p. 37.
Chaitophorus salicivora Pass. (salicivora Walker?) Passerini, 1863, p. 58.
Lachnus viminalis Boyer. Kaltenbach, 1874, p. 585.

S. repens L.
Chaitophorus hypogeus Del Guercio. Schouteden, 1906, p. 213.

S. caprea L.
Aphis alterna Walker. Walker, 1849c, p. 43.
Aphis capreae Fab. (A. aegopodii Scop.) Kaltenbach, 1843, p. 109.

Aphis populea Kalt. (Lachnus punctatus Burmeister). Kaltenbach, 1843, p. 117.
Aphis saliceti Kalt. Buckton, 2, p. 53.
Aphis salicis Linn. Kaltenbach, 1874, p. 586.
Aphis secunda Walker. Walker, 1849c, p. 44.
Chaitophorus capreae Koch. Buckton, 2, p. 137.
Chaitophorus salicivorus (Walker) Pass. Buckton, 2, p. 135.
Lachnus viminalis Boyer. Kaltenbach, 1874, p. 585. Del Guercio 1907 (1908) Redia V, p. 345.

S. cinerea L.
Aphis saliceti Kalt. Del Guercio, 1909 (1910) Redia VII, p. 297.
Chaetophorus salicivorus Passerini. Schouteden, 1906a, p. 213.
Chaetophorus salicti Schrank. Schouteden, 1906a, p. 213.
Lachnus viminalis (Boyer) (Aphis saligna Sulzer, Walker, p. 959). (A. salicina Zett.). (A. salicis Curtis) (Lachnus dentatus Le Baron) Del Guercio, 1907 (1908) Redia V, p. 345.
Melanoxantherium sp. Schouteden, 1906a, p. 215.

S. cordata Muhl.
Chaitophorus cordatae Williams. Williams, 1910 (1911), p. 27.
Chaitophorus viminalis Monell. Williams, 1910 (1911), p. 30.

S. daphnoides Vill.
Lachnus viminalis (Boyer) Pass. (salicis Shaw?) (salicis Curtis?) (saligna Walker). Buckton, 3, p. 57.

S. discolor Muhl. Glaucous Willow.
Aphis (*Siphonophora*) *salicicola* (Thomas) Monell. Oestlund, 1887, p. 63.

S. fragilis L. (Russelliana). Crack Willow.
Aphis vitellinae Schrank. Kaltenbach, 1874, p. 585.
Lachnus viminalis Boyer. Kaltenbach, 1874, p. 585.

S. glaucophylla.
Chaitophorus n. sp. Sanborn. Sanborn, 1904, p. 34.

S. speciosa.
Aphis spectabilis Ferrari. Ferrari, 1872, p. 64.

S. triandra L.
Aphis vitellinae Schrank. Kaltenbach, 1874, p. 585.

S. viminalis L. Osier.
Aphis saliceti Kalt. Ferrari, 1872, p. 64. Del Guercio, Redia VIII, p. 297.
Aphis salicti Kalt. Theobald, 1911-12.
Cladobius populea (Kalt.) Koch. Passerini, 1863, p. 56.
Lachnus longirostris Fab.? (Aphis). Ferrari, 1872, p. 81.
Lachnus viminalis (Boyer) Pass. (A. saligna Walker?). Passerini, 1869, p. 64. (dentatus Le Baron) Del Guercio, 1907 (1908), Redia V, pp. 281, 345.
Melanoxanthus salicis (Linn.). Buckton, 2, p. 23.

S. vitellina L.
Aphis populea Kalt. Kaltenbach, 1874, p. 561.
Cladobius populea (Kalt.) Koch. Passerini, 1863, p. 56.

Lachnus longirostris Fab. Kaltenbach, 1874, p. 92.
Lachnus longirostris Pass. Kaltenbach, 1874, p. 562.

S sp.

Aphis amenticola Kalt. Kaltenbach, 1874, p. 586.
Aphis cicutae Koch. (capreae Fab.) Kaltenbach, 1874, p. 585.
Aphis gracilis Walker. Walker, 1852, p. 1040.
Aphis saliceti Kalt. Kaltenbach, 1874, p. 585.
Aphis saliceti Schrank. Kaltenbach, 1874, p. 586.
Aphis salicicola (Thomas) Monell (A. brevifurca Monell MSS) Monell, 1879, p. 24.
Aphis salicicola Thomas. Gillette, 1910, p. 403.
Aphis salicina Zetterstedt. (Chaitophorus?) Tullgren, 1909, p. 6.
Aphis pilosa Haldeman (A. salicis?) Hunter, 1901, p. 102.
Aphis spectabilis Ferrari (? amenticola Kaltenbach). Schouteden, 1906a, p. 228.
Aphis truncata Hausmann. Lichtenstein, La Flore.
Chaitophorus populeus (Kalt.) (Lachnus punctatus Burm?) Buckton, 2, p. 139.
Chaitophorus salicicola Monell. (Lachnus salicicola Uhler?) Thomas, 1879, p. 105.
Chaitophorus salicis Williams. Williams, 1891, p. 27.
Chaitophorus viminalis Monell. Patch, 1913, Bul. 213, p. 80.
Chaitophorus sp. Davidson, 1909, p. 301.
Cladobius rufulus Davidson. Davidson, 1909, p. 300.
Lachnus dentatus Le Baron. Weed, 1890, p. 117.
Lachnus salicellis Fitch (L. salicicola Harris?). Thomas, 1879, p. 119.
Lachnus saligna Walker. Lichtenstein, La Flore.
Lachnus viminalis (Boyer) (L. dentatus Le Baron). Oestlund, 1887, p. 32.
Macrosiphum laevigatae Essig. Patch, 1913, Bul. 213, p. 84.
Melanoxantherium antennatum Patch. Patch, 1913, Bul. 213, p.
Melanoxanthus bicolor Oestlund. Weed, 1891, p. 290.
Melanoxantherium flocculossum (Weed). Gillette, 1909a, p. 385.
Melanoxantherium salicis (Linn.). Gillette, 1909a, p. 387, Patch, 1913, Bul. 213, p. 88.
Melanoxantherium salicti Harris. Patch, 1913, Bul. 213, p. 86.
Melanoxanthus salicis (Linn.). Weed, 1890, p. 115.
Melanoxanthus smithiae (Monell). Gillette, 1909a, p. 387; Patch, 1913, Bul. 213, p. 86.
Myzus achyrantes Monell. Sanborn, 1904, p. 71.
Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 35.
Nectarophora californica Clarke. Clarke, 1903, p. 254.
Phylloxera salicicola Pergande. Pergande, 1904b, p. 269.
Phylloxerina salicis (Licht.) CB. Börner, 1909b, p. 60.
Pterocomma pilosa Buckton. Buckton, 2, p. 144.
Siphocoryne aegopodii Scopoli. Lichtenstein, La Flore.
Siphocoryne salicis Monell. Weed, 1893, p. 297.
Siphonophora salicicola Thomas. Thomas, 1879, p. 193.

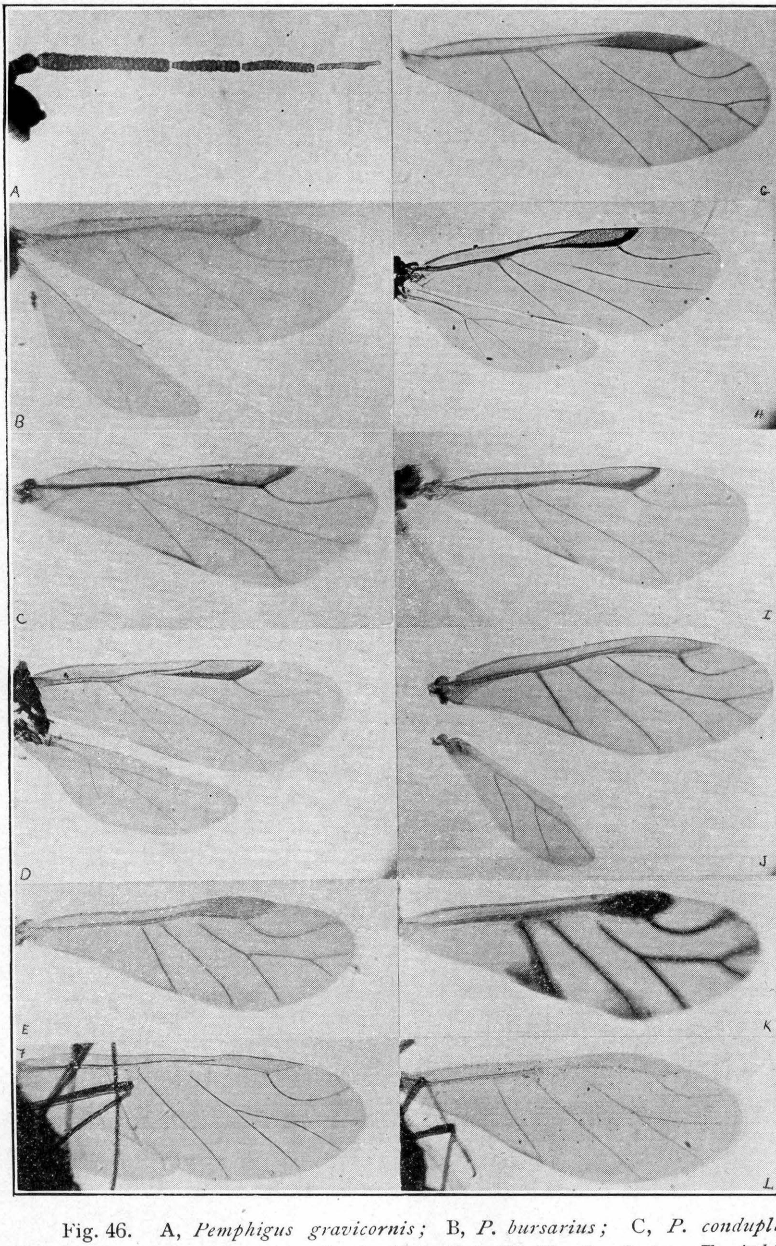


Fig. 46. A, *Pemphigus gravicornis*; B, *P. bursarius*; C, *P. conduplifolius*; D, *P. populimonilis*; E, *C. viminalis?* G, *Mac. laevigatae*; F, *Aphis dorsalis*; H, *P. gravicornis*; I, *P. populicaulis*; J, *Melanoxantherium salicis*; K, *C. populicola*; L, *A. salicicola*.

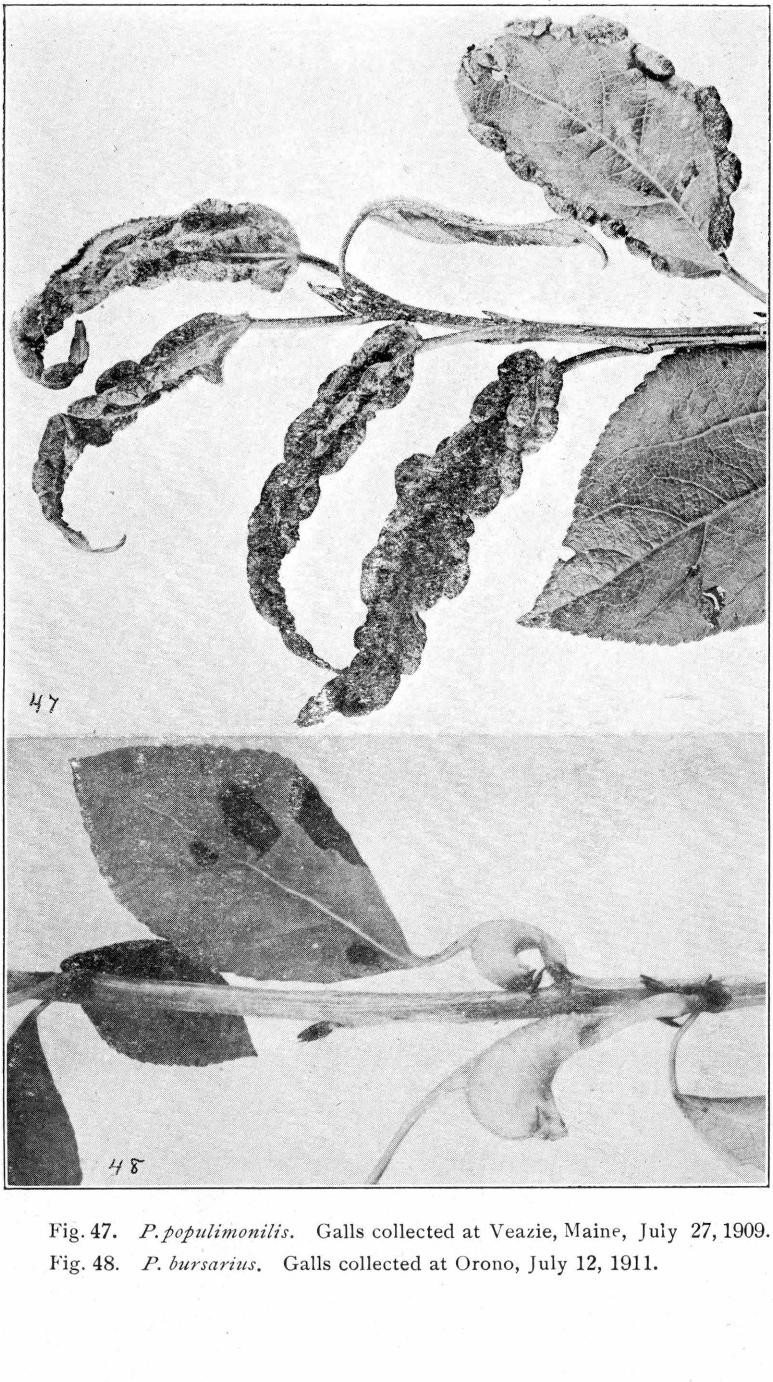
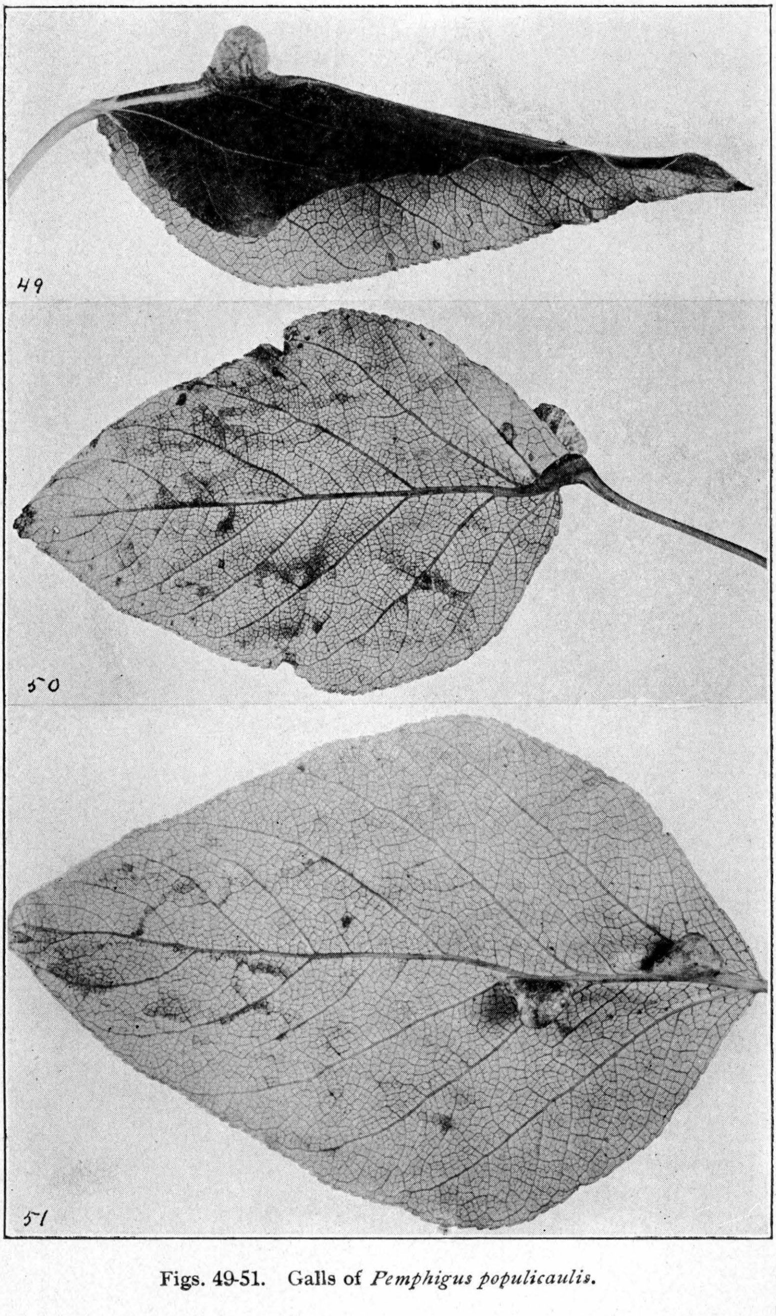


Fig. 47. *P. populimonilis.* Galls collected at Veazie, Maine, July 27, 1909.
Fig. 48. *P. bursarius.* Galls collected at Orono, July 12, 1911.



Figs. 49-51. Galls of *Pemphigus populicaulis.*

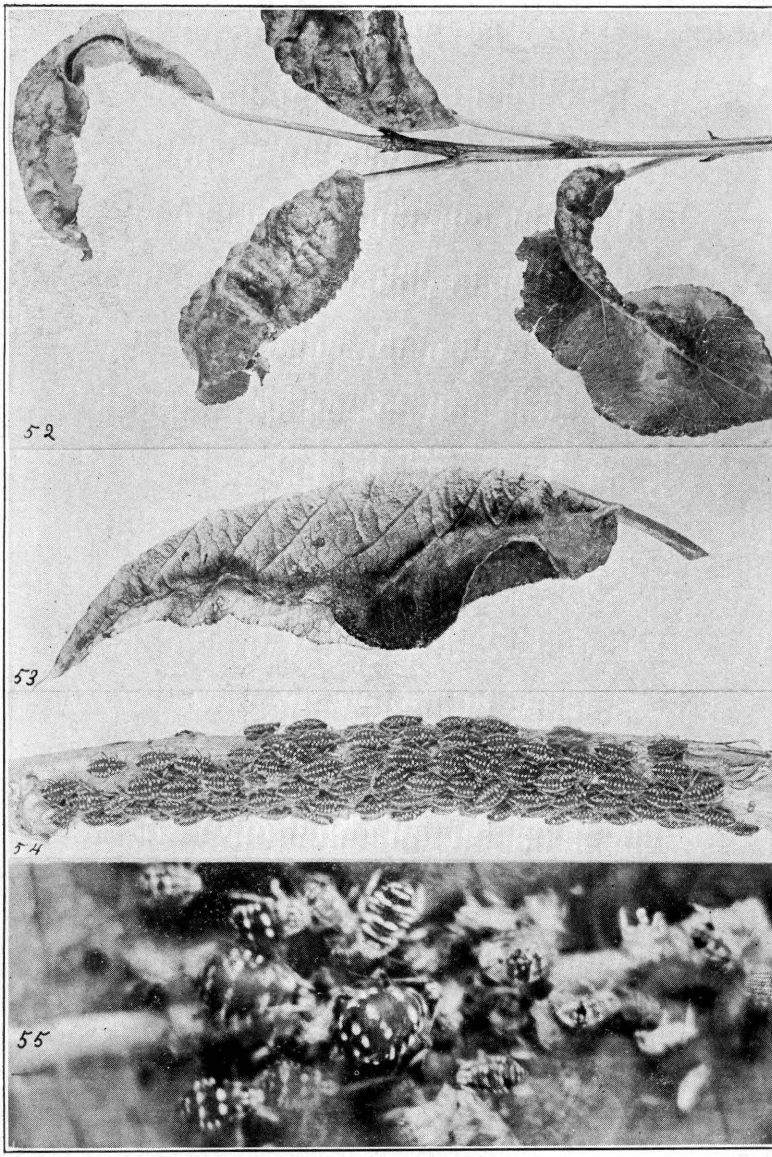


Fig. 52. *P. populiconduplifolius.* Galls collected at Orono, July 15, 1912. Fig. 53. *P. gravicornis.* Galls collected at Orono, July 7, 1911.

Fig. 54. *Melanoxantherium salicis.* Collection made at Orono, May 16, 1910. Fig. 55. *Aphis populifoliae.* Collection made at Veazie, July 18, 1912.

BULLETIN No. 214.

THE BIOLOGY OF POULTRY KEEPING.*

RAYMOND PEARL.

There are certain phases or branches of agriculture which are from their very nature specialized and locally restricted either in space or time. The growing of beef cattle is not adapted to the conditions of the city back-lot not could it be considered sound economic policy for the Saskatchewan wheat grower to set out an orange grove. There is, however, one kind of farming, which in one form or another, knows no limitations of space, and only those limitations of climate which forbid any sort of agriculture whatever. This is poultry keeping. No plot of ground is too small to keep a few hens on, or at least to try to keep them on, and no ranch, however large, is complete without a flock of hens to furnish eggs for the table and perhaps a few over to sell. It may be safely said that there is no phase of agriculture which is so universal and wide spread over the whole world as poultry husbandry. The adaptability of the business is marvellous. Poultry raising may be, and probably has been, successfully combined with every other kind of farming known to man. One farm recently visited would seem to have about reached the limit in the way of oddity of the combination. This was a *fox and poultry farm.* Raising foxes was one part of the business, and raising chickens and turkeys the other part. Needless to say the two lines of endeavor were kept strictly apart.

When combined with other things as an integral part of diversified farming poultry keeping is usually one of the most profitable activities of the farm, and can be made so in every

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* A lecture given at Columbia University on Jan. 31, 1912, in a course of "Lectures on Economic Agriculture."

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case with attention to fundamental principles. If given a chance hens will make money on a farm. Of specialized poultry plants, where the chickens form the main or sole line of endeavor, there are all sizes ranging from the town dweller's one, two or three hens in a box in the back yard, or on the roof, or the fire escape, to the immense poultry ranches or farms where the unit of production is the flock of a thousand birds and there may be many such units. Sad it is but true that not all of these specialty plants are profitable. The back yarder's usually is, but after a certain magnitude of plant and of operation is passed trouble begins and frequently does not end until the available capital is exhausted and the business is brought to an end.

If it is true that some men find poultry keeping profitable while others fail in it, we may well ask what are the *essentials* to success in the business. It would appear that there are three fundamental elements involved in every successful venture in poultry husbandry. These are:

1. Good stock
2. Proper management
3. Good business sense in the conduct of the commercial end, including:
   a. Buying the supplies.
   b. Selling the product.
   c. Economically controlling the labor factor in the business.

Of the third of these categories, namely good business ability, nothing further need be said here. It is something with which the hens have nothing to do. It is not primarily a biological problem as are the other two. Furthermore nearly every normal man feels sure, down deep in his own mind, that while he may not be a financial genius, still after all he possesses a reasonable modicum of business sense, and is quite certainly not keen on being advised as to how to run his business by any itinerant college professor.

Good Stock.

Good stock is in last analysis a question of breeding. Of course it may not be directly such for the man just starting out in the poultry business. He must purchase his stock in one form or another. But somebody must have bred it. There is no way to get stock of high quality except by breeding. Good stock may be very much hurt by bad management, and on the other hand stock which has been run down by improper management may be very much improved by correcting the evils in this direction. But stock which is inherently poor can only be made inherently good by changing its innate constitution. Such a change can only be wrought by careful breeding along definite lines.

In considering the subject of breeding from the practical standpoint it must always be remembered that the rank and file of successful poultrymen are not in any sense of the word *scientific* breeders. They know little or nothing about the science of breeding and are only interested in it, if at all, in what might be called a somewhat academic manner. Indeed it is fair to say that many of those doctrines which the practical poultry breeder usually holds to with the greatest firmness on the supposition that they are "scientific" principles of breeding are things which modern exact scientific studies of heredity have shown to be either quite erroneous or of exceedingly limited applicability. What the successful practical poultry breeder is an expert at, however, is the *art* of breeding. Possibly some who are interested only in the investigation of the laws of inheritance may be inclined to doubt whether really there is any such thing as an art of breeding, distinct from the science of breeding. The contention might possibly be made that what we call the art of breeding is merely a convenient verbal shroud to cover the nakedness of the empiricism in breeding, which in large part can now be reduced to scientific principles and should ultimately be entirely so. This sounds well in theory, but anyone who is disposed to maintain that there is no such thing as an art or craft of breeding, quite apart from the scientific side of the matter, should attempt once to produce, on scientific principles, a winning male in the Barred Rock class in the Madison Square Garden Poultry Show, for example. Let me hasten to say that no doubt this could be done. But when it is done the person accomplishing it will in the meantime have become something more than a student of the science of inheritance. He will have become an expert practical poultry breeder.

Granting that practical success in the breeding of poultry depends upon the knowledge of something more than the laws of inheritance thus far set down in books, it is none the less important to know the fundamental principles or qualifications upon which success in this field depends. There are three primary factors involved in poultry breeding without anyone of which success of the highest type will never come, and with all three of which it is sure to come in time.

THE RECOGNITION OF INDIVIDUALITY.

The first of the factors is what may be characterized as the ability to "*see*" a bird. This is the most fundamental qualification for a breeder to possess and is the most difficult of all to acquire. Some years ago, at a very enthusiastic meeting of men engaged in the teaching of poultry husbandry in the various colleges and schools of agriculture in this country, a whole day's session of the meeting was devoted to the pedagogy of poultry husbandry. With much vigor and at great length such matters were debated as the text work method versus the lecture method in imparting a knowledge of how to grow chickens; whether the higher theory of caponizing should precede or follow the advanced philosophy of broiler production in general; how the recondite subject of "brooding" might be best presented and so on. After the discussion had proceeded along these lines all day the chair finally called upon a distinguished teacher of poultry husbandry, who had not hitherto taken any part, for an expression of his opinion on these weighty matters. In response this gentleman said that, while he had been much interested in the discussion which had gone on, it seemed to him after all very academic. After considerable experience in trying to teach poultry husbandry he had found that about all he could hope to do in four years was "to teach the students to see a chicken." He felt if he succeeded in doing this that his teaching had been successful, as measured by the highest standards. He admitted, however, that he by no means always succeeded. It is worth noting that this gentleman's summing up of the essential purpose of a college course in poultry husbandry agrees precisely in principle with the statement of James that the function of a college in general was to help you "to know a good man when you see him."

It is in regard to just this point of ability to see a bird that lies the chief difference between the expert poultryman and the rank amateur. By "seeing a chicken" is meant, in brief, the recognition of the individuality of that bird. Every human being is able to recognize the individuality in the appearance of other human beings. At a glance we recognize in looking at a number of people the points of difference which distinguish one individual from another. The distinguishing trait may be only some very unimportant feature. Almost certainly it is something which is nearly, if not quite, impossible of accurate description. The case simply is that our eyes are trained to recognize individuality in appearance amongst men. It is just precisely this ability to recognize instantly, easily and fully individual differences amongst fowls which characterizes the expert poultryman.

To him a flock of chickens is not simply an aggregation of living things all very much like one another. It is, on the contrary, a group of *individuals*, each one of which possesses some distinguishing trait which can be found, if one cares to look for it, and which will mark this bird out from its fellows for all time to the "seeing" eye. The minute differences upon which such distinction of individuals depends may be in form, or color, or size, or pattern. Quite as often there will be differences in behavior, expression, or disposition. Such matters as carriage, the method of holding the head and the body, the expression of the eyes, and so on are characteristic of individual fowls as of individual men. Many of the differences which the expert poultryman will readily recognize are quite as difficult of precise description as are the differences which prevent you from confusing your next-door neighbors when you meet them.

Not only does this ability to "see" a bird mean the ability to recognize it as an individual of the flock, but also it means the ability to form a judgment as to its bodily condition and state of health. We are able to recognize at a glance whether a person appears to be in good health, or whether, on the contrary, he is off condition. Relatively small differences of this kind in human beings are easily recognized. It is not necessary that an individual should be moribund before we are able to say that he is not looking well. In the case of poultry, however, it usually has to be a very sick chicken before the amateur will realize that there is anything the matter with it. On the contrary the expert, who is accustomed really to see his fowls as individuals, will recognize as slight changes in well-being among them as he will among his fellow men.

The first great underlying principle then, which biology has to give to animal husbandry of any sort, and particularly to poultry husbandry, is the principle of *individuality*. The living organism, whether it be a hen or a dairy cow, is not primarily a fraction of a flock or a herd, but is before anything else an *individual,* endowed with a whole mass of individual peculiarities of structure, physiology and behavior. Furthermore the ultimate foundation for practical success in the conduct of a poultry business depends not only upon a recognition of this principle of individuality, but an ability to put it into actual operation in the daily work. No one can ever be a successful practical poultryman until he acquires, in some degree, the ability to see his fowls as individuals, in the same sense that he sees his fellow men as individuals. Other things being equal the greater his powers of discrimination in this particular, the greater will be his practical success in the business.

Constitutional Vigor.

Having acquired the ability to see the individual birds as individuals, the next step is to learn to distinguish a good bird from a poor one. Here it is ever to be kept in mind that the primary and most essential characteristic of a good bird must always be a sound constitution and plenty of vitality and vigor. Without these qualities it is impossible to have first class stock. Constitutional vigor and vitality may be put as the second fundamental requisite in the successful practical breeding of poultry. In all kinds of breeding operations whether for utility purposes, or for the fancier's show pen, or for the purpose of experimentation in the field of heredity, the first selection of birds for the breeding pen should be made on the basis of their general constitutional vigor. No bird which shows signs of weakness in this fundamental regard should ever be used as a breeder under any circumstances. If such a bird is used the breeder will eventually have to pay the penalty.

The external, visible evidences of a sound constitution and a possession of abundant vitality and vigor are numerous. In the first place the bird of sound constitution will be in perfect health. Perhaps its most striking characteristic will be an independence of disposition and demeanor. By this is not necessarily meant aggressiveness. The bird, whether male or female, which is forever picking quarrels with its fellows is by no means always the bird of greatest vigor. Strange as it may seem a bird may indeed be very far from a mollycoddle and yet have a peaceable disposition. It may be taken as an unfailing characteristic of birds of high constitutional vigor, however, that they are able to take care of themselves and may not be imposed upon, or bullied by their fellows, with impunity. While they may not pick a quarrel, they are abundantly able to make a forceful presentation of the merits of their end of any debate which another bird may choose to enter upon with them. In other words they have, as has been said, an independence of disposition; an ability, reaching to the limits of gallinaceous capacity, to meet all situations which may arise in the day's work of a fowl, whether food getting, fighting, rearing young, or what not.

The bird of high constitutional vigor will have a thrifty appearance with a bright eye, and clean, well kept plumage. The head will be broad and relatively short, giving in its appearance plain indication of strength. It will show nothing of the long-drawn-out, sickly, crow-like appearance of the head which is all too common amongst the inhabitants of the average poultry yard. The beak will be relatively short and strong, thus correlating with the general conformation of the head. Comb and wattles will be bright in color and present a full-blooded, healthy, vigorous appearance.

The body of the bird of high constitutional vigor will be broad and deep and well meated, with a frame well knit together, strong in the bone but not coarse. In fowls of strong constitution and great vigor all the secondary sexual differences will usually be well marked. In other words the males will be masculine to a degree in appearance and behavior, and the females correspondingly feminine. It must be noted, however, that this last is a general rule to which there are occasional exceptions.

INBREEDING.

The third basic factor which makes for success in practical breeding is *inbreeding*.* This may seem a radical statement, but a careful study of the history of the best improved strains of live stock of all sorts, including poultry, leaves no room for doubt that the attainment of the highest degree of excellence has always been associated with the practice of a very considerable amount of inbreeding, of rather close degree. It is a curious paradox of animal husbandry in general, and of poultry husbandry in particular, that while, as a matter of fact, every successful breeder of high grade stock practices inbreeding to a greater or lesser extent, a great many of these men are violent, even fanatical, opponents to inbreeding in theory. Most of them will deny stoutly that they ever practice inbreeding. They contend that they practice "line breeding," but never, never "inbreeding."

The distinction here is obviously verbal and not biological, being in its essentials precisely similar to that between Tweedledum and Tweedledee. The essential and important biological point is that what is actually done is to *purify* the stock in respect to all characters to as great a degree as possible. What the successful breeder aims to do is to get his stock into such condition that he has only one kind of "blood" in it. Expressed more precisely, though unfortunately more technically, it may be said that the breeder endeavors to get his stock homozygous with reference to all important characters or qualities. The quickest way, indeed the only way, practically to obtain this result is by the practice of some degree of inbreeding. Sometimes a great stride towards the desired end may be made by mating brother and sister or parent and offspring together.

That a mating of such close relatives will surely result in disaster is one of the carefully nursed superstitions of breeding, which has often been exploded, but will doubtless always be with us. It may be said that all the evidence which may be gleaned from the experience of stock breeders indicates that the results which follow inbreeding depend entirely upon the nature of the individuals inbred. If one inbreeds weak animals, lack-

* The following discussion of inbreeding has already appeared, in slightly altered form, in The Farm and Home Poultry Annual for 1913.

ing in constitutional vigor, and carrying the determinants of undesirable qualities in their germ cells, the offspring resulting from such a mating will undoubtedly be more nearly worthless than were their parents. If, on the other hand, one inbreeds in the same way strong and vigorous animals, high in vitality, and carrying the germinal determiners of desirable qualities there may be expected a corresponding intensification of these qualities in the offspring. The time has come when a vigorous protest should be made against the indiscriminating condemnation of inbreeding. It should be clearly recognized that if the experience of stock breeders extending throughout the world, and as far back as trustworthy data are available, means anything at all it plainly indicates that some degree of inbreeding* is an *essential* to the attainment of the highest degree of success in the breeding of animals, poultry forming no exception to this rule.

This contention receives full support from the results of modern exact studies in genetics. Such studies show that the personal bodily characters of the parents have no casual relation to the personal characters of the progeny. What the progeny shall be like is determined by the constitution of the germ cells of the parents. When by a proper system of selective breeding the point is reached where these germ cells are pure with reference to a particular character, or degree of a character, then that character will unfailingly appear in the offspring, in the degree of perfection in which it is represented in the germ cells. This is the highest goal of the practical breeder. But in a sexually reproducing organism like the domestic fowl purity of the germ cells with respect to the determiners of any character is only to be obtained, in the hands of a practical breeder without special scientific training, by the practice of inbreeding.

It should not be understood that indiscriminate inbreeding without definite purpose or reason is advised, or advocated as a panacea for all the difficulties which beset the breeder's path. All successful breeding is the working out of carefully made plans. In those plans inbreeding has a place. For the average

* Of course if the term "inbreeding" makes too violent a strain upon anyone's intellectual, moral or merely human prejudices, there is no objection to his using for the practice the term "line-breeding," or some other even milder designation.

poultryman who does not keep individual pedigrees, and could scarcely afford to do so if he wanted to, the safest and wisest plan to follow in breeding is to make matings without any thought whatever of the relation to one another of the individuals mated. In some instances they will be closely related, in others not so, purely as a result of chance. If *only* individuals of high constitutional vigor are used as breeders no thought need be taken as to relationship, and there will be no necessity of going out of the flock to get "new blood" to rejuvenate the stock. Further if "new blood" is not brought in there will be sufficient inbreeding purely from chance to bring about in time (in a flock of not too diverse origin) a considerable degree of purification in respect to selected characters.

Introduction of new blood for purposes of rejuvenation or reinvigoration, which is one of the commonest practices of the poultryman, is, as ordinarily done, one of the surest ways to prevent any real or permanent improvement of his stock by breeding. The difficulty here is that when one introduces new blood he runs the risk of introducing a whole set of characters *inferior* in their degree of perfection to what he already has in his own stock. The real cause which so frequently leads poultrymen who should know better to take this risk is a failure rigorously to select breeding birds for high constitutional vigor. The average poultryman finds it very hard to discard some particularly fine specimen just because it shows a little weakness in one way or another. He is disposed "just this once" to let the bird by, and use it as a breeder. This practice continued will make "new blood" necessary for rejuvenating purposes.

Again the careful breeder often finds himself in this situation. He has by well planned and executed breeding brought his stock up to a particular level of excellence. There the improvement stops. His birds breed true to that particular degree of quality but cannot be made to attain a higher degree. In other words, he has substantially purified his stock relative to the characters which interest him. But he sees that the stock of some other breeder is measurably better than his. If A is to get his stock up to the B level he must introduce some B blood. This has long been the poultryman's procedure, and if done in the right way, it is found to be as successful in practice, as it is justifiable in theory in the light of modern ideas respecting inheritance. The danger in the matter in such a case as this under discussion all turns on the way in which the thing is done. If one feels it to be desirable, for the reason specified, to introduce "new blood" into his flock of birds let him by all means do it gradually, and not swamp the whole flock with the new germinal combinations all at once. For if he does he may destroy in this way at one blow results which have taken years of careful breeding to build up. The proper procedure in introducing "new blood" is, in most cases, to buy a male bird and mate it the first year with only a small number of females, perhaps three or four. In this way it is possible to find out whether the new "blood" "nicks" with the old, as the breeders express it.* If it does he may then extend its introduction to the whole flock. If it does not "nick" he will not have lost all, but may still continue with his original foundation stock, with all its good qualities.

Having considered in detail the principles involved in the production of good stock in poultry keeping, we may next turn to the conservation of this stock once it has been obtained. While well bred stck of sound constitution is fundamental for all permanent success in the poultry business, yet it is equally true that the best stock in the world may be made very unproductive, and in nearly all respects practically worthless, by improper management. Furthermore in the hands of a skillful poultryman the same stock can be made to yield a great deal more profit, both in egg production and in meat production, than if handled and cared for by an amateur without any understanding of the business.

Housing.

In the management of adult fowls there are in the main two things to be considered, housing and feeding. A vast multitude of methods of doing these two things to poultry have been tried during the history of the industry.

There have been published plans for poultry houses of all conceivable shapes and sizes. Long houses, short houses, tall houses

* From the standpoint of modern conceptions of heredity "nicking" possibly means nothing more than that the individuals mated form homozygous combinations of many important characters rather than heterozygous combinations.

low houses; square, hexagonal, octagonal and round houses; heated houses and cold houses; all these and many more have had their advocates and detailed plans for their construction can be found. It would appear that there must be realized here the primary condition of the experimental method, namely the "trying of all things." It only remains to discover that which is "good" in order that we may "hold fast" to it.

This discovery has indeed been made in regard to a few of the basic things in the housing of poultry. It would be strange if something had not come out of all the indignities to which innocent and inoffensive generations of fowls have been submitted in the way of dwelling accommodations. It is now clearly recognized, and generally admitted by all competent poultrymen, that certain things are absolutely essential in any poultry house which is to give good results. These are (1) fresh air, (2) freedom from dampness, (3) freedom from draughts, (4) sun-light, and (5) cleanliness.

If these five things are realized in a poultry house the birds will thrive and be productive in it provided they are well and regularly fed and watered. It makes no difference particularly to the well-being of the birds how these necessary specifications of their dwelling are attained. To the poultryman, however, it is important that they be attained at the smallest expense, having regard to (a) initial cost, (b) repairs and up-keep and (c) labor necessary to operate the house to get the specified results. The housing problem is to the poultryman, then, both a biological and an economic one. The biological solution is definite. The requisites named above must be met, and there is one additional factor to be taken into account; namely size of house. Experiments made at various times and places indicate clearly that in northern climates, where birds must be shut up in the house during a part of the year in order to give best results, there should be allowed in the house at least three square feet of floor space per bird, and preferably a little more. Four square feet floor space per bird is a liberal allowance.

A factor which it was formerly thought necessary to control in the housing of poultry was the temperature. It was long held that if fowls were to lay well in the winter it was necessary that they should be in a heated house. Later experience has shown conclusively that this was an utterly fallacious idea. As a matter of fact, even in the coldest climates, fowls will lay better during the winter months in a properly constructed house wide open to the outside air in the day time, so that they are living practically out of doors, than in any heated house which has yet been devised. If a laying house is *dry* the temperature factor may be neglected. If a house has a tendency to dampness, it will give poor results regardless of temperature.

From the economic standpoint there are two systems of housing poultry to be considered. One of these is the system of long continuous houses for the laying birds. The other is the so-called colony house system, in which the birds are housed in small separate houses which may either be set a considerable distance apart over a relatively wide area, or may be placed relatively near one another. Each system has its strenuous advocates. Experience covering a fairly long period of years now has demonstrated that both systems have good points. As to which shall be adopted in a particular instance depends upon a variety of considerations, each in some degree peculiar to the particular case in hand.

In the extreme northern part of the country where the climate is very cold in the winter and there is an abundance of snow there can be no question that the long house is much to be preferred to a colony system. There are two reasons for this. In the first place experience indicates that the birds are somewhat more productive and keep in better condition in a properly constructed and managed long house than in colony houses. Furthermore the labor expense involved in caring for a given number of fowls is much less, under such climatic conditions, than with the colony house system, where the birds are scattered over a wider area and more paths must be broken out in the snow.

The great advantage of the colony house system is its flexibility. Furthermore it gets around the troubles involved in the contamination of the ground by the long continued keeping of poultry on the same small area. In general, local conditions and circumstances must decide in each individual case which system of housing shall be adopted.

Having decided upon the general system to be followed, what particular type of house is best? There is one outstanding type of "long" house which has been very widely used with great satisfaction. This is the so-called "curtain front house." The particular form of this which was devised and has been used for many years at the Maine Station is probably the most widely used. See Fig. 56 and 57. Description of this house with specifications for its construction may be found in Circular No. 471 of the Maine Agricultural Experiment Station, which will be sent free to any resident of Maine. The essential feature of this type of house is that during the day the front of each pen, which is formed of a cloth curtain, is wide open, so that the pen becomes in effect a shed open on the south side. At night this curtain is closed, but it still permits of some circulation of air so that the house is at all times a strictly "fresh air" house.

In the case of the colony house there cannot be said to be any single type which, by common consent, is of such outstanding merit as the "curtain front" type in the case of the long house. There are two types of colony houses which are at present popular and seem to be of greatest merit. One of these is essentially nothing more than a single unit or pen of a "curtain front" house. That is, it is a "curtain front" *colony* house built on essentially the same plan as the long house only very much smaller. The other type of colony house is the so-called Tolman house, which is another modification of the open front principle. Another house of this general type which has been advocated is the Woods house.*

FEEDING.

Having housed our fowls they must be fed. Here the same sort of history is to be found as in the case of housing. Substantially all known edible substances must, at some time or other, have been suggested or tried as component parts of the rations of fowls. Not only have many and curious substances been suggested as poultry food, but they have been combined in formulæ as weird as a medieval apothecary's prescription

* Detailed plans and specifications for the construction of poultry houses of various types may be found in Bulletin 215 of the Wisconsin Agricultural Experiment Station, entitled "Poultry House Construction," by J. G. Halpin and C. A. Ocock; "Poultry Houses and Fixtures" published by the Reliable Poultry Journal Pub. Co., Quincy, Ill., and many other standard poultry books give house plans.

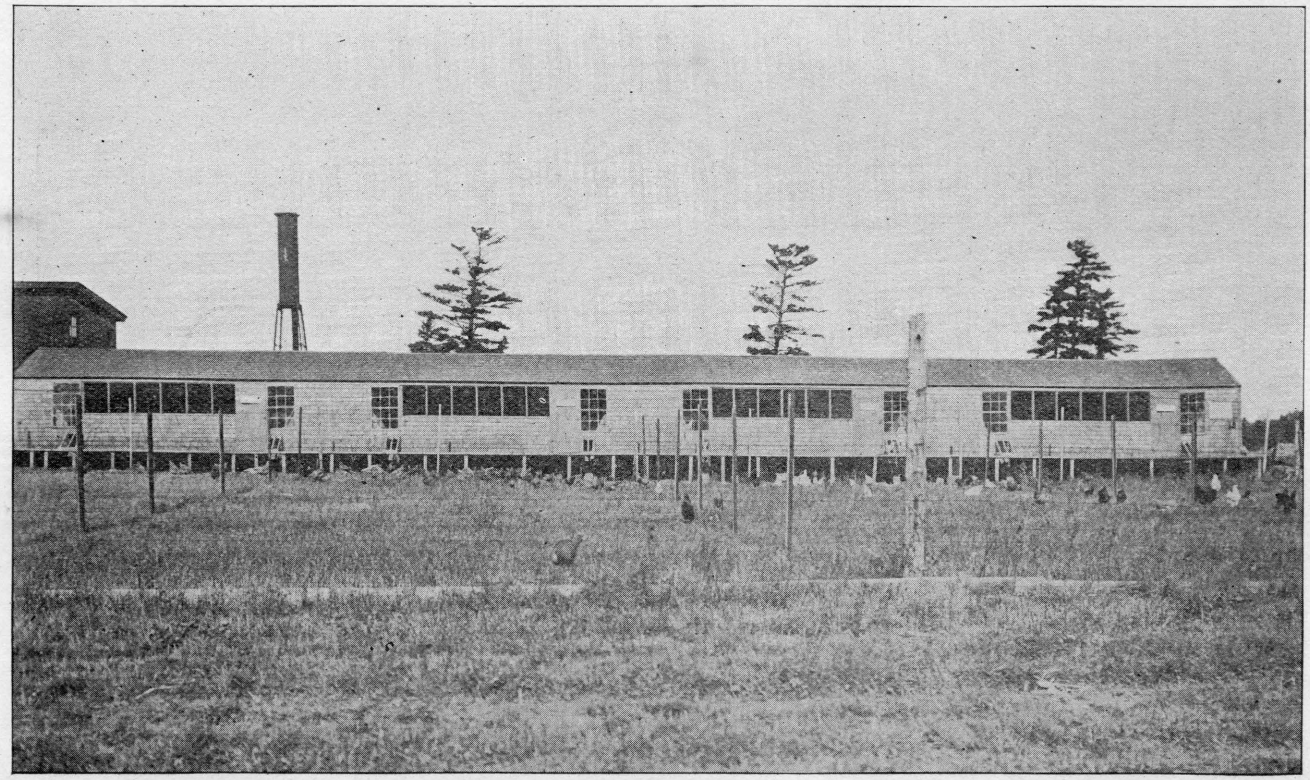


FIG. 56. Curtain-front poultry house No. 3, at the Maine Agricultural Experiment Station.

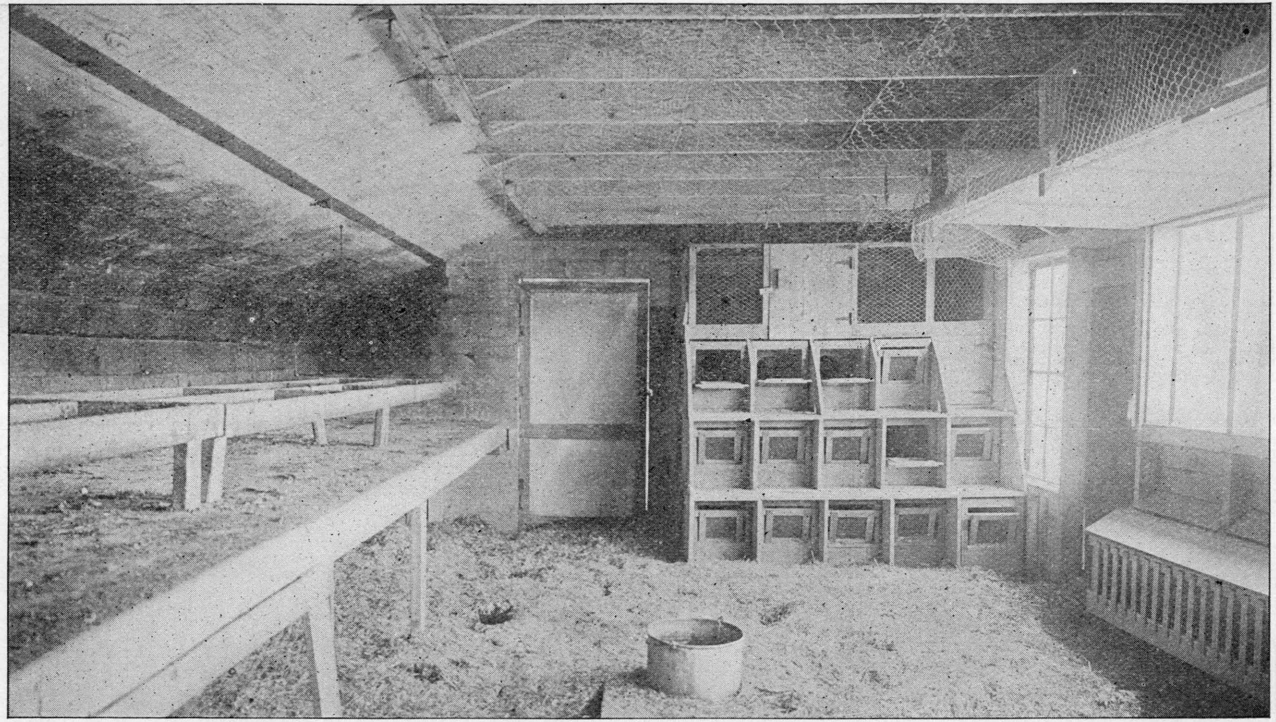


Fig. 57. Interior of curtain-front poultry house No. 3.

Actually practical poultry feeding is much more of an art than a science, in the present state of knowledge. While for pedagogical reasons it seems wise in the teaching of poultry husbandry to spend a considerable amount of time in calculating balanced rations and nutritive ratios it is very doubtful if all such activity has any very real or tangible relation to practical poultry feeding.

Such attempts at a science of poultry feeding would appear to suffer from a serious defect. The assumption is made in calculating a nicely balanced ration that all hens are going to partake of this ration in the same way. But this is very far from the biological actuality. Some individual hens like no grain except corn, and if fed a mixture will eat only corn. Others are very partial to beef scrap, and so on. To anyone who studies the behavior of fowls it is clear that the ration on paper and the ration in the crop are two very different things.

The successful feeding of poultry depends upon experience and acquaintance with fowls. The basic biological factor is, once more, individuality. Each individual hen is an independent living thing, possessing well marked likes and dislikes of her own with respect to food. There can be no question that the best results in the way of egg production and meat production would be obtained if a skillful feeder could feed each individual fowl by and for itself. Evidence that this is the case is found in the fact, which is universal wherever poultry is kept, that on the average fowls kept in small flocks, of say under 25 birds each, do relatively much better than larger flocks. The production and money returns per bird are greater. The fundamental reason for this is that the birds in small flocks get better care as individuals. When a man has only such a small number to take care of he can recognize their individual peculiarities more easily. Furthermore an individual bird stands a better chance of having its peculiar taste gratified in a small than in a large flock.

So while the biological ideal would be to feed each bird individually, this is obviously impossible in practice. With poultry the individual unit of production (the hen) is so small that it must be handled in flocks. The correct principle of management is to feed and handle a flock in such a way as to afford the maximum opportunity for the expression and gratification of the individual preferences of the component units, with a minimum labor cost. The larger the flock and the plant as a whole, the more machine-like the methods of feeding and handling must be. They must of necessity be calculated to suit that mythical creature, the average hen. Coincidently the total production or profit per bird will diminish. Presently a point is reached in size of plant where the outgo exceeds the income over a period of years. Such a plant if it has a hustling business man at the head takes a fancy name to itself, advertises a great deal, invents a "system," writes and sells a book about it, manufactures incubators and supplies, in general endeavors to make a loud noise about what a profitable thing the poultry business is, and finally goes dismally, completely and permanently "broke."

In the practical feeding of flocks of poultry large enough to be a commercial proposition, the methods which have been worked out empirically by the successful poultryman are essentially attempts to satisfy the individual tastes of the birds to as great a degree as possible, at a minimum labor cost. This result is obtained in practice by offering to the flock a variety of food materials so that they may have some opportunity of choice as to what they shall eat. If we feed corn, wheat, and oats the fowl which likes corn has the opportunity to live on corn, whereas the fowl which likes about three parts wheat and one part oats is able to satisfy her taste in this regard.

As a result of this manifest need for a variety of food it has come about that the practice now generally accepted as best is to put regularly before fowls food substances belonging to four different categories. These categories are:

1. Dry whole (or coarsely broken) grains (e. g., corn, wheat oats, barley, etc.).

2. Ground grains (e. g., bran, middlings, corn meal, linseed meal and other finely ground grains).

3. Animal products (e. g., beef scrap, blood meal, fish scrap, green cut bone, etc.).

4. Succulent or green foods (e. g., mangolds, cabbages, beets, sprouted oats, green corn fodder, etc.).

The proportions in which these different kinds of food material are fed differ to a considerable extent among different poultrymen. The *exact* proportions in which they are given really matters very little, owing to the fact, already brought out, that the hen compounds her own ration to her own taste if given the material. Furthermore it makes little difference whether the ground grains are fed dry or wet. It is cheaper to feed them dry (because of labor saved), and therefore the "dry-mash system" of feeding has become popular.

At the Maine Agricultural Experiment Station the following ration is fed to laying pullets.

Dry whole (or cracked) grains.

Early morning. Cracked corn in litter.

11 A. M. Mixture of equal parts of wheat and oats in litter.

These grains are fed at the rate of about 2 quarts for 50 birds.

Ground grains (dry mash) thoroughly mixed together.

First month pullets are in laying house.

Wheat bran	300 lbs.
Corn meal	100 lbs.
Daisy flour (or other low grade flour)	100 lbs.
Meat scrap	100 lbs.

Second month in house.

Wheat bran	200 lbs.
Corn meal	100 lbs.
Daisy flour (or other low grade flour)	100 lbs.
Gluten feed	100 lbs.
Meat scrap	100 lbs.

Third month in house.

Same mixture as second month with 50 lbs. linseed meal added.

Fourth month in house.

Same mixture as second month.

Thereafter put 50 lbs linseed meal in second month mixture on each alternate month.

This ground grain mixture or "dry mash" is kept in open hoppers before the pullets at all times.

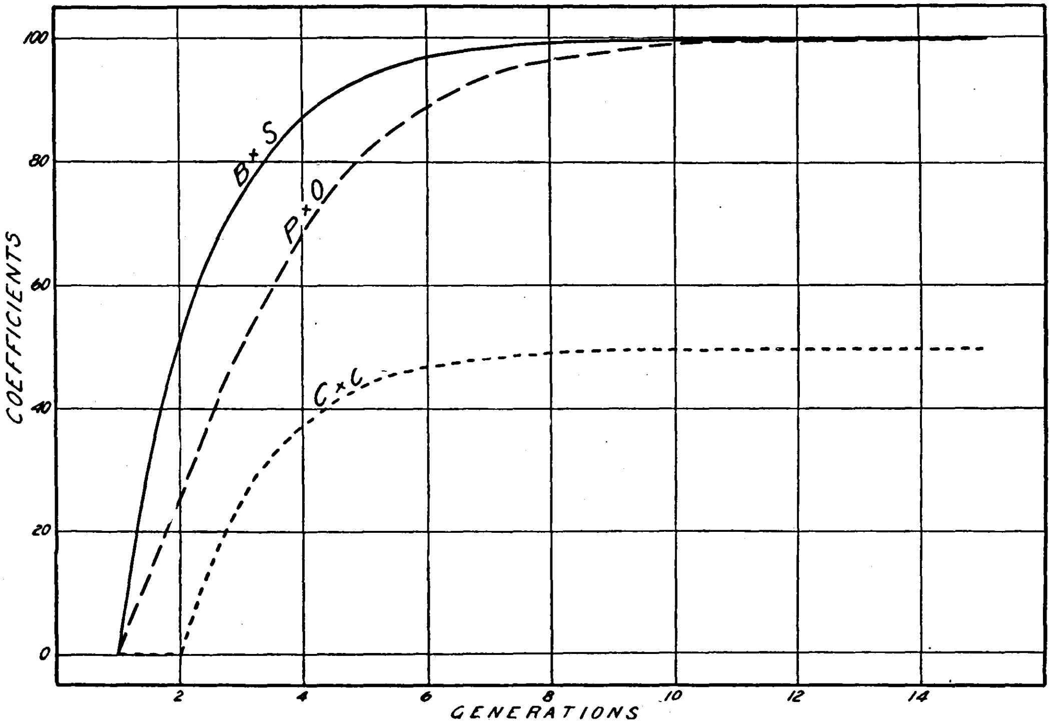
For green or succulent food either cabbages, mangolds or green sprouted oats or a mixture of these materials.

A detailed account of the methods of feeding poultry in the use at the Maine Station is given in Circular No. 471 of that Station, entitled "Poultry Management at the Maine Station.

Other ration formulæ for fowls are given in all books on poultry husbandry and in bulletins published by agricultural experiment stations in the various states and by the Department of Agriculture in Washington.

In feeding fowls in flocks it is important, in accordance with the principle of individuality, to select the birds which are to make up a flock so that they will be as uniform a lot as possible in respect to size, stage of development, etc. Careful grading in this way in putting birds into the laying house pays in the egg basket. The more nearly uniform in structure and habit the component units of a flock are, the more will the effect of individuality be minimized.

In conclusion it may be said that while the poultry business is not a gold mine, nor a get-rich-quick scheme, it is a legitimate business. When properly conducted it will pay liberal interest on the investment of capital and labor. The keynote to success in it is to begin in a very modest way, and only enlarge the plant, if it be enlarged at all, as the fundamental principles of breeding and management are thoroughly mastered. Chickens are not machines. They are living creatures. A poultry plant is not a factory. It partakes much more of the nature of a girl's boarding school, with a strong leaning on the part of its inhabitants towards suffragette doctrines. Poultry management is a biological problem, and to be successful must have due regard to fundamental biological principles.



Curves of inbreeding, showing (*a*) the limiting case of continued brother × sister breeding, wherein the successive coefficients of inbreeding have the maximum values; (*b*) continued parent × offspring mating; and (*c*) continued first cousin × first cousin mating.

BULLETIN No. 215.

THE MEASUREMENT OF THE INTENSITY OF INBREEDING.[1]

RAYMOND PEARL.

The effect of inbreeding on the progeny is a much discussed problem of theoretical biology and of practical breeding. It has been alternately maintained, on the one hand, that inbreeding is the most pernicious and destructive procedure which could be followed by the breeder, and on the other hand, that without its powerful aid most of what the breeder has accomplished in the past could not have been gained and that it offers the chief hope for further advancement in the future. While there is now, among animal breeders at least, a more widespread tendency than was formerly the case towards the opinion that inbreeding *per se* is not a surely harmful thing, nevertheless this opinion is by no means universally held and in any case does not rest upon a definite and well-organized body of evidence. Aside from a relatively small amount of definite experimental data one's judgment in the matter (so far as it is not wholly speculative) is finally formed on the basis of his *interpretation* of the vast accumulation of material comprised in the recorded experience of the breeders of registered (pedigreed) livestock.

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[1]This bulletin is essentially an abstract (with some new material—see p. 134) of a more extended technical discussion of the subject published, with the title "A Contribution towards an Analysis of the Problem of Inbreeding," in the American Naturalist (Vol. XLVII, 1913). The complete paper contains illustrative pedigrees and examples of the calculation of coefficients of inbreeding, together with a more detailed discussion of the theoretical significance of these coefficients. Anyone wishing to make use of these coefficients of inbreeding should consult the original paper, in addition to this abstract. The paper referred to is *not* available for general distribution by the Maine Agricultural Experiment Station. Recourse must be had by those wishing to examine it to the files of the American Naturalist, a journal available in many of the larger public libraries, or by purchase at a nominal cost from the publishers.

In order that progress may be made in the analysis of this important problem of inbreeding there is a fundamental need which must first be met. This is the need for an appropriate and valid method of pedigree analysis, which possesses generality, and can on that account be depended on to give comparable results when applied to two (or more) different pedigrees. Specifically, there seems not to have been worked out any *adequate general method of measuring quantitatively the degree of inbreeding which is exhibited in a particular pedigree.* Without such a measure it is clearly impossible to proceed far in the analysis of inbreeding.

It is the purpose of the paper of which this is an abstract to present a method for measuring, and expressing numerically in the form of a coefficient, the degree of inbreeding which exists in any particular case, and to show by illustrations the manner in which these coefficients may be computed. It is shown that the method is (a) *unique,* in the sense that the value obtained in any particular instance can only be affected by the degree or amount of inbreeding which has been practiced in the line of descent under consideration, and (b) *general,* in the sense that it is equally applicable to all pedigrees and to all degrees and types of inbreeding.

Preliminary Definitions.

In attempting any general analysis of the problem of inbreeding from the theoretical standpoint one is confronted with the necessity for a definition of inbreeding, which shall be at once precise and general, that is, such as to include all of the most diverse ways in which this sort of breeding may be practised.

Leaving aside for the moment all consideration of details as to *how* a particular piece of inbreeding may be brought about is to be found the concept of a *narrowing* of the network of descent as a result of mating together individuals genetically *related* to one another in some degree. Let us take this as our basic concept of inbreeding. It means that the number of potentially *different* germ-to-germ lines, or "blood-lines" concentrated in a given individual animal is *fewer* if the individual is inbred than if it is not. In other words, *the inbred individual possesses fewer different ancestors in some particular generation or generations than the maximum possible number for that* *generation or generations.* This appears to be the most general form in which the concept of inbreeding may be expressed. In whatever way the mating of relatives is accomplished, or whatever the degree of relationship of the individuals mated together, the case in last analysis comes back to the above statement, namely that there are actually in the pedigree of the inbred individual fewer *different* ancestors in some particular generation or generations than the maximum possible number.

The Measurement of the Degree of Inbreeding.

This brings us to a consideration of a practical and general measure of the degree of inbreeding exhibited in a particular pedigree. This problem has been attacked by a number of other investigators, but so far as I have been able to learn, all previous measures have been modifications in one form or another of the scheme of Lehndorff. All systems based on the number of "free generations" alone, as in Lehndorff's, do not furnish a precise or reliable measure of the real intensity of inbreeding. The essential reason for this failure, stated baldly, is that they do not take account of the composition of the generation to which the "common ancestor" of an inbred pair belongs.

In developing a general measure of the intensity of inbreeding we may well start from the conception set forth in the preceding section, namely that the inbred individual possesses fewer different ancestors than the maximum possible number. Besides this factor account must be taken of the generation or generations in which the reduced number of different ancestors is found, and the extent to which these generations are removed (in the sense of Lehndorff mentioned above) from the individual or generation under consideration. In other words the two factors which must be included in a general measure of the intensity of inbreeding are (a) the *amount* of ancestral reduction in successively earlier generations, and (b) the *rate* of this reduction ever any specified number of generations.

Both of these demands are met by taking as a measure of the intensity of inbreeding in any generation the proportionate degree to which the actually existent number of different ancestral individuals fails to reach the maximum possible number, and by specifying the location in the series of the generation under discussion.

This statement is amplified and made more precise in the following propositions.

1. The production of the individual must be the point of departure in any analytical consideration of inbreeding, leading towards its measurement. That is, the question to which one wants an answer is: What degree of inbreeding was involved in the production of this particular animal?

2. It is therefore necessary practically to *start* with the individual and work *backwards* into the ancestry in measuring inbreeding, rather than to start back in the ancestry and work down towards the individual.

3. In the genetic passage from the $n+1$'th generation to the n'th, or in other words the contribution of the matings of the $n+1$'th generation to the total amount of inbreeding involved in the production of an individual, the degree of inbreeding involved will be measured by the expression

$$Z_n = \frac{100\,(p_{n+1} - q_{n+1})}{p_{n+1}} \tag{i}$$

where p_{n+1} denotes the maximum possible number of different individuals involved in the matings of the $n+1$ generation, q_{n+1} the *actual* number of different individuals involved in these matings. Zn may be called a *coefficient of inbreeding*. If the value of Z for successive generations in the ancestral series be plotted to the generation number as a base, the points so obtained will form a curve which may be designated as the *curve of inbreeding*.

It will be noted that the coefficient of inbreeding Z is the percentage of the difference between the maximum possible number of ancestors in a given generation and the actual number realized in the former. The coefficient may have any value between 0 and 100. When there is no breeding of relatives whatever (that is, in the entire absence of inbreeding) its value for each generation is 0. As the intensity of the inbreeding increases the value of the coefficient rises.

4. The above measure of inbreeding has to do solely with the *relationship* aspect of the problem. It has nothing whatever

to do *directly* with the gametic or zygotic constitution of individuals.

5. Since the only possible infallible criterion of relationship between individuals is common ancestry in some *earlier* generation, we are led to the practical rule, in measuring the degree of inbreeding in a pedigree, *to regard all different individuals as entirely unrelated until the contrary is proved by the finding of a common ancestor.* This no doubt appears at this stage of the discussion as an exceedingly obvious truism. The reader is urged to accept it as such, and hold fast to it, because it will help him over some apparent paradoxes later.

The method of calculating coefficients of inbreeding, and their real significance will be made much clearer by the consideration of illustrative examples of their application. To these we may therefore turn.

THE CALCULATION OF COEFFICIENTS OF INBREEDING.

We may first consider some simple hypothetical pedigrees,

PEDIGREE TABLE I. (HYPOTHETICAL).

To illustrate the Breeding of Brother × Sister, out of Brother × Sister, Continued for a Series of Generations.

x	*a*	*c*	*e*	*g*
				h
			f	*g*
				h
		d	*e*	*g*
				h
			f	*g*
				h
	b	*c*	*e*	*g*
				h
			f	*g*
				h
		d	*e*	*g*
				h
			f	*g*
				h

before attacking the more complicated ones actually realized in stock-breeding.

ILLUSTRATION I. CONTINUED BROTHER × SISTER BREEDING.

Let us begin with the most extreme type of inbreeding possible, namely the mating of brother with sister for a series of generations. Pedigree Table I gives the pedigree of an individual so bred.

Let us now proceed to calculation of the coefficients of inbreeding Z_0, Z_1, Z_2, and Z_3. For Z_0 we have

$$p=2,$$
$$q=2,$$

whence $$Z_0 = \frac{100\ (0)}{2} = 0$$

In the same way $$Z_1 = \frac{100\ (4-2)}{2} = 50$$

$$Z_2 = \frac{100\ (8-2)}{8} = 75$$

$$Z_3 = \frac{100\ (16-2)}{16} = 87.5$$

These results may be expressed verbally in the following way: In the last two ancestral generations x is 50 per cent inbred; in the last three generations it is 75 percent inbred; and in the last four generations it is 87.5 per cent inbred.

This pedigree table and the constants will repay further consideration, since the case is a limiting one. With the table at hand it is possible to grasp a little more clearly the precise biological meaning of the coefficients of inbreeding. Thus it is seen that what the value of $Z_1=50$ really signifies is that because the individual a and b were brother and sister the number of different ancestors which x can possibly have in any ancestral generation cannot be *more* than 50 percent of the total number theoretically possible for the generation. That is, x's sire and dam having been brother and sister means that x cannot have more than 2049 different great-great-great-great-great-great-great-great-great-grandparents, instead of the possible 4096. He may have had fewer than 2049, but $Z_1=50$ tells us that he could not have had more. Similarly $Z_2=75$ indicates that since c and d, the grand-sire and grand-dam of x were brother and sister, x cannot have in any ancestral generation more than 25 percent of the theoretically possible number of ancestors for that generation. And so on for the other values of Z.

In the limiting case of the closest inbreeding possible the successive Z's will have the values given in the following table.

TABLE I.

Values of the Successive Coefficients of Inbreeding (Z_0 to Z_{15}) in the Case of the Most Intense Inbreeding Possible (Brother × Sister Out of Brother × Sister Continued).

COEFFICIENT OF INBREEDING.	Ancestral Generations Included.	Numerical Value of Coefficient.
Z_0	1	0
Z_1	2	50
Z_2	3	75
Z_3	4	87.5
Z_4	5	93.8
Z_5	6	96.9
Z_6	7	98.4
Z_7	8	99.2
Z_8	9	99.6
Z_9	10	99.8
Z_{10}	11	99.9
Z_{11}	12	99.95
Z_{12}	13	99.98
Z_{13}	14	99.99
Z_{14}	15	99.994
Z_{15}	16	99.997

From this table it is apparent that while the narrowing or exclusion of the possible different source lines of descent proceeds very rapidly in the first few generations of brother × sister breeding, only relatively little change is made by further generations of this sort of breeding. Thus in seven generations of brother × sister breeding all but about 1 1-2 percent of the potentially different ancestral "blood-lines" will have been eliminated.

The values of the Z's in Table 1 are maxima: No particular coefficient of inbreeding can have a higher value than that given in the table. It is not possible, for example, so to breed any domestic animal that its pedigree on analysis will give $Z_3 \ngtr$

87.5. If therefore, the coefficients of Table 1 are plotted the result will be the maximum limiting *curve* of inbreeding.

ILLUSTRATION II. PARENT × OFFSPRING BREEDING.

The next illustration of the application of coefficients of inbreeding will be the general case of back-crossing, that is the mating of parent × offspring.

The values of the successive coefficients for parent × offspring breeding for 16 ancestral generations are given in Table 2.

TABLE 2.

Values of the Successive Coefficients of Inbreeding in the Case of Continued Parent × Offspring Mating.

COEFFICIENT OF INBREEDING.	Ancestral Generations Included.	Numerical Value of Coefficient.
Z_0	1	0
Z_1	2	25
Z_2	3	50
Z_3	4	68.75
Z_4	5	81.25
Z_5	6	89.06
Z_6	7	93.75
Z_7	8	96.48
Z_8	9	98.05
Z_9	10	98.93
Z_{10}	11	99.41
Z_{11}	12	99.68
Z_{12}	13	99.83
Z_{13}	14	99.91
Z_{14}	15	99.95
Z_{15}	16	99.97

By comparison of this table with Table 1 it is evident that while the increase in intensity of inbreeding is not so rapid in the first few ancestral generations by this parent × offspring type of breeding as with the brother × sister type, by the time the 10th ancestral generation is reached the values are, for practical purposes, the same.

ILLUSTRATION III. THE PEDIGREE OF THE JERSEY COW, BESS WEAVER (155121).*

Leaving now the hypothetical cases we may consider some pedigrees of actually existing animals. For a first illustration of this sort the Jersey cow Bess Weaver may be taken. Her pedigree through four ancestral generations is shown in pedigree table II.

Pedigree Table II.

Sex ♀ No. 155121 Bess Weaver	♂ No. 53598 Davy Stoke Pogis	No. 35913 ♂ Sisera's Stoke Pogis	No. 26271 ♂ Juno's Stoke Pogis	No. 14207 ♂ Alphea's Stoke Pogis
				No. 14436 ♀ Carlo's Juno
			No. 37346 ♀ Sisera	No. 18811 ♂ Duchess Stoke Pogis
				No. 6246 ♀ Edith Darby
		No. 79860 ♀ Baltimore	No. 19350 ♂ Patrick Fawkes	No. 10469 ♂ Regal Koffee
				No. 21574 ♀ Kermesse
			No. 17900 ♀ Avoca 2nd	No. 3286 ♂ Champion's Son
				No. 17769 ♀ Avoca
	♀ No. 126629 Peg Weaver	No. 35913 ♂ ⊕ Sisera's Stoke Pogis	No. 26271 ♂ × Juno's Stoke Pogis	No. 14207 ♂ × Alphea's Stoke Pogis
				No. 14436 ♀ × Carlo's Juno
			No. 87346 ♀ × Sisera	No. 18811 ♂ × Duchess Stoke Pogis
				No. 6246 ♀ × Edith Darby
		No. 126626 ♀ Kate Weaver	No. 36382 ♂ General Kelly	No. 19350 ♂ ⊗ Patrick Fawkes
				No. 95606 ♀ ⊕ Balm
			No. 95606 ♀ Balm	No. 7056 ♂ America's Champion
				No. 95605 ♀ Maid of Gilead 2nd

In the twelfth ancestral generation the theoretically possible number of different ancestors is 4096. In a relatively long pedigree, such as arises in dealing with registered cattle, it would obviously be an extremely tedious business to determine the value of q by direct counting, as has been done in the preceding simpler illustrations. The calculation of the coefficients of inbreeding may be greatly simplified in the case of long pedigrees by a system of counting which makes the *line of*

* The illustrations from actual pedigrees used in this abstract are not the same as those used in the complete paper. The two illustrations here given are chosen because of their probably greater interest to the Station's constituency.

descent the unit rather than the individual. This system is used in the above pedigree as an illustration of method, although only 4 ancestral generations are here considered. While each individual animal which is eliminated because of previous appearances in a lower ancestral generation is marked with an *X*, those at the apex of a line of descent are marked with a cross within a circle. These latter are all that need to be counted directly. Their elimination automatically eliminates their own ancestors. Thus the bull Sisera's Stoke Pogis first appears in the second ancestral generation as the sire of Davy Stoke Pogis. He next appears (here marked with a cross within a circle) in the same generation as the sire of Peg Weaver. He will, by the general rule for coefficients of inbreeding, not be counted as a "different" ancestor the second time in this generation. But this automatically eliminates his two parents in the third ancestral generation, his four grandparents in the fourth generation, and so on until in the twelfth generation 1024 ancestors of Sisera's Stoke Pogis will be so eliminated. The same consideration applies in every other like case.

Practically then the method of dealing with a pedigree of this sort is first to go through and indicate in a distinctive way every *primary** reappearance of individuals. Then form a table on the plan of Table 3, the character of which is so obvious as not to need detailed explanation.

This table is to be read in the following way: Because of the reappearance of Sisera's Stoke Pogis in the 2nd ancestral generation Bess Weaver has 1 fewer ancestors in that generation than she would have had in the entire absence of inbreeding; 2 fewer in the 3rd generation and so on. The totals of the columns of this table are the values, for each generation, of

$$p_{n+1} - q_{n+1}$$

* By "primary" reappearance in the pedigree is meant a reappearance as the sire or dam of an individual which has not itself appeared before in the lower ancestral generations. Thus Patrick Fawkes makes a *primary* reappearance in the fourth ancestral generation as the sire of General Kelly, a bull which is not found in any generation below the third.

TABLE 3.

Working Table Used in Calculating the Coefficients of inbreeding for Pedigree Table II.

ANIMAL.	ANCESTRAL GENERATION.		
	2.	3.	4.
Sisera's Stoke Pogis..............	1	2	4
Patrick Fawkes..................	–	–	1
Balm..........................	–	–	1
Totals......................	1	2	6

in (i). These totals, multiplied by 100, have then merely to be divided by p_{n+1} in order to obtain the successive Z's. The whole operation may be very quickly carried out. It is not necessary, in fact, to fill out the whole of the later columns of the table, the entries may be cumulated.

For the present pedigree we have

$$Z_0 = 0, \text{ as always*}$$

$$Z_1 = \frac{100\ (1)}{4} = 25\%$$

$$Z_2 = \frac{100\ (2)}{8} = 25\%$$

$$Z_3 = \frac{100\ (6)}{16} = 37.5\%$$

From these values it is seen that in the first four ancestral generations the cow Bess Weaver is 37.5 percent inbred. This is a perfectly definite figure, directly comparable with similar constants for other animals. Of course, if we were to go back more generations we should find Bess Weaver still more inbred, that is, the coefficients would grow larger with each case of the mating of relatives. Since the case is cited here merely for illustration of method, four generations only are considered.

* The apparent paradox implied in the fact that Z_0 must always be zero, or in other words that in the first ancestral generation, considered *alone,* there is no inbreeding will be cleared up, if it strikes the reader as paradoxical, by a reconsideration of the general principle numbered 5 on p. 127. The point of course is that it is impossible to say whether the parents are or are not related to one another until something is known of *their* parentage, or in other words, until a *second* ancestral generation is considered.

ILLUSTRATION IV. THE PEDIGREE OF THE JERSEY COW, FIGGIS 20th OF HOOD FARM (190306).

Figgis 20th of Hood Farm (190306) is a cow which, in official test for advanced registry, produced as a two year old 437 lbs. 14.4 oz. butter fat. This is a high record. The complete pedigree of this animal has been worked out for 12 ancestral generations, and the coefficients of inbreeding calculated. Twelve generations cover practically the whole of the known pedigree of this cow. On account of its great length it is impossible in the space here available to reproduce this pedigree. Nor is it necessary. The inbreeding coefficients in a quarter of a page give more clear and definite information regarding the amount of inbreeding practised in the breeding of Figgis 20th than could any visual inspection of the pedigree itself. Furthermore the list of names in Table 4 shows just what animals appear more than once in the pedigree, and how frequent are their reappearances.

Table 4 is precisely the same sort of table for Figgis 20th that Table 3 is for Bess Weaver.

In dealing with this and all other pedigrees it is assumed, in the absence of information on the point and the impossibility of acquiring any, that any imported animal for which there is no further pedigree, was not inbred to any degree whatsoever. This is probably not often strictly true, but, on the other hand, some assumption must be made, and this puts all individuals on an equal footing. It is in accord with the principle laid down earlier (p. 127) that in pedigree analysis all individuals must be considered to be unrelated until the contrary is proved by the evidence of their ancestry. After all, the only thing we can possibly measure is the inbreeding shown in the *recorded* pedigree. All that happened prior to the beginning of the record must be a matter of assumption. The *same* assumption should, however, be made for all cases. What this assumption really means practically is that, in all cases of analysis of actual pedigrees, which are bound after a time to come to an end, the values of the coefficients of inbreeding obtained are *lower limiting values*. They signify that the intensity of inbreeding in a particular case could not have been *less* than that indicated; it may have been more. Whether it was or not is not a question open to scientific determination but only to speculation.

From this table the following coefficients of inbreeding for Figgis 20th are easily calculated.

$Z_0 = 0$
$Z_1 = 0$
$Z_2 = 12.50$ percent
$Z_3 = 12.50$ "
$Z_4 = 21.88$ "
$Z_5 = 25.00$ "
$Z_6 = 32.03$ "
$Z_7 = 35.94$ "
$Z_8 = 37.30$ "
$Z_9 = 37.99$ "
$Z_{10} = 38.48$ "
$Z_{11} = 38.57$ "

These coefficients show that Figgis 20th was at least 38 1-2 percent inbred. That is, she had rather less than two-thirds as many different ancestors as she would have had in the event of no inbreeding whatever. It is further clear that most of this inbreeding took place in the fourth and earlier ancestral generations, chiefly in the fourth, fifth, and sixth generations.

Comparing Figgis 20th with Bess Weaver we see that the latter is practically as much inbred in the first 4 ancestral generations as Figgis 20th is in the first 12. Considering in each case only the first four ancestral generations the figures show that, within these generations, Bess Weaver is exactly 3 times more intensely inbred than Figgis 20th.

The Relation of Coefficients of Inbreeding to the Hereditary Constitution of the Individual.

What, if any is the relation of coefficients of inbreeding to the zygotic constitution (i. e., the hereditary make-up) of the individual? Do the coefficients tell us anything regarding this matter? A little consideration shows that they do. The successive coefficients of inbreeding indicate the rate and degree to which the possible number of *different* hereditary unit factors present in the ancestry is subsequently reduced as a result of inbreeding. They give no indication of the condition in which the *remaining* factors are present (i. e., whether in homogygous

TABLE 4.

Working Table for Calculating the Coefficients of Inbreeding of Figgis 20th.

Animal.	Ancestral Generations.									
	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Sophie's Tormentor	1	2	4	8	16	32	64	128	256	512
Ida's Stoke Pogis	–	–	1	2	4	8	16	32	64	128
Catono	–	–	1	2	4	8	16	32	64	128
Rosabelle Hudson	–	–	1	2	4	8	16	32	64	128
Khedive	–	–	–	1	2	4	8	16	32	64
Young Fancy	–	–	–	1	2	4	8	16	32	64
Stoke Pogis 3rd	–	–	–	–	1	2	4	8	16	32
Marjoram	–	–	–	–	1	2	4	8	16	32
Lord Lisgar	–	–	–	–	1	2	4	8	16	32
Tormentor	–	–	–	–	1	2	4	8	16	32
Oonan	–	–	–	–	1	2	4	8	16	32
Landseer	–	–	–	–	1	2	4	8	16	32
Optimus	–	–	–	–	1	2	4	8	16	32
Jersey Bull of Scituate	–	–	–	–	1	2	4	8	16	32
Hebe	–	–	–	–	1	2	4	8	16	32
Victor Hugo	–	–	–	–	–	1	2	4	8	16
Lord Lisgar	–	–	–	–	–	1	2	4	8	16
Victor Hugo	–	–	–	–	–	1	2	4	8	16
Roxbury	–	–	–	–	–	1	2	4	8	16
Gen'l Scott	–	–	–	–	–	1	2	4	8	16
Europa	–	–	–	–	–	1	2	4	8	16
Europa	–	–	–	–	–	1	2	4	8	16
Mollie	–	–	–	–	–	1	2	4	8	16
Sir Charles	–	–	–	–	–	1	2	4	8	16
Pharos	–	–	–	–	–	1	2	4	8	16
Clement	–	–	–	–	–	–	1	2	4	8
Hebe	–	–	–	–	–	–	1	2	4	8
Lady Mary	–	–	–	–	–	–	1	2	4	8
Fancy	–	–	–	–	–	–	1	2	4	8
Sir Charles	–	–	–	–	–	–	1	2	4	8
Mary Lowndes	–	–	–	–	–	–	1	2	4	8
Victor	–	–	–	–	–	–	1	2	4	8
Potomac	–	–	–	–	–	–	–	1	2	4
Splendid	–	–	–	–	–	–	–	1	2	4
Saturn	–	–	–	–	–	–	–	1	2	4
Saturn	–	–	–	–	–	–	–	1	2	4
Rhea	–	–	–	–	–	–	–	1	2	4
Countess	–	–	–	–	–	–	–	1	2	4
Dick Swiveller, Jr	–	–	–	–	–	–	–	1	2	4
Countess	–	–	–	–	–	–	–	–	1	2
Taintor	–	–	–	–	–	–	–	–	1	2
Comus	–	–	–	–	–	–	–	–	1	2
Comus	–	–	–	–	–	–	–	–	1	2
St. Clement	–	–	–	–	–	–	–	–	1	2
Major	–	–	–	–	–	–	–	–	1	2
Czar	–	–	–	–	–	–	–	–	1	2
Countess	–	–	–	–	–	–	–	–	1	2
Dick Swiveller	–	–	–	–	–	–	–	–	1	2
Dove	–	–	–	–	–	–	–	–	1	2
Diana	–	–	–	–	–	–	–	–	–	1
Custard	–	–	–	–	–	–	–	–	–	1
Prince John	–	–	–	–	–	–	–	–	–	1
Splendens	–	–	–	–	–	–	–	–	–	1
Totals	1	2	7	16	41	92	191	389	788	1,580

or heterozygous condition). The meaning here will be clear if a concrete example is considered. When one brother and sister mating is made 50 percent of the maximum possible number of different ancestors is eliminated. It is at least readily conceivable, if indeed it cannot be said to be highly probable, that no two individuals among higher animals and plants are *exactly* alike in zygotic constitution when *all* hereditary characters are taken into account. This means, in last analysis, that each individual must differ from every other by at least one unit factor, possibly more. Once mating of brother and sister will diminish the number of such differences by 50 percent from what it would have been had no such mating occurred. The number of homozygous individuals *with respect to the hereditary differences remaining,* however, will not increase. This is practically equivalent to saying that while self-fertilization increases the proportion of *individuals* homozygous with reference to all characters, the closest inbreeding other than self-fertilization, if continued, increases the proportion of *characters* with respect to which all individuals are homozygous. Thus while both processes tend towards uniformity in the progeny, it is a different kind of uniformity obtained in a different way, in the one case from what it is in the other.

While in the above discussion only brother $\times$ sister mating is mentioned it is clear that the same reasoning applies regarding the meaning of the coefficients of inbreeding in all other types of mating.

There are other theoretical relations of inbreeding coefficients which are of interest, but to discuss them in detail here is not possible.

Concluding Remarks.

In this paper has been presented in abstract a general method of measuring the intensity or degree of the inbreeding practised in any particular case. The method proposed is shown to be perfectly general. It is based on no assumption whatever as to the nature of the hereditary process. On the contrary it is founded on the most completely logical and comprehensive definition of the concept of inbreeding that it seems possible to formulate. This is, in simplest form, that the most fundamental objective criterion which distinguishes an inbred individual from one not inbred is that the former has fewer different ancestors than the latter. It is believed that the proposed coefficients of inbreeding may be made extremely useful in studies of the problem of the effect of inbreeding, whether in relation to its purely theoretical aspects, or in the practical fields of stock-breeding and eugenics.

Table Showing the Maximum Possible Number of Different Ancestors in the First Twenty Ancestral Generations (Obligate Bisexual Reproduction).

Ancestral Generation.	Maximum Possible Number of Ancestors.	Ancestral Generation.	Maximum Possible Number of Ancestors.
1	2	11	2,048
2	4	12	4,096
3	8	13	8,192
4	16	14	16,384
5	32	15	32,768
6	64	16	65,536
7	128	17	131,072
8	256	18	262,144
9	512	19	524,288
10	1,024	20	1,048,576

Birds-eye View of the Poultry Plant of the Maine Agricultural Experiment Station.

BULLETIN No. 216.

POULTRY NOTES 1911-1913.

By RAYMOND PEARL.

The purpose of this bulletin is twofold. Its first object is to present descriptions of new methods of management, appliances, etc., which have been put into operation on the Station poultry plant, and found to be useful and practical for poultrymen in general. In connection with the investigations in breeding, which constitute the chief work of the Station with poultry, constant effort is made to discover better methods of managing and caring for the birds at all stages of their life history. The results of these practical studies and tests have no place in the reports of the scientific work on breeding. Therefore they are provided for in these Poultry Notes.

The second purpose of this bulletin is to present in brief abstract and in popular form the results of such technical studies on poultry as have not been, and will not be, published in other bulletins from the Station. The original technical reports are published in full in various scientific journals. They are not available for distribution by the Station.

THE VALUE, METHOD OF PRESERVATION, AND ECONOMICAL USE OF HEN MANURE.

One of the most valuable by-products of any live-stock industry is the manure. Its proper care and use is one of the distinguishing features of a successful stock farm. The high nitrogen content of poultry droppings makes them in certain respects the most valuable of farm manures. At the same time this quality necessitates special treatment to preserve the nitrogen and utilize it economically.

According to experiments carried on at this Station some years ago* the night droppings average 30 pounds per hen per year.

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*Woods C. D. and Bartlett, J. M. Ann. Rept. Me. Agr. Expt. Sta. 1903, pp. 199-204.

They contain .8 pound of organic nitrogen, .5 pound of phosphoric acid and .25 pound of potash. At the present price of fertilizers this material would be worth about 20 cents. No data are available on the amount of day-voided dung. Since the hens spend less than one-half their time on the roosts, and since more dung is voided while the birds are exercising than when at roost, the authors estimate that during a year probably 45 pounds of dung are voided by each bird while off the roost. Allowing that more than one-half of the fertilizing elements of the day dung are necessarily lost, the value of the total droppings, if properly cared for, should be at least 30 cents per bird per year

The poultryman or farmer who properly cares for the droppings can add a neat further profit to his business. For example the droppings from 1000 birds, if preserved without needless loss, will be worth at least $300.

Poultry manure contains more nitrogen than other farm manure, because in birds the excretion of the kidneys is voided in solid form (uric acid), with the undigested portions of the food. This form of nitrogen is easily available to plants. Unfortunately, however, it is not stable. Putrifactive processes easily change it to ammonia compounds, and unless special care is taken of the droppings one-third to one-half of the nitrogen passes off as ammonia gas.

The mechanical condition of poultry manure is poor. As Storer* says: "It is apt to be sticky when fresh and lumpy when dry." On this account, if used untreated, it can only be successfully applied to the land by hand, as it does not work well in drills or spreaders. Hen manure used alone is very wasteful of nitrogen as it carries this element in too large a proportion to its phosphorus and potassium.

In the experiments referred to above the problem undertaken by Woods and Bartlett was the determination of a method of treatment of hen manure which would first prevent the loss of nitrogen; second, add sufficient phosphorus and potassium in forms available for plant food to make a balanced fertilizer; and third, so improve the mechanical condition of the dung that it can be applied to the land with a manure spreader. Seven

*Storer, F. H. Agriculture in Some of its Relations with Chemistry. Chas. Scribner's Sons, New York, 1899, Vol. 1.

different methods of treatment were tested. The authors give the following summary of their results.

"By itself, hen dung is a one-sided nitrogenous fertilizer. As usually managed, one-half or more of its nitrogen is lost, so that as ordinarily used it does not carry so great an excess of nitrogen. Because of its excess of nitrogen it will be much more economically used in connection with manures carrying phosphoric acid and potash. As both acid phosphate and kainit prevent the loss of nitrogen, it is possible to use them in connection with sawdust or some other dry material as an absorbent (good dry loam or peat will answer nicely) so as to make a well balanced fertilizer. For example, a mixture of 30 pounds of hen manure, 10 pounds of sawdust, 16 pounds of acid phosphate, and 8 pounds of kainit would carry about .25 per cent nitrogen, 4.5 per cent phosphoric acid, and 2 per cent potash, which, used at the rate of 2 tons per acre, would furnish 50 pounds nitrogen, 185 pounds phosphoric acid, and 80 pounds potash."

At the present price of fertilizing ingredients this mixture is worth about $10.00 per ton. It is a well balanced, stable, fertilizer which, while still not fine enough to work well in drills, can be successfully applied with a manure spreader.

The kind of absorbent used should be the one which can be obtained at least cost, since the amount of plant food added by any of those suggested is negligible, and since they are about equally effective as dryers (the slight acidity of peat gives it some advantage as it helps a little to preserve the nitrogen). It is probably that one of the three can be obtained by any poultryman or farmer at little or no expense.

The absorbent and the acid phosphate and kainit should be kept conveniently at hand and each day when the droppings are collected they should be treated. It may be best to weigh the ingredients a few times, after which it will be possible to make sufficiently close estimates by measure.

The treated droppings should be well sheltered until time to apply them to the land, i. e., shortly before plowing. Any form of shelter may be used. For a temporary plant, or for a small farm, a small wooden building or a bin in a larger building will probably be the best place practicable; but for a large, permanent poultry plant a cement manure shed or tank is advisable.

A general farmer also will find such an equipment for the storage of all farm manure a paying investment. A portion of this shed can be partitioned off for hen manure.

A properly constructed cement building will not have to be constantly repaired and frequently replaced like a wooden structure, which rots out quickly when used for the storage of manure. The cement building is water tight, preventing the entrance of water from without and the escape of any unabsorbed liquid manure. It is, in fact, a perfect permanent shelter.

The New Maine Station Manure Shed.

Last fall (October 1912) this Station built at its poultry plant a manure shed large enough to accommodate the droppings from one thousand adult birds, over a period of a year, and the droppings collected from the range where about three thousand chicks are annually reared.

The inside measurements of this shed are 12x7 feet. It is 5 feet high at the eaves and 8 feet 2 inches to the peak of the roof. It is illustrated in figures 58 and 59.

The droppings are thrown into the shed through trap doors in the roof, and taken out from one end, which is of removable plank. The other three walls, and enough of this end wall to form the grooves which hold the ends of the planks; the floor; and the foundation are formed of one continuous cement mass (monolithic construction). The gables are board. The gable at the open (plank) end of the shed is removable to give more head room, when shoveling the manure into carts. It is held in place by hooks.

It was necessary to place this building on a very heavy clay soil which heaves badly with frost. For this reason it was placed on a much deeper foundation than would be necessary in a more favorable location. The foundation is a solid block of cement and rock, the size of the outside measurements of the shed and extending five feet below the surface of the ground. It was made by using as many rocks and as little cement as was consistent with the formation of a firm solid mass. For a few inches near the top, however, clear cement was used and this was smoothed off at ground level to form the floor. At the edges of this foundation the cement was continued up into the

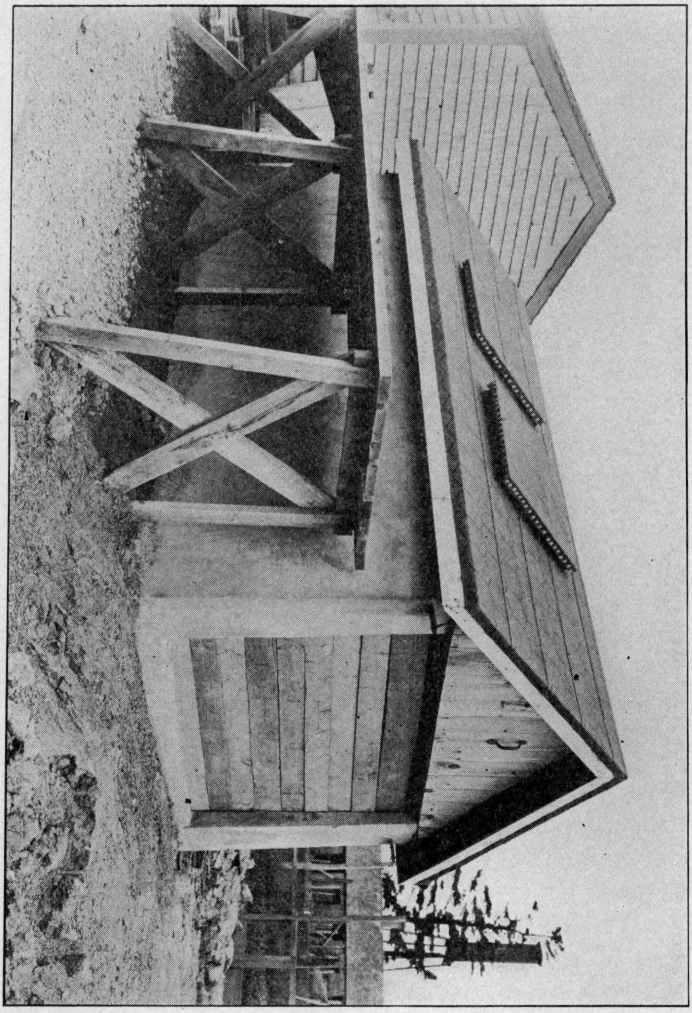


Fig. 58. Photograph of manure shed on poultry plant of Maine Agricultural Experiment Station. Note walk, trap-doors in roof, plank end, and removable gable.

wall forms which were built so that the walls are ten inches thick at the base and six at the top.

An iron bar ending in a ring was set in the cement near the top of the wall at each corner of the building. These rings project a few inches from the end walls. The roof is firmly secured to the walls by bolts passing through it and through these rings.*

*This is an awkward and unnecessary arrangement, and was only used through a misunderstanding on the part of the builder.

As stated above the larger part of one end of the shed is plank. The cement wall is continued on this end only far enough from either corner to provide a place for the slot into which the planks are slipped. This slot is formed by a groove two inches deep and a little more than two inches wide in each end of the cement wall. See Figs. 58 and 59. These grooves were formed by placing angle iron posts within the board forms.

This completes the description of the cement work in the building.

The removable end is of two inch planks which are slipped into the above described slot in the cement wall.

The plates and rafters are of 2x4 timbers. Inch boards were used for roof boards, gables, etc. The gable on the plank end is removable. It is held in position by hooks and is provided with a handle in the center.

The roof is covered with roofing paper. In one side are two trap doors also covered with this roofing. Each of these doors is 2 feet 4 inches x 2 feet 10 inches and fits over a frame in the roof, to which it is hinged at the top. The end of a lath is attached by a double screweye hinge to the inside of each door at the right edge about half way from bottom to top. The edge of this lath is provided with notches which hook over a nail on the inside of the door frame. When hooked this lath holds the door open. A 2x4 strip is nailed across the inside of each door frame a little more than half way from bottom to top. This serves as a rest for the basket when droppings are emptied into the shed.

This shed is placed at the end of the line of poultry houses. The wide raised walk which extends along the entire front of the houses is continued past the shed as a 2-foot walk. Between the last poultry house and the shed the walk is built on an incline so that at the end of the shed it is only 1 foot 8 inches from the eaves. This is a convenient height from which to reach the doors with the baskets of droppings.

The Cost of the Shed.

The itemized cost of this shed is as follows:

Cement	$45.60
Gravel	20.00
Inch boards	17.50

2x4 timber	13.00
2 in. plank	1.20
Finishings	10.00
Roofing	8.00
Labor	70.00
	$185.50

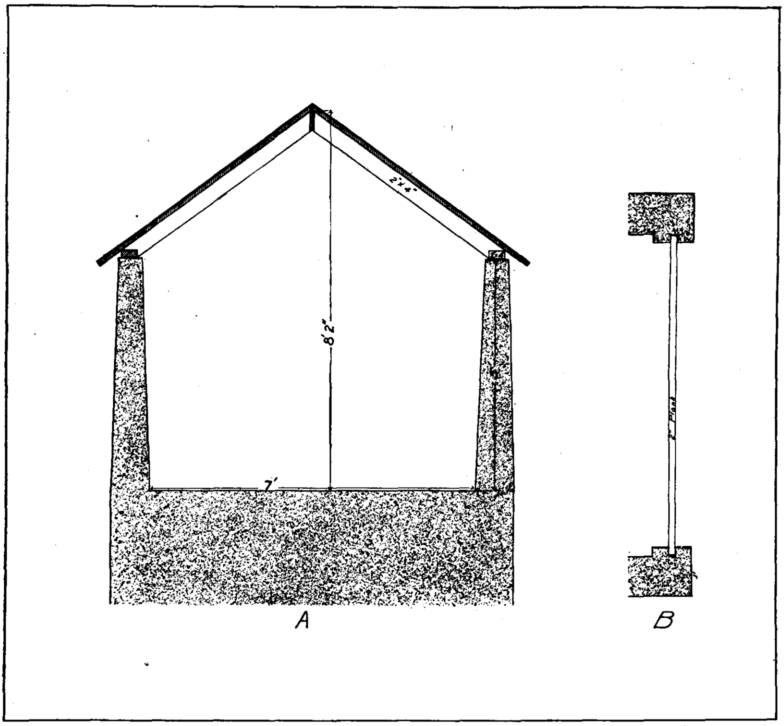


Fig. 59. *A*. Cross section of manure shed, showing dimensions and plan of construction. *B*. Horizontal section of front, showing planks in the grooves in the cement walls.

On many large poultry plants little or nothing is received for the manure. Probably few poultry plants save more than one-half the fertilizing elements possible, if proper methods of treatment and shelter were used. If the droppings are treated by the methods described above, and are kept properly sheltered, the saving on any large poultry farm would in 1 to 3 years easily equal the cost of a permanent shed similar to the one here described.

A CREMATORY FOR DEAD POULTRY.

On every poultry plant and around every farm there are bound to occur from time to time a greater or less number of deaths of chickens and adult fowls from disease or other natural causes. The disposal of these dead bodies offers a problem to the poultryman, the correct solution of which may in many cases become a very important matter. This is especially true in the cases of death from contagious diseases, which include a considerable proportion of the deaths of poultry generally. The method usually practiced by the farmer and poultryman for the disposition of dead carcasses is insanitary in the extreme. To throw the dead bodies on the manure pile is to invite the spread of disease on the plant. Burying is far from being a satisfactory way of dealing with the matter for two reasons. Unless the grave is dug deep, which costs a good deal of time and labor, there is considerable likelihood that dogs or other marauding animals will dig out the carcasses, and, after feeding on them, scatter the remains around on the top of the ground. Furthermore, burying cannot be resorted to at all during the winter months when the ground is frozen.

The only really sanitary method of dealing with dead bodies is to incinerate them. The difficulty of following this plan in practice is that the farmer or poultryman usually does not have any suitable source of heat ready at hand at all times. To be sure, during certain seasons of the year, those poultrymen who employ large brooder houses with a hot water heating system have a furnace in operation, and the dead chicks can be burned up in the furnace. This, however, covers only a part of the year. At other times resort must be had to burying or some other means of disposal, as the poultryman is not likely to fire up a large furnace for the sake of burning a few dead birds.

At the Station plant it has been felt for some time that it was desirable to have a small crematory conveniently located, and so easy and economical of operation that dead birds could be disposed of immediately, with a minimum amount of trouble and labor. To meet this requirement there has recently been devised the small crematory here described. The construction was carried out with the idea of keeping the first cost as low as possible, in order that there should be nothing about it which any poultryman or farmer could not easily afford to duplicate. As a matter of fact, the cost of materials for the crematory here described was less than ten dollars. The labor was done by the poultryman and his assistant at odd times, when an hour or two could be spared for this work. The result is, therefore, not beyond the reach of any poultryman or farmer. At the same time the crematory is so satisfactory in operation that anyone who builds one will wonder, after he has completed and used it for a time, why he did not long before have so simple and sanitary an adjunct to his plant.

The crematory shown in Figure 60 is very simple in construction. It consists essentially of a cement base or fire box, bearing on its top a series of grate bars which are in turn covered by a cremating box or oven in which the material to be incinerated is placed.

The crematory here described is sufficiently large to take care of all the needs of a plant carrying 1000 head of adult stock, raising 3000 to 4000 chickens annually, and in which a good deal of anatomical and physiological research is going on, necessitating a much larger amount of waste animal material than the ordinary commercial poultryman would have. Therefore, it is doubtful if it would be necessary in any but the very largest commercial plants to build a larger crematory than the one here described.

In building this an excavation was first made for the base, in which a lot of loose stones and gravel were placed, in order to secure adequate drainage below the cement. On top of this the cement base and fire box were made.

This base consists essentially of a rectangular box made of cement, open at the top, and with a small opening in front through which the fire is fed and which serves as a draught. The walls are about 6 inches thick. The outside dimensions of the fire box base are 3 feet, 4 inches by 2 feet, 6 inches. The inside dimensions of the fire box are 2 feet, 3 inches by 1 foot, 9 1-2 inches by 1 foot, 4 inches. Across the top of the fire box there were laid, while the cement was still soft, some old grate bars from a small steam boiler, which had been discarded and thrown on the dump heap. These were set close together and held firmly in place when the cement hardened. They form the grate on which the material to be incinerated is thrown. These old boiler grate bars, besides costing nothing, had another advantage; namely that of their thickness and weight. When they become thoroughly heated from the fire below they will hold the heat for a considerable time charring and burning the animal material above.

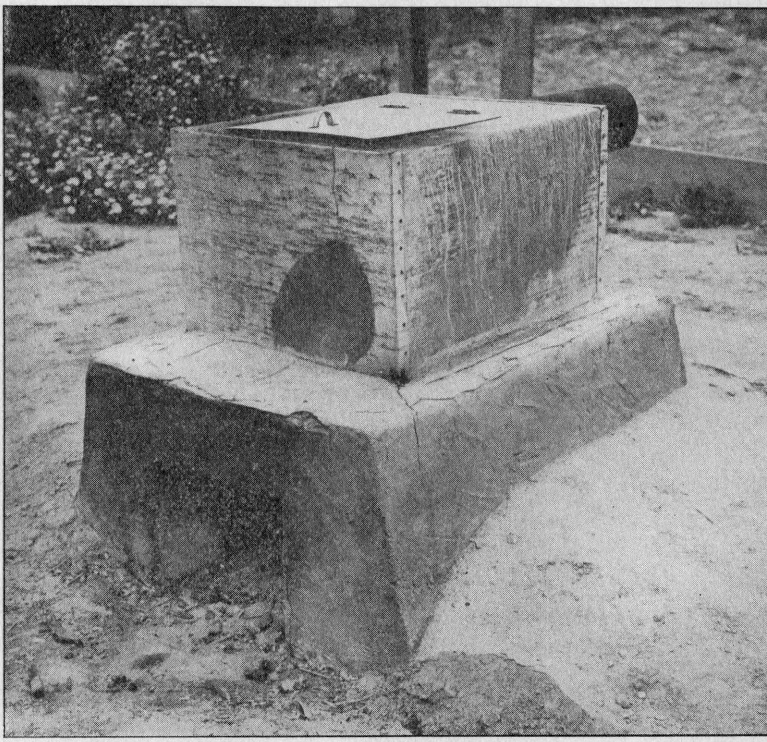


Fig. 60. Photograph of crematory described in text. Note cement base, with opening in front into fire box; galvanized iron cremating box on top; cover of cremating box.

The incinerating chamber proper was made from galvanized iron by a local tinsmith. This consists of a rectangular box having the following dimensions: Length 2 feet, 2 inches;

width 1 foot, 10 inches; height 1 foot, 6 inches. In the top of this is cut a round hole, 12 inches in diameter which is protected by a hinged cover 15 inches by 14 1-2 inches. This galvanized box has no bottom. It is placed on top of the grate bars, and held firmly in place by cement worked up around its lower edges. At the back end of this iron cremating box is an opening for a stove pipe, which is necessary in order to give the proper draught. It is found in practice that only a short piece of stove pipe is necessary to get sufficient draught to make a very hot fire, which entirely consumes the birds in a few hours. The funnel may best be left removable so that when the crematory is not in use it can be taken off and stored inside the wooden box, which then sets over the galvanized iron portion to protect it from the weather.

It is important in locating a crematory of this kind to plan matters so that there will be good drainage from around it. In particular pains should be taken to insure that water does not run into the firebox and freeze during the winter.

In operation the apparatus works as follows: Dead birds are thrown into the incinerating chamber through the opening in the top and the lid closed, while a wood fire is burning in the fire box below. The aim should be to use dry wood and get a quick and very hot fire. This first roasts the material and then chars it, and finally reduces it to fine ashes.

An Improved Range Feed Trough.

The type of slatted feed trough used here in feeding growing chickens on the range, and described in "Methods of Poultry Management at the Maine Stations" (Circular 471), is open to certain objections. It is very difficult to keep the grain dry in it in wet, stormy weather. Furthermore, the fact that very small chickens cannot use this type of trough entails additional labor. There must be flat boards with narrow rims for the very young chickens in addition to the range troughs for the older chicks. An improved range trough devised by the Station poultryman, Mr. Frank W. Tenney, obviates both of these disadvantages and has other points to recommend it. The essential features of this trough are shown in Figs. 61 to 63. The improvements consist, first, in making the slatted front of the trough removable as a whole, leaving then a flat board bottom with a rail in front of it an inch high to hold the grain in place. With the slat front removed the trough duplicates the conditions of the flat chick feeding board, used by many poultry keepers for feeding chicks during the first two or three weeks of life. As the chicks grow older this slatted front can be put on the trough and held in place with the hooks and eyes shown in the photograph.

A second improvement consists in hinging the top rather than making it in one piece and removing as a whole, as was the case with the older feed troughs at this Station. It will be noted that this feed trough is open to the birds only from one side. The reason for this arrangement is that it is designed to place the feed troughs in holes cut in the longitudinal fences in the range yards, with the back part of the trough and the hinged cover extending into a long walk running the whole length of the range behind the yards. In this way the troughs can be filled from the outside without the necessity of going into the yard, opening gates, etc., thus reducing the labor cost of operation considerably.

Of course it is entirely possible to make troughs in accordance with the principle of this improvement, with removable slatted openings on both sides, to be set down in the middle of the yards so that the birds can get at the feed from both directions.

The dimensions of the troughs as used here are those given in the following table. It is, of course, not essential that these dimensions be absolutely followed in building feed troughs according to this principle, particularly the length dimensions. The dimensions of the boards forming the roof, however, and their angle, are of more or less importance since actual trial has shown that when built as here pictured and described the grain will keep dry in the trough even in driving showers or storms. A strip of canvas keeps the hinged joint of the roof dry.

Dimensions of Feed Trough.

Length	8	ft.	4	inches
Height to peak	1	"	6	"
Width at bottom			3	"
Width at widest point			9½	"
Height of front opening			12½	"
Width of roof boards (front and back same)			11	"

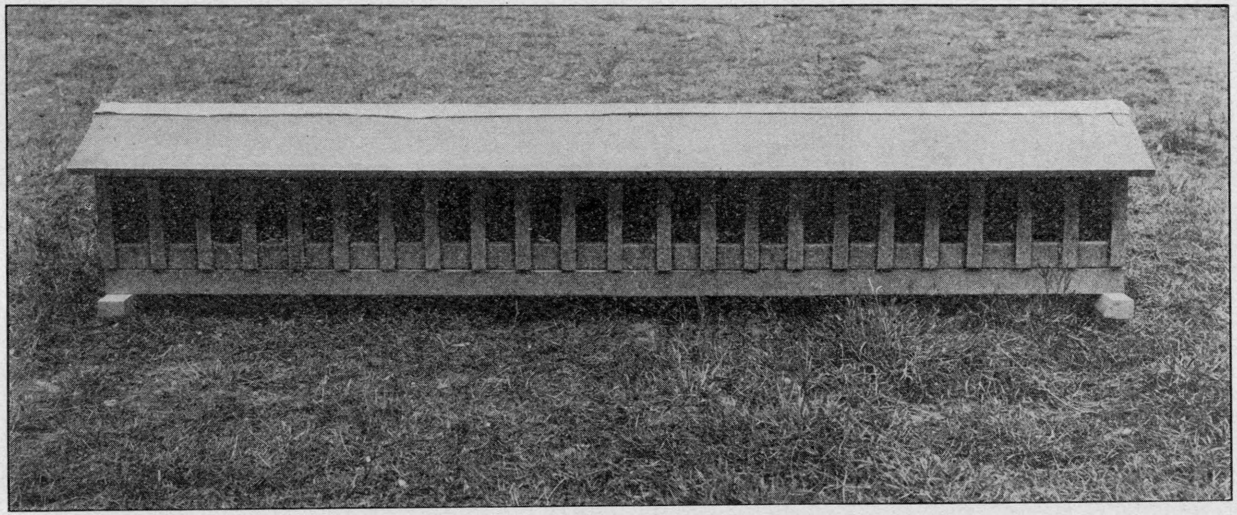


Fig. 61. Front view of feed trough, with slats in place. For large chickens.

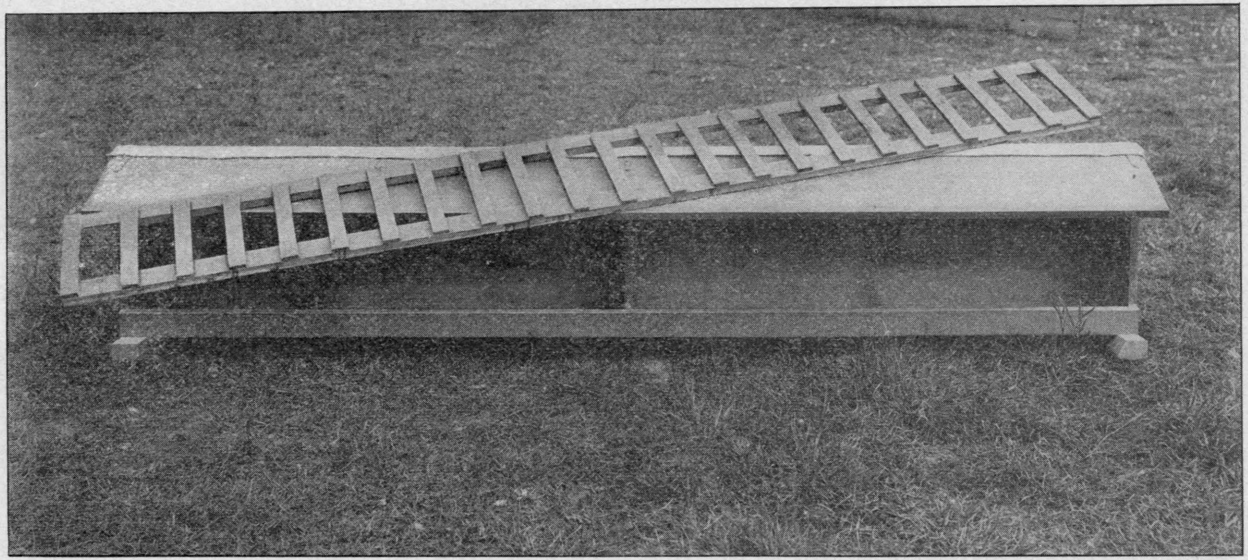


Fig. 62. Front view of feed trough with slats removed and laid across top. This trough is now in condition for the use of very small chicks.

Natural Enemies of Poultry.

One of the chief difficulties that the poultryman has to contend with is the continued loss of chicks, and sometimes even of nearly full grown birds, as a consequence of the depredations

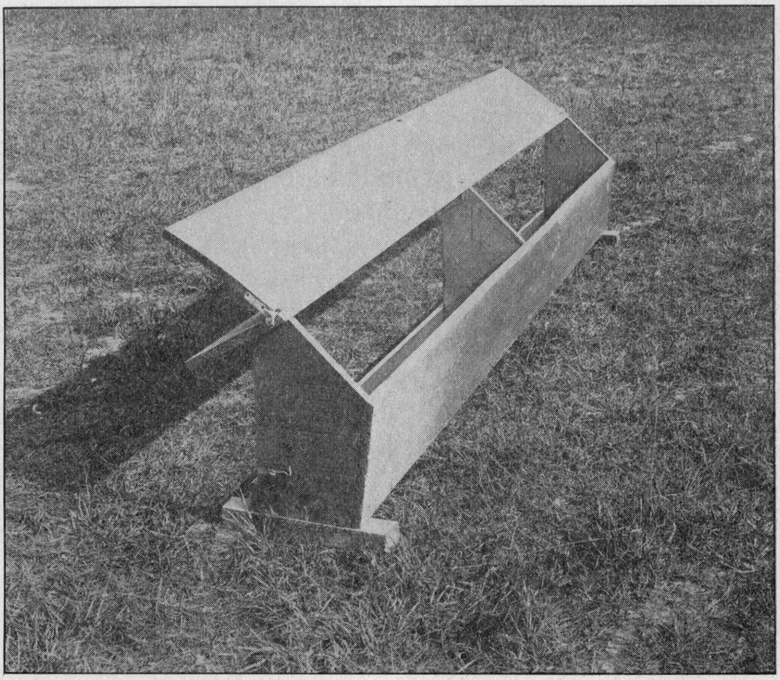


Fig. 63. End and top view of trough with cover open and slatted front removed. Note hook which holds front in place.

of natural enemies. It is safe to say that the magnitude of the loss from this source is not anything like fully realized by any one who has not kept an accurate account of all his birds. In the experimental breeding work with poultry at the Maine Station it is necessary to keep account of every bird on the plant. It has, therefore, on this account been possible to check up and form an adequate estimate of the losses due to the creatures that prey upon poultry. A good deal of attention has been devoted to the problem of how these losses may be cut down and the results of this experience may be of benefit to other poultry keepers.

In the experience of this Station the most destructive natural enemy of poultry in the long run has been found to be the crow. The depredations of the hawks are more spectacular perhaps, but in the long run far less destructive. A hawk will only visit a poultry yard occasionally, and especially if he is shot at once or twice will be very wary about approaching it again. On the contrary the crow is a steady and persistent robber. He will continue his depredations just as long as it is physically possible for him to do so. While there may be some doubt as to whether crows are beneficial or harmful as regards other phases of agriculture, there can be no question that, so far as the poultry man is concerned, the only good crow is a dead one. For a number of years the crows killed and either carried away, or left behind partly eaten, a large number of chicks on the Station poultry plant. The losses were not by any means confined to the small chicks, but half grown birds, each nearly equal in weight to the crow itself, were killed, partly eaten, and left behind on the range.

One after another all the devices which had been suggested by others, or could be thought of by those in charge of the poultry work, were tried in order to stop these ravages. In a single year the crows destroyed something over 500 chicks. One important reason for these heavy losses is the location of our poultry range. It borders upon a pine forest in which the crows congregate in great numbers. In the case of a range farther from the woods, the losses, without protection, would not be nearly so heavy. Various sorts of "scare-crows" were tried but with no effect whatever. Dead crows were hung up on stakes about the yards as solemn warnings to their fellows, but instead of operating as warnings they appeared rather to serve as "invitations to the dance." Decoying the birds in various ways so that they might be shot was tried, but with very slight individual success and no substantial effect on the steady losses. Poisoning is reported to have been used with success in other places, but has never been tried on the Station plant. It is doubtful whether it is justifiable, save under very exceptional circumstances. The point is that it is difficult to manage affairs in such way as to insure that only the crows will get the poison. There are so many useful and valuable animals about the farm that easily might get the poison before the crow did, with a resulting loss greater than that caused by the crow, that it would seem wise to resort to poisoning only when it can be done under well controlled conditions.

The plan which has finally been adopted at the Station poultry plant for dealing with crows is one which is perfectly safe and sure in its operation. It consists simply in running strands of binder twine about two feet apart over the whole of the poultry range occupied by the young birds, until they reach such size that they are able to take care of themselves. These strings are run over the tops of the brooder houses, and on supports made by cross strands of either wire or two or three strings of binder twine twisted together. These cross strands are held up where necessary by posts. The whole network of strings thus formed is put at such height that the attendants in working about the yard, will not hit the string when standing upright. The area covered in with strings in this way on the Station poultry plant is usually about 3 acres per year. The expense of covering this area is from $15 to $20 for twine. The labor of putting it up is comparatively small. It forms a perfect and complete protection against both crows and hawks.

The appearance of the range when covered with strings is shown in figure 64.

Next in importance to the predaceous birds, as poultry enemies, stand the rats and the foxes. In times past foxes have destroyed many chickens from the Station's poultry plant. Of late years, however, none has been lost. The protection is afforded by a fox proof fence surrounding the whole plant. Rats may become a very serious pest. They live under the brooder houses and take the young chicks. Various methods have been tried at the Station, but no wholly satisfactory way of dealing with rats has yet been found. Trial was made some years ago of one of the most widely advertised of the bacterial rat destroyers, which when fed to rats is supposed to induce a disease which kills them all. No effect whatever was observed to follow the use of this preparation. The rats ate freely of grain which had been moistened with it and if any disease developed as a consequence it has not yet benefited us, or perceptibly inconvenienced the rats. Digging the rats out of their holes

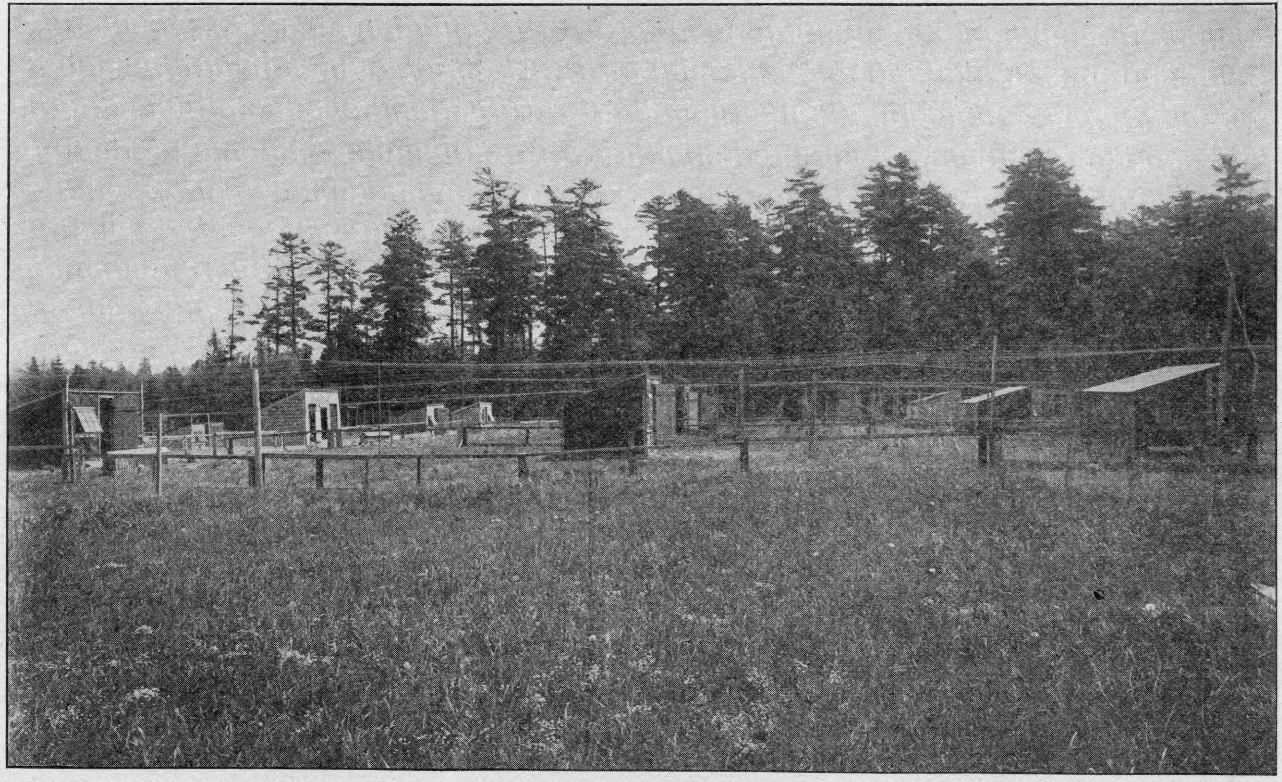


Fig. 64. Showing poultry range in 1913 covered with strings two feet apart, as a protection against crows and other predaceous birds.

and shooting them is one effectual method of dealing with them. Several good cats on the place also aid materially in fighting this pest. A systematic trapping campaign is productive of good results. It must, however, be continued without interruption over a considerable period of time. Desultory trapping produces little effect on the rat population. A thorough-going campaign, however, tends to drive the uncaught rats away from the premises.

Green Food for Poultry.

During recent years an increasing amount of attention has been paid by poultrymen everywhere to the furnishing of green food to their fowls during the winter months, when it is impossible, in northern parts of the country, at least, for the birds to get fresh succulent pasturage out of doors. General experience seems to teach that an addition of green succulent food to the ration of laying hens tends to keep them in better physical condition and helps towards a better egg production. On the poultry plant of the Maine Station considerable attention has been given to this matter of supplying green and succulent food and as a result of experience extending now over a number of years, a satisfactory scheme of furnishing this necessary part of the ration under our conditions has been worked out.

To be satisfactory not only must the green food given to poultry be of the proper kind to give good results in egg production, but also it must be something which can be produced and handled at small cost. Furthermore a factor which is frequently lost sight of is that fowls need something besides succulence in their so-called "green" food. There is a distinction between a succulent fodder and a "green food" in the strict sense. One can supply succulence in the form of root crops such as mangolds. A careful consideration of the case, however, indicates that apparently the fundamental need of the fowls is not for succulence as such, but rather for the tonic effect which is produced by green plants, probably primarily because of the presence of chlorophyll. In feeding fowls for high egg production it is neessary that they be given a ration rich in protein. Only fowls of strong constitution, and with thoroughly sound digestive systems, can handle the heavy laying rations carrying meat scrap and oil meal, which are now so widely used by poultrymen for egg production with successful results. On these heavy rations there is always a tendency for the birds' livers to become impaired in function, and ultimately to become enlarged and diseased. As the matter has been studied here it would appear that one of the chief functions of green food in the ration is to counteract this tendency of the digestive system, and especially the liver, to break down under the strain of handling heavy laying rations over a long period of time. It would appear that the green food given to poultry acts primarily rather as a mild tonic than as a food in the proper sense. There seems to be very little of this tonic effect produced from succulent non-green foods like mangolds.

The practical problem then becomes to devise a system which shall insure a supply of green food for the birds at all seasons of the year. The following system of rotation in the green food supply has been in use for several years on the poultry plant here with satisfactory results. It should be said that, owing to the small area of ground available for the poultry work at the Station in relation to the number of birds it is necessary to carry, green food must be added to the ration practically throughout the year, not only for the adult fowls in the laying houses, but also for the chicks growing on the range.

Beginning in the early fall when the pullets are put in the laying house they are given green corn fodder cut fine in a fodder cutter. Stalks, leaves and ears are cut together in pieces averaging about 1-2 inch in length. The birds eat this chopped corn fodder greedily. It is one of the best green foods for poultry that we have yet been able to find. Its usefulness is limited only by the season within which it is possible to get it. The feeding of corn fodder is continued until the frost kills the plants.

When the corn can no longer be used cabbage is fed. The supply of this usually lasts through December. In the event of the supply of cabbage failing before it is desirable to start the oat sprouter* the interval is filled out by the use of mangolds. From about January 15 to May 15 green sprouted oats

*For description of the method of sprouting oats used at the Station see "Methods of Poultry Management at The Maine Agricultural Experiment Station." Circular 471. pp. 50-54.

from the source of green food. From about May 15 until the corn has grown enough to cut, fresh clover from the range is used. During the summer the growing chicks on the range are given rape (Dwarf Essex) and green corn fodder cut as described above, to supplement the grass of the range, which rather rapidly dries out and becomes worthless as a source of green food under our conditions. The very young chicks in the brooders are given the tops only of green sprouted oats chopped up fine.

Dwarf Essex rape is an excellent source of green food for poultry but it must be fed with great caution to birds which are laying because if eaten in any considerable amounts it will color the yolks of the eggs green, with disastrous results in the market.

Technical Studies on Poultry Already Published.

A considerable portion of the more technical scientific work of the department of biology of the Station, which has in charge the work with poultry, is published in current biological journals, not readily accessible to the agricultural public. It is the purpose of the present section of this bulletin to give briefly the essential points brought out in certain of these technical studies which have been published during the period covered by the present bulletin.

HOW THE WHITE OF THE EGG IS MADE.*

The oviduct of a laying hen is divided into five main parts, readily distinguishable by gross observation. Beginning at the anterior end of the organ these parts, in order, are: (a) the infundibulum, or funnel, (b) the albumen secreting portion,

*This is an abstract of a more extended paper by Raymond Pearl and Maynie R. Curtis having the title "Studies on the Physiology of Reproduction in the Domestic Fowl. V. Data regarding the Physiology of the Oviduct," published in the Journal of Exper. Zoölogy, Vol. 12, pp. 99-132. 1912.

(c) the isthmus (d) the uterus or "shell gland" and (e) the vagina. These parts are shown in Figure 65.

Each of these parts is generally supposed to play a particular and exclusive role in the formation of the protective and nutritive envelopes which surround the yolk in the complete egg as laid. Thus the funnel grasps the ovule at the time of ovulation; the glands of the albumen region secrete the different sorts of albumen (thick and thin) found in the egg; the shell membranes are secreted in the isthmus; and finally the glands of the uterine wall secrete the calcareous shell. This is in brief, the classical picture of the physiology of the oviduct.

For some years past experiments and observations have been systematically carried on in the Biological Laboratory of the Maine Station with the object of acquiring a more extended and precise knowledge of the physiology of the hen's oviduct than is to be gained from the literature. It is the purpose here to present a certain part of the results which have been obtained regarding the physiology of two of the lower divisions of the duct, namely the isthmus and the uterus. Our results indicate that these portions of the oviduct perform certain functions which have not hitherto been observed or described.

So far as the existing literature indicates, the opinion has been held by all who have worked upon the subject that the particular functional activity of each portion of the oviduct (as above described) is *limited* to that portion. Thus it is commonly held that when an egg in its passage down the oviduct leaves the albumen portion it has all the albumen it will ever have; when it leaves the isthmus it has all its shell membrane; and when it leaves the uterus all its shell. On this prevailing view there are in the albumen portion only albumen secreting glands, in the isthmus only membrane secreting glands, and in the uterus only shell secreting glands. The entire truthfulness of this assumption was first made doubtful by the observation, frequently made in connection with routine autopsy work, that (a) eggs in the isthmus with completely formed shell membranes, and (b) eggs in the uterus, bearing in addition to the complete shell membranes a partially formed shell, weighed considerably less than the normal average for laid Barred Plymouth Rock eggs. This observation led to an inquiry as to

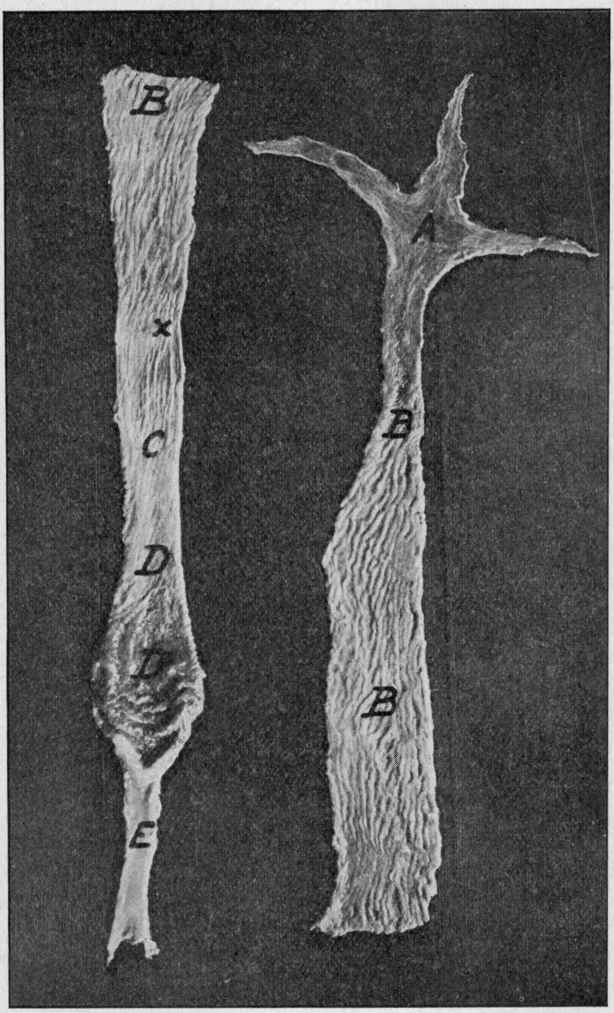


Fig. 65. Photograph of a hen's oviduct which has been removed, slit longitudinally throughout its length and opened out flat in order to show the gross anatomy. In order to get the whole duct on the photographic plate it was necessary to transect it at about the middle. *A*, the infundibulum. Note muscle fibers in wall and absence of any extensive gland development. *B*, albumen secreting portion; note heavy glandular development. The albumen portion ends and the isthmus begins at *x*. The line of demarcation is very distinct in the freshly prepared oviduct. *C*, the the isthmus. *D*, the uterus or shell gland. *E*, the vagina. About one-third natural size.

whether this apparently lower weight of presumably completed, but not laid eggs, as compared with those which has been laid, was a real phenomenon of general occurrence, and if so to what it was due. Does the egg increase in weight after the formation of shell membranes and shell merely by the absorption of water or by the actual addition of new albumen?

Observations and Experiments.

In the normal egg of the hen there are certainly three and possibly four different albumen layers which can easily be distinguished on the basis of physical consistency. These are: (*a*) the *chalaziferous layer*. This is a thin layer of very dense albuminous material which lies immediately outside the true yolk membrane. It is continuous at the poles of the yolk with the chalazæ, and is undoubtedly formed in connection with those structures. It is so thin a layer that it might well be, and often has been, taken for the yolk membrane. (*b*) The inner layer of *fluid* (thin) *albumen*. This layer is only a few millimeters in thickness and there is some doubt as to its existence as a separate distinct layer. (*c*) The *dense albumen*. This is the layer which makes up the bulk of the "white" of the egg. It is composed of a mass of dense closely interlaced albumen fibres with some thin albumen between the meshes of the fibrous network. The dense albumen as a whole will not flow readily but holds itself together in a flattened mass if poured out upon a plate. (*d*) the outer layer of *fluid albumen*. This is the principal layer of thin albumen, which makes up the fluid part of the "white" observed when an egg is broken.

In order to determine when and where these different layers were added to the egg, particularly the last one (*d*), hens having an egg in the oviduct were killed and the location and condition of the egg determined. Many such autopsy records agree in showing that *the egg does not receive the outer layer of thin fluid albumen (layer d) during its sojourn in the so-called albumen secreting portion of the oviduct.*

A single illustrative protocol may be cited here. *Autopsy No. 301.* Hen No. E. 39. July 14, 1909.

When this bird was killed an egg was found at the lower end of the albumen portion of the oviduct just about to enter the isthmus. Not yet having entered the isthmus the egg had no shell membrane upon it. It consisted merely of a yolk surrounded by albumen. The outermost layer of this albumen was dense and corresponded to layer *c* described above. There was no trace of thin albumen (layer *d*) on this egg although it was just on the point of leaving the so-called albumen region of the oviduct.

The successive autopsy records reported in the complete paper show that beginning with an egg 11 cm. away in front of the isthmus and going downwards in the duct until the actual boundary of the isthmus is reached, there is no qualitative change in the albumen secretion. Whatever albumen is added to the egg immediately prior to the formation of the shell membrane, is of the dense fibrous variety (layer *c*), so far as direct observation indicates.

In cases where one-half of the egg lies within the isthmus and bears a membrane, while the other half is in the albumen portion and has no membrane, it can plainly be seen that *the shell membrane is deposited directly on the outer surface of the thick albumen (layer c) and that no trace of the thin albumen (layer d) is present at the time the membrane is formed.*

A detailed and careful study of the weights of the several parts of the egg (yolk, albumen, shell membranes) in eggs taken from different levels of the oviduct, leads to the following results.

When the egg leaves the albumen portion of the oviduct it weighs roughly only about a half as much as it does when it is laid. Nearly all of this difference is in the albumen. Thus these weighings fully confirm the conclusion reaches from direct examination of the eggs, as already described. The evidence shows that the egg gets all of its thin albumen (layer *d*), which constitutes nearly 60 per cent by weight of the total albumen, only *after* it has left the supposedly only albumen secreting portion of the oviduct, and has acquired a shell albumen, and the shell is in process of formation.

The weighings show that in general the farther down the oviduct the egg proceeds the more albumen it gets. Very nearly one-half the total weight of albumen of the completed egg is added in the uterus, an organ hitherto supposed to be entirely devoted to shell formation Clearly much more albumen is added to the egg in the uterus than in the isthmus. This, of course, does not necessarily mean any more rapid rate of secretion in the uterus, because of the time element involved. The egg stays much longer in the uterus than in the isthmus.

The rate of albumen secretion per unit of time as the egg passed down the oviduct was determined, and was found to be expressed by a parabola,

$$y=17.5915x-.8171x-0.4164$$

in which y denotes percentage of albumen and x time in hours during which the egg has been in the oviduct. This relation is shown in Figure 66.

There is scarcely any diminution in the rate of secretion until nearly the total amount has been acquired by the egg. There is not the slightest evidence of any break in the rate of secretion of albumen after the egg leaves the so-called "albumen portion" of the duct. From the time the yolk enters the upper end of the "albumen portion" there is a gradual diminution of the rate of secretion of albumen, giving rise to the parabolic curve. But there is no sudden change. The egg gets more than half of its total albumen after it leaves the "albumen portion" of the duct and it takes this at nearly the same rate as it did the earlier part.

While the two lines of evidence already presented amply demonstrate that the "thin" albumen is added to the egg after it leaves the so-called albumen portion of the duct, it seemed advisable, because of the novelty of the results, to collect still further evidence of another kind. This evidence has to do with the nitrogen content of the albumen in eggs taken from different levels of the oviduct.

The point of greatest interest and importance in connection with these chemical data hinges upon the *absolute* amount of nitrogen in the albumen. Since it is solely the "thin" albumen layer which is added after the egg leaves the so-called albumen portion of the oviduct the possibility is at once suggested that what happens in the lower portions of the duct is not a true secretion of another albumen layer but merely a taking up of of water from the blood by osmosis, and a dilution or partial solution of the "thick" albumen already present. Such a view assumes in other words that all that is added to the albumen after the egg enters the isthmus is water.

Clearly the only way to test finally the validity of this idea is to make chemical determinations. What the figures from the analyses show is that the oviduct egg *has absolutely less nitrogen in its albumen than the normal laid egg of the same hen.* This, of course, is what would be expected if there is an actual

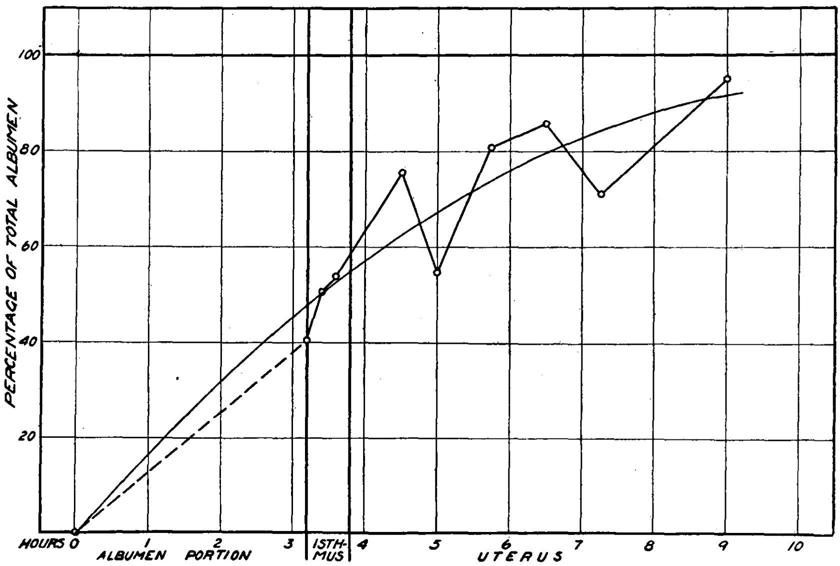


Fig. 66. Diagram showing what percentage of the total amount of albumen present in the normal laid egg is present at successive levels in the oviduct. The smooth curve is the parabola for which the equation is given in the text.

secretion of albumen by the glands of the isthmus and uterus, and this secretion is added to the egg. It means that these oviduct eggs have been removed before they received their full amount of albumen. If it were the case, on the contrary, that only water was added to the egg after it left the albumen portion of the duct, it would be expected that the amount of nitrogen would be the same in an oviduct egg from the isthmus or uterus as in the normal laid egg. *The chemical data clearly indicate that there is a definite addition of albumen to the egg in the isthmus and shell gland and that the "thin" layer does not represent solely a dilution of the "thick" layer.*

Summary of Results.

Putting all the evidence together the following account of the processes by which the hen's egg acquired its protective and nutritive coverings summarizes the results of the present study.

1. After entering the infundibulum the yolk remains in the so-called albumen portion of the oviduct about three hours and in this time acquires only about 40-50 per cent by weight of its total albumen, and not all of it as has hitherto been supposed.

2. During its sojourn in the infundibular and albumen portions of the duct the egg acquires its chalazæ and chalaziferous layer, and the "thick" albumen layer.

3. Upon entering the isthmus, in passing through which portion of the duct something under an hour's time is occupied instead of three hours as has been previously maintained, the egg receives its shell membrane by a process of discrete deposition.

4. At the same time, and during the sojourn of the egg in the uterus, it receives its outer layer fluid, or "thin" albumen which is by weight 50-60 per cent of the total albumen.

5. This "thin" albumen is taken in as a dilute fluid by osmosis through the shell membranes already formed. The fluid albumen added in this way diffuses into the dense albumen already present, dissolves some of the latter and so brings about its dilution in some degree. At the same time the fluid albumen is made more dense in this process of diffusion, and comes to have the consistency of the thin albumen layer of the normal laid egg. The fluid albumen taken into the egg by osmosis is a definite secretion of glands of the isthmus and uterus.

6. The addition of albumen to the egg is completed only after it has been in the uterus from 5 to 7 hours.

7. Before the acquisition of albumen by the egg is completed a fairly considerable amount of shell substance has been deposited on the shell membrane.

8. For the completion of the shell and the laying of the egg from 12 to 16, or exceptionally even more, hours are required.

BULLETIN No. 217

WOOLLY APHID OF THE APPLE.*

(*Schizoneura lanigera*)

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.

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

*Papers from the Maine Agricultural Experiment Station: Entomology No. 67.

**There are other elm aphids belonging to this same genus which do not migrate to apple. In order to avoid confusion those are treated in a separate bulletin soon to be published by this Station.

†*Pemphigus tessellata* (*acerifolii.*)

‡*Pemphigus tessellata* (*acerifolii*) and *Pemphigus aceris.*

and their colonies are thus readily detected by the masses of white "wool" which renders them conspicuous. Figs. 68, 69 and 78.

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. 77.

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. 74.

In August and later, among the wingless ones, winged females appear in abundance. Fig. 73. 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. I have not yet observed under out-door conditions the return of the fall migrant to the elm, but I have repeatedly during two years observed the spring migration from elm to apple and mountain ash and the subsequent development of the summer colonies so that there is no doubt that the species returns to the elm for the deposition of the winter egg. 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, with the exception of a statement* that in South Africa, *lanigera* does not produce any alate forms at all in the fall.

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."

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

*Moore: So. Af. Ag. Journal. Sept. 1912, p. 428.

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 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. 70) producing the next generation. The antenna is shown in Fig. 79.

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. 72. Their progeny are the third generation and attain wings. These winged aphids are known as the springs 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. 71. 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

*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.

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. 78, 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. 78). 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. 69. 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) 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.

*Previously recorded in Journal of Economic Entomology, Vol. 5, No. 5, 1912.

The elm leaf aphid which has been here under discussion as migrating to apple, mountain ash and hawthorn is the common elm leaf species making a leaf cluster or "rosette" (Figs. 70 and 71) on the American elm, composed of terminal leaves more or less bunched together. 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 everywhere some years and comparatively rare during other seasons.

Fig 67 shows a different type of leaf deformation common on elm which is designated as "leaf curl" or "roll". Three different species of aphids belonging to the same genus (*Schizoneura*) produce this type of pseudogall in America.* One of these elm leaf curlers migrates to apple; another appears to be the English species which migrates to the roots of currants and gooseberries; and the destination of the third is at present unknown. The second and third species will be treated in further detail in a separate bulletin, this paper being concerned only with the elm-apple aphids.

Whether the leaf curler which migrates to apple is a distinct species from the form which inhabits the rosette, I am not at present prepared to state. The apterous viviparous generations have the same general type of wax glands (Fig. 72), the winged generations accord in characters.

It seems quite possible that under different conditions (as weather or the size or position of the leaf attacked) that the same species might produce two types of elm leaf deformation. However that may be it was Missouri migrants from such leaves as the one shown in Fig. 67 that gave me my first successful transfer test under control conditions.

Through the kindness of several southern entomologists, elm leaf curl in considerable abundance with winged forms ready for migration was secured in May, 1912, thus lengthening the season for purposes of experimenting. These migrants, as previously explained (Science, Vol. 36, pp. 30-31), were caged over apple seedlings greenhouse-grown for the purpose, the seeds having been planted in December 1911 and January 1912. A few very successful colonies of woolly aphids were thus established on apple seedlings by the progeny of the elm migrants, the earliest of which was one started by migrants received May 12. (Fig. 68). The fall migrants of this colony were mature and taking flight September 20-23.

So far as I am at present able to judge, the progeny of these migrants from leaf curl and the progeny of migrants from rosette both look and behave identically alike. Certainly if they prove to be distinct it will

*Since Bulletin 203 went to press last year, significant collections both from Maine and other parts of the country have come to my attention which have added much to our knowledge of these species concerning which much still remains to be learned.

be a difficult problem to decide which is *lanigera!* The other two leaf curlers, however, are certainly distinct.

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 182 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 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

*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.

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 really are 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 production of about a dozen nursery firms. The bulk of the seed used comes from France, and therefore is of the same stock as the imported French seedlings."

Mr. Lohrenz (1911) in recording observations on two-year-old nursery stock made at three nurseries containing respectively about 30,000; 45,000; and 300,000 trees, states that he found from 20 per cent to 25 per cent of the trees infested by the woolly aphid.

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.	APPLE: Alternate Host.
EGGS. (Under bark all winter)	NYMPHS. (Hibernating young, migrating to trunk or branches in early spring)
STEM-MOTHER. (first generation in leaf. Apterous viviparous females).	
SECOND GENERATION. (apterous viviparous females in leaf)	SEVERAL GENERATIONS.
SPRING MIGRANTS Migrate to apple . . . . → (third generation. Alate viviparous).	
	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. Antennae without annulations.

B. Females.

C. Viviparous.

D. Antenna typically 5-jointed, Fig. 79. Wax glands not of type shown in Fig. 72. First spring generation hatched from over-wintering egg and found in elm rosette early in June ....*Stem Mother.*

DD. Antenna 6-jointed. Fig. 80. Wax glands as shown in Figs. 72 and 80. Progeny of stem mother developing in rosette in June ....*Second Elm Generation.*

DDD. Antenna 6-jointed. Fig. 82. Wax glands of same type as those shown in Fig. 72. 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. 75. 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. 76. Rarely seen but easily obtained by imprisoning fall migrant in vial......*True Male.*

AA. Alate forms. Antennae with annulations.

B. Antenna typically with III as long as or longer than IV+V+VI. VI typically without annulations. Fig. 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. Figs. 83, 84, 85. Developing in fall in woolly colonies on bark of apple, hawthorn and mountain ash. Fig. 73. Progenitor of true males and females ....*Fall Migrant*

HABITAT KEY.

Woolly Aphids of the Elm.

Those species not migrating to apple are to be treated in a separate bulletin but a key is given here to aid in distinguishing the woolly aphid of the apple from the other elm species with which it may easily be confused in the spring of the year.

A. Conspicuous woolly colonies on bark of *Ulmus americana.* Throughout the summer on young elms. No alternate host known. Widely distributed in America. ....*S. rileyi.*

AA. Spring generations in elm leaves, causing various types of deformation.

B. Large baggy gall on *Ulmus campestris.* Alternate host unknown. European species. Taken in Connecticut in 1913..*S. lanuginosa.*

BB. Terminal leaf cluster or rosette (Figs. 70-71 on *Ulmus americana.* Spring migration to apple, mountain ash, and hawhawthorn. Maine to Colorado............................ ....*S. lanigera* (*americana* in part, of authors).

BBB. Leaf curl or roll type of deformation.

C. Leaf roll as shown in Fig. 67. Wax glands of apterous generations and antennae of winged generations apparently the same as those of the rosette dweller. Spring migration to apple. Recorded as yet only from the south................ ....*S. lanigera* (*americana* in part, of authors).

CC. Leaf roll of *Ulmus scabra* and *U. campestris.* Antenna of winged generations with V and VI without annulations. Spring migration to gooseberry and currant. European species. In America found in California, Oregon and Maine (1913).........................*S. ulmi* (*fodiens*).

CCC. Leaf roll of *Ulmus americana.* Second apterous spring generation with wax gland distinctly unlike those of Fig. 72. Spring migrant with antenna typically with III not longer than IV+ V+ VI. Alternate host unknown. Maine to California...........*S. americana* in part, of authors.

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.

Tobacco stems or tobacco dust	2 pounds
Water	4 gallons

Put the tobacco in the water, enough to cover, which may be either cold or hot. Place over the fire and when the water has reached the boiling point, remove some of the fire and allow the water to simply *simmer* for fully one hour, when the liquid is ready to be drained off, diluted to the above proportions and applied. Boiling violently drives off the nicotine.

If whole-leaf tobacco is used, prepare as above, using one pound of tobacco to each four gallons of water.

No lime or other alkaline substance should be added to the tobacco *while cooking*. Apply at once, or within a few days after making if possible.

Certain reliable extracts such as *"Black Leaf," "Black Leaf 40,"* and *"Nikoteen"* are on the market and can be secured through local druggists. (The Black Leaf preparations are manufactured by *The Kentucky Tobacco Product Company*, Louisville Ky., and are carried by the Collins Hardware Company, 97 Friend St., Boston, Mass. *Nikoteen* is manufactured by The Nicotine Manufacturing Company, St. Louis, Mo., and can be secured from Joseph Brick & Sons, 47-54 N. Market St., Boston, Mass.).

Directions for use come with the products. There is nothing to do in the preparation of these extracts except to stir the contents of the can before pouring out any quantity for dilution. In most cases one gallon of the *Black Leaf* will be found sufficient for each seventy gallons of water. But if in the treatment of any louse this does not seem sufficient it may be used in preparation of one gallon to sixty or sixty-five gallons of water. Careful sprayers have usually succeeded in killing plant lice with this preparation in the proportion of one gallon to each one hundred gallons of water. Thoroughness of application is of as much importance as the strength of 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.

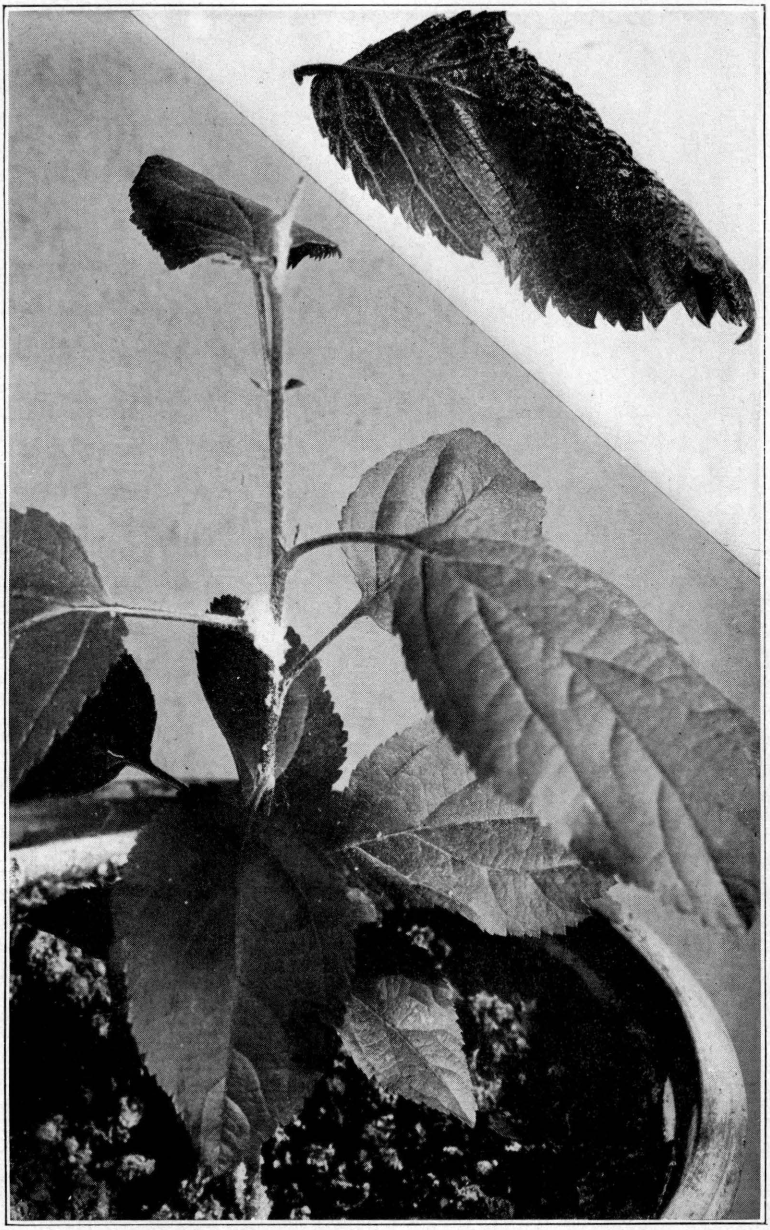


FIG. 67. Southern leaf curl, migrants from which colonized apple seedling shown in accompanying figure.

FIG. 68. Seedling apple, photographed July 23, 1912 to show colony of woolly aphids which are the descendants of migrants from elm leaf curl (Fig. 67) received from Columbia, Missouri, May 12, 1912.

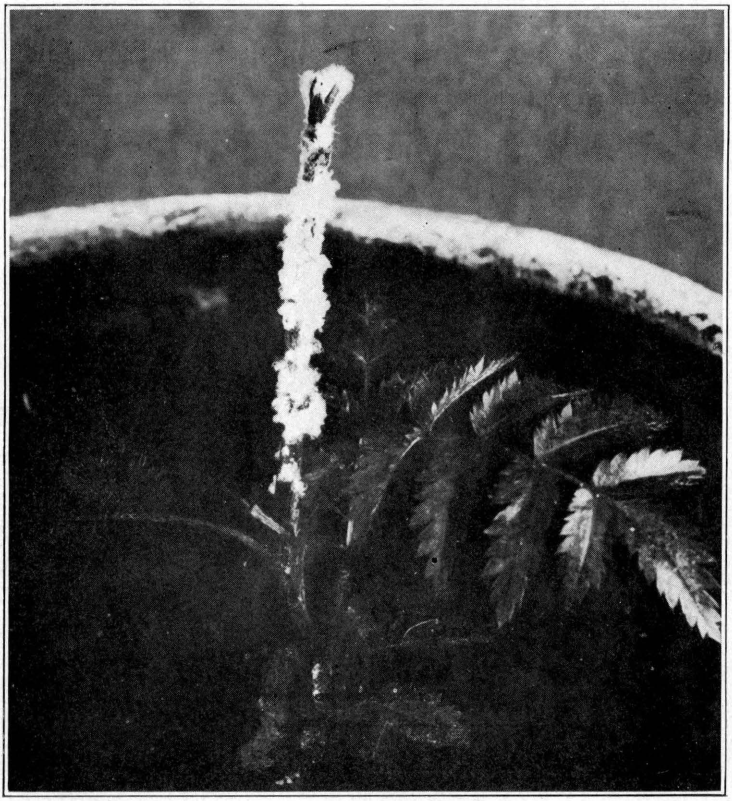


FIG. 69. Seedling mountain ash photographed June 25, 1913 to show colony of woolly aphids which are the progeny of migrants from elm leaf rosette caged with mountain ash, June 17, 1913. Two apterous generations matured on this seedling, but the third generation proved too much for the little tree which was so nearly dead by August 10 that the last of the aphid colony perished at that time.

The antenna of one of the winged progenitors of this colony is shown as Fig. 81.

FIG. 70. Young rosette photographed June 6, 1913. Small picture at right.
FIG. 71. Old rosette photographed July 17, 1913.

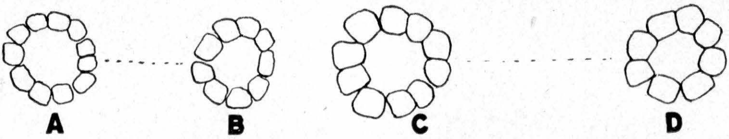
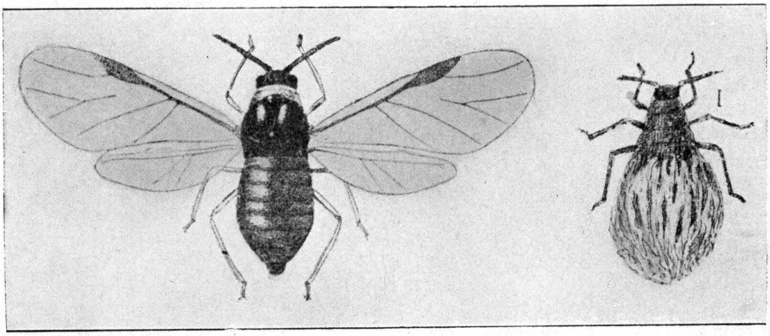
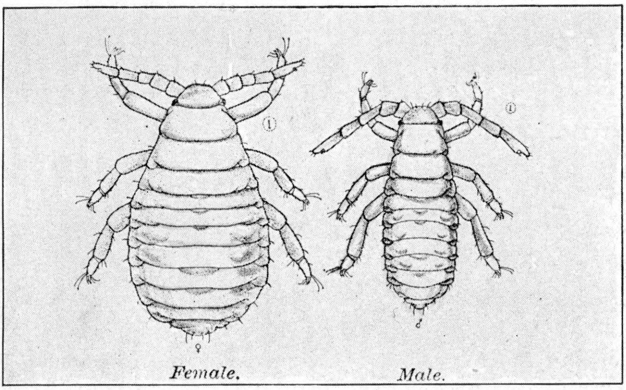


FIG. 72. Dorsal wax gland of rosette aphid, second generation. A & B, a pair on head. C & D, a pair on prothorax. Notice that the sections are not uniform in number as is often the case.



FIGS. 73 and 74. Woolly Aphid. Winged and wingless forms. Greatly enlarged (After Marlatt.)



FIGS. 75 and 76. Mature sexual individuals of the Woolly Aphid,—the oviparous female and male. Real size shown in circles at right of figures. (After Alwood.)

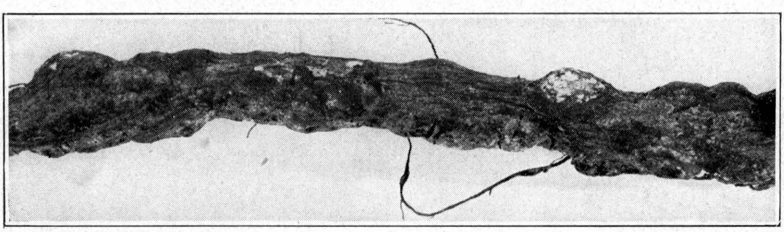


FIG. 77. Apple root, showing knotty growth caused by Woolly Aphid.

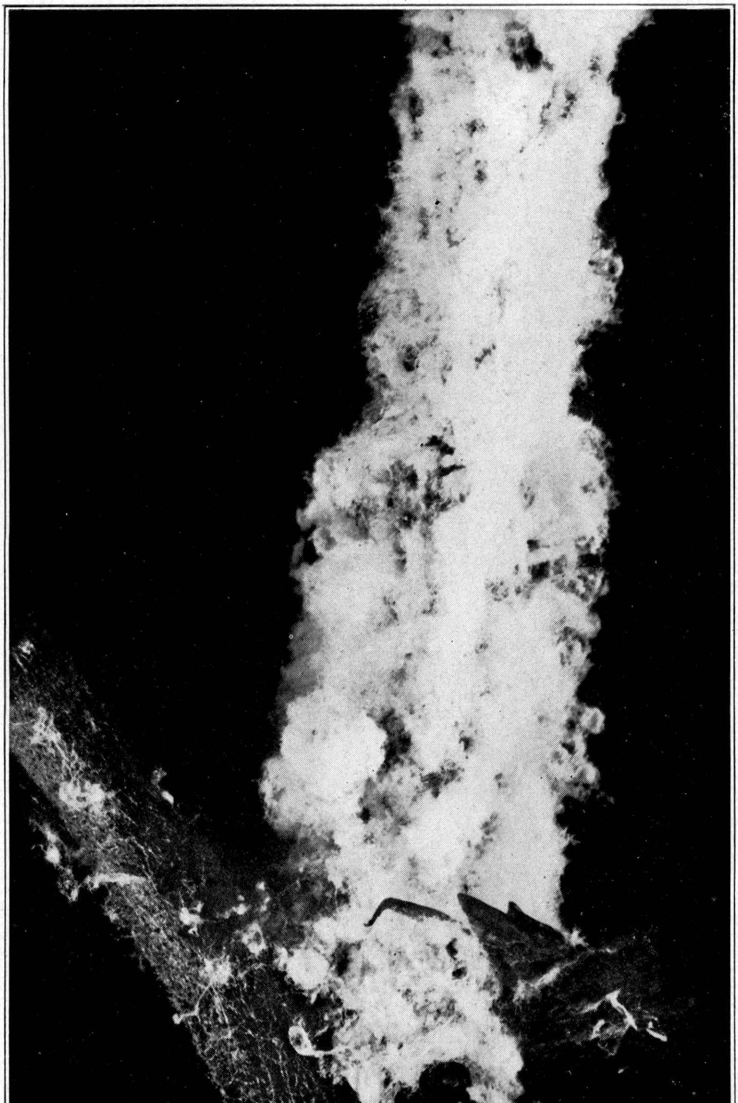
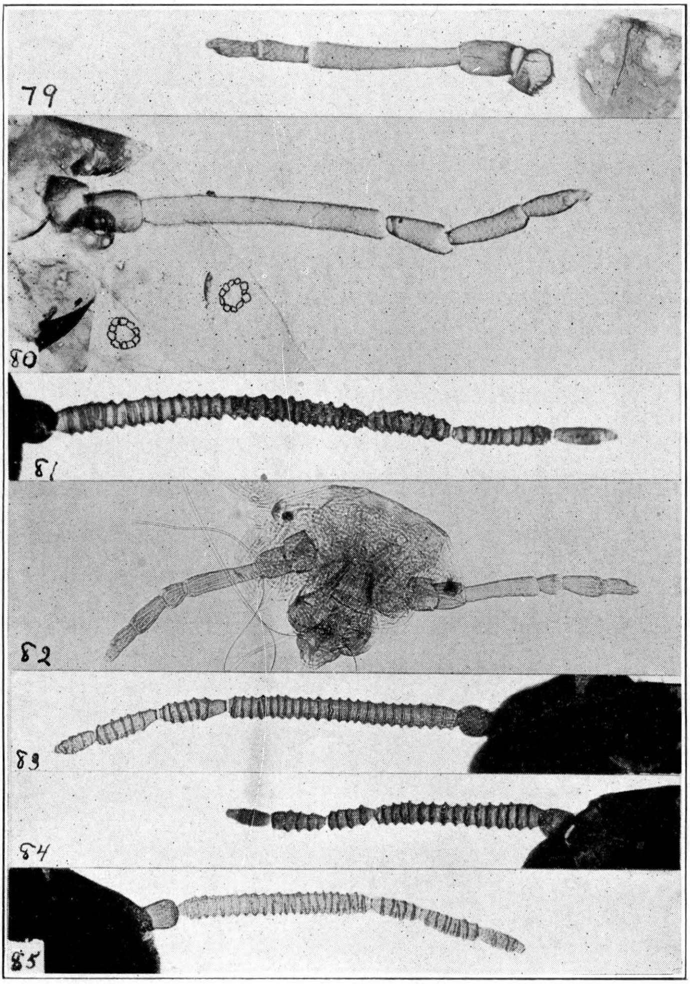


FIG. 78. Nymphs of the Woolly Aphid, *Schizoneura lanigera* on water shoot of mountain ash, *Pyrus americana*,—the immediate progeny of migrants from elm leaf rosette. Photographed at Orono, June 28, 1912. Enlarged.



Antennae of Woolly Aphid. Fig. 79—Stem mother from rosette June 5, 1913 (33-13); Fig. 80—Second generation, from rosette June 12, 1913; Fig. 81—Spring migrant from rosette and progenitor of summer generations on *Pyrus* (57-13); Fig. 82—Apterous viviparous form on apple bark (98-08); Fig. 83—Fall migrant from apple (115-06); Fig 84—Fall migrant from the bred colony shown in Fig. 68 (9-12 sub 1); Fig. 85—Fall migrant from *Crataegus*.

BULLETIN No. 218.

TABLES FOR CALCULATING COEFFICIENTS OF INBREEDING.*

RAYMOND PEARL AND JOHN RICE MINER.

In two recent papers from this laboratory** a method of measuring the degree of inbreeding exhibited in a particular pedigree has been described. This method consists in the determination of coefficients of inbreeding, which are quantities defined by the equation

$$Z_n = \frac{100(p_{n+1} - q_{n+1})}{p_{n+1}}, \qquad \text{(i)}$$

where Zn denotes the coefficient of inbreeding for any particular ancestral generation n; p_{n+1} the maximum possible number of different ancestors in the preceding generation; and q_{n+1} the actually realized number of different ancestors in that generation.

It is believed that this method of measuring inbreeding may be of a great deal of practical value to the stock breeder in his study of pedigrees. If this is to be the case, however, it is essential that the computation incident to the application of the method be reduced to the smallest possible amount and the simplest terms. In order to attain this end the accompanying tables have been prepared.

In the paper referred to above a very simple method was described for finding the values of the successive $(p_{n+1} - q_{n+1})$ quantities. This consisted in the formation for each pedigree studied of a table in which each primary reappearance of an animal was listed for the generation in which it reappeared, to-

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*Papers from the Biological Laboratory of the Maine Agricultural Experiment Station. No. 51.

**Pearl, R. A Contribution Towards an Analysis of the Problem of Inbreeding. American Naturalist, Vol. XLVII, pp. 577-614, 1913.

—The Measurement of the Intensity of Inbreeding. Me. Agr. Expt. Sta. Bulletin 215, pp. 123-138, 1913.

gether with an automatic elimination of such animals' ancestors in earlier generations.

This method leads to the formation of such a table as the following for the Jersey cow, Figgis 20th of Hood Farm (copied from Bulletin 215, p. 136.)

TABLE I.

Working Table for Calculating the Coefficients of Inbreeding of Figgis 20th.

Animal.	Ancestral Generations.									
	3	4	5	6	7	8	9	10	11	12
Sophie's Tormentor	1	2	4	8	16	32	64	128	256	512
Ida's Stoke Pogis	–	–	1	2	4	8	16	32	64	128
Catono	–	–	1	2	4	8	16	32	64	128
Rosabelle Hudson	–	–	1	2	4	8	16	32	64	128
Khedive	–	–	–	1	2	4	8	16	32	64
Young Fancy	–	–	–	1	2	4	8	16	32	64
Stoke Pogis 3d	–	–	–	–	1	2	4	8	16	32
Marjoram	–	–	–	–	1	2	4	8	16	32
Lord Lisgar	–	–	–	–	1	2	4	8	16	32
Tormentor	–	–	–	–	1	2	4	8	16	32
Oonan	–	–	–	–	1	2	4	8	16	32
Landseer	–	–	–	–	1	2	4	8	16	32
Optimus	–	–	–	–	1	2	4	8	16	32
Jersey Bull of Scituate	–	–	–	–	1	2	4	8	16	32
Hebe	–	–	–	–	1	2	4	8	16	32
Victor Hugo	–	–	–	–	–	1	2	4	8	16
Lord Lisgar	–	–	–	–	–	1	2	4	8	16
Victor Hugo	–	–	–	–	–	1	2	4	8	16
Roxbury	–	–	–	–	–	1	2	4	8	16
General Scott	–	–	–	–	–	1	2	4	8	16
Europa	–	–	–	–	–	1	2	4	8	16
Europa	–	–	–	–	–	1	2	4	8	16
Mollie	–	–	–	–	–	1	2	4	8	16
Sir Charles	–	–	–	–	–	1	2	4	8	16
Pharos	–	–	–	–	–	1	2	4	8	16
Clement	–	–	–	–	–	–	1	2	4	8
Hebe	–	–	–	–	–	–	1	2	4	8
Lady Mary	–	–	–	–	–	–	1	2	4	8
Fancy	–	–	–	–	–	–	1	2	4	8
Sir Charles	–	–	–	–	–	–	1	2	4	8
Mary Lowndes	–	–	–	–	–	–	1	2	4	8
Victor	–	–	–	–	–	–	1	2	4	8
Potomac	–	–	–	–	–	–	–	1	2	4
Splendid	–	–	–	–	–	–	–	1	2	4
Saturn	–	–	–	–	–	–	–	1	2	4
Saturn	–	–	–	–	–	–	–	1	2	4
Rhea	–	–	–	–	–	–	–	1	2	4
Countess	–	–	–	–	–	–	–	1	2	4
Dick Swiveller, Jr	–	–	–	–	–	–	–	1	2	4
Countess	–	–	–	–	–	–	–	–	1	2
Taintor	–	–	–	–	–	–	–	–	1	2
Comus	–	–	–	–	–	–	–	–	1	2
Comus	–	–	–	–	–	–	–	–	1	2
St. Clement	–	–	–	–	–	–	–	–	1	2
Major	–	–	–	–	–	–	–	–	1	2
Czar	–	–	–	–	–	–	–	–	1	2
Countess	–	–	–	–	–	–	–	–	1	2
Dick Swiveller	–	–	–	–	–	–	–	–	1	2
Dove	–	–	–	–	–	–	–	–	1	2
Diana	–	–	–	–	–	–	–	–	–	1
Custard	–	–	–	–	–	–	–	–	–	1
Prince John	–	–	–	–	–	–	–	–	–	1
Splendens	–	–	–	–	–	–	–	–	–	1
Totals	1	2	7	16	41	92	191	389	788	1580

The totals of this table are the quantities $(p_{n+1}-q_{n+1})$ of (i). To get from them the successive values of Z it is necessary only to divide by p_{n+1}.

It is obvious from equation (i) that $(p_{n+1}-q_{n+1})$ must in practice always be something less than $p_{n+1}-1$. Furthermore p_{n+1}, the maximum possible number of ancestors in any generation, presents a definite series of values, namely the successive powers of 2. If then there were available tables which would give for each successive value of p_{n+1}, the quotients obtained from dividing each integer smaller than p_{n+1} by this same quantity, evidently the value of Z for any particular case could be read off from the table, without the necessity for any arithmetical work whatever.

The tables accompanying this paper are of just the sort described. For the first ten ancestral generations, beginning with the second, all possible values of

$$\frac{100(p_{n+1}-q_{n+1})}{p_{n+1}}$$

are tabled, to 3 places of figures.

The arrangement of the tables is as follows: In the right hand columns are the successive value of $(p_{n+1}-q_{n+1})=A$.* These columns are headed A. The values in the A columns of the tables correspond to the "Totals" of such pedigree elimination tables as is shown above in Table 1 for Figgis 20th. Over against these A columns are given the corresponding values of the coefficient of inbreeding Z.

Example Showing Use of Tables.

We may take, as an example to show the method of using these tables, the case of Figgis 20th, for which the pedigree elimination table has been given above. We see that in this case the first entry is for the third ancestral generation and is 1. Turning to the table for the third ancestral generation we find that for $A=1, Z=12.500$. Thus we may write at once, $Z_2=12.500$. For the fourth ancestral generation the total is 2 From the table for this generation it is seen, on the second line of this table, that $Z=12.500$ when $A=2$. Hence, $Z_3=12.500$.

*Used merely for convenience to save printing the longer expression.

The total for the fifth ancestral generation of Figgis 20th is 7. In the corresponding table we find for $A=7$, $Z=21.875$, or $Z_4=21.875$.

The total for the next (sixth) ancestral generation is 16. The table for this generation gives for $A=16$, $Z=25.000$, or $Z_5=25.000$.

The total of the next generation is 41. For $A=41$ the seventh generation table gives $Z_6=32.031$.

For the eighth ancestral generation the total is 92. The table for this generation shows that when $A=92$, $Z_7=35.938$.

The total for the ninth generation is 191. For $A=191$ the ninth generation table gives $Z_8=37.305$.

For the tenth generation the total is 389. The last of the tables gives for $A=389$, $Z_9=37.988$.

INBREEDING COEFFICIENT TABLES.

SECOND ANCESTRAL GENERATION. $p_{n+1}=4$		THIRD ANCESTRAL GENERATION. $p_{n+1}=8$		FOURTH ANCESTRAL GENERATION. $p_{n+1}=16$		FIFTH ANCESTRAL GENERATION. $p_{n+1}=32$			
A	Z	A	Z	A	Z	A	Z	A	Z
1	25.000	1	12.500	1	6.250	1	3.125	16	50.000
2	50.000	2	25.000	2	12.500	2	6.250	17	53.125
3	75.000	3	37.500	3	18.750	3	9.375	18	56.250
–	–	4	50.000	4	25.000	4	12.500	19	59.375
–	–	5	62.500	5	31.250	5	15.625	20	62.500
–	–	6	75.000	6	37.500	6	18.750	21	65.625
–	–	7	87.500	7	43.750	7	21.875	22	68.750
–	–	–	–	8	50.000	8	25.000	23	71.875
–	–	–	–	9	56.250	9	28.125	24	75.000
–	–	–	–	10	62.500	10	31.250	25	78.125
–	–	–	–	11	68.750	11	34.375	26	81.250
–	–	–	–	12	75.000	12	37.500	27	84.375
–	–	–	–	13	81.250	13	40.625	28	87.500
–	–	–	–	14	87.500	14	43.750	29	90.625
–	–	–	–	15	93.750	15	46.875	30	93.750

SIXTH ANCESTRAL GENERATION.

$p_{n+1}=64$

A	*Z*	*A*	*Z*
1	1.562	51	79.688
2	3.125	52	81.250
3	4.688	53	82.812
4	6.250	54	84.375
5	7.812	55	85.938
6	9.375	56	87.500
7	10.938	57	89.062
8	12.500	58	90.625
9	14.062	59	92.188
10	15.625	60	93.750
11	17.188	61	95.312
12	18.750	62	96.875
13	20.312	63	98.438
14	21.875	–	–
15	23.438	–	–
16	25.000	–	–
17	26.562	–	–
18	28.125	–	–
19	29.688	–	–
20	31.250	–	–
21	32.812	–	–
22	34.375	–	–
23	35.938	–	–
24	37.500	–	–
25	39.062	–	–
26	40.625	–	–
27	42.188	–	–
28	43.750	–	–
29	45.312	–	–
30	46.875	–	–
31	48.438	–	–
32	50.000	–	–
33	51.562	–	–
34	53.125	–	–
35	54.688	–	–
36	56.250	–	–
37	57.812	–	–
38	59.375	–	–
39	60.938	–	–
40	62.500	–	–
41	64.062	–	–
42	65.625	–	–
43	67.188	–	–
44	68.750	–	–
45	70.312	–	–
46	71.875	–	–
47	73.438	–	–
48	75.000	–	–
49	76.562	–	–
50	78.125	–	–

SEVENTH ANCESTRAL GENERATION.

$p_{n+1}=128$

A	*Z*	*A*	*Z*	*A*	*Z*
1	.781	51	39.844	101	78.906
2	1.562	52	40.625	102	79.688
3	2.344	53	41.406	103	80.469
4	3.125	54	42.188	104	81.250
5	3.906	55	42.969	105	82.031
6	4.688	56	43.750	106	82.812
7	5.469	57	44.531	107	83.594
8	6.250	58	45.312	108	84.375
9	7.031	59	46.094	109	85.156
10	7.812	60	46.875	110	85.938
11	8.594	61	47.656	111	86.719
12	9.375	62	48.438	112	87.500
13	10.156	63	49.219	113	88.281
14	10.938	64	50.000	114	89.062
15	11.719	65	50.781	115	89.844
16	12.500	66	51.562	116	90.625
17	13.281	67	52.344	117	91.406
18	14.062	68	53.125	118	92.188
19	14.844	69	53.906	119	92.969
20	15.625	70	54.688	120	93.750
21	16.406	71	55.469	121	94.531
22	17.188	72	56.250	122	95.312
23	17.969	73	57.031	123	96.094
24	18.750	74	57.812	124	96.875
25	19.531	75	58.594	125	97.656
26	20.312	76	59.375	126	98.438
27	21.094	77	60.156	127	99.219
28	21.875	78	60.938	–	–
29	22.656	79	61.719	–	–
30	23.438	80	62.500	–	–
31	24.219	81	63.281	–	–
32	25.000	82	64.062		
33	25.781	83	64.844	–	–
34	26.562	84	65.625	–	–
35	27.344	85	66.406	–	–
36	28.125	86	67.188	–	–
37	28.906	87	67.969	–	–
38	29.688	88	68.750	–	–
39	30.469	89	69.531	–	–
40	31.250	90	70.312	–	–
41	32.031	91	71.094	–	–
42	32.812	92	71.875	–	–
43	33.594	93	72.656	–	–
44	34.375	94	73.438	–	–
45	35.156	95	74.219	–	–
46	35.938	96	75.000	–	–
47	36.719	97	75.781	–	–
48	37.500	98	76.562	–	–
49	38.281	99	77.344	–	–
50	39.062	100	78.125	–	–

EIGHTH ANCESTRAL GENERATION.

$$p_{n+1}=256$$

A	*Z*	*A*	*Z*	*A*	*Z*	*A*	*Z*	*A*	*Z*	*A*	*Z*
1	.391	51	19.922	101	39.453	151	58.984	201	78.516	251	98.047
2	.781	52	20.312	102	39.844	152	59.375	202	78.906	252	98.438
3	1.172	53	20.703	103	40.234	153	59.766	203	79.297	253	98.828
4	1.562	54	21.094	104	40.625	154	60.156	204	79.688	254	99.219
5	1.953	55	21.484	105	41.016	155	60.547	205	80.078	255	99.609
6	2.344	56	21.875	106	41.406	156	60.938	206	80.469	–	–
7	2.734	57	22.266	107	41.797	157	61.328	207	80.859	–	–
8	3.125	58	22.656	108	42.188	158	61.719	208	81.250	–	–
9	3.516	59	23.047	109	42.578	159	62.109	209	81.641	–	–
10	3.906	60	23.438	110	42.969	160	62.500	210	82.031	–	–
11	4.297	61	23.828	111	43.359	161	62.891	211	82.422	–	–
12	4.688	62	24.219	112	43.750	162	63.281	212	82.812	–	–
13	5.078	63	24.609	113	44.141	163	63.672	213	83.203	–	–
14	5 469	64	25.000	114	44.531	164	64.062	214	83.594	–	–
15	5.859	65	25.391	115	44.922	165	64.453	215	83.984	–	–
16	6.250	66	25.781	116	45.312	166	64.844	216	84.375	–	–
17	6.641	67	26.172	117	45.703	167	65.234	217	84.766	–	–
18	7.031	68	26.562	118	46.094	168	65.625	218	85.156	–	–
19	7.422	69	26.953	119	46.484	169	66.016	219	85.547	–	–
20	7.812	70	27.344	120	46.875	170	66.406	220	85.938	–	–
21	8.203	71	27.734	121	47.266	171	66.797	221	86.328	–	–
22	8.594	72	28.125	122	47.656	172	67.188	222	86.719	–	–
23	8.984	73	28.516	123	48 047	173	67.578	223	87.109	–	–
24	9.375	74	28.906	124	48.438	174	67.969	224	87.500	–	–
25	9.766	75	29.297	125	48.828	175	68.359	225	87.891	–	–
26	10.156	76	29.688	126	49.219	176	68.750	226	88.281	–	–
27	10.547	77	30.078	127	49.609	177	69.141	227	88.672	–	–
28	10.938	78	30.469	128	50.000	178	69.531	228	89.062	–	–
29	11.328	79	30.859	129	50.391	179	69.922	229	89.453	–	–
30	11.719	80	31.250	130	50.781	180	70.312	230	89.844	–	–
31	12.109	81	31.641	131	51.172	181	70.703	231	90.234	–	–
32	12.500	82	32.031	132	51.562	182	71.094	232	90.625	–	–
33	12.891	83	32.422	133	51.953	183	71.484	233	91.016	–	–
34	13.281	84	32.812	134	52.344	184	71.875	234	91.406	–	–
35	13.672	85	33.203	135	52.734	185	72.266	235	91.797	–	–
36	14.062	86	33.594	136	53.125	186	72.656	236	92.188	–	–
37	14.453	87	33.984	137	53.516	187	73.047	237	92.578	–	–
38	14.844	88	34.375	138	53.906	188	73.438	238	92.969	–	–
39	15.234	89	34.766	139	54.297	189	73.828	239	93.359	–	–
40	15.625	90	35.156	140	54.688	190	74.219	240	93.750	–	–
41	16.016	91	35.547	141	55.078	191	74.609	241	94.141	–	–
42	16.406	92	35.938	142	55.469	192	75.000	242	94.531	–	–
43	16.797	93	36.328	143	55.859	193	75.391	243	94.922	–	–
44	17.188	94	36.719	144	56.250	194	75.781	244	95.312	–	–
45	17.578	95	37.109	145	56.641	195	76.172	245	95.703	–	–
46	17.969	96	37.500	146	57.031	196	76.562	246	96.094	–	–
47	18.359	97	37.891	147	57.422	197	76.953	247	96.484	–	–
48	18.750	98	38.281	148	57.812	198	77.344	248	97.875	–	–
49	19.141	99	38.672	149	58.203	199	77.734	249	97.266	–	–
50	19.531	100	39.062	150	58.594	200	78.125	250	97.656	–	–

NINTH ANCESTRAL GENERATION.

$$p_{n+1}=512$$

A	Z	A	Z	A	Z	A	Z	A	Z	A	Z
1	.195	51	9.961	101	19.727	151	29.492	201	39.258	251	49.023
2	.391	52	10.156	102	19.922	152	29.688	202	39.453	252	49.219
3	.586	53	10.352	103	20.117	153	29.883	203	39.648	253	49.414
4	.781	54	10.547	104	20.312	154	30.078	204	39.844	254	49.609
5	.977	55	10.742	105	20.508	155	30.273	205	40.039	255	49.805
6	1.172	56	10.938	106	20.703	156	30.469	206	40.234	256	50.000
7	1.367	57	11.133	107	20.898	157	30.664	207	40.430	257	50.195
8	1.562	58	11.328	108	21.094	158	30.859	208	40.625	258	50.391
9	1.758	59	11.523	109	21.289	159	31.055	209	40.820	259	50.586
10	1.953	60	11.719	110	21.484	160	31.250	210	41.016	260	50.781
11	2.148	61	11.914	111	21.680	161	31.445	211	41.211	261	50.977
12	2.344	62	12.109	112	21.875	162	31.641	212	41.406	262	51.172
13	2.539	63	12.305	113	22.070	163	31.836	213	41.602	263	51.367
14	2.734	64	12.500	114	22.266	164	32.031	214	41.797	264	51.562
15	2.930	65	12.695	115	22.461	165	32.227	215	41.992	265	51.758
16	3.125	66	12.891	116	22.656	166	32.422	216	42.188	266	51.953
17	3.320	67	13.086	117	22.852	167	32.617	217	42.383	267	52.148
18	3.516	68	13.281	118	23.047	168	32.812	218	42.578	268	52.344
19	3.711	69	13.477	119	23.242	169	33.008	219	42.773	269	52.539
20	3.906	70	13.672	120	23.438	170	33.203	220	42.969	270	52.734
21	4.102	71	13.867	121	23.633	171	33.398	221	43.164	271	52.930
22	4.297	72	14.062	122	23.828	172	33.594	222	43.359	272	53.125
23	4.492	73	14.258	123	24.023	173	33.789	223	43.555	273	53.320
24	4.688	74	14.453	124	24.219	174	33.984	224	43.750	274	53.516
25	4.883	75	14.648	125	24.414	175	34.180	225	43.945	275	53.711
26	5.078	76	14.844	126	24.609	176	34.375	226	44.141	276	53.906
27	5.273	77	15.039	127	24.805	177	34.570	227	44.336	277	54.102
28	5.469	78	15.234	128	25.000	178	34.766	228	44.531	278	54.297
29	5.664	79	15.430	129	25.195	179	34.961	229	44.727	279	54.492
30	5.859	80	15.625	130	25.391	180	35.156	230	44.922	280	54.688
31	6.055	81	15.820	131	25.586	181	35.352	231	45.117	281	54.883
32	6.250	82	16.016	132	25.781	182	35.547	232	45.312	282	55.078
33	6.445	83	16.211	133	25.977	183	35.742	233	45.508	283	55.273
34	6.641	84	16.406	134	26.172	184	35.938	234	45.703	284	55.469
35	6.836	85	16.602	135	26.367	185	36.133	235	45.898	285	55.664
36	7.031	86	16.797	136	26.562	186	36.328	236	46.094	286	55.859
37	7.227	87	16.992	137	26.758	187	36.523	237	46.289	287	56.055
38	7.422	88	17.188	138	26.953	188	36.719	238	46.484	288	56.250
39	7.617	89	17.383	139	27.148	189	36.914	239	46.680	289	56.445
40	7.812	90	17.578	140	27.344	190	37.109	240	46.875	290	56.641
41	8.008	91	17.773	141	27.539	191	37.305	241	47.070	291	56.836
42	8.203	92	17.969	142	27.734	192	37.500	242	47.266	292	57.031
43	8.398	93	18.164	143	27.930	193	37.695	243	47.461	293	57.227
44	8.594	94	18.359	144	28.125	194	37.891	244	47.656	294	57.422
45	8.789	95	18.555	145	28.320	195	38.086	245	47.852	295	57.617
46	8.984	96	18.750	146	28.516	196	38.281	246	48.047	296	57.812
47	9.180	97	18.945	147	28.711	197	38.477	247	48.242	297	58.008
48	9.375	98	19.141	148	28.906	198	38.672	248	48.438	298	58.203
49	9.570	99	19.336	149	29 102	199	38.867	249	48.633	299	58.398
50	9.766	100	19.531	150	29.297	200	39.062	250	48.828	300	58.594

NINTH ANCESTRAL GENERATION. (Concluded.)

$$p_{n+1} = 512$$

A	Z	A	Z	A	Z	A	Z	A	Z
301	58.789	351	68.555	401	78.320	451	88.086	501	97.852
302	58.984	352	68.750	402	78.516	452	88.281	502	98.047
303	59.180	353	68.945	403	78.711	453	88.477	503	98.242
304	59.375	354	69.141	404	78.906	454	88.672	504	98.438
305	59.570	355	69.336	405	79.102	455	88.867	505	98.633
306	59.766	356	69.531	406	79.297	456	89.062	506	98.828
307	59.961	357	69.727	407	79.492	457	89.258	507	99.023
308	60.156	358	69.922	408	79.688	458	89.453	508	99.219
309	60.352	359	70.117	409	79.883	459	89.648	509	99.414
310	60.547	360	70.312	410	80.078	460	89.844	510	99.609
311	60.742	361	70.508	411	80.273	461	90.039	511	99.805
312	60.938	362	70.703	412	80.469	462	90.234	–	–
313	61.133	363	70.898	413	80.664	463	90.430	–	–
314	61.328	364	71.094	414	80.859	464	90.625	–	–
315	61.523	365	71.289	415	81.055	465	90.820	–	–
316	61.719	366	71.484	416	81.250	466	91.016	–	–
317	61.914	367	71.680	417	81.445	467	91.211	–	–
318	62.109	368	71.875	418	81.641	468	91.406	–	–
319	62.305	369	72.070	419	81.836	469	91.602	–	–
320	62.500	370	72.266	420	82.031	470	91.797	–	–
321	62.695	371	72.461	421	82.227	471	91.992	–	–
322	62.891	372	72.656	422	82.422	472	92.188	–	–
323	63.086	373	72.852	423	82.617	473	92.383	–	–
324	63.281	374	73.047	424	82.812	474	92.578	–	–
325	63.477	375	73.242	425	83.008	475	92.773	–	–
326	63.672	376	73.438	426	83.203	476	92.969	–	–
327	63.867	377	73.633	427	83.398	477	93.164	–	–
328	64.062	378	73.828	428	83.594	478	93.359	–	–
329	64.258	379	74.023	429	83.789	479	93.555	–	–
330	64.453	380	74.219	430	83.984	480	93.750	–	–
331	64.648	381	74.414	431	84.180	481	93.945	–	–
332	64.844	382	74.609	432	84.375	482	94.141	–	–
333	65.039	383	74.805	433	84.570	483	94.336	–	–
334	65.234	384	75.000	434	84.766	484	94.531	–	–
335	65.430	385	75.195	435	84.961	485	94.727	–	–
336	65.625	386	75.391	436	85.156	486	94.922	–	–
337	65.820	387	75.586	437	85.352	487	95.117	–	–
338	66.016	388	75.781	438	85.547	488	95.312	–	–
339	66.211	389	75.977	439	85.742	489	95.508	–	–
340	66.406	390	76.172	440	85.938	490	95.703	–	–
341	66.602	391	76.367	441	86.133	491	95.898	–	–
342	66.797	392	76.562	442	86.328	492	96.094	–	–
343	66.992	393	76.758	443	86.523	493	96.289	–	–
344	67.188	394	76.953	444	86.719	494	96.484	–	–
345	67.383	395	77.148	445	86.914	495	96.680	–	–
346	67.578	396	77.344	446	87.109	496	96.875	–	–
347	67.773	397	77.539	447	87.305	497	97.070	–	–
348	67.969	398	77.734	448	87.500	498	97.266	–	–
349	68.164	399	77.930	449	87.695	499	97.461	–	–
350	68.359	400	78.125	450	87.891	500	97.656	–	–

TENTH ANCESTRAL GENERATION.

$p_{n+1} = 1024$

A	Z	A	Z	A	Z	A	Z	A	Z	A	Z
1	.098	51	4.980	101	9.863	151	14.746	201	19.629	251	24.512
2	.195	52	5.078	102	9.961	152	14.844	202	19.727	252	24.609
3	.293	53	5.176	103	10.059	153	14.941	203	19.824	253	24.707
4	.391	54	5.273	104	10.156	154	15.039	204	19.922	254	24.805
5	.488	55	5.371	105	10.254	155	15.137	205	20.020	255	24.902
6	.586	56	5.469	106	10.352	156	15.234	206	20.117	256	25.000
7	.684	57	5.566	107	10.449	157	15.332	207	20.215	257	25.098
8	.781	58	5.664	108	10.547	158	15.430	208	20.312	258	25.195
9	.879	59	5.762	109	10.645	159	15.527	209	20.410	259	25.293
10	.977	60	5.859	110	10.742	160	15.625	210	20.508	260	25.391
11	1.074	61	5.957	111	10.840	161	15.723	211	20.605	261	25.488
12	1.172	62	6.055	112	10.938	162	15.820	212	20.703	262	25.586
13	1.270	63	6.152	113	11.035	163	15.918	213	20.801	263	25.684
14	1.367	64	6.250	114	11.133	164	16.016	214	20.898	264	25.781
15	1.465	65	6.348	115	11.230	165	16.113	215	20.996	265	25.879
16	1.562	66	6.445	116	11.328	166	16.211	216	21.094	266	25.977
17	1.660	67	6.543	117	11.426	167	16.309	217	21.191	267	26.074
18	1.758	68	6.641	118	11.523	168	16.406	218	21.289	268	26.172
19	1.855	69	6.738	119	11.621	169	16.504	219	21.387	269	26.270
20	1.953	70	6.836	120	11.719	170	16.602	220	21.484	270	26.367
21	2.051	71	6.934	121	11.816	171	16.699	221	21.582	271	26.465
22	2.148	72	7.031	122	11.914	172	16.797	222	21.680	272	26.562
23	2.246	73	7.129	123	12.012	173	16.895	223	21.777	273	26.660
24	2.344	74	7.227	124	12.109	174	16.992	224	21.875	274	26.758
25	2.441	75	7.324	125	12.207	175	17.090	225	21.973	275	26.855
26	2.539	76	7.422	126	12.305	176	17.188	226	22.070	276	26.953
27	2.637	77	7.520	127	12.402	177	17.285	227	22.168	277	27.051
28	2.734	78	7.617	128	12.500	178	17.383	228	22.266	278	27.148
29	2.832	79	7.715	129	12.598	179	17.480	229	22.363	279	27.246
30	2.930	80	7.812	130	12.695	180	17.578	230	22.461	280	27.344
31	3.027	81	7.910	131	12.793	181	17.676	231	22.559	281	27.441
32	3.125	82	8.008	132	12.891	182	17.773	232	22.656	282	27.539
33	3.223	83	8.105	133	12.988	183	17.871	233	22.754	283	27.637
34	3.320	84	8.203	134	13.086	184	17.969	234	22.852	284	27.734
35	3.418	85	8.301	135	13.184	185	18.066	235	22.949	285	27.832
36	3.516	86	8.398	136	13.281	186	18.164	236	23.047	286	27.930
37	3.613	87	8.496	137	13.379	187	18.262	237	23.145	287	28.027
38	3.711	88	8.594	138	13.477	188	18.359	238	23.242	288	28.125
39	3.809	89	8.691	139	13.574	189	18.457	239	23.340	289	28.223
40	3.906	90	8.789	140	13.672	190	18.555	240	23.438	290	28.320
41	4.004	91	8.887	141	13.770	191	18.652	241	23.535	291	28.418
42	4.102	92	8.984	142	13.867	192	18.750	242	23.633	292	28 516
43	4.199	93	9.082	143	13.965	193	18.848	243	23.730	293	28.613
44	4.297	94	9.180	144	14.062	194	18.945	244	23.828	294	28.711
45	4.395	95	9.277	145	14.160	195	19.043	245	23.926	295	28.809
46	4.492	96	9.375	146	14.258	196	19.141	246	24.023	296	28.906
47	4.590	97	9.473	147	14.355	197	19.238	247	24.121	297	29 004
48	4.688	98	9.570	148	14.453	198	19.336	248	24.219	298	29.102
49	4.785	99	9.668	149	14.551	199	19.434	249	24.316	299	29.199
50	4.883	100	9.766	150	14.648	200	19.531	250	24.414	300	29.297

TENTH ANCESTRAL GENERATION. (Continued.)

$p_{n+1} = 1024$

A	*Z*	*A*	*Z*	*A*	*Z*	*A*	*Z*	*A*	*Z*	*A*	*Z*
301	29.395	351	34.277	401	39.160	451	44.043	501	48 926	551	53.809
302	29.492	352	34.375	402	39.258	452	44.141	502	49.023	552	53.906
303	29.590	353	34.473	403	39.355	453	44.238	503	49.121	553	54.004
304	29.688	354	34.570	404	39.453	454	44.336	504	49.219	554	54.102
305	29.785	355	34.668	405	39.551	455	44.434	505	49.316	555	54.199
306	29.883	356	34.766	406	39.648	456	44.531	506	49.414	556	54.297
307	29.980	357	34.863	407	39.746	457	44.629	507	49.512	557	54.395
308	30.078	358	34.961	408	39.844	458	44.727	508	49.609	558	54.492
309	30.176	359	35.059	409	39.941	459	44.824	509	49.707	559	54.590
310	30.273	360	35.156	410	40.039	460	44.922	510	49.805	560	54.688
311	30.371	361	35.254	411	40.137	461	45.020	511	49.902	561	54.785
312	30.469	362	35.352	412	40.234	462	45.117	512	50.000	562	54.883
313	30.566	363	35.449	413	40.332	463	45.215	513	50.098	563	54.980
314	30.664	364	35.547	414	40.430	464	45.312	514	50.195	564	55.078
315	30.762	365	35.645	415	40.527	465	45.410	515	50.293	565	55.176
316	30.859	366	35.742	416	40.625	466	45.508	516	50.391	566	55.273
317	30.957	367	35.840	417	40.723	467	45.605	517	50.488	567	55.371
318	31.055	368	35.938	418	40.820	468	45.703	518	50.586	568	55.469
319	31.152	369	36.035	419	40.918	469	45.801	519	50.684	569	55.566
320	31.250	370	36.133	420	41.016	470	45.898	520	50.781	570	55.664
321	31.348	371	36.230	421	41.113	471	45.996	521	50.879	571	55.762
322	31.445	372	36.328	422	41.211	472	46.094	522	50.977	572	55.859
323	31.543	373	36.426	423	41.309	473	46.191	523	51.074	573	55.957
324	31.641	374	36.523	424	41.406	474	46.289	524	51.172	574	56.055
325	31.738	375	36.621	425	41.504	475	46.387	525	51.270	575	56.152
326	31.836	376	36.719	426	41.602	476	46.484	526	51.367	576	56.250
327	31.934	377	36.816	427	41.699	477	46.582	527	51.465	577	56.348
328	32.031	378	36.914	428	41.797	478	46.680	528	51.562	578	56.445
329	32.129	379	37.012	429	41.895	479	46.777	529	51.660	579	56.543
330	32.227	380	37.109	430	41.992	480	46.875	530	51.758	580	56.641
331	32.324	381	37.207	431	42.090	481	46.973	531	51.855	581	56.738
332	32.422	382	37.305	432	42.188	482	47.070	532	51.953	582	56.836
333	32.520	383	37.402	433	42.285	483	47.168	533	52.051	583	56.934
334	32.617	384	37.500	434	42.383	484	47.266	534	52.148	584	57.031
335	32.715	385	37.598	435	42.480	485	47.363	535	52.246	585	57.129
336	32.812	386	37.695	436	42.578	486	47.461	536	52.344	586	57.227
337	32.910	387	37.793	437	42.676	487	47.559	537	52.441	587	57.324
338	33.008	388	37.891	438	42.773	488	47.656	538	52.539	588	57.422
339	33.105	389	37.988	439	42.871	489	47.754	539	52.637	589	57.520
340	33.203	390	38.086	440	42.969	490	47.852	540	52.734	590	57.617
341	33.301	391	38.184	441	43.066	491	47.949	541	52.832	591	57.715
342	33.398	392	38.281	442	43.164	492	48.047	542	52.930	592	57.812
343	33.496	393	38.379	443	43.262	493	48.145	543	53.027	593	57.910
344	33.594	394	38.477	444	43.359	494	48.242	544	53.125	594	58.008
345	33.691	395	38.574	445	43.457	495	48.340	545	53.223	595	58.105
346	33.789	396	38.672	446	43.555	496	48.438	546	53.320	596	58.203
347	33.887	397	38.770	447	43.652	497	48.535	547	53.418	597	58.301
348	33.984	398	38.867	448	43.750	498	48.633	548	53.516	598	58.398
349	34.082	399	38.965	449	43.848	499	48.730	549	53.613	599	58.496
350	34.180	400	39.062	450	43.945	500	48.828	550	53.711	600	58.594

TENTH ANCESTRAL GENERATION. (Continued.)

$$p_{n+1} = 1024$$

A	Z	A	Z	A	Z	A	Z	A	Z	A	Z
601	58.691	651	63.574	701	68.457	751	73.340	801	78.223	851	83.105
602	58.789	652	63.672	702	68.555	752	73.438	802	78.320	852	83.203
603	58.887	653	63.770	703	68.652	753	73.535	803	78.418	853	83.301
604	58.984	654	63.867	704	68.750	754	73.633	804	78.516	854	83.398
605	59.082	655	63.965	705	68.848	755	73.730	805	78.613	855	83.496
606	59.180	656	64.062	706	68.945	756	73.828	806	78.711	856	83.594
607	59.277	657	64.160	707	69.043	757	73.926	807	78.809	857	83.691
608	59.375	658	64.258	708	69.141	758	74.023	808	78.906	858	83.789
609	59.473	659	64.355	709	69.238	759	74.121	809	79.004	859	83.887
610	59.570	660	64.453	710	69.336	760	74.219	810	79.102	860	83.984
611	59.668	661	64.551	711	69.434	761	74.316	811	79.199	861	84.082
612	59.766	662	64.648	712	69.531	762	74.414	812	79.297	862	84.180
613	59.863	663	64.746	713	69.629	763	74.512	813	79.395	863	84.277
614	59.961	664	64.844	714	69.727	764	74.609	814	79.492	864	84.375
615	60.059	665	64.941	715	69.824	765	74.707	815	79.590	865	84.473
616	60.156	666	65.039	716	69.922	766	74.805	816	79.688	866	84.570
617	60.254	667	65.137	717	70.020	767	74.902	817	79.785	867	84.668
618	60.352	668	65.234	718	70.117	768	75.000	818	79.883	868	84.766
619	60.449	669	65.332	719	70.215	769	75.098	819	79.980	869	84.863
620	60.547	670	65.430	720	70.312	770	75.195	820	80.078	870	84.961
621	60.645	671	65.527	721	70.410	771	75.293	821	80.176	871	85.059
622	60.742	672	65.625	722	70.508	772	75.391	822	80.273	872	85.156
623	60.840	673	65.732	723	70.605	773	75.488	823	80.371	873	85.254
624	60.938	674	65.820	724	70.703	774	75.586	824	80.469	874	85.352
625	61.035	675	65.918	725	70.801	775	75.684	825	80.566	875	85.449
626	61.133	676	66.016	726	70.898	776	75.781	826	80.664	876	85.547
627	61.230	677	66.113	727	70.996	777	75.879	827	80.762	877	85.645
628	61.328	678	66.211	728	71.094	778	75.977	828	80.859	878	85.742
629	61.426	679	66.309	729	71.191	779	76.074	829	80.957	879	85.840
630	61.523	680	66.406	730	71.289	780	76.172	830	81.055	880	85.938
631	61.621	681	66.504	731	71.387	781	76.270	831	81.152	881	86.035
632	61.719	682	66.602	732	71.484	782	76.367	832	81.250	882	86.133
633	61.816	683	66.699	733	71.582	783	76.465	833	81.348	883	86.230
634	61.914	684	66.797	734	71.680	784	76.562	834	81.445	884	86.328
635	62.012	685	66.895	735	71.777	785	76.660	835	81.543	885	86.426
636	62.109	686	66.992	736	71.875	786	76.758	836	81.641	886	86.523
637	62.207	687	67.090	737	71.973	787	76.855	837	81.738	887	86.621
638	62.305	688	67.188	738	72.070	788	76.953	838	81.836	888	86.719
639	62.402	689	67.285	739	72.168	789	77.051	839	81.934	889	86.816
640	62.500	690	67.383	740	72.266	790	77.148	840	82.031	890	86.914
641	62.598	691	67.480	741	72.363	791	77.246	841	82.129	891	87.012
642	62.695	692	67.578	742	72.461	792	77.344	842	82.227	892	87.109
643	62.793	693	67.676	743	72.559	793	77.441	843	82.324	893	87.207
644	62.891	694	67.773	744	72.656	794	77.539	844	82.422	894	87.305
645	62.988	695	67.871	745	72.754	795	77.637	845	82.520	895	87.402
646	63.086	696	67.969	746	72.852	796	77.734	846	82.617	896	87.500
647	63.184	697	68.066	747	72.949	797	77.832	847	82.715	897	87.598
648	63.281	698	68.164	748	73.047	798	77.930	848	82.812	898	87.695
649	63.379	699	68.262	749	73.145	799	78.027	849	82.910	899	87.793
650	63.477	700	68.359	750	73.242	800	78.125	850	83.008	900	87.891

TENTH ANCESTRAL GENERATION. (Concluded.)

$p_{n+1} = 1024$

A	*Z*	*A*	*Z*	*A*	*Z*	*A*	*Z*	*A*	*Z*
901	87.988	926	90.430	951	92.871	976	95.312	1001	97.754
902	88.086	927	90.527	952	92.969	977	95.410	1002	97.852
903	88.184	928	90.625	953	93.066	978	95.508	1003	97.949
904	88.281	929	90.723	954	93.164	979	95.605	1004	98.047
905	88.379	930	90.820	955	93.262	980	95.703	1005	98.145
906	88.477	931	90.918	956	93.359	981	95.801	1006	98.242
907	88.574	932	91.016	957	93.457	982	95.898	1007	98.340
908	88.672	933	91.113	958	93.555	983	95.996	1008	98.438
909	88.770	934	91.211	959	93.652	984	96.094	1009	98.535
910	88.867	935	91.309	960	93.750	985	96.191	1010	98.633
911	88.965	936	91.406	961	93.848	986	96.289	1011	98.730
912	89.062	937	91.504	962	93.945	987	96.387	1012	98.828
913	89.160	939	91.602	963	94.043	988	96.484	1013	98.926
914	89.258	939	91.699	964	94.141	989	96.582	1014	99.023
915	89.355	940	91.797	965	94.238	990	96.680	1015	99.121
916	89.453	941	91.895	966	94.336	991	96.777	1016	99.219
917	89.551	942	91.992	967	94.434	992	96.875	1017	99.316
918	89.648	943	92.090	968	94.531	993	96.973	1018	99.414
919	89.746	944	92.188	969	94.629	994	97.070	1019	99.512
920	89.844	945	92.285	970	94.727	995	97.168	1020	99.609
921	89.941	946	92.383	971	94.824	996	97.266	1021	99.707
922	90.039	947	92.480	972	94.922	997	97.363	1022	99.805
923	90.137	948	92.578	973	95.020	998	97.461	1023	99.902
924	90.234	949	92.676	974	95.117	999	97.559	–	–
925	90.332	950	92.773	975	95.215	1000	97.656	–	–

BULLETIN No. 219.

COMPARATIVE STUDIES OF CERTAIN DISEASE PRODUCING SPECIES OF FUSARIUM.

CHARLES E. LEWIS.

The genus, Fusarium, contains a very large number of species. The descriptions of many of these are very incomplete, frequently, being based on the examination of a single collection of material. Since cultural studies of certain species have shown that the same fungus may show quite different characteristics when the conditions for growth are changed, the validity of many of the species is called in question. For example, in certain species of Fusarium starting with material from a colony from a single spore it would be possible by growing the fungus on different culture media to bring about differences as great as those which have been used in the separation of species. In many cases, in those forms which are parasitic, the occurrence of a Fusarium on different though closely related hosts has been considered sufficient reason by certain writers for describing the fungus on each as a different species. A good illustration of this is found in the fungus causing the scab of a number of cereals. It was described under a different name on each host but the work of Selby and Manns * has shown that the same fungus causes the disease in several hosts. This was determined by growing the fungus from each host in culture, comparing the cultures and making cross inoculations.

It is probable that careful and extended cultural studies together with inoculation experiments will greatly reduce the number of species. One great difficulty lies in the incomplete descriptions which make it impossible in many cases to deter-

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* Selby, A. D., and Manns, T. F., Ohio Expt. Sta., Bul. 203, p. 231, 1909.

mine whether the fungus which is being studied has been described. In some cases, an investigator after making an extended study of a species of this genus has described it as new because of the impossibility of placing it among those already described and at the same time has pointed out the possibility that it may have been incompletely described under another name. These new species however in which the descriptions take into consideration the characters of the fungus under different conditions of growth make it possible to determine with a considerable degree of certainty whether a fungus which is being studied agrees with the description or not. In some cases the account of the study of a species may become so extended as to make it difficult for the reader to pick out the most important points. It would be very desirable if each person who works with a species of Fusarium would either keep the fungus in culture or would send a culture to a laboratory which would keep it growing so that others who desire to do so may obtain it for comparison. In the study of this genus, the comparison of species grown side by side under the same conditions is very desirable.

Interest in the genus has increased with the knowledge that a number of very important plant diseases are caused by species of Fusarium. There can be little question that with further study it will be found that some of them which have been regarded as saprophytes are parasites which cause a considerable amount of damage to living plants. Owing to the difficulty in determining the species and the amount of cross inoculation work which should be done in order to determine the extent of the parasitism of each, a large amount of study is necessary in order to come to definite knowledge in regard to the characteristics of each and its importance as a cause of disease.

On account of the lack of knowledge of the diseases caused by species of Fusarium in Maine, although such fungi were frequently encountered in the examination of diseased plant tissues, it has seemed desirable to make some study of the forms isolated from different hosts and to test their pathogenicity by means of inoculation experiments.

In the study of the fungi responsible for the decay of Maine apples, two species of Fusarium were isolated from decaying fruit in 1908. These fungi were grown in pure culture and were tested to determine the extent to which they would cause decay of ripe apples. It was found that each of these caused rot and at about the same rate as some of the well known apple decay fungi which were being studied at the same time. Not much work was done with these fungi until the next summer when green apples were inoculated and a decay was produced in each case. The decay of the green fruit was regarded as better proof that they are parasites than the rot of the ripe fruit because a number of fungi are able to grow on ripe apples which cannot attack green fruit. The organisms were re-isolated in pure culture in a sufficient number of cases to make sure that the decay was caused by the fungus with which the apple was inoculated. These strains were designated Fusarium I and Fusarium II from apple, or F I and F II. (See list on p. 222).

In looking up the subject, no reference was found to any report of a Fusarium decay of apples in America but it was found that Osterwalder * had studied and described such a decay in Europe. The fungus which causes the rot enters the apples through the blossom end and grows down into the cavity around the seeds spreading from here into the surrounding tissues. The tissues become light brown in color and bitter to the taste.

Osterwalder studied the fungus not only as it occurs in nature but in culture on a number of media and describes its characteristics in some detail. He regarded it as a new species, *F. putrefaciens*. Inoculations were made on both apples and pears and it was found that when the fungus was placed in wounds it caused decay, but attempts to produce infection through the uninjured epidermis resulted in failure. Only one such apple rotted and this rot was caused by another fungus, *Cephalothecium roseum* Cda.

The review of this article in Experiment Station Record, Vol. XVII, p. 50, says: "The author claims that the fungus is identical with that reported by Eustace as *Cephalothecium roseum* which causes a rot of apples. He agrees with Eustace † and

* Osterwalder, A. Ueber eine bisher unbekannte Art der Kernobstfäule verursacht durch *Fusarium putrefaciens* Nov. spec. Centrabl. Bakt. Zweite Abt. 13, 207-213; 330-338, 1904.

† Eustace, H. J., N. Y., State Sta. Bul. 227, 1902.

others on the ability of this fungus to cause a rotting of the fruits in this way refuting the claims of a number of European investigators." The writer did not find anything in Osterwalder's account to indicate that he regarded *F. putrefaciens* and *C. roseum* as identical. In connection with the fact that *C. roseum* was isolated from an apple which decayed after inoculation with the Fusarium, the status of *C. roseum* as an apple decay is discussed but this is followed in the next paragraph by a discussion of the species of Fusarium which have been described from apple fruit with the result that it was decided that the Fusarium which had been studied should be regarded as a new species, *F. putrefaciens.*

Owing to the similarity of the decay found in Maine to that described by Osterwalder and the fact that one of the fungi, F I, found here seemed to agree rather closely with the description of *F. putrefaciens,* a culture was secured from Dr. Osterwalder in July, 1909, and has been grown on the same media since that time for comparison with the species isolated in Maine:* Some slight differences have been observed in cultural characteristics chiefly in the red color of the mycelium. The red color is much brighter in the Maine form than in the European on the same medium under the same conditions. Inoculations of apples showed that *F. putrefaciens* and the similar form from Maine caused decay of fruit at so nearly the same rate that one could not be regarded as a more active cause of decay than the other.

Each year since 1908 a considerable number of apples have been found in which a Fusarium was causing decay. The Fusarium rot is easily distinguished from the other common apple rots in its later stages when the mycelium has grown out through the lenticels and has partially covered the surface of the apple. This aerial mycelium is white at first but soon takes on some red and yellow color. In the early stages it is not always possible to distinguish this rot from those caused by other fungi. The decayed tissues are light brown in color and are bitter to the taste. The skin of the apple is darker in color than in the case of apples rotted by Penicillium but not so dark as with Sphaeropsis or Glomerella.

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* See foot-note p. 254.

Fusarium may attack the apple fruit in 2 ways. Both of the species isolated in 1908 were first found growing in wounds on the surface of the fruits. Associated with them were other fungi, part of which proved to be parasites and part saprophytes when inoculations were made into apple fruits. Later each of the two species was found growing in the cavity around the seeds and spreading into the surrounding tissues to cause decay just as Osterwalder described for *F. putrefaciens*. In such cases the fungus enters the seed cavities through the canal which extends down from the blossom end and which does not become closed in some varieties. Apples which appear sound may show when cut open a growth of mycelium around the seeds. If such apples are kept in cold storage, the fungus cannot grow but when the apples are subjected to a higher temperature for several days the mycelium spreads into the surrounding tissues causing the loss of the fruit. Either F I or F II may be responsible for such decay. As will be shown later Fusarium forms from a number of sources are capable of causing rot of apple fruits upon inoculation but these two species are the only ones which have been found to occur on the fruit in nature to such an extent as to cause much loss. A third form was isolated from a decaying apple in 1909 but has not been found again.

While these species of Fusarium are to be regarded as causes of storage rot of ripe apples, that part of the infection which takes place through the blossom end probably occurs in most cases before the apples are placed in storage. In some cases, infection through wounds may also occur before harvesting as in apples injured by insects or by hail. Wounds caused by rough handling also serve as a place of entrance for these as for other rot fungi. In a few cases green apples on the tree showing growth of Fusarium on wounded places have been found. Fig. 105 shows the appearance of such an apple. The fungus was isolated from this apple and has been grown for more than two years in comparison with Fusarium I with the result that the two strains are regarded as belonging to the same species. This has been isolated a number of times from apples. In one lot of Milden apples which were under observation in 1912 mycelium of a Fusarium was found in the core in many cases. Later an attempt was made to isolate the fungus from each of 20 of the apples which were either partially or wholly decayed and in which the rot appeared to be caused by a species of Fusarium. Small pieces of decayed tissue were removed from the inner part of each apple and placed in plates containing 10 c. c. of prune agar. From 15 of the 20 apples pure cultures of Fusarium were found. The plates from the other apples showed a growth of Fusarium but there was also a growth of other fungi. Transfers were made from the plates to tubes and the growth on various media agreed very closely with that of F I. Tests were made of ten of these strains which proved that each was capable of producing decay in apples of three varieties, Baldwin, Mann and Bellflower. One strain was used in making inoculations of apples of each of the following varieties: Rhode Island Greening, Baldwin, Gano and Northern Spy, with the result that decay was produced in all.

F I grows readily on a large number of the culture media which are in common use in growing fungi for study. On sterilized bean pods, potato, carrot, turnip, and beet cylinders in tubes, a rather large amount of white aerial mycelium is produced within 3 to 5 days after transfers are made if the cultures are kept at a favorable temperature for growth. Usually within 5 days, red color begins to appear in the mycelium near the culture medium. In a few days, this covers the whole slant in vegetable cylinders and becomes a very bright red. When the cultures become older there is some yellowish and greenish yellow mycelium. This was especially noticeable on beet cylinder cultures three weeks old.

In cultures grown under favorable conditions, great quantities of spores are produced. In young cultures spores of many shapes and sizes are found. These include as one extreme one-celled spores, about 8 microns in length, which have usually been designated microconidia and as the other large, 5-septate spores, 52 microns in length, which have been called macroconidia. In older cultures of this fungus when the conditions of growth are favorable to their development, orange colored masses of spores are produced. The spores found in these sporodochia are more uniform in shape and size than those found in the young cultures, as shown in Figs. 86, 87 and 88.

Appel and Wollenweber * regard these as normal spores while the spores of various shapes and sizes are regarded as abnormal. They base much of their classification of species on the shape and size of the spores produced in sporodochia. According to their account the sporodochia are produced readily when fully developed normal spores are transferred to sterilized plant stems in tubes. If on the other hand, mycelium is transferred there is growth of much more mycelium and the sporodochia do not develop so readily, if at all. The writer is able to confirm this from the results of work with certain strains of this species from apple. Sporodochia appeared in the cultures and when transfers were made from these to potato cylinders the whole slant became covered with an orange colored mass of spores, after a few days' growth. On the same date transfers were made using material from the aerial mycelium from the same tube with the results that in the cultures from this source mycelium began to develop at once giving a growth so different in character from that which developed from spores that the two sets of cultures might be classified as belonging to different species or even genera if the classification was based on these cultures alone without regard to their origin.

F II from apple agrees in certain characteristics with F I. On the same culture media the two fungi give a somewhat similar appearance. Both produce an abundance of white aerial mycelium although the amount is slightly greater in F II. The red color is the same in the two forms and differs from that in the cultures of *F. putrefaciens,* F XII, sent to me by Osterwalder when all are grown on the same medium. In *F. putrefaciens* the red color is not so bright but seems dull in comparison and it extends to the aerial mycelium to a greater extent than in F I and F II so that there is not so much contrast between the white aerial mycelium and the red color next to the medium. This difference has been noted many times.

F II can be readily distinguished from F I by microscopic examination of the spores. In the former, an additional type of spore is found. These spores are obovate to pyriform in shape, the obovate spores usually being one-celled and pyriform spores

* Appel, O., and Wollenweber, H. W. Grundlagen einer Monographie der Gattung Fusarium (Link). Arbeiten aus der Kaiserlichen Anstalt für Land-und Forstwirtschaft. Band VIII, Heft I, 1910.

2-celled. Very frequently in cultures 2 to 4 weeks old the spores of the obovate type in this fungus are about equal in number to those of the septate Fusarium type while in the same cultures when a few days old a much smaller proportion of obovate spores is found. This is especially striking when the spores are sown in prune agar plates. The young colonies begin to produce spores of the septate Fusarium type in 3 to 4 days but if the cultures are allowed to continue their growth for 3 to 4 weeks large number of spores of the obovate type are produced. Figs. 89 to 93 show the different forms of spores which are found in cultures of this fungus, F II and F IV being strains of the same fungus. The obovate spores are as a rule about 8 microns in diameter, the septate vary from 11 to 41 microns in length and from 2.75 to 5.5 in width. They are one to 5-septate and may be straight or curved. According to the system of Appel and Wollenweber the spores which occur in the young cultures on agar are to be regarded as abnormal.

The first thought to occur on finding spores of the obovate and pyriform types in cultures which in other respect are so strikingly similar to typical cultures of Fusarium is that the cultures must not be pure. Plating out and starting from colonies which had developed from single spores gave cultures which produced the different types of spores. Moreover, it is possible to find spores of the long type and of the obovate type cut off from the same conidiophore so that one is forced to the conclusion that the extremely different forms belong to the same fungus.

In the first examinations of fungi of the type of F II found in connection with studies of decaying apples, the writer felt no hesitancy in referring the fungus to that genus on account of its striking similarity to other species of the genus. Later when it was found that the obovate, pyriform, and septate spores belonged to the same fungus the question of its proper classification became more difficult. Of the many species of Fusarium, the writer found none which was described as producing spores of such a strikingly obovate form. However, it is to be remembered that only a comparatively small number of the species of Fusarium were described from material which had been under observation in culture for a long enough time that all of the spore forms could be taken into consideration. For example material of F II collected as it occurs naturally in decaying apples may show in some cases practically all spores of the septate Fusarium type while in other cases the obovate spores predominate. A description of the fungus which took into consideration either of these conditions without regard to the other would not be complete.

Soon after it had been determined that the different spore forms belonged to this fungus, the writer read Stewart and Hodgkiss'* account of the Sporotrichum Bud-Rot of Carnations and the Silver Top of June Grass. Stewart isolated a fungus from decaying carnation buds, studied it in culture and carried on inoculation experiments in which he proved that it caused the rot of the buds. Diseased buds were sent to Dr. Peck who described the fungus as a new species, *Sporotrichum anthophilum*. Some time before this, Stewart had found a similar fungus associated with the silver top of June grass which Dr. Peck had named *Sporotrichum poae*. The descriptions of both species were based on material as it occurs in nature.

When Stewart grew the fungi from the two sources in culture, it was found that they gave exactly the same kind of growth on a number of media. Both were characterized by the production of a large amount of white aerial mycelium and by red color next to the medium. The spores in both were obovate to pyriform with occasional septate spores of the type of Fusarium macroconidia. By means of inoculations, he showed that the fungus isolated from June grass would also cause the rot of carnation buds and therefore concluded that the two species, *S. poae* and *S. anthophilum* should be regarded as one species which should be called *S. poae* because that species name was used earlier than the other.

The writer was impressed by the striking similarity of the carnation bud-rot fungus and the fungus from apples which has been referred to as F II. The fungus from apples agrees with the description of the one from carnations and June grass in its rapid growth, production of a large amount of white aerial mycelium, production of red color on a number of media and in

* Stewart, F. C., and Hodgkiss, H. E. The Sporotrichum Bud-Rot of Carnations and the Silver Top of June Grass. N. Y. Agr. Exp. Sta. Technical Bulletin No. 7, 1908.

the spores which vary from the obovate type of Sporotrichum to the septate type of Fusarium. The chief difference which is to be noted is that the fungus studied by Stewart is described as producing a predominance of spores of the obovate to pyriform type while in the fungus isolated from apples in Maine the type of spore which predominates varies with the age of the culture and with the conditions of growth.

In response to a request for cultures of the carnation bud-rot fungus for comparison with the apple fungus, Stewart replied that after the completion of their studies the cultures had been allowed to die. Some of the old cultures had been saved, however, and these were sent. While the writer did not have the opportunity to see this fungus alive and growing under the same conditions as the fungus from apple, there seemed little reason to doubt that the two fungi were very closly related. The proportion of obovate spores seemed greater in the old cultures which were sent by Stewart than in old growths of the apple fungus. The fact that so few spores of the septate type were found caused Stewart to regard the fungus as being more properly classified in the genus Sporotrichum than in Fusarium, although he points out that no other species of Sporotrichum is described as having septate spores.

At about the same time that Stewart was studying the carnation bud-rot Heald * was investigating a similar disease in Nebraska. In Heald's first account of this disease published in Science † a species of Fusarium was regarded as the cause of the rot but in the later publication the causal fungus is considered to be *Sporotrichum anthophilum*. Later in this paper data will be presented which will show that the fungi encountered in the two cases were not necessarily the same. The writer determined by means of inoculation experiments that certain typical species of Fusarium can cause rot of carnation buds so that it is not impossible that Heald was working with two different fungi. On the other hand the bud-rot fungus may have shown a large proportion of septate spores in one case and of

* Heald, F. D. The Bud Rot of Carnations, Neb. Expt. Sta. Bul. 103, 1908.

† Science, N. S., 23:620, 1906.

obovate spores in the other. The illustrations of the fungus in the later publication show no septate spores of the Fusarium type.

The writer tried to secure a culture of the fungus but it was no longer available. Dr. Heald kindly offered, however, to examine cultures of the apple fungus and give his opinion as to its identity with the one which he had studied in connection with carnation bud-rot. After growing the apple fungus for some time he reached the conclusion that it was very similar to his carnation bud-rot fungus and should probably be regarded as belonging to the same species.

Soon after noticing the similarity of the carnation bud-rot fungus and the apple rot fungus which had been designated as F II, inoculation experiments were begun in which the one from apple was tested on carnations in order to determine whether it would cause bud-rot. A detailed account of the inoculations and the results is given later in this paper. Here it is sufficient to say that as the result of these inoculations it was found that not only F II would cause the rot of the buds but that what appear to be closely related fungi isolated from other hosts can also produce the same disease. It was also found that certain typical species of Fusarium were capable of causing the destruction of the buds.

Fungi of the same type as the carnation bud-rot organism seem to be quite widely distributed in nature. The question of whether these are to be regarded as strains of one species or as closely related species is a difficult one. A fungus which is very similar to the one associated with the carnation disease was isolated from an ear rot of corn in Illinois and described by Burrill and Barrett.* This fungus which they called Fusarium I from corn produced a large amount of white aerial mycelium which later shows red color next to the culture medium. It was described as producing spores of two kinds, obovate to pyriform microconidia and septate macroconidia of Fusarium.

In the fall of 1910 the writer asked Dr. Barrett if it would be possible to obtain a culture of this fungus for comparison with the apple decay fungus. At that time the cultures had been

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* Burrill, T. J., and Barrett, J. T. Ear Rots of Corn. Ill. Expt. Sta. Bul. 133, p. 86, 1909.

allowed to die in the Illinois Laboratory but Dr. Barrett offered to look over material of the apple fungus and give his opinion as to its identity with the corn Fusarium I. Later, in the fall of 1911, Dr. Barrett again secured cultures of the corn Fusarium and after growing it and the apple fungus for some time under the same conditions sent a culture (carried in this laboratory as F XXXVI) to the writer with the opinion that the two should be regarded as distinct.

Examination of material from young cultures of the corn fungus shows that it produces a much greater proportion of obovate spores than does F II from apples. In this it agrees more closely with the carnation bud-rot fungus than do the forms isolated from apples.

In December, 1912, the writer made some study of the fungi associated with the decay of ears of flint corn in Maine. On some ears obovate spores were found and on others septate Fusarium spores. Cultures were made with the result that two strains or species were secured one of which, F XLVIII, produces large numbers of obovate spores with occasional septate spores while the other, F XLIX, produces many septate spores with a much smaller proportion of the obovate form. The first of these fungi agrees closely with the one secured from Illinois while the other seems to be identical with F II from apples, showing that this may also occur on ears of corn. Since in the culture studies the two strains have been found to require the same conditions for growth it is probable that both occur frequently on moldy corn. Not enough work has been done to determine which is the more common in Maine. To determine this would require a large number of isolations of the fungi from different sources and their comparison in culture. On account of the fact that no difference can be noted in their effects on corn the value of this work would be questionable.

In connection with this study, the writer has isolated fungi from a number of sources for comparison with F II from apple. In this way a considerable number of strains have been secured. Some of these have proved to be typical species of Fusarium, while a number although showing certain characteristics of Fusarium have been found to produce spores of the obovate type. In many cases these forms cannot be distinguished from typical species of Fusarium until a microscopic examination is made of the spores.

In May 1910 a diseased potato was sent to this laboratory by Dr. G. E. Stone of the Massachusetts Agricultural College. When material from the diseased surface of the tuber was examined septate Fusarium spores were found. Cultures were made from these and the fungus which developed, F IX, produced an abundance of spores of the obovate type such as had been found in F II from apples. Early in the study of this it was noted that while the growth of mycelium was very similar and the spores identical in shape and size to those of the fungus from apple the proportion of obovate spores was much greater in the potato fungus. With the latter, the septate spores were produced in the young colonies when obovate spores were sown in agar plates but when aerial mycelium began to develop the obovate spores were produced in greater numbers than the septate.

In September 1910 a fungus, F VI, was isolated from diseased ears of sweet corn. The same fungus has been found on sweet corn a number of times since, but it is probable that the total amount of loss caused by it is small. It agrees very closely in its characteristics with F IX described above from potato.

A fungus, F XIII, isolated from diseased heads of sunflower, *Helianthus annuus* L. shows the same characteristics as F II from apple. While in older cultures it produces large numbers of obovate spores there are always present a good proportion of spores of the septate Fusarium type. This fungus causes a complete decay of sunflower heads and destroys the seeds. Upon inoculation the sunflower fungus was found to cause a rot of carnation buds and 47 of the 71 buds inoculated were destroyed.

In June and July, 1911, a number of grasses on the University grounds and farm at Orono showed silver-top. These grasses were examined from time to time in order to determine whether the fungus which Stewart found associated with the silver-top of June grass in New York occurred in Maine and if it did occur to isolate it from as many different grasses as possible for comparison with similar fungi from other sources.

On June 7, 50 culms of June grass, *Poa pratensis,* affected with silver-top were examined and only one was found which showed the spores of a fungus. These spores agreed in size and appearance with those of *Sporotrichum poae*. Dilution plate cultures were made and in three days colonies had developed which were producing spores. These were of both the one-celled, obovate and the septate types. Transfers were made from the colonies in the plates to sterilized bean pods in tubes. When the growth on bean pods was examined three days later it was found that large numbers of the obovate spores had been produced and only a small proportion of the septate type. It will be seen that this fungus, F XXIV, agrees very closely in its characters with *Sporotrichum poae* as described by Stewart. It also agrees closely with Barrett's Fusarium I, F XXXVI, from corn from Illinois and with one of the fungi isolated from potato, F IX, and one from sweet corn by the writer, F VI. The fungus was tested on carnation buds by inoculating 24 buds of the Enchantress variety and 22 of these were destroyed.

After about 2 weeks, June grass was again examined. This time a large number of plants showed the presence of the fungus on the injured culms. The mites which Stewart and Hodgkiss found associated with the fungus were also found here.* The explanation of the common occurrence of the fungus at this time in contrast to its rare occurrence 2 weeks earlier is found in the fact that the second examination was preceded by a period of rainy and cloudy weather which was favorable to the growth of the fungus.

Fowl meadow grass, *Glyceria nervata* (Willd.) Trin. which had been injured by the grass thrips was examined June 28 and showed the presence of a fungus which seemed to be identical with the one from June grass, F XXIV. On July 7 a rather large number of plants were examined and the fungus was found to be of frequent occurrence. Dilution plate cultures were made, F XXVII, and later material was transferred from colonies to tubes of various media where the growth was so nearly the same as that of the June grass fungus that one could not be distinguished from the other.

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* Cary, see pp. 100 and 112 of the 18th Annual Report of the Maine Agricultural Experiment Station, attributes the "silver top" of Jnue grass and certain other grasses in Maine to the grass thrips *Anaphothrips striata* Osborn. Material examined during different seasons showed both the mites and the thrips associated with the diseased plants.

In the same way material was examined from plants of red top, *Agrostis alba* L., F XXV; timothy, *Phleum pratense* L., F XXVIII; and quack grass, *Agropyron repens* (L) Beauv., F XXVI, which had been injured by the grass thrips. In all of these, the fungus was found and isolations were made in each case. A fungus, F XXX, showing the same characteristics was also found associated with silver top of timothy collected in Indiana in July 1911. Another, F XXIX, a typical species of Fusarium was also isolated from some of the diseased culms from Indiana.

An ornamental grass, *Phalaris arundinacea* L. var. *picta* growing on the University campus also showed the presence of the fungus with obovate spores on the shrunken culms which had been injured.

The fungi isolated from these different grasses have the same cultural characters. When they are grown side by side on the same medium, it is impossible to distinguish one from the other. They also agree very closely with the one from potato, F IX, described earlier in this paper, with the fungus from sweet corn, F VI, and with Barrett's Fusarium I from corn, F XXXVI, from Illinois. Some work has been done to determine the relation of these fungi to the carnation bud-rot by means of inoculations of carnation buds. It will be remembered that Stewart produced bud-rot of carnations with the fungus isolated from June grass and from these results reached the conclusion that the fungus from June grass and the one from carnation buds should be regarded as one species, a conclusion which no doubt is correct. In the inoculation work carried on by the writer, there has been wide difference in the results obtained with the very similar fungi from different sources. With the fungi from June grass, F XXIV; red top, F XXV, and quack grass, F XXVI, the proportion of decayed buds was so great as to lead to the conclusion that if the decay of carnation buds is taken as a standard by which to measure their relationship, they would be regarded as one species. Some of the fungi which seem identical with the one from June grass, F XXIV, in cultural and morphological characters did not cause a rot of carnation buds. These include the fungus from fowl meadow grass, F XXVII, Barrett's corn Fusarium I, F XXXVI, and the fungus with obovate spores from potato, F IX. On the other hand a number of cultures of typical Fusarium which could not possibly be considered as belonging to the same species as the fungi with obovate spores have been found to cause rot of carnation buds upon inoculation. It would seem that a number of species can cause carnation bud-rot but that what appears to be one morphological species isolated from different host plants has certain strains which cause the rot and others which do not. The fungus from fowl meadow grass seems identical with that from June grass yet it failed to attack carnation buds of the same variety that were destroyed by the June grass fungus. F II from apple and the sunflower fungus, F XIII, caused rot of the buds which was exactly the same in appearance as that caused by the June grass organism although they differ from it in the production of a much larger proportion of septate spores and might possibly be regarded as belonging more properly to a different species. *Fusarium putrefaciens,* F XII, and F I from apple caused rapid decay of carnation buds and there is no question but that these are typical Fusarium forms.

In the course of this study species of Fusarium have been isolated or secured from a number of different sources and have been carried through periods of growth on the same media as the forms with obovate spores for comparison. Cultures of two species of Sporotrichum, *S. roseolum* Oudem. and Beyer and *S. bombycinum* (Corda) Rabenh. were secured from the Association Internationale des Botanistes and these have been carried in culture for more than two years. These species bear little resemblance to the fungi with obovate spores which are under consideration as they produce almost no aerial growth on any of the media on which they have been grown. The writer has had little experience with the genus Sporotrichum, never having grown but one other species in culture but after growing several fungi of the same general group, if not strains of the same species, as the carnation bud-rot fungus in comparison with a number of typical species of Fusarium, some of which resemble that fungus in certain characteristics, and taking into consideration that Sporotrichum is a genus characterized by producing one-celled spores while Fusarium is a genus in which different types of spores are produced in a given species under different conditions of growth, it would seem that this group of fungi should be considered as more closely related to Fusarium than to Sporotrichum.

Cultures of the fungus which has been called F II from apple showing both obovate, one-celled spores and septate spores were sent to Dr. Peck in March, 1910, together with a letter calling attention to the similarity of the apple fungus to that causing carnation bud-rot and to the fact that in the cultures of the fungus from apple large numbers of spores of the septate type were present. In replying Dr. Peck stated that in describing the fungi from June grass and carnation buds only material as it occurs in nature was examined. For that reason only spores of the obovate type were observed. Dr. Peck also said that he knew of no genus which would properly include a fungus with spores of both the Sporotrichum and Fusarium types. It may be possible that the fungi with these two kinds of spores constitute a group of species which should be placed in a new genus. It is well known, however, that many species of Fusarium produce in culture large quantities of spores of such shape and size as to place them in other genera if the classifications were based on these spores which are usually called micrononidia. The writer believes that the obovate spores in the group under consideration should be regarded in the same way that the small spores of a Cephalosporium type are regarded in certain species of Fusarium and that the fungi with obovate spores agreeing in other characteristics with Fusarium can safely be included in that genus.

As has been stated, a number of typical species of Fusarium have been carried in culture side by side with the fungi already discussed and used to some extent for comparison with them. *F. roseum* Lk, F XVIII, was isolated from scabby wheat which was kindly sent to the writer from Ohio by Dr. Thomas Manns, then of the Ohio Agricultural Experiment Station.* This fungus produces a large amount of white aerial mycelium with bright red color next to the culture medium. In appearance the cultures closely resemble those of F II from apple but microscopic examination shows that the wheat scab fungus produces very few spores in culture and none of these are of the obovate form.

* See foot-note p. 254.

In September 1910, a Fusarium was found on glumes of wheat in Maine. The fungus, F VIII, was isolated and has been found to agree in cultural characters with F I from apple. There is less aerial mycelium than in *F. roseum,* F XVIII, secured from Ohio and spores are produced in large quantities in sporodochia. These masses of spores are orange colored. When apples were inoculated with this fungus it caused as much decay as F I from apple.

A fungus, F XXXI, isolated from summer squash in the summer of 1911 agrees somewhat closely in cultural characters with F II from apple. There are, however, a very small proportion of spores of the obovate type. The spores agree in appearance with those of other fungi which have been described in this paper. This fungus produces such a large proportion of septate spores that it would seem that its classification should be based on these rather than on the obovate spores. It is difficult, however, to separate the fungi which produce spores of these types and place all which show a large proportion of septate spores in the genus Fusarium and those which produce a smaller proportion in another genus.

A species of Fusarium, F XL, was found causing rot of squashes in storage in December, 1911. This fungus produced much white aerial mycelium with red and yellow color near the medium. The decaying tissues of the squash took on a bright red color.

A fungus, F XVII, similar to the one from squash was isolated from ears of yellow dent corn from Indiana. The growth of this fungus agrees very closely wih that of the one from squash when they are grown on the same culture medium. The corn fungus grew rapidly and produced the same effects on squash as the squash fungus when both were used in making inoculations. Neither of these strains has produced many spores in cultures.

A fungus which agrees in cultural characters with *F. oxysporum* as described by Smith and Swingle * was secured from two sources, Ohio, F XVI, and Vermont, F XV, and these strains have been grown on a number of media.†

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* Smith, Erwin F., and Swingle, Deane B., Bureau of Plant Industry, Bulletin 55, 1903.

† See foot-note p. 254.

A fungus F VII isolated from diseased cucumbers in Maine has agreed closely with these fungi in its growth. This was striking in the experiments testing the effect of different amounts of several acids on growth. In each case these 3 strains were able to grow in media containing larger amounts of acid than any of the other 21 strains used in these tests. Two other species of Fusarium have been obtained from diseased cucumbers. One of these, F XX, shows some blue color in the mycelium while in the other, F XIX the mycelium remains white. All of these strains from cucumber produce large numbers of chlamydospores in the cultures. These chlamydospores may occur singly or several may occur together in the hypha. Two strains from tomato, F XXI and F XXII, and one from squash, F XXIII, agreed closely with the strain from cucumber in which the mycelium remained white.

In addition to the forms from potato which have been mentioned four others have been isolated. One of these, F XXXVIII, which was isolated from sporodochia on stems has shown the same cultural characters as F I from apple, and the fungus, F VIII, isolated from wheat in Maine. When apples were inoculated with the potato fungus, rot followed. The other three fungi illustrate very well the fact that a number of species of Fusarium may occur in stored potatoes and that some of these species can be easily distinguished form one another by their growth on a few culture media. One of these forms, F XXXIII, showed blue color of mycelium, one red, F XXXV, and the other white, F XXXIV, when grown on potato cylinders. These fungi have been under observation for two years and have not shown variation from these colors except in the case of the red which has not been uniform.

Each summer for the past three years specimens of China aster, the stems of which were affected with a fungous disease, have been sent to this laboratory. In each case cultures have been secured by taking material from the inner part of the stem, using sterilized instruments. The cultures secured from different sources give evidence that the same fungus, F XIV, is responsible for the disease in different localities. The fungus shows a small amount of white aerial mycelium and no color has appeared in the cultures. The spores are mostly of the non-septate type but occasional septate sporés are seen. Chlamydospores occur in the cultures. No inoculations have been made on China asters.

LIST OF ORGANISMS STUDIED.

F I.	Fusarium I from apple fruit.
F II.	Fusarium II form apple fruit, produces obovate spores.
F III.	Fusarium III from apple fruit.
F IV.	Fusarium IV from apple fruit, produces obovate spores.
F V.	Fusarium from ears of sweet corn from Orono. This did not produce obovate spores.
F VI.	Fusarium from ears of sweet corn from Monmouth, Me. This produces many obovate spores.
F VII.	Fusarium isolated from decaying cucumber. Closely resembles F XV and F XVI from potato.
F VIII.	Fusarium isolated from diseased wheat collected in Maine.
F IX.	Fungus with obovate spores from potato. Isolated by Dr. W. J. Morse from a potato tuber sent from Massachusetts by Dr. Geo. E. Stone.
F X.	Fusarium from Red Astrachan apple. This fungus is identical with F II.
F XI.	Fusarium isolated from a green apple which was decaying on the tree August 1, 1910. This fungus is apparently identical with F I.
F XII.	*F. putrefaciens* Osterwalder.* Culture secured from Dr. Osterwalder in 1910 and carried in culture since that time in comparison with the Maine forms.
F XIII.	Fusarium from sunflower. Isolated from decaying head of sunflower from garden in Orono.
F XIV.	Fusarium from China aster. Isolated from stems of diseased plants sent by Mrs. E. C. Bodman of Seal Harbor, Maine. September, 1910.
F XV.	Agrees closely in cultural characters with *F. oxysporum** as described by Smith and Swingle. This strain was secured from Vermont through the courtesy of N. J. Giddings.
F XVI.	A culture of this fungus which was isolated from internal tissues of potato tuber from Sharpsburg, Ohio, was secured from Dr. Thomas Manns. Fungus seems identical with F XV.

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* See foot-note p. 254.

F XVII.	Fusarium from yellow dent corn. Isolated from decaying ear of corn sent from Indiana. January, 1911.
F XVIII.	*F. roseum* Lk.* Isolated from diseased wheat which was secured from Dr. Thomas Manns then of the Ohio Experiment Station.
F XIX.	Fusarium isolated from decaying cucumber. This fungus differs from F VII in that the mycelium remains white in old cultures while in F VII it takes on some purple color on certain media.
F XX.	Fusarium isolated from cucumber by Dr. W. J. Morse. Grows slowly and produces less aerial mycelium than XIX. Shows some blue color in old cultures. Spores are mostly 3-septate.
F XXI.	Fusarium from tomato. Isolated from decaying tomato. Similar in cultural characters to F XIX.
F XXII.	Fusarium from tomato. This strain seems to be identical with F XXI.
F XXIII.	Fusarium from squash. Isolated from decaying squash. Very similar in cultural characters to F XXI.
F XXIV.	Fungus isolated from June grass which showed silver top June, 1911. This fungus is identical in cultural characters with the one which Stewart isolated from June grass and which he regarded as identical with the carnation bud-rot fungus.
F XXV.	Fungus isolated from red top which showed silver top, 1911. Identical with F XXIV.
F XXVI.	Fungus isolated from quack grass, 1911.
F XXVII.	Fungus isolated from fowl meadow grass, 1911.
F XXVIII.	Fungus isolated from timothy from Maine, July, 1911.
F XXIX.	Fusarium from timothy from Indiana, 1911. This is a typical species of Fusarium and does not show the obovate spores.
F XXX.	Fungus with obovate spores from timothy which showed silver top. From same lot of material as F XXIX. F XXX is identical in cultural characters with the forms isolated from the different grasses in Maine.
F XXXI.	Fusarium isolated from summer squash, July, 1911. This fungus produces a small proportion of obovate spores in cultures.
F XXXII.	Fusarium isolated from diseased stem of garden pea, July, 1911.
F XXXIII.	Fusarium in which the mycelium takes on a blue color. Isolated from potatoes in storage, 1911.

* See foot-note p. 254.

F XXXIV. Fusarium with white mycelium from potato. From same lot of potatoes as F XXXIII.

F XXXV. Fusarium in which the mycelium takes on red color. Isolated from the same lot of potatoes as F XXXIII.

F XXXVI. Fungus secured from Dr. Barrett from Illinois. This culture was a later isolation which Dr. Barrett regarded as identical with the fungus described as Fusarium I from corn in Illinois Bulletin 133.

F XXXVII. Fusarium from Milden Apple. Culture from a strain isolated by M. Shapovalov, November, 1912. This fungus is identical in cultural characters with F I.

F XXXVIII. Fusarium from potato stems. Culture started from sporodochia on stems, September, 1912. There was no evidence that the fungus was growing as a parasite. This strain shows cultural characters identical with F I and it also caused rot of apple fruit upon inoculation.

F XXXIX. *F. vasinfectum* var *pisi* Van Hall. Culture secured from Centralstelle für Pilzkulturen, September, 1912.

F XL. Fusarium from decaying winter squash. This fungus which was isolated December, 1911 shows strikingly different cultural characters from F XXIII as F XL produces much white aerial mycelium with red and yellow color near the medium.

F XLIV. Fusarium from China aster. Isolated from diseased stem of China aster sent from Winter Harbor, Maine, in 1908.

F XLV. Fusarium from China aster. Isolated from material from Seal Harbor, Maine, August, 1911.

F XLVI. *F. niveum* Smith. Culture secured from Kral in February, 1910.

F XLVII. Fusarium strains a, b, c, d, and e. All seem to be the same species as F I unless it is e. Isolated from decaying Milden apples December, 1912.

F XLVIII. Fungus with obovate spores from flint corn. Same cultural characters as F XXXVI. Isolated from decaying corn from Winslow, Maine, January, 1913.

F XLIX. Fusarium with small proportion of obovate spores. Isolated from same lot of corn as XLVIII.

CULTURE STUDIES.

On account of the fact that certain species of Fusarium show very different cultural characteristics when grown under different conditions, it is difficult to compare the forms from different sources unless they can be grown on the same medium under the same conditions. The desirability of growing the fungi which are to be compared on a number of culture media should be readily apparent.

In this work comparative studies were begun with the forms isolated from apples and later other fungi were included so that with most of the media forms from 24 sources, F I to F XXIV, were grown on each medium at the same time. This number was used in comparing the effect of different sugars and acids on growth and also in the studies in which fermentation tubes were used.

In all of the work reported here, each form was grown on at least two tubes or plates of the medium and in many cases this was repeated several times. Cylinders of vegetables, as potato, turnip, carrot and beet are very satisfactory media for the growth of species of Fusarium. When potato cylinders are prepared in the same way from time to time and the cultures are kept under the same conditions in other respects there is very little variation in the appearance of the mycelium of a given strain. The writer has observed no striking changes in the cultural characters of certain species of Fusarium which have been grown upon this medium with frequent transfers for four years. The species of Fusarium are usually regarded as very variable, but what have been considered as variations can probably be explained in every case as responses to changed conditions.

Some of the most important characters to be made use of in comparing representatives of this genus are: mycelium as to amount of aerial growth and color, presence or absence of chlamydospores, shape and size of conidia, and with those forms which are parasitic, the extent of the parasitism should be determined by means of inoculations.

Owing to the incompleteness of many of the published descriptions, these characters have little value in placing forms in the described species. The amount of aerial growth and the color of the mycelium may be very different in sets of cultures of the same fungus on different media. A species which on one medium may show much bright red color of the mycelium next to the substratum and extending to the aerial growth may show little or no red color in cultures of the same age on another medium. In this same fungus, other conditions may lead to the production of still other colors. On the other hand there are certain species in which the mycelium remains white whatever culture medium is used. In regard to color, it is not sufficient to state that a form shows a given color without giving some account of the conditions under which this color was produced. In cultures of a given species, the spores may show differences in shape and size. For this reason the measurements of spores as they are usually given in descriptions of species may apply equally as well to the spores of another. Any description of a new species of Fusarium should be based on cultural studies extended enough so that the characteristics which are brought out by growth under different conditions can be taken into consideration.

There are some media, however, which do not have much value in furnishing characters of growth which can be used in the separation of species of this genus. In these studies considerable work was done in comparing the growth of species from different sources on media which contained different amounts of sugars and acids. In general, the conditions which are favorable to the growth of one species seem to be favorable to others. For example, the amount of a given acid which when added to a 2 per cent dextrose broth renders the medium so acid that one of the forms which has been tested will not grow prevents the growth of all. The only exception to this was with the strains F VII, F XV, F XVI, which grew in media which contained enough acid to prevent the growth of other species. The following account gives the cultural characters of a number of forms on different media.

Germination of Spores.

The species isolated from apple were studied in hanging drop preparations of the spores and this taken together with observations of the germination of the spores of other species in agar plates gives the basis for the statement that Fusarium spores germinate very readily when they are placed under favorable conditions for growth. Frequently, in cultures where there is a large amount of moisture present, spores germinate soon after they are produced.

Spores of F I from apple, taken from a culture three weeks old on turnip cylinder, were placed in a number of hanging drops of a decoction of apple wood at 4 P. M. The next day at 8 A. M. nearly all of the spores had germinated and in some cases the germ tube had branched. Other cultures were made in the same way at 9 A. M. and when these were examined at 4.30 P. M. all stages of germination were found. In some spores, the germ tubes grow out from the end cells in the direction of the long axis. In other cases, the germ tubes grow from the sides of other cells, the end cells being empty of contents. Fusions frequently take place between the germinating spores as shown in Fig. 94.

Spores of F II from apple taken from a bean pod culture three weeks old were sown in hanging drops of apple wood decoction at 10.30 A. M. At 2.30 P. M. the greater part of these spores had germinated. The next day at 2 P. M. considerable mycelium had developed and many spores were being formed. Most of these were of the long septate type but some obovate spores were seen.

Spores of F III from apple were sown in hanging drops at 9.15 A. M. At 4 P. M. many of these spores had germinated. As a rule the germ tubes grew out from the end cells in the direction of the long axis of the spores but in some cases the germ tubes developed from the sides of other cells.

Spores of F IV from apple, a fungus identical with F II, were taken from an agar plate culture and sown in hanging drops of 2 per cent saccharose broth where they began to germinate in 4 to 5 hours. The large septate spores germinate in the same ways that have been described for spores of the other species from apple. The small non-septate spores germinate after a little longer time than the large septate ones. They may or may not become septate before germination. The mycelium developed rapidly so that at the end of 24 hours a branched growth had formed from a single spore. After two days conidia were being produced. These were mostly of the obovate and pyriform types, although the long type were not rare. Cross walls were not seen in the long spores until after they had separated from the conidiophores.

Spores of F IV from apple, the greater part of which were of the obovate type, were placed in hanging drops of distilled water, potato broth, and dextrose broth at 3.30 P. M. At 8 A. M. the following day many stages of germination could be observed. The obovate spores become somewhat swollen and put out as a rule a single germ tube which soon branches. The spores sown in distilled water germinated well but the growth was soon checked while the mycelium in the broths made good growth and spores were formed.

Growth on Vegetable Cylinders.

Cylinders of vegetables in tubes make excellent media for the growth of the mycelium of species of Fusarium. At the present time the writer has strains from 50 sources representing, however, a smaller number of species, all of which grow well on cylinders of potato, beet, turnip and carrot. These media and especially the potato are used for keeping the stock cultures and, in addition to this, series of cultures of the different strains have been made in which a number of the fungi are grown on the different vegetables at the same time for comparison.

Potato Cylinders. All of the strains of Fusarium which have been isolated here have been grown on this medium. The amount of aerial mycelium and the color which develops are of value in placing the forms from different sources in large groups. Part of these have produced a large amount of white aerial mycelium with bright red color next to the potato, others have shown a white mycelium with no other color except some browning in old cultures, while others have developed blue color.

The following fungi have shown a bright red color on this medium. F I, F II and F IV from apples together with a number of other isolations from apples which proved to be identical with one or the other of these, all the forms with obovate spores which were isolated from various hosts, *F roseum,** F XVIII, from wheat sent from Ohio, another Fusa-

* See foot-note p. 254.

rium, F VIII, isolated from wheat grown in Maine, 2 strains, F V and F VI, from ears of sweet corn collected in Maine and another from yellow dent corn from Indiana, F XVII, one from decaying winter squash, F XL, and one from summer squash, F XXXI. This color usually appears in 3 to 7 days after the transfers are made when the cultures are kept at room temperature and exposed to the light from a North window.

Species of Fusarium from the following sources have been carried in culture on this medium for almost three years and have always shown white mycelium: One species from cucumber, F XIX; two strains from tomato, F XXI and F XXII, probably one species; one from squash, F XXIII; three different isolations from diseased stems of China aster, F XIV, F XLIV, F XLV, and one from decaying potato, F XXXIV A species from stored potato, F XXXIII, and one from cucumber, F XX, have produced blue color.

Beet Cylinders. This medium was favorable to the growth of all the species of Fusarium which were tested upon it. In general the growth on beet is very similar to that on potato with possibly a little more red color in those species which produce it.

F I from apple nearly covered the slants after 4 days growth. One tube showed bright red color at the surface of the liquid and extending up along the glass where the cylinder was in contact with the wall of the tube. There was also some red color over the surface of the slant. The other tube did not show quite so much but there was some mixture of red and yellow. One week later there was little difference in the appearance of the 2 tubes. When the cultures were one month old septate spores were found which measured 4 x 25 to 41 microns.

In the tubes of F II from apple the white aerial mycelium almost fiilled the space between the slant and the wall of the tube and extended 8 mm. above the top of each slant at the end of four days. Red color showed at this time on the surface of the medium and was especially bright where the cylinder was in contact with the wall of the tube. The amount of aerial mycelium was greater with this fungus than with F I. One week later the red color was becoming dull and some yellow had appeared. There was a small amount of browning in the aerial growth. When the cultures were one month old examination showed the presence of spores of different types. The most abundant were obovate in shape and about 8 microns in diameter but there were many septate spores 4 to 5.5 x 14 to 20 microns and consisting of 2 or 3 cells. There were also non-septate spores of the shape that usually occurs in cultures of Fusarium. No long septate spores were observed at this time.

F III from apple does not make as great a growth on any medium which has been used as the other forms from apples. On the beet cylinder cultures four days old, the mycelium covered a little more than one-half of each slant. There was very little aerial growth and this was white in color. No red color ever appeared in these cultures, although occasionally a little red color has been observed on other media.

The growth of F IV from apple was identical in appearance with what has been described for F II. Spores of the same type were found in the cultures.

Another fungus, F X, which was isolated from Red Astrachan apples which were decaying around the core had exactly the same cultural characters on this medium as F II.

The fungus, F XIII, from sunflower heads produced the same amount of aerial growth, the same colors and the same types of spores as the strains with obovate spores from apples.

Strains of a fungus from potato, F IX, and sweet corn, F VI, which produced both obovate and septate spores with a predominance of the obovate type were grown on this medium and gave cultures which in color and amount of mycelium agreed quite closely with the forms described above from apples and sunflower. Comparisons showed, however, that the cultures from apple and sunflower produced a larger proportion of septate spores than the similar fungi from other sources.

The mycelium of *F. putrefaciens,** F XII grown over the entire surface of the slants when the cultures were 4 days old. Not so much aerial mycelium had developed as in the forms with obovate spores but about the same amount as in F I from apple. The color differed from that in the Maine form, however, the red and yellow of the European fungus being dull in comparison. The dull red color extended to the aerial mycelium

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* See foot-note p. 254.

to a much greater extent than in any other fungus in this set of cultures. In cultures one month old large numbers of spores were found. These varied from non-septate spores 8 microns in length to spores 47 microns in length with 5 septa. The spores of this fungus are very similar to those of Fusarium I from apple.

A strain of Fusarium, F XI, which was isolated from an apple which was decaying on the tree August 1, 1910, and another, F VIII, isolated from wheat collected at Orono in September, 1910, were so similar to Fusarium I from apple when the three fungi were grown on beet cylinders that they could not be distinguished when placed side by side.

F. roseum, F XVIII, from wheat produced a luxuriant growth of white aerial mycelium and bright red color developed next to the medium. There was slightly more aerial mycelium than in the cultures of the fungi with obovate spores. Careful examination of material from these tubes showed only a few spores.

A fungus, F XVII, isolated from decaying ears of yellow dent corn sent from Indiana produced a growth very similar to that of *F. reseum* but there was some yellow color as well as red in the fungus from corn.

The species of Fusarium from cucumber, squash, and tomato grew well on beet cylinders but the amount of aerial mycelium was small in comparison with that of the forms which have been described and the color was white.

The 3 strains from cucumber seem to be distinct species although they agree closely in certain characters. One strain, F VII, has agreed closely with *F. oxysporum,* F XV and F XVI, from potato. On certain media this fungus has produced some purple color. Chlamydospores were formed in the cultures on beet cylinders and the conidia were of the one-celled type for the most part. One of the other strains from cucumber, F XIX, has agreed with this in spore characters but the color has remained white except for some brown in old cultures. The third form, F XX, produces less aerial mycelium than the others, the conidia are mostly three-septate and chlamydospores occur in the cultures. The first two forms would seem to be closely related to each other and to *F. oxysporum* as described by Smith and Swingle while the third should be placed in another group of species.

One Fusarium with white mycelium from squash, F XXIII, and the two strains from tomatoes, F XXI and F XXII, have resembled very closely in their growth the species from cucumber in which the mycelium remained white. These fungi in addition to chlamydospores produced larger rounded cells with a small amount of contents. These cells were as much as 30 microns in diameter in some cases.

Carrot Cylinders. The growth on this medium was so nearly identical with that on beet cylinders that the details will not be given. The most striking characteristic was the early development and brightness of the red color in those strains which have been described as showing this color on potato and beet. There was much red color on this medium at the end of 3 days.

Turnip Cylinders. All of the fungi made a good growth on this medium. There was not so much development of the red color on turnip as on potato, beet and carrot. Microscopic examination showed that the spore production agreed with that on beet.

Synthetic Agar. The species of Fusarium studied produce a good growth of mycelium on this medium which is prepared according to the following formula:

Dextrose	50	g.
Peptone	10	"
Ammonium nitrate	10	"
Potassium nitrate	5	"
Magnesium sulphate	2.5	"
Potassium monophosphate	2.5	"
Calcium chloride	0.1	"
Agar	20	"
Distilled water	1000	c. c.

This agar was titrated and made neutral with NaOH but it was found that upon sterilizing changes took place which rendered the medium somewhat acid. However, the medium which has been treated in this way with NaOH is more satisfactory for the growth of fungi than the same medium without this treatment.

The fungi were grown both in Petri dishes which contained 10 c. c. of the medium and on slants in tubes which contained 5 c. c. The appearance of the growth of a number of the fungi in Petri dishes is shown in Fig. 95 to 104. The development of red color was held somewhat in check on this medium in that it did not appear so early nor spread so rapidly as in the growth on some other media.

F I from apple spread rather rapidly, so that at the end of one week the mycelium had reached almost to the edges of the plates. The amount of aerial growth was less than in F II from apple. Viewed from the under side there was some yellow color and some red, but 3 days later the red color had increased so that one of the plates showed red over more than one-half of the under surface. Large quantities of spores were produced and when these were examined on the tenth day they were found to range from small one-celled to 5-septate spores 55 microns in length.

F II from apple made a very rapid growth on synthetic agar. At the end of one week the Petri dishes, which were almost 10 cm. in diameter, were filled with white aerial mycelium. Viewed from the under side both cultures were slightly yellowish and one showed some reddish color at the center. When the cultures were 10 days old both obovate and septate spores were found in large numbers. More than one-half of these were septate.

All of the strains with obovate spores from various sources have been grown on this medium. They have all agreed in the production of a large amount of white aerial mycelium and in showing some red or yellow color on the under side. The forms from apple and the one from sunflower have differed from the others in the production of a larger proportion of septate spores, but in other characters could not be distinguished from the other strains.

In the young cultures, *F. putrefaciens*, F XII, showed about the same amount of white aerial mycelium as F I from apple. When the cultures were one week old the mycelium took on a yellow color.

The Fusarium which was isolated from an apple which was decaying on the tree, F XI, the one from wheat collected at Orono, F VIII, and F I from apple made a very similar appearance on this medium, adding to the evidence that these strains belong to one species. All produced about the same amount of white aerial mycelium and all showed some yellow and considerable red color when the plate cultures two weeks old were viewed from the under side.

F. roseum. F XVIII, from wheat made a rapid growth and the Peri dishes were completely filled by the white aerial mycelium when the cultures were 5 days old. Later a small area which showed red color appeared at the center of each plate. A small number of septate spores were found in these cultures.

The forms from cucumber, F VII and F XIX, squash, F XXIII, and tomato, F XXI and F XXII, produced a rather large amount of white aerial mycelium. The one species from cucumber, F XX, which has been referred to as making less growth than the others on other media did not spread so rapidly in the plates as the others and could easily be distinguished from them. The culture of this fungus is shown in Fig. 104. All of the forms from cucumber produced chlamydospores.

The Fusarium, F XIV, F XLIV and F XLV, from China aster made a good growth but only a small amount of aerial mycelium developed. The color was white throughout. The spores were nearly all of the small one-celled type.

Prune Agar. The prune agar used in this work was prepared by making a decoction from 6 large prunes for each 1000 c. c. and adding 2 per cent dextrose and 2 per cent agar. It has been found that when too many prunes are used the agar becomes soft and that the use of a small enough number of prunes to give a solid agar makes the medium too poor in food for good growth of fungi. It was thought that adding 2 per cent dextrose to the agar containing the decoction from 6 prunes in 1000 c. c. would overcome both of these difficulties and the results have been fairly satisfactory. Species of Fusarium grow readily on this agar but do not produce aerial mycelium to such an extent as on synthetic agar. Prune agar is a favorable medium for the production of red color in those species which are characterized by the development of that color.

Fusarium forms I, II, and IV from apples spread rapidly over the plates but showed only a small amount of white aerial growth. Red color appeared at the center of the plates in 3 to 5 days and a little later the whole of each plate showed deep red, when viewed from the under side, except for a little yellow in F I. In the plates of F II and F IV the small amount of white aerial growth produced large numbers of spores of the obovate type. When these spores were sown in other plates of prune agar the young colonies first produced long, septate spores and later, on the aerial growth, large numbers of obovate spores developed.

F III from apple developed no aerial mycelium on this medium. When the cultures were 3 weeks old many spores were being formed. These were aggregated in a number of little masses surrounding the center of each plate. The large hyphæ showed some yellow color.

All of the fungi from various sources which have been described as producing obovate spores agreed quite closely with what has been described for the similar strains from apples. Some of these did not produce as large a proportion of septate spores as the strains from apple but all did produce septate spores in young colonies when the obovate spores were sown in plates of prune agar. This has been observed so frequently in forms from different sources as to give evidence that the development of the different types of spore depends to a large extent on the conditions of growth.

F. putrefaciens, F XII, differed very much in its appearance on this medium from the other apple fungi. No red color developed but instead many of the large hyphæ showed a deep yellow color.

The Fusarium from wheat, F VIII, which has been referred to as giving a growth identical with that of Fusarium I and other strains from apple gave further evidence of this relation when grown on this medium as the growth was very similar.

F. roseum, F XVIII, made a rather rapid growth so that 3 days after the transfers were made the colonies were 2.5 cm. in diameter. At that time the central part of each colony was deep red, the color extending out a little more than one-half of the distance from the center to the edge of the growth. At the end of one week, the mycelium covered the entire surface of each plate and showed a deep red color identical with that in the forms with obovate spores. Careful examination failed to show the presence of spores.

The forms from cucumber, tomato and squash produced only a small amount of white aerial mycelium. One of the species from cucumber, F VII, agreed with cultures of *F. oxysporum*, F XV and F XVI, from potato in showing at the center of each plate an area of reddish purple color. All of the species from cucumber produced chlamydospores on this medium.

F. oxysporum, F XV and F XVI, from potato made good growth on prune agar but did not produce much aerial mycelium. When the cultures were one week old, the center of each plate had taken on a reddish purple color for an area of about 4.5 cm. in diameter. At three weeks old, the dark reddish purple color had spread over the entire surfaces of the plates and a small amount of white aerial mycelium had developed. Examination showed large numbers of one-celled spores. Material from near the center of one plate showed chlamydospores.

Prune Decoction. This medium was prepared by cooking 6 large prunes in a part of the water, filtering the decoction and making up the filtrate to 1000 c. c. The fungi were grown in tubes containing 5 c. c. of this material. All of the forms which were tested made some growth but this was not a favorable medium for normal development. The mycelium spread through the liquid and in many cases formed a pellicle on which a small amount of aerial mycelium developed. Material from cultures of different ages was examined and it was found that few spores were produced and that these were abnormal as compared with spores of the same fungus grown on more favorable media.

Sugar Broths. In order to determine whether the growth in media containing different sugars would bring out characteristics which might be used to assist in classification, beef extract broths were prepared each of which contained one per cent of a different sugar and each of the strains, F I to F XXIV, was grown in the different media at the same time for comparison. The sugars used were dextrose, saccharose, lactose, and mannite. It was found that all the strains made good growth of mycelium in each broth but that dextrose and saccharose gave better growth than the others. None of the cultures gave a normal development of spores. The conclusion is that the use of sugar broths has no value in the classification of these fungi.

Growth in Fermentation Tubes.

All of the 24 strains which were used in the other culture work were grown in fermentation tubes. Each fungus was grown in two tubes for each medium and the following media were used: one per cent dextrose, saccharose, lactose and mannite broths, and 5 per cent glycerin broth. None of the fungi grew in the closed end of the fermentation tube in any of these broths and none produced gas so the fermentation tube proved to be of no diagnostic value.

Relation of Growth to Alkali and Acids.

One per cent dextrose broth was used as the basis for the media in testing the effects of different strengths of alkali and acids upon the growth of strains from 24 sources. It was found that all of these fungi made good growth even when large amounts of NaOH were added to neutral dextrose broth. At — 60 of Fuller's scale only a little difference could be noted when the tubes were compared with cultures of the same age growing in the neutral broth. When larger amounts of NaOH were added, the growth was less so that at — 100 a distinct difference could be noted in the amount of growth as compared with the check cultures. There was a small amount of growth in all of the tubes at — 150 NaOH but no growth took place when the medium was made — 200 of Fuller's scale. Not enough difference in the growth of the different forms in relation to the alkalinity of the medium could be observed to be of value in the separation of species.

In determining the amount of acid which prevents the growth of Fusarium, the acids used were hydrochloric, sulphuric, nitric, lactic, oxalic, and formic. Normal solutions of these acids were prepared and these were added to neutral one per cent dextrose broth in sufficient quantity to make the medium of the desired acidity. The same fungi which were used in the other culture work were grown in the media which were the same except for the amount and kind of acid which had been added. Two tubes were used for each fungus with each strength of a given acid. The amount of an acid which prevented the growth of one of the fungi had the same effect on the others except for the strains, F VII, F XV and F XVI, which grew in media which contained sufficient acid to prevent the growth of the others.

Hydrochloric, nitric, and sulphuric acids were unfavorable to the growth of all the forms when added in sufficient quantity to make the broth + 20 of Fuller's scale. At + 40 the growth was very much checked and at + 50 there was no growth. With lactic acid, there was a small amount of growth up to + 100 of Fuller's scale but above + 60 the strains of *F. oxysporum* showed better growth than the others. Oxalic acid checked the growth at + 40 and there was very little growth of any strains except those of the *F. oxysporum* type at + 60. At + 80 no other forms showed growth. With formic acid all of the tubes showed a small amount of growth at + 20, at + 30 there was very little growth and no growth in any at + 40.

Growth in Relation to Temperature.

There was very little growth of any of the 24 forms, F I to F XXIV, when transferred to potato cylinders and kept at a temperature of 5° C., or below. At 15° C. there was good growth but not so much as at 20° to 25° C. When cultures were placed in the incubator at a temperature of 30° C. the growth was not so rapid as at 20° to 25° C. At 33° C. it was less than at 30°, and those forms which produce a bright red color at lower temperatures showed a rather dull red and in a part of the forms yellow instead of red. At 37° C. none of the strains showed growth at the end of one week but when after that time the cultures were removed from the incubator and kept at room temperature most of the fungi made good growth.

Growth from Old Cultures.

Growth from old cultures has been reported for a number of species of Fusarium. By making transfers from time to time it was found that cultures of the species isolated from apples in Maine and also of *F. putrefaciens,* F XII, on bean pods, apple wood, and potato cylinders were alive after a period of 18 months in which the cultures became dried out at the temperature of the laboratory.

TESTS OF PATHOGENICITY.

Apple Inoculations.

Apples have been inoculated with each of the species of Fusarium isolated from apples and also with strains from other sources and it has been found that those isolated from apples and some of the strains from other host plants cause decays of the fruit which are equal in amount and very similar to the rot caused by *F. putrefaciens,* F XII, which has been used for comparison. While these fungi are not so active as causes of decay as the apple rot fungi Sphaeropsis and Penicillium, yet they are capable of causing complete destruction of apples when the conditions are favorable for their entrance and growth.

October 28, 1908, five apples were inoculated with material of F I from a pure culture. The fungus caused a distinct decay and was re-isolated in pure culture from the rotted tissues.

December 5, 1908, five apples were inoculated with material from a pure culture of F II from apple. The fungus soon showed evidence of growth and at the end of five days each apple showed a small decayed area at the point of inoculation. After two weeks the rot had spread to include an area which was from 1.5 to 2.5 cm. in diameter. Pieces of the decaying tissue were removed with a scalpel which was sterilized by flaming and each piece was placed in a Petri dish which contained 10 c. c. of prune agar. The fungus grew out from the tissues in each case and examination proved that the growth was identical with that of the fungus which was used in making the inoculations. The decayed tissue was quite bitter to the taste.

Ten green apples were inoculated August 10, 1909, with material from a pure culture of F I. At the end of 4 days an area about 6 mm. in diameter surrounding each point of inoculation was decayed and some white mycelium had developed. The rot spread slowly but at the end of one month the apples varied from one-half to two-thirds decayed. The diseased tissue was light brown in color, soft, and bitter to the taste when held on the tongue half a minute or more. Plates were made and the fungus was re-isolated in pure culture from the decaying tissues.

Sets of 4 Bellflower apples were inoculated January 4, 1910, with each of the following fungi: F I, II, III and IV from apple, F XV from potato, and F XIV from diseased stem of China aster. After 6 days all of the apples which had been inoculated with the Fusarium forms from apples and with F XV showed decay. The decayed area was about one cm. in diameter in each case and no difference could be noted in the rot caused by these fungi. The fungus from China aster did not cause rot of apples. The appearance of some of the inoculated apples is shown in Figure 111. As much difference could be noted among the apples inoculated with a given fungus as among those inoculated with the 5 fungi from different sources. The taste of the decayed tissue was slightly bitter in all of the apples except those in which the decay was caused by F XV in which no bitter taste could be detected.

August 19, 1910, 6 green apples were inoculated with each of the following fungi; F I, II, and III from apples, F XII, received from Europe, as *F. putrefaciens,* and what was called *F. oxysporum* from each of 2 sources, F XV and XVI. On September 1 all the apples showed some decay but in some cases the amount differed considerably in the 6 apples inoculated with the same fungus. F II caused less decay than the other fungi in this set of inoculations. Figures 108 to 110 show the appearance of the rot on a part of the apples.

Fusarium forms from 16 sources, including strains, F I, F II, F III, F XI, and F XII, from apple, F IX, from potato, F VII, and F XX, from cucumber, F XXII from tomato, F V and F VI from sweet corn, F VIII and F XVIII from wheat, F XIII from sunflower, and F XIV from China aster, were used December 9, 1910, in making inoculations of Greening apples. All made some growth at the points of inoculation but this variety seemed to be resistant to the attack of these fungi and only a small part of the apples showed much decay. There was considerable difference in some cases in the amount of decay in different apples inoculated with the same fungus as has been noted in other sets of inoculations. In this set of inoculations, some of the fungi from other host plants caused as much decay as fungi which had been isolated from apples. It was found that the Fusarium isolated from wheat, F VIII, and which agreed closely with F I from apples caused a distinct decay of these apples. A Fusarium isolated from cucumber, F VII, and which agrees closely with the strains carried as *F. oxysporum* from potato caused as much decay of apples as any fungus which was used in this set of inoculations.

Green McIntosh apples were inoculated August 10, 1911, with strains of Fusarium, F I to F XXVI. The fungi made some growth of mycelium at the points of inoculation but did not spread into the green fruit to cause much decay.

September 1, 1912, Duchess apples were inoculated with strains of Fusarium from 34 sources. Observations from time to time for one month showed that all of these fungi made a little growth but that none of them caused much rot.

January 9, 1913, one Mann apple and 2 Baldwins were inoculated with material of each of 7 strains of a fungus, F XLVII, of the type of F I from apple. Each strain was isolated from a different decaying Milden apple.

One week after inoculation there was a decayed region about 1.5 cm. in diameter at each of the two points of inoculation on each Mann apple. Little difference could be noted in the decay caused by the different strains. The decay spread more slowly in the Baldwin than in the Mann apples. One month after inoculation the Mann apples were almost entirely rotted while the Baldwins showed decayed areas 2 to 3 cm. in diameter.

January 17, 1913, Bellflower apples were inoculated with 40 strains of Fusarium isolated from different sources. One week later all of the fungi showed some growth at the points of inoculation. The strains of F XLVII from Milden apples caused decay more rapidly than any of the others. Later observations showed that strains of this fungus whether isolated from apples, wheat, or potato caused more decay of apples than any other forms used. The forms with obovate spores from various sources did not cause nearly so much decay in this set of inoculations as the fungi of the type of F I from apple. There was in some cases considerable difference in the amount of decay in different apples inoculated with material from the same culture. The results of the inoculation work would seem to justify the conclusion that a number of species of Fusarium may cause decay of apple fruit but that strains of one species are more actively parasitic than the others.

Inoculations of Pears.

Three pears were inoculated September 16, 1909, with material of F II from apple. The fungus spread rather rapidly through the tissues and caused the complete decay of the pears. The mycelium of the fungus grew out over the surface forming little tufts.

August 16, 1910, 3 green pears in each case were inoculated with F I, II and III from apple and with F XII, the organism carried as *F. putrefaciens*. Eight days later each of the pears showed a decayed area about one cm. in diameter. F XII and F I grew out around the points of inoculation producing mycelium of a dull red color. F II and III showed white aerial mycelium at the points of inoculation and Fusarium II was producing large numbers of spores, most of which were of the obovate type although some septate spores were observed. One month after the time of inoculation the entire surface of each pear inoculated with F XII or with F I was covered by mycelium which showed red, yellow and white colors. These two fungi gave a very similar appearance on the decaying pears. Fig. 112 to 114 are illustrations showing the extent of the decay 17 days after the time of inoculation.

Potato Inoculations.

Potato tubers have been inoculated a number of times with each of the Fusarium forms isolated from apples as well as with forms from other sources. The potatoes were inoculated by making a small injury with a sterilized needle or scalpel and placing in this a small amount of fungus material from a pure culture. The inoculated tubers were kept in closed glass jars at the temperature of the laboratory. Nearly all of the fungi made some growth at the points of inoculation but this did not spread into the uninjured tissues to cause decay. Surface injuries to the potato tuber soon become dried out and covered by a corky layer which prevents the entrance of the mycelium unless the tubers are kept under conditions of considerable moisture.

Cucumber Inoculations.

Species of Fusarium have been isolated from decaying cucumbers a number of times at this laboratory. In order to determine the extent to which these species and others would cause decay, cucumbers were inoculated with material of the forms isolated from cucumber, F VII, F XIX, F XX, squash, F XXIII, China aster, F XIV, sweet corn, F VI, apple F XII, and F II. All of these fungi caused a rapid decay. The appearance of 2 of the inoculated cucumbers is shown in Figs. 117 and 118.

Inoculation of Carnation Buds.

Owing to the similarity in cultural characteristics of the fungus with obovate spores from apple and the carnation bud rot fungus described by Stewart and Heald, it was decided to test the apple fungi on carnation buds in order to determine whether or not they would cause the bud rot. Later, the work was extended to include fungi from a number of other sources, a part of which were typical species of Fusarium. Four varieties of carnation were used,—Enchantress, Windsor, Gomez and Lady Bountiful. All of these, except the Gomez, were susceptible to the attack of part of the fungi which were used in making the inoculations. This variety proved to be very resistant and only a very small per cent of the Gomez buds were injured by any fungus which was tested. The Enchantress was used to a greater extent than either of the other varieties in comparing the amount of injury caused by different fungi.

All of the inoculations were made in the same way. A small injury was made in the side of the bud with a sterilized needle and a small amount of material from a pure culture was pushed in through the opening. Usually this material consisted of both mycelium and spores. In a few of the earlier experiments, the plants bearing inoculated buds were placed under bell-jars so that the buds were in a moist atmosphere favorable to the growth of the fungus. This procedure was followed for only a very short time as it was felt to be desirable to test the fungi under greenhouse conditions rather than under the abnormal conditions of a moist chamber.

The detailed account of a number of inoculation experiments follows. In the first part of the work only a small number of plants were available so the number of buds used in the earlier experiments was necessarily small.

Two buds of the Enchantress variety were inoculated March 4, 1910, with material of the apple fungus, F IV. The plants were placed under bell-jars and were kept covered for three days. At the end of this time it could be noted that the fungus was making some growth at the points of inoculation. The buds did not increase much in size and 12 days after inoculation the calyx of each bud appeared somewhat discolored. One bud was examined and it was found that all parts inside the calyx were destroyed by the fungus. When material from the decayed petals was teased out on a slide and examined with a microscope, spores of both the obovate and septate types were found, although the number of either kind was not great. The outer covering of the other bud was removed with instruments sterilized by flaming and the inner decaying part was placed in a tube containing 5 c. c. of sterile distilled water. White aerial mycelium grew out from this and the second day large numbers of spores were being produced, a part of which were obovate and a part of the long septate type. After 5 days the mycelium formed a thick red pellicle over the surface of the water. The white aerial mycelium was bearing many spores of the obovate and pyriform types which agreed in size with the spores of the carnation bud rot fungus.

April 21, 1910, 3 Enchantress buds were inoculated with F IV from apples. One of these buds was removed and examined 4 days later when the fungus showed only a small amount of growth. Two days later one of the other buds was examined and it showed that the fungus was making considerable growth in the tissues. April 29, 8 days after inoculation, the third bud was examined. All parts inside the calyx were destroyed and spores of the fungus were found. It is probable that if the first 2 buds had not been examined until 8 or 10 days after inoculation they would have shown a greater amount of decay as the fungus was growing in each at the time of examination and it has been found that about 10 days are necessary under favorable conditions for the complete destruction of the buds.

On account of the similarity in cultural characteristics of the fungi with obovate spores and certain species of Fusarium it was decided to test a number of fungi which gave evidence of being typical species of Fusarium to see if these also would cause decay of carnation buds.

April 20, 1910, 3 buds of Enchantress were inoculated with F I from apple and check punctures to which no fungus material was added were made in 2 buds. Five days later one of the buds, which was large at the time of inoculation, had opened and showed no decay. April 27 both of the others showed all inside the calyx destroyed and large numbers of spores of the fungus used in making the inoculations were present. One of the check buds was entirely open April 30 and showed no decay, the other opened a few days later and showed no injury from the puncture.

Since F I had caused decay another typical culture of Fusarium later found to be identical with F I was tested. April 28, 4 small buds were inoculated with F III from apple. One week later one of these was examined and it showed a small amount of decay of the petals and stamens. May 9 two other buds were examined and they showed more decay than was noted in the one examined May 5. When the last bud was examined, May 11, the interior was badly decayed.

May 5, 1910, 4 buds were inoculated with F III. May 16, 3 of the buds were badly rotted while the fourth remained healthy.

Five Enchantress buds were inoculated with F IV May 5 and were all badly rotted one week later. Three buds inoculated with the same fungus May 18 were decayed at the end of one week.

May 12, 1910, 2 Enchantress buds were inoculated with each of the fungi, F I, II and IV, from apple. All of these 6 buds were destroyed by the fungi within 10 days.

F XII, the organism carried as *F. putrefaciens,* is in every respect a typical species of the genus. July 11, 1910, 26 Enchantress buds were inoculated with this fungus. Eight days later, 21 of the buds were badly rotted. Material from a part of these was examined and septate spores of the Fusarium were found with no evidence of the presence of any other fungus.

July 26, 1910, 12 buds were inoculated with F XII and punctures were made in 13 buds to serve as checks. The injuries to the check buds were exactly like those in the others except that no fungus material was placed in the wounds. Examination 11 days later showed that all of the 12 inoculated buds were ruined by the fungus while the 13 checks were opening and showed no bad effects from the punctures.

F II from apple was used in making inoculation of 42 Enchantress buds July 11, 1910. Eight days later, 34 of these were badly decayed, 4 showed a small amount of injury and 4 were not damaged at all by the fungus. Eight buds were inoculated with F II July 26, 1910, and 11 days later all were rotted while one bud which had been punctured as a check had opened to a perfect flower except for the place broken by the puncture.

F XV from potato was used in making inoculations of 30 Enchantress buds August 18, 1910. None of these buds decayed. September 14, 13 buds were inoculated with the same fungus and 6 of these showed a small amount of rot, although the fungus did not spread through the tissues so rapidly as the different strains from apples.

August 26, 1910, 25 buds were inoculated with F IV and all of these rotted.

September 15, 1910, 18 buds were inoculated with F I and 30 buds with F III from apple. Of the 18 buds inoculated with F I, 11 decayed and of the 30 inoculated with F III, 20 decayed

The fungus, F XIII, with both obovate and septate spores from sunflower was used October 17, 1910, in making inoculations of 18 buds of Enchantress. Two weeks later 10 of the 18 buds had been destroyed by the fungus.

The Gomez variety was found to be very resistant to the fungi which caused a rot of Enchantress and other varieties which were used in later experiments.

Fourteen Gomez buds were inoculated August 26, 1910, with F I from apple. When these were examined 18 days later only one had rotted.

September 30, 1910, 37 Gomez buds were inoculated with the fungus, F XIII, from sunflower. Only 4 of these buds showed rot after 17 days.

F II from apple was used in making inoculations of 95 Gomez buds November 3, 1910. Observations from time to time indicated that the fungus was not causing decay and that the buds were developing normally. When a careful examination was made November 21 it was found that nearly all the buds had opened into perfect flowers. A few were slightly injured but none badly rotted.

In 1911 tests were made of part of the fungi which had been used in 1910 on 2 other varieties of carnation, Lady Bountiful and Windsor, and a number of fungi which had not been used in 1910 were tested on these varieties as well as on Enchantress.

May 4, 1911, 37 Enchantress buds were inoculated with F II from apple and punctures were made in 22 buds as checks. May 22, 20 of the inoculated buds showed decay and one of the 22 checks had become infected and was also rotted.

May 24, 1911, 30 Enchantress buds were inoculated with F II from apple and 37 with the organism carried as *F roseum*, F XVIII from wheat. Three buds of Lady Bountiful and 5 of Windsor were inoculated with F II from apple. June 6, 10 days after inoculation, 24 of the 30 buds inoculated with F II showed rot, all of the Lady Bountiful had rotted, 3 of the 5 Windsor had decayed. Of the 37 buds inoculated with F XVIII, 25 were destroyed by the fungus.

June 12, 1911, 24 buds were inoculated with material of the fungus, F XXIV, from June grass from a bean pod culture 3 days old, 22 buds with material from a potato cylinder culture 5 days old of the fungus, with obovate spores, F IX, from potato, 15 buds with material from a potato cylinder culture 5 days old of the fungus, F XIII, from sunflower, and check punctures were made in 10 other buds, June 21, 9 days later, 22 of the 24 buds inoculated with the fungus from June grass were decayed and all of the 15 buds inoculated with the fungus from sunflower were destroyed by the fungus. None of the 22 buds inoculated with the fungus from potato and none of the 10 checks showed any rot.

The fungus, F XXVI, isolated from quack-grass was used July 7, 1911, in making inoculations of 7 Enchantress, 6 Lady Bountiful and 12 Windsor buds. July 21, 6 of the 7 Enchantress, 5 of the 6 Lady Bountiful and 10 of the 12 Windsor were rotted. Examination of material from some of these showed the presence of many spores of both the septate and obovate types.

Eleven Enchantress, 7 Lady Bountiful and 12 Windsor buds were inoculated July 25 with material of the fungus, F XXV, from red top. Two weeks later, 8 of the 11 Enchantress, 5 of the 7 Lady Bountiful and 9 of the 12 Windsor were decayed.

The fungus from fowl meadow grass, F XXVII, which is identical in appearance in culture with the fungi from the other grasses was used September 27, 1911, in making inoculations of 16 Enchantress, 6 Lady Bountiful, and 6 Windsor buds. None of these buds decayed.

The fungus, F XXX, isloated from culms of timothy collected in Maine was used August 11, 1911, in making inoculations of 3 Lady Bountiful, 2 Enchantress and 15 Windsor buds. Ten days later 2 Lady Bountiful, 1 Enchantress and 7 Windsor buds were decayed. Great numbers of spores of the obovate form were found but there was no evidence of the presence of any other fungus.

November 21, 1911, 27 Enchantress, 15 Windsor, and 7 Lady Bountiful buds were inoculated with F IV from apple. Two weeks later, 22 of the Enchantress, 7 of the Windsor and 5 of the Lady Bountiful buds were rotted. This fungus had been carried in culture for about 2 years but still remained actively parasitic.

The fungus from corn, F XXXVI, which was designated Fusarium I by Burrill and Barrett was received from Dr. Barrett in November, 1911. December 13, 7 Enchantress, 6 Lady Bountiful and 8 Windsor buds were inoculated using material of this fungus from a potato cylinder culture 12 days old. None of these buds decayed.

The results of the rather large number of inoculations with fungi from different sources would indicate that a bud rot of carnations very similar to that described as due to *S. poae* may be caused by a number of different fungi some of which at least are typical species of Fusarium. A number of fungi which produce obovate and septate spores and agree in cultural characters with the carnation bud rot fungus were tested and most of these caused the rot. Three strains which appear to be very closely related to the carnation bud rot fungus in morphological and cultural characters failed to cause the rot. These were the fungus isolated from potato tuber, F IX, the one from fowl meadow grass, F XXVII, which is identical in appearance with the strains from the other grasses and the fungus from corn sent from Illinois by Dr. Barrett. Whether the failure of these fungi to cause the rot was due to the conditions at the time of inoculations or to the fact that these strains were not pathogenic to the carnation bud might be open to question. However, this point seems to have been determined rather definitely by inoculating a number of buds of the same variety with very similar fungi from different sources at the same time. The experiment of June 12, 1911, will illustrate this. The fungi used were the strain from June grass, F XXIV, which seems to be identical with *S. poae* as described by Stewart, the fungus with obovate spores from potato tuber, F IX, and the fungus from sunflower, F XIII. The material for all of the inoculations was taken from young actively growing cultures. Nine days after inoculation 22 of the 24 buds inoculated with the fungus from June grass and all of the 15 buds inoculated with the sunflower fungus were decayed. None of the 22 buds inoculated with the potato fungus showed any rot. Since the carnations were all of the same variety, Enchantress, and the different lots were growing side by side in the greenhouse, the fungus from potato had the same conditions for the attack of the buds as the other 2 fungi and the only conclusion which the writer can reach from the results is that the patoto fungus is not parasitic on carnation buds. This fungus resembles the carnation bud rot fungus more closely than do a number of other fungi which caused a rot of the buds. The fact that 2 other strains which are so like the fungus from June grass that it is impossible to distinguish cultures of one from the others failed to cause the rot of the buds would seem to indicate that certain strains are unable to go from one host to another. The most striking example of this was the fungus from fowl meadow grass, F XXVII. This fungus seemed identical in cultural characters with the strains from other grasses and yet it failed to cause the rot of carnation buds while the other strains caused the rot in a rather large proportion of the inoculations.

In his first account of carnation bud rot, Heald regarded a species of Fusarium as the cause of the disease. In his later publication, the fungus described was identical with the one described by Stewart as *Sporotrichum poae* and it was regarded as *S. anthophilum* which Stewart proved to be the same as *S. poae*. The inoculation experiments reported in this paper prove conclusively that a number of typical species of Fusarium cause a rot of carnation buds upon inoculation. Therefore, it is possible that Heald worked with different fungi, one a typical

Fusarium and the other the fungus with both obovate and septate spores, or it may be possible, as Stewart believed, that Heald's fungus showed at one time a predominance of septate spores and at another time of obovate spores and in that way led Heald to classify it at one time as Fusarium and later as a Sporotrichum.

The writer has found 3 types of fungi capable of causing the rot: first those with a predominance of obovate spores, as in the fungus from June grass, F XXIV; second, those which produce large numbers of both obovate and septate spores as in F II from apple and the fungus from sunflower, F XIII; and, third, certain typical species of Fusarium which produce no obovate spores as F I from apple and the fungus carried as *F. roseum,* F XVIII, from wheat. From the results of his inoculation experiments and culture studies Stewart concluded that his carnation bud-rot fungus, the fungus from June grass, and Heald's carnation fungus were identical. This conclusion is probably correct, yet attention should be called to the fact that emphasis should be placed on the cultural and morphological characters as well as on the results of inoculations because it has been shown that a number of species which are quite distinct in morphological characters may cause the rot of the buds.

The fact that a number of species or strains from different sources may cause the rot makes the question of control a more difficult one than it would be if only one fungus were responsible for the trouble. Heald regarded the bud rot as serious only in neglected houses while Stewart reported cases in which considerable loss occurred in houses which were well cared for. The fact that the fungi which cause the rot attack no other part of the plant than the interior of the bud would seem to indicate that in order to reach this part the fungus would have to enter through a wound in the calyx. In the greenhouse where the inoculation experiments reported in this paper were carried on, decay of buds which had not been inoculated was of very rare occurrence. In a very few instances, check buds in which punctures had been made were attacked by the fungi. The writer believes that as a rule in houses where every precaution is taken to remove and destroy material which might carry infection and where good conditions for growth are maintained there will be little trouble from the attacks of these fungi.

When it is considered that a vast number of spores may be produced on one diseased bud the necessity for great care in this work becomes apparent.

SUMMARY.

Species of Fusarium occur on a large number of host plants. A part of these fungi are destructive parasites. Owing to the confused condition or the classification of the species of this genus it is frequently difficult to distinguish a parasitic species from a saprophyte which has some similar characteristics. In many cases the same fungus has been described under a number of different names. In order to compare the fungi from different sources, it is necessary to grow them in culture under the same conditions. However, there is a wide difference in the value of different media for this purpose. Liquid media and agars give an abnormal growth as compared with the growth of the fungus on more favorable media such as cylinders of vegetables and other plant parts. Wollenweber * considers stems of plants the best medium for normal development of species of Fusarium.

In order to determine the extent of the parasitism of a given species it is necessary to carry out inoculation experiments. In some cases the same morphological species occurs on more than one host plant and it is only by inoculations that the question can be answered as to whether the strains occurring on one host can cause disease in another.

Two species of Fusarium have been isolated from Maine apples and it has been found that each of these is capable of causing decay. One of these, F I, agree quite closely with the organism received as *F. putrefaciens,* and which was described by Osterwalder as a cause of apple decay in Europe. The same fungus was isolated from diseased glumes of wheat, F VIII, and from potato stem, F XXXVIII. These strains also caused rot of apple fruit upon inoculation. One of the species, F II and F IV, from apple produces obovate spores similar to conidia of Sporotrichum in addition to typical septate Fusarium spores. This fungus resembles very closely in cultural characters the fungus which was described as the cause of a rot of carnation

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* Wollenweber, H. W. Studies on the Fusarium Problem. Phytopathology 3 : 25, 1913.

buds under the name *Sporotrichum poae* by Stewart. The chief difference is in the larger proportion of septate spores in the apple fungus. Similar strains have been isolated from a number of other hosts. All of these except one strain from sunflower, F XIII, and one from ears of flint corn, F XLIX, agree closely with the carnation bud-rot fungus in the proportion of septate and obovate spores. The strain from apple and the one from sunflower cause a rot of carnation buds which is identical with that caused by a strain from June grass which appears to be identical with the fungus described by Stewart. The writer believes that all of the strains which have both obovate and septate spores mentioned in this paper are closely related and that they constitute a group of species, each of which has strains occurring on a number of hosts. These fungi seem to be closely related to Fusarium in cultural characters and in being parasitic on plants. The chief difference between the form from apple and the one from June grass is in the proportion of septate spores. A fungus from summer squash, F XXXI, produces a few obovate spores in culture but the proportion is much less than in the form from apples. Thus there can be built up a series extending from strains in which most of the spores are of the septate Fusarium type with a few obovate spores to those with a small proportion of septate spores. Such a fungus as the one from summer squash would seem to be properly classified in the genus Fusarium but the other forms with the two types of spore are so similar to this one in cultural characters that all seem so closely related as to comprise a group. It may be possible that this group of species should be placed in another genus but after growing certain strains in comparison with species of Fusarium for a long period of time on a number of culture media the writer believes that the fungi with both septate Fusarium spores and obovate spores show closer relationship to Fusarium than to any other genus.

Inoculation experiments proved that strains of the fungi with obovate spores from a number of hosts as well as certain typical species of Fusarium cause a rot of carnation buds which seem identical with the disease described by Stewart and by Heald as due to Sporotrichum. Since the inoculation experiments show that not all the species or strains are confined to a single host plant in their parasitism, a large amount of work in cross inoculation experiments will be necessary in determining the extent to which each species may cause disease.

CONCLUSION.

Plant pathologists have felt the need of a comprehensive piece of work in which species of Fusarium from a large number of sources would be grown in culture under uniform conditions so that their classification could be based on the characteristics brought out in the cultures. In 1910 the first part of a monograph of this genus, based on this method, was published by Appel and Wollenweber.* By their methods of culture, what they consider normal development is secured and cultures from different sources can be compared.

Later, in the winter of 1911, Dr. Wollenweber came to this country to study American forms. Realizing the importance of this work, the writer turned over to him transfers from cultures of 35 strains from various sources in February, 1912. These are being studied in culture according to Dr. Wollenweber's methods and it is expected that matters of interest in regard to their classification will be included in a part of the monograph to be published later.

It was hoped both by Dr. Wollenweber and the writer that part or all of the strains would be classified in time so that the names could be included in this paper, but on account of other work only a limited amount of time could be given to these cultures and for that reason Dr. Wollenweber made only a preliminary report on the classification of a part of the fungi.

APPENDIX.

Shortly after Dr. Lewis severed his connection with this Station Dr. Wollenweber made a more detailed report of his conclusions with regard to the relationship of the cultures of the various strains of Fusarium which had been received by him from Maine. Since Dr. Lewis' paper had been written up largely from the standpoint of the data obtained from his own studies and independent conclusions it would, in a measure, destroy its individual value as well as tend to obscure the important features of Dr. Wollenweber's report were the latter to be incor-

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* See foot-note p. 209.

porated within the body of the former. Moreover to do this would necessitate making an entire recast of the article which for several reasons is impracticable and would lead to still farther delay in publication. Therefore, it seemed best to include this report in the form of the following tables, along with certain explanatory matter and comments, as an appendix to the original paper.

Attention is called to the fact that Dr. Wollenweber has determined the species without knowing the results of Dr. Lewis' studies on their pathogenicity. Only a list of the hosts from which the species were isolated was furnished when the original pure cultures were delivered to him for determination. As will be seen in the discussion following the table most of the species are already described or have been mentioned in the literature upon the subject. In case complete descriptions are lacking he will include them in his monograph or some other publication in the near future. He has very kindly consented to this preliminary publication of the names previous to the final and more complete description. However characters considered to be important for the differentiation of new forms and new combinations have been furnished by him and are briefly discussed in the following pages.

List of Species of Fusarium as Determined by Dr. Wollenweber.†

F I	1171	*F. pirinum* (Fries) Sacc.	Apple fruit
F II	1172	*F. helianthi* Sacc. (s. var.)	" "
F III	1173	*F. pirinum*	" "
F IV	1254	*F. helianthi*	" "
*F V			Sweet corn
F VI	1269	*F. poae* (Peck) n. n.	" "

† In the above list the Roman numerals preceded by the letter F designate the names under which the different strains or cultures of Fusarium are carried in this laboratory. The second and third columns give Dr. Wollenweber's serial, laboratory number and his determination of all the cultures sent him, with two exceptions, F X and F XI. The last column gives the source from which each culture was obtained. Those marked (*) were not sent to him. Attention is called to the fact that F XII, F XV (including F XVI), and F XVIII, received by and carried in this laboratory as *F. putrefaciens* Osterwalder, *F. oxysporum* Smith and Swingle, and *F. roseum* Lk. and referred to by these names throughout his paper by Dr. Lewis are designated as *F. pirinum* (Fries) Sacc., *F. orthoceras* App. and Wr., and *F. reticulatum* Mont. by Dr. Wollenweber.

F VII	1260	*F. orthoceras* App. & Wr.	Cucumber
F VIII	1272	*F. metachroum* App. & Wr.	Wheat
F IX	1247	*F. poae*	Potato tuber
F X	1252	(Not determined)	Apple fruit
F XI	1253	(Not determined	" "
F XII	1255	*F. pirinum*	" "
F XIII	1250	*F. helianthi*	Sunflower
F XIV	1251	*F. conglutinans* Wr.	China aster
F XV	1242	*F. orthoceras*	Potato tuber
F XVI	1243	*F. orthoceras*	" "
F XVII	1270	*F. discolor* var. *majus* n. var	Dent corn
F XVIII	1273	*F. reticulatum* Mont	Wheat
F XIX	1259	*F. reticulatum*	Cucumber
F XX	1261	*F. argillaceum* (Fries) Sacc.	"
F XXI	1248	*F. citrinum* n. sp.	Tomato
* F XXII			"
F XXIII	1256	*F. reticulatum*	Squash
F XXIV	1268	*F. poae*	June grass
F XXV	1265	*F. poae*	Red top
F XXVI	1266	*F. poae*	Quack grass
F XXVII	1267	*F. poae*	Fowl meadow grass
F XXVIII	1262	*F. poae*	Timothy
F XXIX	1264	*F. reticulatum*	"
F XXX	1263	*F. poae*	"
F XXXI	1258	*F. helianthi*	Summer squash
F XXXII	1249	*F. orthoceras*	Garden pea stems
F XXXIII	1244	*F. solani* (Mart.) App. & Wr.	Potato tuber
F XXXIV	1245	*F. conglutinans*	" "
F XXXV	1246	*F. helianthi*	" "
F XXXVI	1271	*F. poae*	Dent corn
* F XXXVII			Apple fruit
* F XXXVIII			Potato stems
* F XXXIX		(Received as *F. vasinfectum* var. *pisi* van Hall)	
F XL	1257	*F. culmorum* (W. Sm.) Sacc.	Squash
* F XLIV			China aster
* F XLV			" "
* F XLVI		(Received as *F. niveum* Smith)	
* F XLVII			Apple fruit.
* F XLVIII			Flint corn
* F XLIX			" "

According to their relationships Dr. Wollenweber has arranged these species in sections of the genus as follows:

Section Martiella: *F. solani, F. argillaceum.*

Section Elegans: *F. orthoceras, F. conglutinans, F. citrinum.*

Section Discolor: *F. discolor* var. *majus, F. culmorum, F. reticulatum.*

Section Roseum: *F. pirinum, F. metachroum, F. helianthi.*

Section Sporotrichella: *F. poae.*

Dr. Wollenweber makes the following comments with regard to certain species.

"*F. culmorum* W. G. Smith is identical with *F. rubiginosum* App. and Wr.

F. citrinum is a new species, differing from *F. orthoceras* App. and Wr. mainly in the absence of a blue color but the presence of a citric color of the mycelium thallus grown on sterilized potato tuber.

F. discolor var. *majus* is a variety of *F. discolor* App. and Wr. having larger conidia and a higher average septation. This variety needs further study as well as *F. argillaceum, F. reticulatum, F. pirinum* and *F. helianthi.* The latter species described as *F. roseum* var. *helianthi* by Saccardo is interesting by the presence of a pyriform microconidial stage, which shows some relation to the corresponding stage of *F. poae.*

The rest of the species have been partly described in Appel and Wollenweber, Grundlagen einer Monographie der gattung Fusarium, 1910, and partly by the latter author in 'Studies on the Fusarium Problem.' Phytopathology, 1913. In this latter paper the sections mentioned above are given with the exception of Sporotrichella, which might be provisionally established for species with small globose to pyriform but also sickle-shaped, septate conidia of the type of *F. poae* (= *Sporotrichum poae*)."

In studying the combined results of these investigations two interesting facts are presented. First it is apparent that in some instances quite a number of different forms or species of Fusarium have been found associated with the diseased tissues of the same host plant, and second that some are quite omnivorous in their habits and occur upon several hosts. Since the great majority of the species of this genus are saprophytes or are at most wound parasites these observations are by no means new or novel. However, these facts may be of considerable importance from an economic standpoint and they are much more apparent when the strains of Fusarium studied are arranged in the form of a host index and in the form of a list which gives the number of different hosts from which the same strain was isolated or in which it was found capable of causing disease upon inoculation.

HOST INDEX.

Apple fruit, (*Pyrus malus* L.)
  F. pirinum, F. helianthi (sub var.)
China aster, (*Callistephus hortensis* Cass.)
  F. conglutinans.
Dent corn, (*Zea mays* L.)
  F. discolor var. *majus, F. poae.*
Flint corn, (*Zea mays* L.)
  F. poae, (F XLVIII and XLIX, not studied by Dr. Wollenweber).
Sweet corn, (*Zae mays* L.)
  F. poae.
Cucumber, (*Cucumis sativus* L.)
  F. orthoceras, F. reticulatum, F. argillaceum.
Fowl meadow grass, (*Poa triflora* Gilib.)
  F. poae.
June grass, (*Poa pratensis* L.)
  F. poae.
Quack grass, (*Agropyron repens* (L.) Beauv.)
  F. poae.
Red top, (*Agrostis alba* L.)
  F. poae.
Timothy, (*Phleum pratense* L.)
  F. poae, F. reticulatum.
Pea, (*Pisum sativum* L.
  F. orthoceras.
Potato (*Solanum tuberosum* L.)
  F. poae, F. orthoceras, F. solani, F. conglutinans, F. helianthi, F XXXVIII. (The latter not studied by Wollenweber but according to Lewis is identical with *F. pirinum.*)
Summer squash (*Cucurbita pepo* L.)
  F. helianthi
Winter squash (*Cucurbita maxima Duchesne*)
  F. reticulatum, F. culmorum.
Sunflower (*Helianthus annuus* L.)
  F. helianthi
Tomato (*Lycopersicon esculentum* Mill.)
  F. citrinum.
Wheat (*Triticum sativum Lam.*)
  F. metachroum, F. reticulatum.

LIST OF SPECIES GIVING HOSTS FROM WHICH THEY WERE ISOLATED AND SUMMARY OF INOCULATION TESTS.

F. argillaceum (Fries) Sacc., from cucumber.
  Produced decay of cucumber on inoculation.
F. citrinum nova species, from tomato.
F. conglutinans Wr. from china aster and potato.
  Caused decay of cucumber but not of apple fruit (?).

F. culmorum (W. Sm.) Sacc., from winter squash.
Caused decay of cucumber fruits.

F. discolor var. *majus* nova var., from dent corn.

F. helianthi Sacc. (sub var.) from apple fruit, potato, summer squash and sunflower.
Produced decay of carnation buds, also fruits of apple and pear. Negative results with strain from apples on potato tubers.

F. metachroum App. and Wr., from wheat.
Caused decay of apples.

F. orthoceras App. and Wr., from cucumber, pea and potato.
Positive results from inoculation of apple and cucumber fruits, negative upon carnation buds.

F. pirinum (Fries) Sacc., from apple fruit. (F XXXVIII from potato considered identical with *F. pirinum* by Lewis.)
Positive results from inoculations upon apple and pear fruits and carnation buds. Negative upon potato tubers.

F. poae (Peck) novum nomen, from dent, flint and sweet corn, fowl meadow grass, June grass, quack grass, red top, timothy and potato tuber.
Positive results from the inoculation of carnation buds with the strains from June grass, quack grass, red top, and timothy.

Negative results upon carnation buds from the strains from fowl meadow grass, dent corn and potato. Strain from sweet corn caused decay of cucumber fruit.

F. reticulatum Mont., from cucumber, winter squash and wheat.
Positive results from inoculation of carnation buds and cucumber fruits.

F. solani (Mart.) App. and Wr., from potato.

The object of the summary of the inoculation tests is simply to assemble in condensed form the more important data secured by Dr. Lewis regarding pathogenicity and align it as far as possible with the names of the different species to which Dr. Wollenweber has referred the various strains of Fusarium under consideration. Mention should be made, however, of the fact that with the possible exception of *F. conglutinans* all of the strains studied produced some decay of some varieties of apples. However, only those which gave constant and marked positive results are so credited in the summary. The details of the inoculation tests will be found on pages 239-251.

W. J. M.

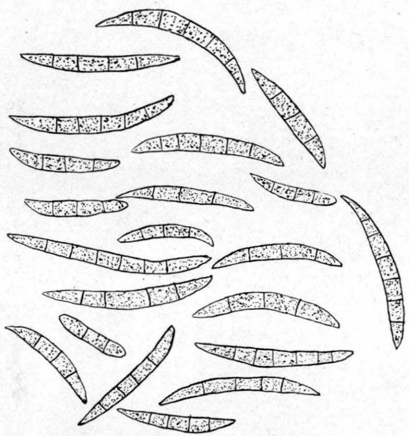

FIG. 86. Spores of F I (*F. pirinum*) from apple, from a potato agar plate culture 3 weeks old. x 480.

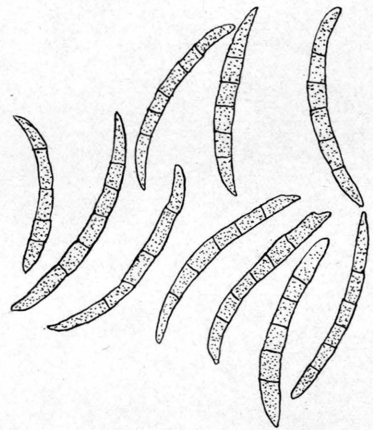

FIG. 87. Spores from a strain of F I (*F. pirinum*) isolated from Milden apple. Spores from sporodochia from a young bean-pod culture. x 480.

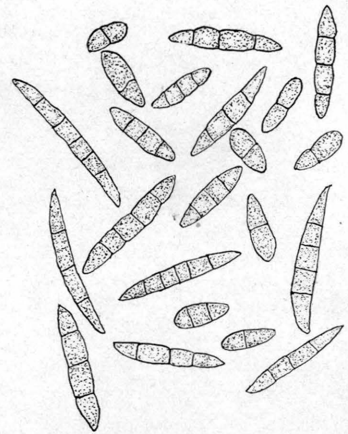

FIG. 88. Spores of F III (*F. pirinum*) from apple, from a potato agar plate culture 3 weeks old. x 480.

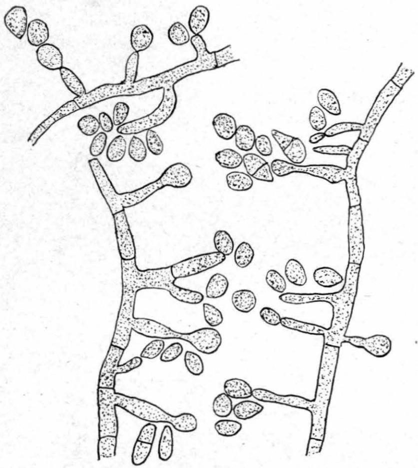

FIG. 89. Obovate spores of F IV (*F. helianthi*) from apple, showing the manner in which they are formed. From a hanging drop culture in one per cent saccharose broth. x 480.

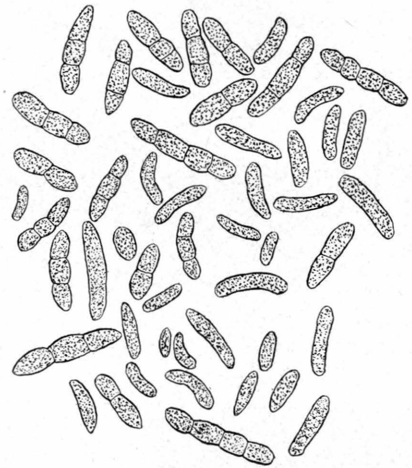

FIG. 90. Spores of F IV (*F. helianthi*) from apple, from a prune agar culture 5 days old. x 480.

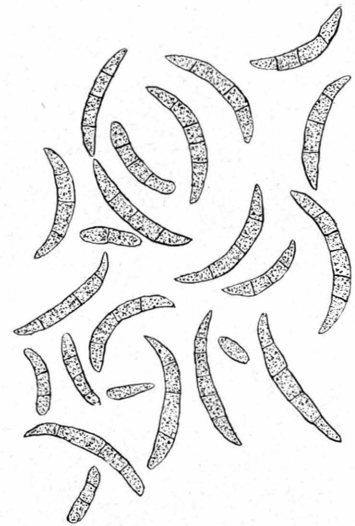

FIG. 91. Spores of F IV (*F. helianthi*) from a potato agar plate culture 3 weeks old. x 480.

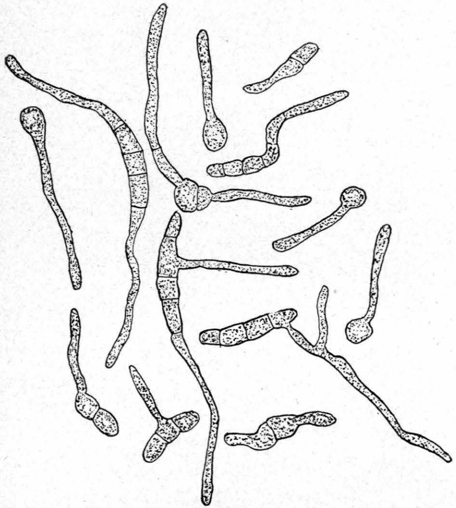

FIG. 92. Germinating spores of F II (*F. helianthi*) from apple after 4 to 6 hours in hanging drop of apple wood decoction. Obovate one-celled, pyriform 2-celled, and septate spores of the Fusarium type are shown. x 480.

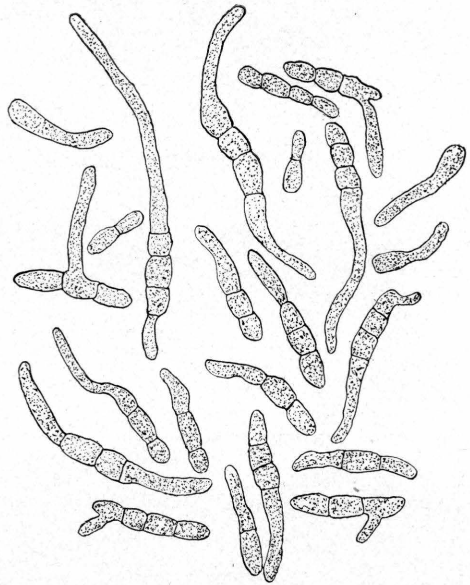

FIG. 93. Germinating spores of F IV (*F. helianthi*) after 5 to 7 hours in one per cent saccharose broth. x 480.

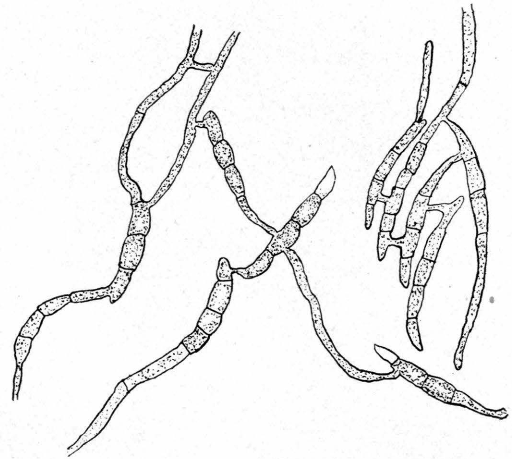

FIG. 94. Germinating spores of F I (*F. pirinum*) showing fusions after 24 hours in hanging drop of apple wood decoction. x 480.

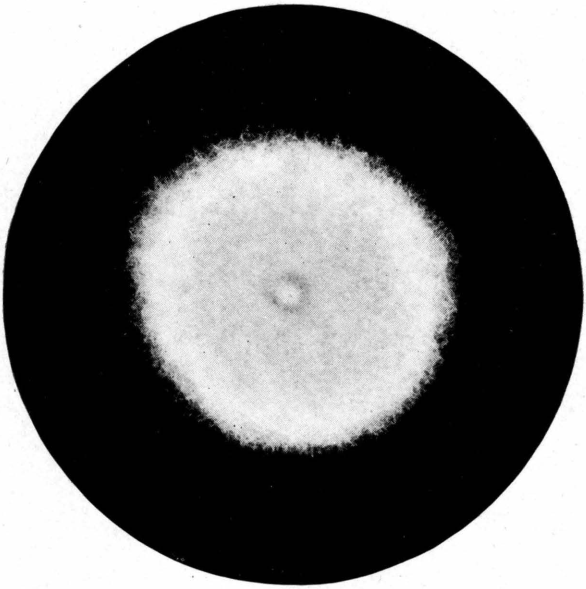

FIG. 95. F II (*F. helianthi*) from apple. Culture 4 days old on synthetic agar.

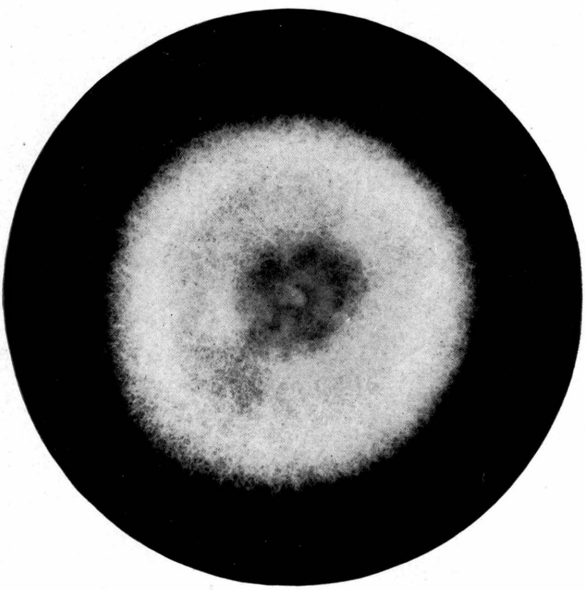

FIG. 96. F XIII (*F. helianthi*) from sunflower. Culture 4 days old on synthetic agar.

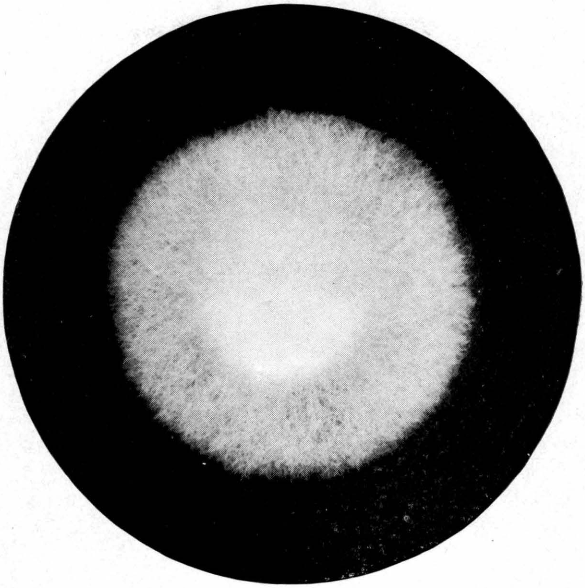

FIG. 97. F XXIV (*F. poae*) from June grass.
Culture 4 days old on synthetic agar.

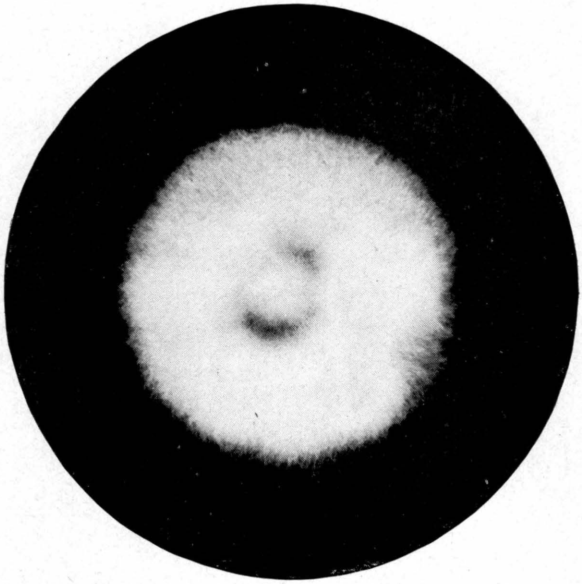

FIG. 98. F XXVI (*F. poae*) from quack grass.
Culture 4 days old on synthetic agar.

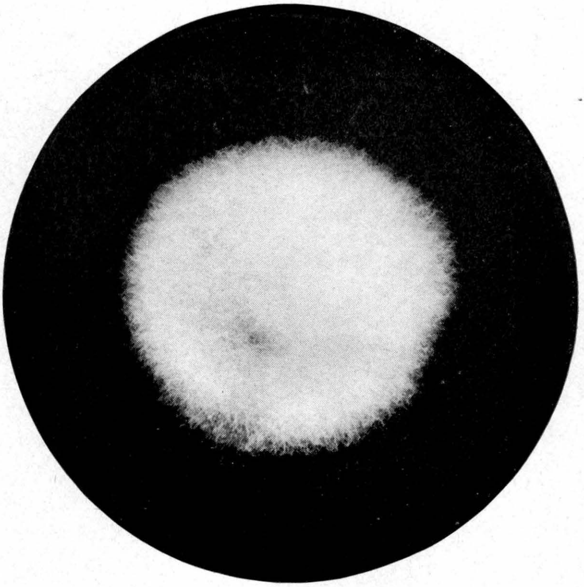

FIG. 99. F XXVIII (*F. poae*) from timothy. Culture 4 days old, on synthetic agar.

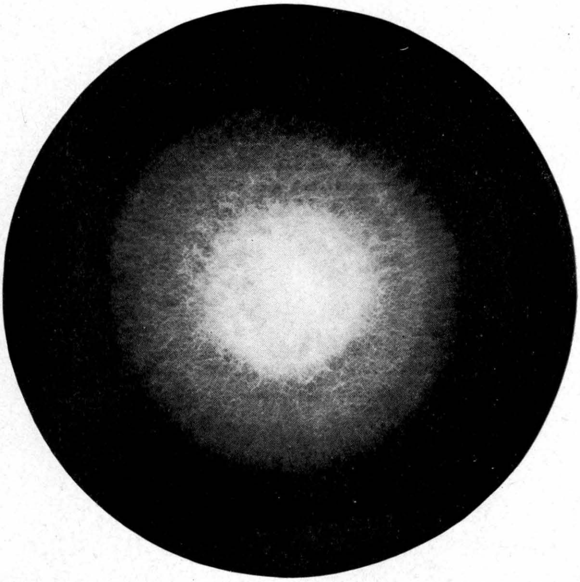

FIG. 100. F III (*F. pirinum*) from apple. Culture one week old on synthetic agar.

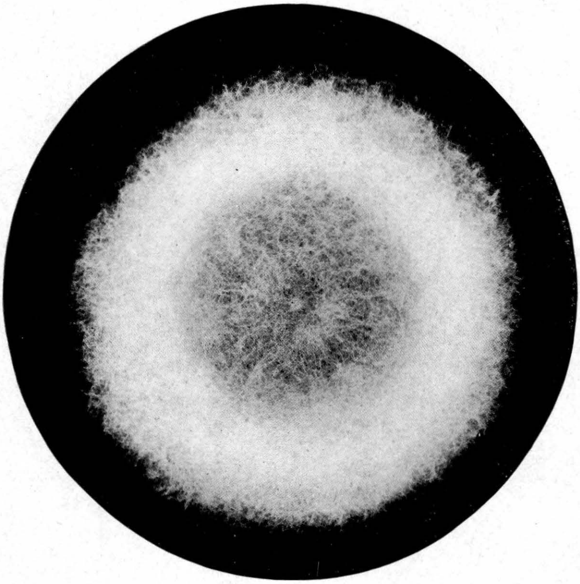

FIG. 101. F II (*F. helianthi*) from apple.
Culture 5 days old on synthetic agar.

FIG. 102. F I (*F. pirinum*) from apple. Culture
one week old on synthetic agar.

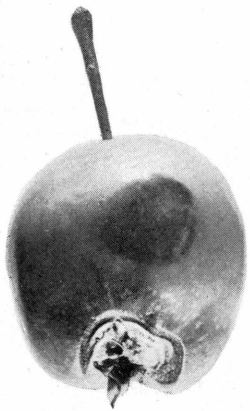

FIG. 105. Fusarium as it occurred on green apple on tree.

FIG. 106. F III (*F. pirinum*) on apple.

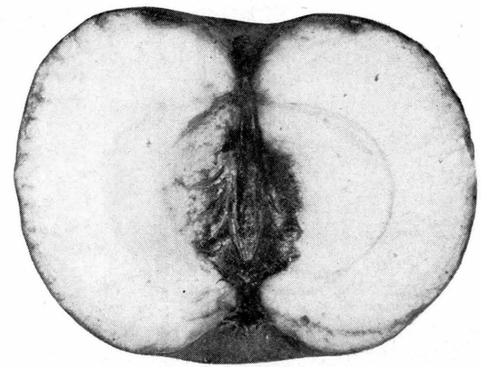

FIG. 107. Fusarium decay in core of apple.

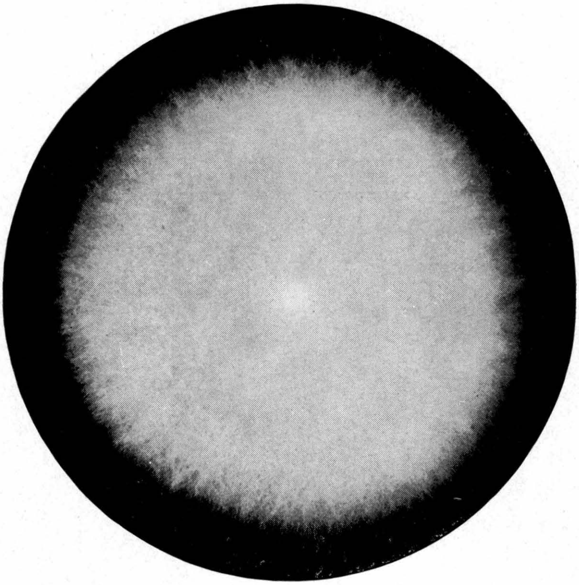

FIG. 103. F XV (*F. orthoceras*) from potato tuber from Vermont. Culture one week old on synthetic agar. This fungus was carried as *F. oxysporum*

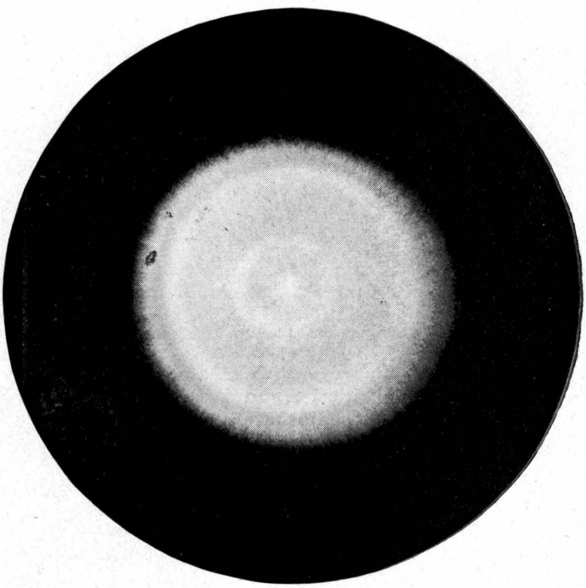

FIG. 104. F XX (*F. argillaceum*) from cucumber. Culture one week old on synthetic agar.

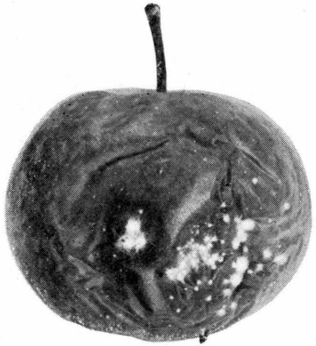

FIG. 108. Green apple 38 days after inoculation with F I (*F. pirinum*).

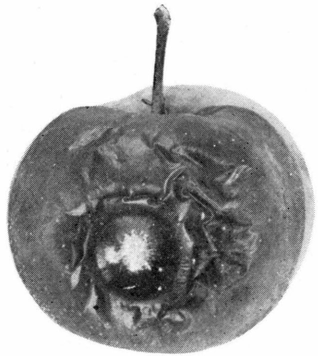

FIG. 109. Green apple 38 days after inoculation with F XII (*F. pirinum*).

FIG. 110. Green apple 38 days after inoculation with F XV (*F. orthoceras*), which is referred to in the text as *F. oxysporum*.

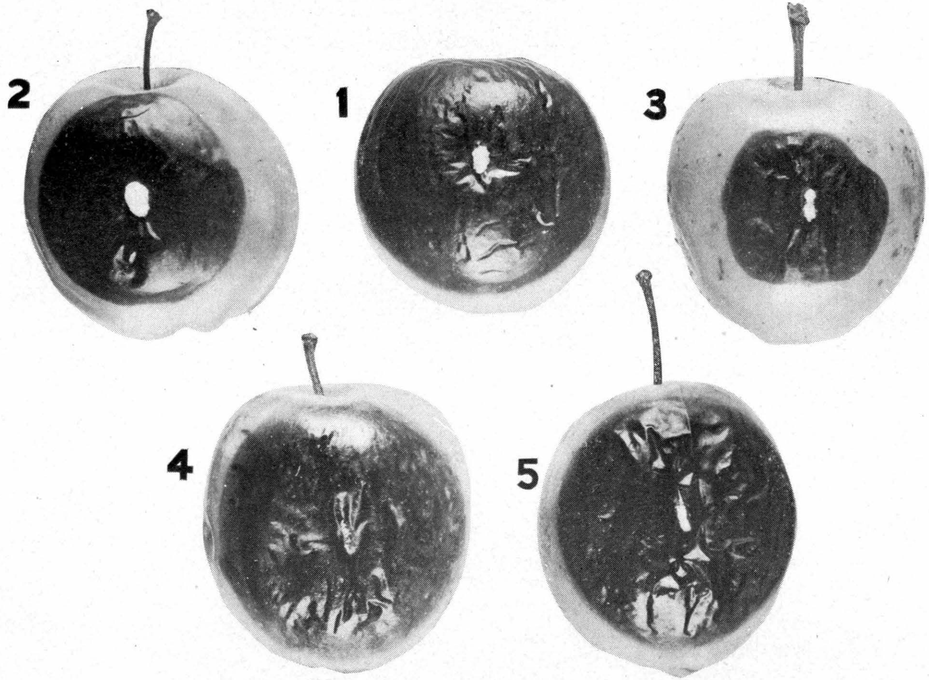

FIG. 111. Bellflower apples inoculated with Fusarium. 1 with F I, 2 with F II, 3 with F III, 4 with F IV, 5 with F XV.

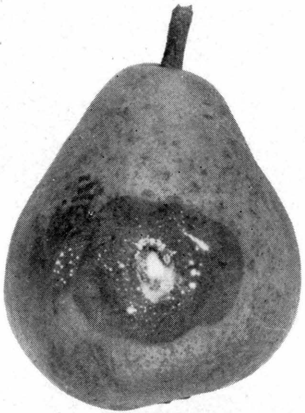

FIG. 112. Pear inoculated with F I (*F. pirinum*) from apple.

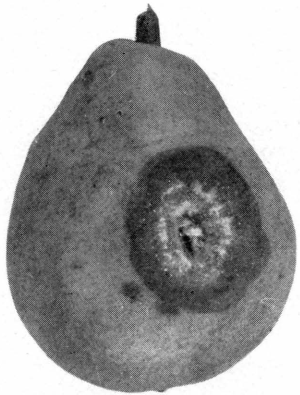

FIG. 113. Pear inoculated with F II (*F. halianthi*) from apple.

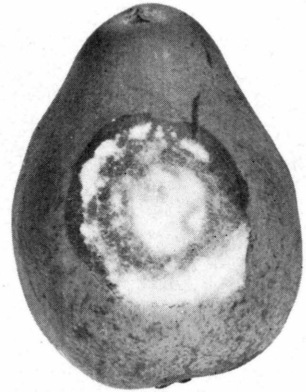

FIG. 114. Pear inoculated with culture received from Osterwalder as *F. putrefaciens* (*F. pirinum*, according to Wollenweber).

FIG. 115. Carnation bud-rot produced by inoculation with F II (*F. helianthi*) from apple.

FIG. 116. Carnation bud-rot produced by inoculation with culture received as *F. putrefaciens*. (*F. pirinum*, according to Wollenweber).

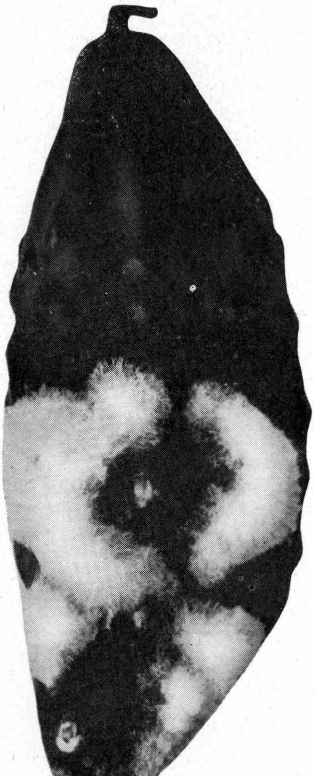

Fig. 117. Decay of cucumber produced by inoculation with F II (*F. helianthi*) from apple.

Fig. 118. Cucumber inoculated with F XIII (*F. helianthi*) from sunflower.

BULLETIN No. 220

WOOLLY APHIDS OF THE ELM.*

Edith M. Patch.

Since the publication of Bulletin 203 about one year ago, the elm aphids belonging to the genus *Schizoneura* have been making such rapid history that that publication is not only out of print but also out of date. It is the purpose of Bulletin 217 and the present paper to bring together what information I have on this group of elm aphids, more as a report of progress in order to clear away certain previous confusions than as an attempt at a complete treatment.

I have received very considerable aid in this study from entomologists in widely separated parts of this and other countries and express my appreciation of such help in general rather than in specific terms, not from any desire to assume credit for data worked in accordance with suggestions from others but in order that no one else need find himself made responsible for the manner in which these fragments are presented.

While it is to be regretted that we have not the total stories of all the species discussed it seems wise to bring the account up to date, trusting that the missing links will be forthcoming sometime, somewhere.

The present discussion takes no account of such species as have as yet been collected only in the far West as those can most fittingly be introduced by the entomologists who have been observing them at close range.

Among the points of specific value in separating these aphids are the antenna of the stem females with especial reference to

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* Papers from the Maine Agricultural Experiment Station: Entomology No. 68.

the relative length of the joints, the wax glands of the apterous generations other than the stem mother, and the antennal characters of the winged females. The habitat and the species of the elm concerned are also of much significance.

The text figures of antennæ in this bulletin are all drawn to the same scale.

Woolly Aphid of Elm Bark.

(*Schizoneura rileyi.*)

It is not uncommon to find the trunks and branches of young elms with tender places in the bark closely packed with colonies such as are shown in Figure 140. That Riley was correct in describing this as a distinct species a further acquaintance with the aphids leads me to believe. The stem mother has joint III of antenna conspicuously shorter than those of the "leaf roll" or "rosette." The wax glands of the second generation are of a type similar to *lanigera* but with a tendency to a larger central area. The antenna of the winged forms has joint III with the annulations less symmetrical than the other elm *Schizoneurans,* and the grooves between the annulations are of more varying depths.

There are several matters of biological interest in connection with this aphid which set it apart from any other species I know at present. Winged forms are developed both in June and in August, but both are developed on the elm. Whether they have lost their function as migrants altogether, whether they simply take wing to other elms, or whether there is a kink in the total life cycle of this insect which we have not yet learned, I do not know.

On September 23, 1908, I made a collection of apterous viviparous forms which gave birth to the true sexes. As in this genus, so far as I know, the mothers of the sexual generation are in other cases winged this seems peculiar. Individuals were inclosed in vials with bits of cloth and the records carefully taken so there could have been no mistake.

The minute apterous oviparous females are born with a beak which is lost with the molt. They have a 5-jointed antenna. Total length of body 0.8 mm. This form lays but a single egg.

The apterous males are but 0.55 mm. long and their bodies are slender. Their antennæ and legs are relatively much longer than those of the female. Antennæ are 5-jointed. Mature male without beak, this being lost at molt. Described from specimens taken September 23, 1908. Maine collection number, 89-08.

Antennal drawings of different forms are given here for comparison with the other species.

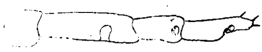

Fig. 119. The antenna of the stem mother of *rileyi* is distinguished at once from those of the curl and rosette dwellers by the difference in length, it being much shorter in this species. It is normally a 5-jointed structure but there is frequently a clear spot in III as shown in this figure which seems to be a vestigial indication of another joint. (52-13).

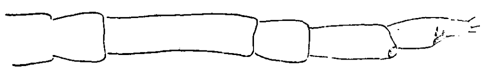

Fig. 120. Evidently a part at least of the second generation become winged as winged forms are present by the middle of June at which time the stem mother is still actively producing nymphs. The antenna of the pupa is given in this figure. (7-08). It is characterized by a rather short bulged IV.

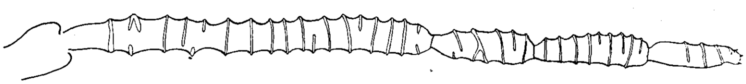

Fig. 121. The antenna of the spring winged generation is characterized by having wider spaces between the annulations on III than is usual for the curl and rosette dwellers, and with less symmetry as to the antennal grooves. Annulations are com-

mon on VI. The antenna of this generation is practically the same in appearance as that of the fall winged generation. (7-08).

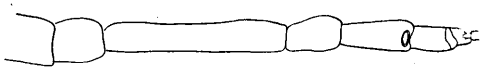

Fig. 122. The antenna of an apterous viviparous form giving birth to the true sexes. (89-08). The relative length of the joints are approximately the same as those of the pupa.

The following collection notes are perhaps worth keeping as a part of the discussion of this species:

Aphid 69-05. September 2, 1905. Present in great numbers in woolly clusters along trunk of small elms at Orono. Apterous viviparous form and nymphs. This material was determined by Mr. Pergande as *Schizoneura rileyi* during the winter of 1905-06.

Aphid 95-06. August 4, 1906. Orono. Apterous and alate forms present on trunk of young elm.

Aphid 7-08. June 16, 1908. Woolly mass on trunk of small elms. Winged viviparous forms just developing from pupæ.

Aphid 89-08. Sept. 23, 1908. Orono. Apterous viviparous forms in woolly bunches on trunk and branches of young *Ulmus americana*, causing knotty growth. The progeny of these apterous forms were the true sexes,—apterous oviparous females and apterous males. Eggs were plentiful under the bark.

Aphid 52-13. June 14, 1913, Orono. Colonies in tender places on trunk of young elms (*Ulmus americana*). Stem mothers, nymphs and pupæ.

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* No attempt has been made to give a complete bibliography for any species in this paper.

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1905. *Schizoneura rileyi,* Felt, N. Y. St. Mus. Memoir 8: pp. 172, 192. Brief description of work and remedies.
1909. *Schizoneura rileyi,* Gillette. Journal Ec. Ent., p. 357.
1910. *Schizoneura rileyi,* Patch. Bul. 181, Me. Agr. Exp. Sta.
1910. *Schizoneura rileyi,* Williams. The Aphididae of Nebraska, p. 20.
1910. *Schizoneura rileyi,* Davis. Journ. Ec. Ent. p. 413.
1913. *Schizoneura* from elm bark. Patch Annals Ent. Soc. America. Plate 24, Figs. 19, 20, 21, 22.

A New Elm Gall for America.

Schizoneura lanuginosa?

A gall unlike any I have seen before was sent me last August from Connecticut by Doctor Britton. It was deserted and brown and dry, but as Figure 139C will show it resembles the pictures by Buckton of *lanuginosa* so closely that it seems probable that it is that species. The gall was apparently an out growth from the twig at the base of the petiole, resulting in the extreme dwarfing of the nearest leaves. It is figured here merely to call attention to the occurrence of such a gall in New England in hopes that specimens may be collected earlier another season before the migrants have taken wing.

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1843. *Schizoneura lanuginosa,* Kaltenbach, Monogr. d. Fam. d. Pflanzenlause p. 170.
1857. *Schizoneura lanuginosa,* Koch. Die Pflanzenlause, p. 264, Fig. 339, 340.
1863. *Schizoneura lanuginosa,* Passerini, Aphididae italicae, p. 70.
1881. *Schizoneura lanuginosa,* Buckton, Monogr. of Brit. Aphides, Vol. III, p. 104, Pl. CIX, Fig. 5-10.
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1887. *Schizoneura lanuginosa,* Horvath, Math. term. ert. V pp. 130-136.

1893. *Schizoneura lanuginosa,* Rey, Exchange, p. 62.
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1909. *Schizoneura lanuginosa,* Tullgren, Aphid. Stud. Uppsala. p. 170, Fig. 83.
1909 (1910) *Schizoneura lanuginosa,* Henrich, Die Blattlause der Umgebung von Hermannstadt.

Elm Rosette or Leaf Cluster Aphid.

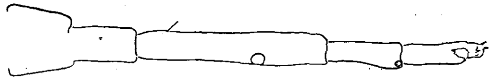
Schizoneura lanigera (*americana* in part of authors).

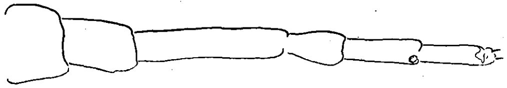
This aphid and the next succeeding are treated in Bulletin 217. I do not know whether the two are distinct, but from the appearance and the behavior of the summer generations of both on *Pyrus* and the antennal characters of the fall migrants do not feel that there is any basis of separating them except as to the nature of their elm habitat.

The antenna of different generations of the rosette aphid, (Figs. 123 to 128) together with some details as to wax glands (Fig. 143 D. J. K.) are given for comparison with the other elm aphids.

This migrates normally to *Pyrus* in Maine the spring migrants from the elm leaves settling on the under side of the leaves of mountain ash and apple, and their immediate progeny creeping to stems of water shoots or tender places in the bark before feeding. Such normal out of door colonies which were watched carefully during their origin are shown in Fig. 78 in Bulletin 217 of this Station. I have also reared the progeny of the spring migrants on mountain ash in confinement, such a colony being shown in Fig. 69 in Bulletin 217.

It is abundant in both Maine and Colorado and doubtless all the way between.





Figs. 123 and 124. Antennæ of stem mother from rosette. The antenna of this form is normally 5-jointed with a trans-parent place varying in shape and size on III that seems to be a vestigial indication of another joint. Indeed 6-jointed antennæ for this form are by no means rare and it sometimes happens that a specimen will have one 5-jointed antenna and the other distinctly 6-jointed. (33-13).

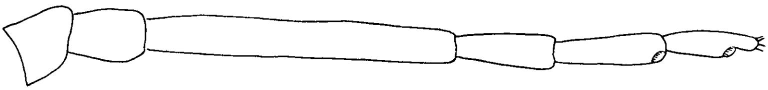


Fig. 125. The antenna of the rosette aphid, second generation, apterous viviparous. (33A-13). Typically this has III as long as or longer than IV+V+VI, and in this respect resembles the antenna of the winged form of this species.

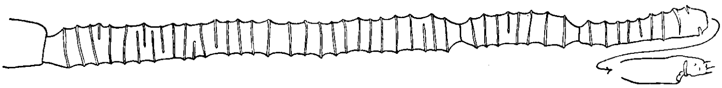
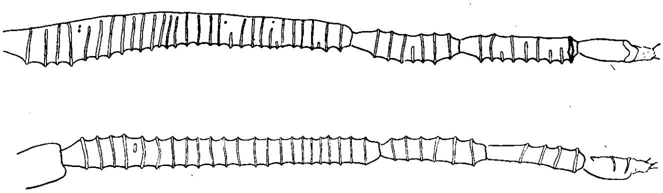


Fig. 126. Antenna of spring migrant from rosette,—one of the collection whose progeny colonized the seedling mountain ash as shown in Bulletin 217, Fig. 69. (57-13).



Figs. 127 and 128. Antennæ of spring migrants from rosette collected July 10, 1912, from under side of mountain ash leaf in the open where they were settled and producing progeny. (See Fig. 78, Bulletin 217) Ordinarily VI is without annulations but these sometimes are present as is shown in Fig. 128. (60-12).

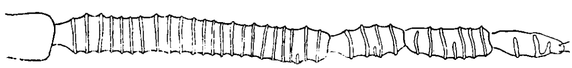


Fig. 129. Antenna of fall migrant collected from hawthorn, *Crataegus*. (114-06).

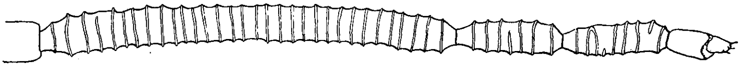


Fig. 130. Antenna of fall migrant collected from mountain ash. *Pyrus* sp. Typically VI is with two or more annulations, but these are sometimes lacking. (63-11).

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1897. *Schizoneura americana,* Gillette. (in part?). Bul. Div. Ent. U. S. Dept. Agric. 9, pp. 78-79. "The attack begins with the opening of the first buds, when the little, wrinkled clusters of leaves begin to appear from the terminal buds of small twigs upon the trunk and large branches of the tree."

1898. *Schizoneura americana,* Gillette. (in part.) Bul. A. E. S. Colo. 47, p. 35 and Fig. 32. "The Elm Leaf-cluster Gall.

1899 (1900). *Schizoneura americana,* Harvey, Bul. Me. Agr. Exp. Sta. No. 61, p. 32. Figure.

1900. *Schizoneura americana,* Lugger (in part). Bul. No. 69. Minn. Agr. Exp. Sta. Id. 6th Ann. Rept St. Ent. of the St. Exp. Sta. Univ. of Minn. p. 169. "If at all numerous they can greatly deform the ends of the twigs, where all the leaves are curled, forming a mass of sickly, yellowish leaves."

1904. *Schizoneura americana* (in part). Sanborn, Kansas Aphid. p. 25. "When numerous they give the leaves a whitish appearance and cause the terminal ones to bunch together, which gives the lice more protection."

1909. *Schizoneura ulmi* (*americana*). Gillette. Jour. Ec. Ent. Oct. Fig. 16. Antenna.

1910. *Schizoneura americana* (in part). Patch. Bul. 181. Me. Agr. Exp. Sta. Fig. 151.

1912. *Schizoneura lanigera* (*americana*). Patch, Woolly aphid migration from elm to mountain ash. Jour. Ec. Ent. pp. 395-398. Figure 2.

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1913. *Schizoneura* sp. Gillette. 25th Ann. Rept. of the Col. Agr. Exp. Sta. p. 30, "the form producing the rosette like cluster of leaves at the tip of elm twigs."

1913. *Schizoneura* sp. Patch. Ann. Ent. Soc. Am. Figs. 68 to 82.
1913. *Schizoneura lanigera.* Patch. Bul. 217. Me. Agr. Exp. Sta. Figs. 69, 70, 71, 72, 78, 79, 80, 81.

SOUTHERN ELM LEAF CURL.

Schizoneura lanigera (*americana* in part of authors).

My acquaintance with this form is limited to material sent me from the south the spring of 1912. I am not sure of the species of *Ulmus* it was taken on, but think it was *americana.*

Photographs of the curl and the woolly colony on apple, bred from migrants of this form are given as Figures 67 and 68 of Bulletin 217.

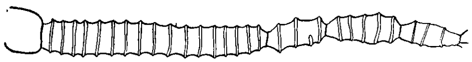

Fig. 131 represents the antenna of the fall migrant (*sexupara*) of the same bred colony. (9-12 sub. 1.)

It will be seen that this has the same characteristics as the corresponding form taken on *Pyrus* or *Crataegus* out of doors as shown in Figures 129 and 130. It is smaller than many of the out door grown individuals but the overstocked and dwarfed little seedling on which it developed may well be responsible for the size of the insects which were reared through the several generations from the spring migrants in confinement on the same potted apple in confinement.

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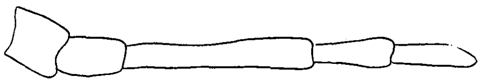
1913. *S. lanigera* (*americana*). Patch. Journal Economic Entomology. Vol. 6, pp. 316-318.
1913. *Schizoneura.* Patch. Annals Entomological Society America. Vol. 6, Plate 24. Fig. 11 and Plate 25. Fig. 27.
1913. *S. lanigera* (*americana* in part). Patch. Bul. 217. Me. Agr. Exp. Sta. Figs. 67 and 68.

Northern Curl of American Elm.

Schizoneura americana in part, of authors.

The popular name here applied to this species may be unfortunate as the same insect exists also in the south, but it is apparently the most common aphid in the northern states inhabiting the roll or curl type of leaf deformation on *Ulmus americana.*

The stem mother matures in Maine early in June, in the young roll. (Fig. 139A) At this time she is somewhat powdery but if removed from the curl and examined in sunlight with a lens her body is found to have a distinctly greenish cast. When mounted alive on a slide in balsam there is no dark reddish stain though the balsam may be slightly yellowed. This species may be distinguished by these signs from the rosette dweller which shows distinctly reddish in the sunlight and stains the balsam a deep red when mounted alive.



Figs. 132 and 133 show the antenna of this form which resembles that of the rosette species closely. Indeed the antennal joints of the first generation of both these species vary enough in different individuals to make this structure of little value in separating the curl and the rosette species in this stage. (32-13 and 32A-13).

The second apterous generations however, are readily distinguished by their wax glands, those of this curl dweller being arranged in an irregular rather elongate mass and not placed about a clear central area as in the case of the rosette dweller.

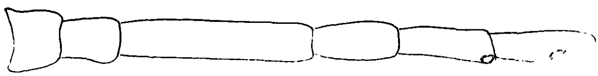


Fig. 134. The antenna of this generation is 6-jointed and distinguished from that of the rosette dweller in having III typically shorter than IV+V+VI. (32A-13.) This generation matures about June 17 in Maine.

Whether the migrant generation maturing late in June are altogether the progeny of the second apterous generation or in part the daughters of the stem mother I do not know. My field observations lead me to think that part of the progeny of the second apterous generation desert the elm leaves and settle under the scales of the elm bark in tender places on the trunk and there subsist as bark feeders in woolly colonies but less conspicuous and more hidden than *rileyi*. At any rate such bark colonies occur here in Maine for which I can not otherwise account.

The fact that the stem mother is still actively giving birth to nymphs for some time after the second apterous generation become mature and are producing young complicates the case considerably when an attempt is made to sort out the young. Figure 139B shows an old roll just deserted by the migrants.

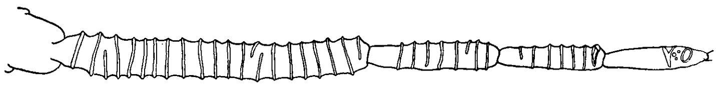


Fig. 135. The antenna of the spring migrant. It is typical for this structure to have III shorter than IV+V+VI and VI subequal to or even longer than V. The length of VI, however, is variable in Maine material and is apparently ordinarily a little shorter than with the same species as it occurs in the western states. The number of annulations on III is also subject to considerable variation. The antennæ of those individuals developing in leaf curl late after the leaf becomes less sappy are likely to differ very strikingly from those developing earlier in the season both in total length of antenna and in the number and distribution of the annulations, as is illustrated in Annals Entomological Society of America, Vol. 6, Plate 24. Figs. 2, 6 and 7 are all drawn to the same scale. Figs. 6 and 7 represent the antenna of individuals collected July 23, 1912 for comparison with specimens, Fig. 2 which developed June 30 in the same leaf rolls. The difference in the total size of the antennæ and in the

number of annulations of the big thrifty early ones from the juicy leaf and the last individuals to develop in the drying roll would seem suggestive of the physiological effect of the habitat on the size of the individual and the character of the antenna. (68-13.)

The migration of this winged generation from the leaf curl is a matter of frequent record and easy to observe. Where it goes and what the food plant of its summer progeny is still unknown. During 1912 a few individuals of this species were taken in the open on *Pyrus* leaves together with the rosette dweller, but a further acquaintance with the elm *Schizoneurans* leads me to believe that they had merely alighted there accidentally on the way to their proper host.

A fall migrant is found on the elm whose antenna accords with that of the spring migrant of this species and is probably the return migrant. Neither the spring nor fall winged forms have the antenna of *lanigera* and the wax glands of the second generation distinguish it from that *Ulmus-Pyrus* species.

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1879. *Schizoneura americana* in part, Thomas (in part). Report of the State Entomologist Ill. VIII, p. 202. Quotes Riley's description.

1887. *Schizoneura americana,* Oestlund, O. W., (in part). Aphid. Minn. p. 27. Description of winged form and pseudo gall.

1890. *Schizoneura americana* Packard, (in part). Fifth Rept. U. S. Entom. Com. p. 279. Extract from Riley Bul. U. S. Geol. and Geograph. Survey, Vol. V, No. 1.

1897. *Schizoneura americana,* Gillette, C. P., (in part?). Bul. Div. Ent. U. S. Dept. Agric. 9 (n. s.): 78-79. Description of work.

1900. *Schizoneura americana,* Lugger, (in part). Bul. No. 69. Minn. Agr. Exp. Sta. Id. 6th Ann. Rept. St. Ent. of the St. Exp. Sta. Univ. of Minn. pp. 168, 169. Fig. 148 after Riley.

1901. *Schizoneura americana,* Aldrich. Idaho Agric. Exp. Sta. Feby. Bul. 26, pp. 20-22. Records summer and fall (return) migration and describes true sexes. Suggests that alternate host plant may be grass.

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1902. *Schizoneura americana,* Cook, M. T. Galls and Insects Producing Them. Ohio Naturalist. Vol. II, No. 7, p. 265 and Fig. 12. Discussion of structure of gall.

1904. *Schizoneura americana,* Sanborn, C. E. (in part). Kansas Aphid pp. 25-26.

1904. *Schizoneura americana,* Cooley, R. A. 10th Ann. Rept. Mont. Agr. Exp. Sta. pp. 43-45. Records this insect as a decidedly obnoxious pest in some parts of Montana on *Ulmus americana.*

1905. *Schizoneura americana,* Felt, E. P., (in part). N. Y. St. Mus. Memoir 8: pp. 172, 177-178. Description of leaf curl, and life history adapted from Riley.

1909. *Schizoneura ulmi* L. (*americana* Riley) Gillette, C. P. (in part). Journal Ec. Ent. Vol. 2, p. 356.

1910. *Schizoneura americana,* Patch, Edith M. (in part). Gall Aphids of the Elm. Me. Agr. Exp. Sta. Bul. 181, pp. 223-235.

1910. *Schizoneura americana,* Williams, T. A. (in part). The Aphididæ of Nebraska, p. 16.

1913. *Schizoneura americana,* Gillette. 25th Ann. Rept. of the Col. Agr. Exp. Sta. p. 30. "the leaf-rolling form" distinguished from "the form producing the rosette like cluster of leaves at the tip of elm twigs."

1913. *Schizoneura* sp. Patch. Ann. Ent. Soc. Am. Figs. 1 to 7.

1913. *Schizoneura americana* in part, of authors. Patch. Bul. 217. Me. Agr. Exp. Sta. p. 184. Habitat Key for Woolly Aphids of the Elm.

ELM-CURRANT APHID OF EUROPE.

Schizoneura ulmi (*fodiens*).

There is apparently little doubt that the literature for *ulmi* in Europe is as mixed as that for *americana* in this country, both being what is known as composite species. What *ulmi* of Linn. was is perhaps past finding out but however that may be that species which migrates to *Ribes* where it was known as *fodiens* evidently has as good a right to the name as any, and most of the recognizable figures are those of the *Ulmus-Ribes* species. That the life cycle of this leaf roller of elms (*Ulmus scabra, U. campestris, U. racemosa* and perhaps others) includes a residence on the roots of currants or gooseberries has been definitely established for Europe. Although the life cycle has not yet been followed through in America, specimens which I have seen collected from California, Oregon, Maine (1913), and Ontario (fall migrants, 1913) are, I believe, identical with *ulmi* (*fodiens*) of other countries and will doubtless prove to have the same cycle here. As will be seen from figure 138A and B the roll caused by *ulmi* is of the same type as that caused by *americana*, and as both species extend from Maine to California it is not unlikely that they have been confused in our literature. So far as I know at present *S. ulmi* from *Ulmus americana* is not recorded nor *S. americana* on the species of elm accepted by *S. ulmi*, but this whole question needs further study.

The first collection of this species made in Maine was at Bath June 23, 1913, when a box of the leaves containing stem mothers, pupæ and migrants were received with the statement that more than a bushel of such leaves had been taken from a Camperdown elm (*Ulmus scabra* Mill. var. *pendula*). Another collection from the same place was secured July 8.

On August 31, 1913, while in Bar Harbor I collected curled leaves from an English elm (*Ulmus campestris*) which contained molted pupal skins, the antennal structure of which proved the work to be that of *ulmi*. No live specimens were present, of course, at that date. The infested elm, though a good sized tree, had hardly a normal leaf. However much alike their rolls look the insects inside are readily distinguished in all their stages.

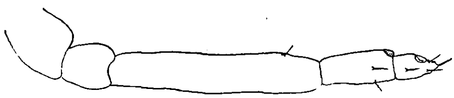

Fig. 136. The antenna of the stem mother. It is at once distinguished from that of the corresponding form of the other species treated in this paper by the very much abbreviated terminal joint.

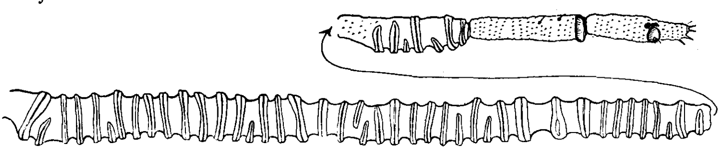

Fig. 137. The antenna of the spring migrant is strikingly different from any other elm species known to me. The annu-

lar sensoria are broad, the hollows between them deep, and they occur only on III+IV. III is nearly twice IV+V+VI in length. The terminal sensorium of V is more or less circular and fringed. In this respect it resembles the corresponding sensorium on the apterous forms of our other elm species whose winged forms have, however, lost this character, their terminal sensorium of V being apparently only a modified annulation a little broadened or otherwise irregular in shape.

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1881. *Schizoneura ulmi.* Buckton Monogr. of Brit. Aphides. Vol. III. Pl. CVIII and CIX. Fig. 1-4.

1881. *Schizoneura fodiens,* Buckton. Monogr. of Brit. Aphides. Vol. III. Pl. CVI. Fig. 6-12.

1896. *Schizoneura fodiens,* Cholodkovsky. Aphidologische Mitteilungen. Zoöl. Anz. N. 520, p. 508-513.

1906. *Schizoneura ulmi (fodiens),* Schouteden. Cat. des Aphides de Belgique.

1909. *Schizoneura ulmi (fodiens),* Tullgren. Aphidologische Studien I. pp. 163-169 and Figs. 78-82.

1912. *Schizoneura ulmi (fodiens),* Theobald. Journ. Econ. Biol. Vol. VII, No. 3, pp. 111-115. Figs. 13 B and C and 14. (Fig. 13 A is evidently not *ulmi-fodiens*).

1913. *Schizoneura ulmi (fodiens).* Reh, L. Handbuch der Pflanzenkrankheiten von Prof. Dr. Paul Sorauer, Dritter Band. Die tierischen Feinde. Bearbeitet von Dr. L. Reh.

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1879. *Schizoneura ulmi,* Courchet. Etude sur les galles produites par les aphidiens, Mem. de. l'acad. Montpellier, p. 99. From description of antenna, evidently not *ulmi (fodiens).*

1908. *Schizoneura ulmi,* Okajima. Contribution to the Study of Japanese Aphididæ. Reprint Bul. Col. Agr. Tokyo Imperial Univ. Vol. VIII, No. 1. Plate II, Fig. 2. This is not *ulmi (fodiens).* III is shorter than IV+V+VI. V is at least twice IV in length and annulated. This antenna has much the same proportions and characters as Theobald 1912, Fig. 13 A and may possibly be the same species.

FOOD PLANT CATALOGUE OF THE APHIDAE OF THE WORLD.

PART III.*

EDITH M. PATCH.

MYRICACEAE. SWEET GALE FAMILY.

MYRICA.

M. Gale L. Sweet Gale.
Aphis myricae Kalt. Kaltenbach, 1874, p. 622.

JUGLANDACEAE. WALNUT FAMILY.

CARYA. (Hicoria) Hickory.

C. alba (L.) Koch. Mocker Nut, White-heart Hickory.
Monellia maculella (Fitch) (?). Gillette, 1910, p. 368.
Monellia marginella (Fitch). Gillette, 1910, p. 368.
Myzocallis (?) *caryaefoliae* (Davis). Gillette, 1910, p. 369.
Phylloxera caryae Fitch. Hunter, 1901, p. 70.
Phylloxera caryaeavellana Riley. Hunter, 1901, p. 70.
Phylloxera caryaefallax Walsh. Thomas, 1879, p. 164.
Phylloxera caryaefallax Riley. Williams, 1891, p. 15.
Phylloxera caryaefoliae Fitch. Hunter, 1901, p. 71.
Phylloxera caryaeglobuli Walsh (D. hemisphericum Shimer) Hunter, 1901, p. 71.
Phylloxera caryaegummosa Riley. Hunter, 1901, p. 71.
Phylloxera caryaescissa Riley. Hunter, 1901, p. 71.
Phylloxera caryaesepta (Shimer). Hunter, 1901, p. 71.
Phylloxera (*Pemphigus*) *caryaevenae* Fitch. Hunter, 1901, p. 71.
Phylloxera (D.) *conica* Shimer. Hunter, 1901, p. 71.
Phylloxera depressa (Shimer). Williams, 1891, p. 15.

C. cordiformis (Wang) K. Koch (amara Nutt) (minima) Bitter Nut or Swamp Hickory.
Lachnus longistigma Monell. Sanborn, 1904, p. 31.
Monellia caryella (Fitch) Oestlund (A. punctatella Fitch) (A. maculella Fitch) (A. fumipennella Fitch) (A. marginella Fitch). Oestlund, 1887, p. 45.
Phylloxera caryaecaulis Fitch. var magna Shimer. Pergande, 1904b, p. 246.

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Phylloxera conica Shimer. Pergande, 1904b, p. 226.
Phylloxera (*Dactylosphaera*) *foveata* Shimer ("forcatum" and "foreatum" by misprint). Pergande, 1904b, p. 209.
Phylloxera globosa Shimer. Pergande, 1904b, p. 238.
Phylloxera globosa var. coniferum (Shimer). Pergande, 1904b, p. 238.
Phylloxera (D.) *spinosa* Shimer. Hunter, 1901, p. 72.

C. glabra Will (Hicoria glabra) Pignut or Broom Hickory.
Aphis caryae Harris. Harris, 1841, also Flint ed. 1862, p. 238.
Phylloxera caryaecaulis (Fitch). Pergande, 1904b, p. 244.
Phylloxera caryaecaulis Fitch (Dactylosphoera subellipticum Shimer) (D. caryaemagnum Shimer). Hunter, 1901, p. 70.
Phylloxera caryaefoliae Fitch. Pergande, 1904b, p. 195.
Phylloxera caryaeglobuli Walsh (D. hemisphericum Shimer). Hunter, 1901, p. 71.
Phylloxera caryae-ren Riley. Pergande, 1904b, p. 257.
Phylloxera caryaesemen Walsh (D. globosum Shimer). Hunter, 1901, p. 71.
Phylloxera caryae-semen (Walsh). Pergande, 1904b, p. 213.
Phylloxera (*Dactylosphoera*) *caryae-septum* (Shimer). Pergande, 1904b, p. 194.
Phylloxera c-septum, var. perforans Pergande. Pergande, 1904b, p. 194.
Phylloxera foveola Pergande. Pergande, 1904b, p. 200.
Phylloxera (*D.*) *gibbosa* Shimer. Hunter, 1901, p. 72.
Phylloxera pilosula Pergande. Pergande, 1904b, p. 203.

C. illinoensis K. Koch. (Hicoria olivaeformis). Pecan.
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Phylloxera caryae-gummosa Riley. Pergande, 1904b, p. 239.
Phylloxera caryae-scissa Riley. Pergande, 1904b, p. 220.
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C. porcina Nutt.
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C. tomentosa Nutt. (Hicoria tomentosa).
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Phylloxera caryae-caulis Fitch var. spinosa Shimer. Pergande, 1904b, p. 244.
Phylloxera caryae-scissa Riley. Pergande, 1904b, p. 220.
Phylloxera (*Pemphigus?*) *caryaevenae* Fitch. Pergande, 1904b, p. 240.
Phylloxera deplanata Pergande. Pergande, 1904b, p. 205.
Phylloxera perniciosa Pergande. Pergande, 1904b, p. 251.
Phylloxera picta Pergande. Pergande, 1904b, p. 198
Phylloxera rimosalis Pergande. Pergande, 1904b, p. 217.
Phylloxera symmetrica Pergande. Pergande, 1904b, p. 230.
Phylloxera symmetrica var. purpurea Pergande. Pergande, 1904b, p. 233.
Phylloxera symmetrica var. vasculosa Pergande. Pergande, 1904b, p. 233.

C. sp.

Callipterus caryae Monell. Monell, 1879, p. 31.
Callipterus caryaefoliae Davis. Davis, 1910a, p. 198.
Longistigma (*Lachnus*) *caryae* (Harris) Wilson. Wilson, 1909c, p. 385.
Phylloxera caryae-globosa Shimer. Thomas, 1879, p. 163.
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Phylloxera minimum (Shimer). Pergande, 1904b, p. 210.
Phylloxera spinuloides Pergande. Pergande, 1904b, p. 248.
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Schizoneura caryae (Fitch). Thomas, 1879, p. 141.

JUGLANS. Walnut.

T. californica Wats.

Monellia californica Essig. Essig, 1912, Aphid. So. Cal. X. p. 770.

J. nigra L. Black Walnut.

Lachnus longistigma Monell. Sanborn, 1904, p. 31.
Monellia caryae (Monell). Gillette, 1910, p. 367.
Monellia maculella (Fitch) (?). Gillette, 1910, p. 368.
Schizoneura caryae (Fitch). Williams, 1891, p. 26.

J. regia L. English Walnut.

Callipterus caryae Monell. Davidson, 1909, p. 301, "on English Walnut."
Callipterus juglandicola Koch. Essig, 1909, p 52.
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Ptychodes juglandis (Frisch) (Aphis) (Lachnus) (Callipterus) Buckton, 3, p. 41.

J. sp.

Aphis juglandina Walker. Walker, 1848a, p. 335.

BETULACEAE. BIRCH FAMILY.

ALNUS. Alder.

A. glutinosa (L.)

Aphis alni Fab. (nicht A. alni Schrank) (A. maculata Heyden). Kaltenbach, 1843, p. 138.

Callipterus giganteus Chol. Cholodkovsky, 1899, p. 474.

Pterocallis alni (Fab.), Pass. Buckton, 3, p. 32.

A. incana (L.) Willd. Speckled or Hoary Alder.

Callipterus giganteus Chol. Cholodkovsky, 1899, p. 474.

Pemphigus tessellata Fitch (acerifolii Riley). Patch, 1908, p. 484.

Vacuna alni (Schrank) Pass. (V. betulae Kalt.) (Glyphina betulae Koch). Passerini, 1863, p. 84.

A. rhombifolia Nutt.

Euceraphis flava Davidson. Davidson, 1912, p. 406.

Myzocallis alni (Fab). Essig, 1912, Aphid. So. Cal. X, p. 767.

A. rubra Boug.

Lachnus alnifoliae Fitch. Williams, 1891, p. 5.

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A. sp.

Aphis alni Fab. Kaltenbach, 1874, p. 620.

Aphis alni Schrank. Kaltenbach, 1874, p. 620.

Aphis bifrons Walker. Walker, 1848a, p. 444. "On alder?"

Callipterus (Pterocallis) alni Fab. Davis, 1910b, p. 415.

Glyphina alni Schrank. Lichtenstein, La Flore.

Lachnus alnifoliae Fitch. Thomas, 1879, p. 118. Essig, 1912, Aphid. So. Cal. X, p. 773.

Pemphigus alni Provancher. Kirkaldy, 1906, p. 15.

Pterocallis maculata Heyden. Lichtenstein, La Flore.

BETULA. Birch.

B. alba L. (papyracea Ait) (pubescens Ehrh) (papyrifera Marsh). Paper, Canoe or White Birch.

Aphis antennata Kalt. Kaltenbach, 1843, p. 115.

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Aphis comes Walker. Walker, 1848a, p. 258.

Aphis nigritarsis Heyden. Kaltenbach, 1843, p. 135.

Aphis quadrituberculata Kalt. Kaltenbach, 1843, p. 134.

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Glyphina alni Schrank (betulae Kaltenbach) (betulina Buckton). Schouteden, 1906a, p. 192.
Hamamelistes spinosus Shimer (Hormaphis papyraceae Oestlund) Oestlund, 1887, p. 20.
Symdobius oblongus (Heyden). Patch, 1910b, p. 245.
Symdobius oblongus Heyden. Schouteden, 1906a, p. 210.
Vacuna betulae Kalt. Kaltenbach, 1843, p. 177.

B. alpestris Fries.

Hamamelistes betulae Mordw. Tullgren, 1909, p. 58.

B. fontinalis.

Calaphis betulaecolens (Fitch). Gillette, 1910, p. 371.
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B. sp.

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Aphis betulae Linn. Kaltenbach, 1874, p. 609. Tullgren, 1909, p. 4.
Aphis (Callipterus) betulae Koch. Kaltenbach, 1874, p. 610.
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Chaitophorus annulatus Koch. Koch, p. 8.
Chaitophorus betulae Buckton. Buckton, 2, p. 140.
Chaitophorus tricolor Koch. Koch, p. 10 (A. betularia?).
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Glyphina betulae Kalt. Tullgren, 1909, p. 48.
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Hamamelistes betulae Mordwilko. (Mss. correction of Cerataphis betulae Mordwilko). Mordwilko, 1899, p. 973.
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Symdobius oblongus Heyden. Schouteden, 1906a, p. 210.
Vacuna betulae Kalt. Kaltenbach, 1874, p. 610.

CARPINUS. Hornbeam.

C. Betulus L.
Callipterus carpini Koch. (A. coryli Kalt?). Buckton, 3, p. 19.
Callipterus coryli (Goetze) Koch. Buckton, 3, p. 18.
Myzocallis coryli (Goetze) Pass. (A. avellanae Schrank) (C. coryli Koch) (C. carpini Koch). Passerini, 1863, p. 55.

CORYLUS. Hazelnut.

C. Avellana L.
Callipterus carpini Koch (A. coryli Kalt.). Koch, p. 216.
Callipterus coryli (Goetze) Koch. (Myzocallis coryli Pass.) Buckton, 3, p. 18.
Myzocallis coryli (Goetze) (Callipterus carpini Koch). Ferrari, 1872, p. 75.
Myzocallis coryli (Goetze) Pass. (A. avellanae Schrank) (C. coryli Koch) (C. carpini Koch). Passerini, 1863, p. 55.
Myzus tetrarhoda Walker (Aphis) (Siphonophora rosarum Koch) Ferrari, 1872, p. 61.
Siphonophora avellanae (Schr.) Koch (coryli Mosley) Buckton, 1, p. 150.
Siphonophora avellanae Koch. (A. avellanae Walker). Passerini, 1863, p. 12.

C. sp.
Callipterus (Myzocallis) coryli Goetze. Davis, 1910b, p. 417.

OSTRYA. Hop Hornbeam.

O. virginiana Mill. American Hop Hornbeam, Leverwood.
Siphonophora sp. ("apparently identical with S. geranii Oestlund"). Osborn and Sirrine, 1893, p. 236.

FAGACEAE. BEECH FAMILY.

CASTANEA. Chestnut.

C. dentata Marsh. Chestnut.
Calaphis castaneae (Fitch). Gillette, 1910, p. 368.
Callipterus castaneae Fitch. Thomas, 1879, p. 114

C. pumila Mill. Chinquapin.
Callipterus quercus Kalt. Buckton, 3, p. 22.

C. sativa Mill. (Castanea vesca).
Aphis castanea-vesca Haldeman. Hunter, 1901, p. 95.
Callipterus castaneae Buckton. Buckton, 3, p. 26.
Dryaphis longipes (Dufour) (*Pterochlorus* Passerini) (*Lachnus* Buckton) (*Dryobius croaticus* Koch) Del Guercio, 1907 (1908) Redia V, pp. 277, 345.
Phylloxera (*Chermes*) *castaneae* Haldeman. Pergande, 1904b, p. 258.
Phylloxera sp. Hunter, 1901, p. 74.

FAGUS. Beech.

F. grandifolia Ehrh. (ferruginea) (Americana).
Pemphigus imbricator (Fitch). Weed, 1893, p. 302.
Pemphigus imbricator (Fitch). Jackson, 1908, p. 189.
Phyllaphis fagi Linn. Gillette, 1909a, p. 385.
Phyllaphis fagi (Linn) ?. Weed, 1893, p. 302.

F. sylvatica L. (sylvestris).
Pemphigus fagi Koch. Passerini, Flora.
Phyllaphis fagi Linn. (Lachnus fagi Burmeister). Buckton, 3, p. 38.
Phyllaphis fagi Linn. Gillette, 1909a, p. 385.
Pterochlorus roboris Linn. (? fasciatus Burmeister) (exsicator Altum). Schouteden, 1906a, p. 208.

F. sp.
Aphis pallipes Hartig. Hartig, 1841, p. 369.
Chermes fagi Kalt. Hartig, R., 1880, p. 156, and Kaltenbach, 1874, p. 631.
Lachnus exsicator Altum. Hartig. R., 1880, p. 151.
Lachnus fagi Linn. Kaltenbach, 1874, p. 631.

QUERCUS. (Pasania) Oak.

Q. acuta Thunb.
Trichosiphum kuwanea Pergande. Okajima, 1908, p. 2.
Trichosiphum pasaniae Okajima. Okajima, 1908, p. 5.

Q. Aegilops L.
Vacuna dryophila (Schrank) Kalt. Passerini, 1863, p. 83.

Q. agrifolia Nee.
Schizoneura querci Fitch. Davidson, 1910, p. 374.

Q. alba L. White Oak.
Lachnus quercifoliae Fitch. Hunter, 1901, p. 85.
Myzocallis (?) sp. Gillette, 1910, p. 369.
Phylloxera querceti Perg. Pergande, 1904b, p. 265.
Phylloxera rileyi Riley (Licht. mss). Pergande, 1904b, p. 263.

Q. bicolor Willd. Swamp White Oak.

Callipterus discolor Monell (Myzocallis bella Thomas) (Myzocallis quercicola Thomas mss.) (C. asclepiadis Monell?). Hunter, 1901, p. 90.

Callipterus discolor Monell. Monell, 1879, p. 30.

Callipterus punctata Monell. Monell, 1879, p. 30.

Phylloxera rileyi Licht. Hunter, 1901, p. 72.

Q. cerris Linn.

Phylloxera spinulosa Targioni-Tozzetti. Zoölogical Record, 1875, p. 512.

Psylloptera quercina Ferrari. Ferrari, 1872, p. 86.

Pterochlorus longipes Leon Dufour (Aphis) (roboris Boyer) (Dryobius croaticus Koch). Ferrari, 1872, p. 82.

Dryaphis cerricola Del Guercio. Del Guercio, 1907 (1908) Redia V, p. 345.

Dryaphis roboris nigra Del Guercio. Del Guercio, 1907 (1908) Redia V, p. 345.

Q. coccifera L.

Phylloxera quercus Boyer, Buckton, 4, p. 50.

Q. coccinea Wang. Scarlet Oak.

Callipterus bellus (Walsh) (C. walshii Monell). Hunter, 1901, p. 89.

Q. cuspidata Thunb. (Pasania cuspidata Oerst.)

Trichosiphum pasaniae Okajima. Okajima, 1908, p. 5.

Trichosiphum tenuicorpus Okajima. Okajima, 1908, p. 4.

Q. dentata Thunb. (daimio.)

Phylloxera querceti Pergande. Pergande, 1904b, p. 265.

Q. Douglasii Hook and Arn.

Callipterus quercus Kalt (?). Davidson, 1910, p. 376.

Q. Farnetto Tenore (pannonica).

Phylloxera querceti Perg. Pergande, 1904b, p. 265.

Q. Ilex L. Evergreen Oak.

Aphis rumicis Linn. (fabae Kirby) (genistae Scop.) (ulicis Fab?) (Euphorbiae Kalt?) (dahliae Mosley) (Cinara rumicis Mosley) (Rumicifex Amyot) (Genistifex Amyot). Buckton, 2, p. 84.

Callipterus quercus (Kalt.) Koch. (Myzocallis quercus Pass.) Buckton, 3, p. 22.

Dryaphis ilicina Del Guercio. (*Aphis ilicicola* Boisduval) Del Guercio, 1907 (1908), Redia V, p. 345.

Dryaphis iliciphila Del Guercio. (*Aphis ilicicola* Boisduval) Del Guercio 1907 (1908) Redia V, p. 345.

Dryobius croaticus Koch (A. roboris Walker *not* Linn). Buckton, 3, p. 76.

Phylloxera coccinea Kalt. Passerini, Flora.

Phylloxera florentina Targioni. Buckton, 4, p. 71.

Phylloxera quercus Boyer. Fusclimi, 1906 (1907) Redia IV, p. 361.

Vacuna dryophila (Schrank) Kalt. Passerini, 1863, p. 83.

Q. imbricaria Michx. Laurel or Shingle Oak.
Callipterus hyalinus Monell. Monell, 1879, p. 30.

Q. Kelloggii Newberry. (Quercus californica.)
Callipterus quercus Kalt. (?). Davidson, 1910, p. 376. Davidson, 1909, p. 302.

Q. lamellosa Sm. (imbricata).
Callipterus hyalinus Monell. Clarke, 1903, p. 249.

Q. lobata Nee.
Callipterus quercus (?) Kalt. Davidson, 1909, p. 302.

Q. macrocarpa Mx. Bur Oak, Overcup or Mossy-cup Oak.
Callipterus bella (Walsh). Williams, 1891, p. 19.
Callipterus discolor Monell. Weed, 1888, p. 131.
Callipterus discolor Monell (Myzocallis bella Thos.). Oestlund, 1887, p. 41.
Callipterus punctata Monell. Williams, 1891, p. 7.
Chaitophorus spinosus Oestlund. Williams, 1891, p. 7.
Phylloxera querceti Perg. Pergande, 1904b, p. 265.
Schizoneura querci (Fitch). Williams, 1891, p. 7.

Q. marilandica Muench. (marylandica). Black Jack or Barren Oak.
Lachnus longistigma Monell. Sanborn, 1904, p. 31.

Q. obtusiloba Michx.
Phylloxera rileyi Riley. Pergande, 1904b, p. 263.

Q. phellos L. Willow Oak.
Phyllaphis niger Ashmead. Hunter, 1901, p. 84.

Q. prinus L. Chestnut Oak.
Callipterus? quercicola Monell. Monell, 1879, p. 31.
Chaitophorus quercicola Monell. Monell, 1879, p. 32.

Q. pubescens.
Phylloxera coccinea Heyden. Lichtenstein, 1876, p. 11.
Phylloxera quercus Boyer. Buckton, 4, p. 50.

Q. Robur L. (pedunculata Ehrh) (fastigiata DC.) (sessiliflora).
Abamalekia lazarewi Del Guercio. Del Guercio, 1905 (1906) Redia III, p. 360.
Callipterus querceus (Kalt.) Koch. Buckton, 3, pp. 22, 26.
Dryaphis minor Del Guercio. Del Guercio, 1907 (1908) Redia V, p. 345.
Dryobius roboris (Linn.) Koch (Lachnus fasciatus Burm?) (Cinara roboris Curtis) (Lachnus roboris Kalt.) (Dryaphis Amyot). Buckton, 3, p. 73. Del Guercio, 1907 (1908) Redia V, p. 273
Lachnus longipes (Dufour) (A. roboris Boyer *not* Linn) (Pterochlorus longipes Rondani). Buckton, 3, p. 61.
Lachnus quercus (L.) Kalt. (A. fusca Geoffrey) (Phylloxera longirostris Boyer). Passerini, 1863, p. 65.
Lachnus roboris Linn. Kaltenbach, 1874, p. 677.
Myzocallis insignis Ferrari. Macchiati, 1883, p. 260.
Myzocallis quercus (Kalt.) Pass. Passerini, 1863, p. 54.

Phylloxera acantho-chermes Kollar (sub. Acantho-chermes quercus). Buckton, 4, p. 68.

Phylloxera coccinea Kalt. (Vacuna coccinea Heyden) (Ph. quercus Boyer). Passerini, 1863, p. 84.

Phylloxera coccinea Heyden. Buckton, 4, p. 68.

Phylloxera coccinea Heyd. (quercus Boyer). Kaltenbach, 1874, p. 677.

Phylloxera coccinea Heyden (quercus Balbiani nec Boyer). Schouteden, 1906a, p. 191.

Phylloxera corticalis Kalt. Buckton, 4, p. 68, and Kaltenbach, 1874, p. 677.

Phylloxera punctata Lichtenstein. Buckton, 4, pp. 68, 45.

Phylloxera punctata Licht. Lichtenstein, 1876, p. 12.

Phylloxera quercus Boyer (coccinea Passerini nec Heyden) (Balbianii Lichtenstein) (florentina Targioni-Tozzetti) (Lichtensteini Balbiani) (signoreti Targioni-Tozzetti). Schouteden, 1906a, p. 191.

Pterochlorus longipes (Dufour) Pass. (A. roboris Boyer) (Pt. roboris Rond.) (Dryobius croaticus Koch). Passerini, 1863, p. 67.

Pterochlorus longipes Dufour (nec Buckton!). (roboris Boyer) (croaticus Koch-Buckton) (? riparius Snellen van Vollenhoven). Schouteden, 1906a, p. 208.

Pterchlorus roboris Linne. (? fasciatus Burmeister) (exsiccator Altum). Schouteden, 1906a, p. 208.

Schizoneura lusitanica Horvath. Horvath, 1908, p. 132.

Stomaphis quercus (Linn) Del Guercio, 1907 (1908) Redia V, p. 344.

Thelaxes dryophila (Heyden) Westwood (Aphis dryophila Ratz). (Vacuda Amyot) (Cinara quercus O. Mosley) Buckton, 4, p. 10.

Vacuna dryophila Schrank (quercus Mosley) (quercicola Westwood) Schouteden, 1906a, p. 192.

Vacuna dryophila Schrank (Aphis). Ferrari, 1872, p. 85.

Q. rubra L. Red Oak.

Callipterus bellus (Walsh). Oestlund, 1887, p. 44.

Callipterus quercifolii Thomas. Thomas, 1879, p. 113.

Myzocallis bella (Walsh). Gillette, 1910, p. 368.

Myzocallis walshii (Monell). Gillette, 1910, p. 368.

Q. serrata Thunb.

Trichosiphum kuwanae Pergande. Pergande, 1906, p. 209.

Trichosiphum pasaniae Okajima. Okajima, 1908, p. 2.

Q. sessilifolia Blume.

Lachnus quercus (L.) Kalt. (A. fusca Geoffrey) (Phylloxera longirostris Boyer). Passerini, 1863, p. 65.

Phylloxera florentina Targ.-Toz. Lichtenstein, 1876, p. 12.

Q. suber.

Dryaphis minor Del Guercio. Del Guercio, 1907 (1908) Redia V, p. 345.

Tavaresiella suberi Del Cuercio. Del Guercio, 1909 (1910) Redia VII, p. 297.

Q. virginiana Mill. (virens). Live Oak.

Lachnus quercicolens Ashmead. Hunter, 1901, p. 85.

Q. undulata Torr.

Schizoneura querci (Fitch). Hunter, 1901, p. 84.

Q. sp.

Acanthochermes quercus (Kollar) CB. Börner, 1909b, p. 60.
Aphis annulatus Hartig. Hartig, 1841, p. 369.
Aphis hirticornis Walker. Walker, 1848a, p. 447.
Aphis quercifoliae Walsh. Walsh, 1862, p. 298.
Aphis quercus-monticula Haldeman. Haldeman, 1844, p. 168.
Aphis suberis Tavares. Schouteden, 1906c.
Callipterus ? quercicola Monell. Monell, 1879, p. 31.
Chaitophorus quercicola Monell (Callipterus quercifolii Thomas) (Chait. spinosus Oestlund). Davis, 1910b, p. 415.
Chaitophorus spinosus Oestlund. Oestlund, 1887, p. 38.
Drepanosiphum? (Aphis) quercifoliae (Walsh). Thomas. Thomas, 1879, p. 79.
Dryobius longirostris Mordwilko. Mordwilko, 1909, p. 85.
Lachnus allegheniensis McCook. McCook, 1877, p. 274.
Lachnus (Dryobius) croaticus Koch. Kaltenbach, 1874, p. 677.
Lachnus fuscus Geoffrey. Lichtenstein, La Flore.
Lachnus longirostris Fab. Lichtenstein, La Flore.
Lachnus (Callipterus?) quercifoliae Fitch. Thomas, 1879, p. 118.
Longistigma (Lachnus) caryae (Harris). Wilson, 1909a, p. 385.
Moritziella (Phylloxera) corticalis (Kalt.) C. B. Börner, 1909b, p. 61.
Myzocallis bella (Walsh). Thomas, 1879, p. 106.
Myzocallis quercea (Kalt.) Pass. Passerini, 1863, p. 55.
Myzocallis quercus Kalt. (Aphis). Ferrari, 1872, p. 75.
Pemphigus pedunculi Hartig. Hartig, 1841, p. 367.
Phylloxera bipunctatum Licht. Lichtenstein, 1874, p. CCI.
Phylloxera coccinea Heyden. Börner, 1909b, p. 62.
Phylloxera-Foaiella (Börneria Grassi et Foa; nec. Willem, nec Axelson) danesii Grassi et Foa. Börner, 1909b, p. 61.
Phylloxera foae CB. Börner, 1909b, p. 62.
Phylloxera glabra Heyden. Börner, 1909b, p. 62.
Phylloxera scutifera Signoret. Lichtenstein, La Flore.
Phylloxera spinulosa Targioni. Lichtenstein, La Flore.
Phylloxera-Acanthaphis Del Guercio (Hystrichiella CB). spinulosa Tg.-Tz. Börner, 1909b, p. 62.
Schizoneura querci Fitch. Davis, 1910b, p. 413.
Schizoneura querci Fitch. Thomas, 1879, p. 139.
Stomaphis quercus Reaum. (Puceron de Chene Reaum) (A. quercus Linn) (longirostris Fab?) (Lachnus quercus Kalt.) Buckton, 3, p. 64.

Stomaphis macrorhyncha Chol. Cholodkovsky, 1894 (1895), p. 405. "auf eichenrinde."
Vacuna dryophila Schrank. Tullgren, 1909, p. 41.

URTICACEAE. NETTLE FAMILY.

ARTOCARPUS.

A. integrifolia L.
Greenidea (Siphonophora) artocarpi Westwood. Schouteden, 1905, p. 183.

CANNABIS. Hemp.

C. sativa L.
Aphis sativae Williams. Williams, 1910, p. 57.
Phorodon cannabis Pass. Ferrari, 1872, p. 60.

HUMULUS. Hop.

H. hepulus L. (neomexicanus).
Aphis gossypii Glover (citrifolii Ashmead, in part) (citrulli Ashmead) (cucumeris Forbes) (forbesi Weed?). Pergande, 1895, p. 314.
Aphis humuli Schrank. Kaltenbach, 1874, p. 534.
Myzus phenax Cockerell. Cockerell, 1903b, p. 115.
Phorodon humuli (Schrank) Pass. Passerini, 1863, p. 18.
Phorodon humuli (Schrank) Pass. (A. pruni Scop) (A. humulifex Amyot). Buckton, 1, p. 167.

MORUS. Mulberry.

M. sp.
Aphis mori Clarke. Clarke, 1903, p. 251.

PARIETARIA. Pellitory.

P. effusa.
Aphis urticaria Kalt. Kaltenbach, 1874, p. 69.
P. officinalis L.
Aphis scabiosae Kalt. (A. chloris Koch?). Buckton, 2, p. 55.
Aphis urticae Fab. (urticaria Kalt.) Macchiati, 1883, p. 258.
P. sp.
Aphis parietariae Licht. (ined). Lichtenstein, La Flore.

PLANERA. Planer Tree.

P. sp.
Schizoneura lanuginosa Hart. Lichtenstein, Flore Supplement.

ULMUS. Elm.

U. americana L. American or White Elm.

Callipterus ulmifolii Williams. Williams 1891, p. 26, 1910, p. 2, "previously described by Monell."

Callipterus ulmifolii Monell (ulmicola Thos.). Oestlund, 1887, p. 42.

Callipterus sp. Sanborn. Sanborn, 1904, p. 42.

Callipterus n. sp. Sanborn. Sanborn, 1904, p. 41.

Colopha ulmicola (Fitch) Monell. Patch, 1910a, p. 197.

Pemphigus walshii Williams. Williams, 1910 (1911), p. 16.

Schizoneura americana Riley. Patch, 1913, Bul. 217 and Bul. 220.

Schizoneura lanigera (*americana* in part). Patch, 1913, Bul. 217, p. 173, Bul. 220, p. 264.

Schizoneura rileyi Licht. Williams, 1891, p. 26.

Schizoneura rileyi Thomas (Eriosoma ulmi Riley). Patch, 1910a, p. 235. 1913. Bul. 217, p. 184 and Bul. 220, p. 260.

Tetraneura graminis (colophoidea Monell) Monell. Patch, 1910a, p. 208.

U. campestris L. (suberosa) English Elm.

Callipterus elegans Koch (Lachnus platani Kalt.) Koch, p. 213.

Schizoneura lanuginosa Hartig. (A. ulmi Boyer) (Mimaphidus ulmi Rondani). Passerini, 1863, p. 70. Patch, 1913, Bul. 217, p. 184, Bul. 220, p. 263.

Schizoneura ulmi (Linn.) (fodiens Buckton). Tullgren, 1909, p. 169. Patch, 1913, Bul. 217, p. 184, Bul. p. 271.

Tetraneura (*Byrsocrypta*) *pallida* (Hal.) Del Guercio (A. alba Ratz) (T. alba Kessler) (P. pallidus Buckton). Tullgren, 1909, p. 185.

Tetraneura ulmi DeGeer (coerulescens Mordwilko nec Passerini) Schouteden, 1906a, p. 200.

Tetraneura ulmi Geoffr. (? Pemphigus coerulescens Pass.) Tullgren, 1909, p. 180.

U. fulva Michx (pubescens Walt.) Slippery or Red Elm.

Pemphigus ulmifusus Walsh. Patch, 1910a, p. 220.

U. montana With. Scabra Mill. (Camperdown pendula). Scotch or Wych Elm.

Schizoneura ulmi Linn. Connold, 1902, p. 245. Patch, 1913, Bul. 217, p. 184, Bul. 220, p. 271.

Tetraneura ulmi (Linn.). Patch, 1910a, p. 219.

Tetraneura ulmisacculi Patch. Patch, 1910a, p. 216.

U. racemosa Thomas. Cork or Rock Elm.

Colopha ulmicola (Fitch) Monell (eragrostidis Middleton). Patch, 1910a, p. 204.

U. sp.

Georgia ulmi Wilson. Wilson, 1911, p. 65.

Lachnus platani Kalt. Kaltenbach, 1874, p. 540.

Lachnus ulmi (Linn.) Thomas, 1879, p. 119 "error for Schizoneura ulmi (Linn.)."
Myzocallis ulmifolii (Monell). Gillette, 1910, p. 369.
Pemphigus pallidus (Haliday) (P. albus Licht.) (ulmi Licht?) Buckton, 3, p. 127.
Pemphigus ulmi Licht. Lichtenstein, 1880, pp. 1-5.
Schizoneura compressa Koch. Lichtenstein, La Flore.
Tetraneura alba Ratz? (Schizoneura compressus Koch) Kaltenbach, 1874, p. 540.
Tetraneura rubra Licht. Lichtenstein, La Flore.

URTICA. Nettle.

U. dioica Pursh. Stinging Nettle.
Aphis tertia Walker. Walker, 1849c, p. 45.
Aphis urticae Fab. (urticaria Kalt.). Ferrari, 1872, p. 65.
Aphis urticaria Kalt. Buckton, 2, p. 51.
Siphonophora pisi (Kalt.) Koch (A. ulmariae Schrank) (onobrychis Boyer) (lathyri Walker). Buckton, 1, p. 135.
Siphonophora urticae (Kalt, Schrank) Koch. Buckton, 1, p. 144.
U. gracilis Ait.
Siphonophora pisi Kalt. Williams, 1891, p. 18.
U. holosericea Nutt.
Macrosiphum pisi Kalt. Davidson, 1909, p. 304.
U. urens L.
Aphis rumicis Linn. Walker, 1850a, p. 19.
Aphis urticae Fab. (urticaria Kalt.). Macchiati, 1883, p. 258.
Aphis urticaria Kalt. Buckton, 2, p. 51.
Siphonophora carnosa Buckton. Buckton, 1, p. 145.
Siphonophora urticae (Kalt., Schrank) Koch. Buckton, 1, p. 145.
U. sp.
Aphis lamii Koch. Koch, p. 85.

POLYGONACEAE. BUCKWHEAT FAMILY.

ERIOGONUM.

E. alatum Torr.
Aphis eriogoni Cowen. Cowen, 1895, p. 119.
E. umbellatum Torr.
Aphis eriogoni Cowen. Cowen, 1895, p. 119.
E. sp.
Nectarophora martini Cockerell. Cockerell, 1903a, p. 171.

POLYGONUM. (Persicaria) Knotweed.

P. aviculare L.
Aphis ? polygoni Macchiati var. Schouteden, 1906a, p. 226.
Aphis polygoni Walker. Walker, 1848c, p. 2249.

Pemphigus betae Doane. Jackson, 1908, p. 218.
Phorodon galeopsidis Kaltenbach. Theobald, 1911-12.
Schizoneura corni (Fab.) (S. venusta Pass.) (E. fungicola Walsh) (E. cornicola Walsh) (S. panicola Thomas). Hunter, 1901, p. 81.
Sipha polygoni Schouteden. Schouteden, 1907, p. 265.

P. Hydropiper L. Common Smartweed or Water Pepper.
Phorodon galeopsidis Kalt. (Aphis). Ferrari, 1872, p. 60.

P. hydropiperoides Michx. Mild Water Pepper.
Aphis maidiradicis Forbes. Vickery, 1910, p. 103.

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

P. lapathifolium L.
Aphis galeopsidis Kalt. Kaltenbach, 1874, p. 484.

P. laxiflorum.
Aphis galeopsidis Kalt. Kaltenbach, 1874, p. 484.

P. mite Schrank (dubium).
Phorodon galeopsidis (Kalt.) Pass. (Walker ex parte). Passerini, 1863, p. 19.

P. Muhlenbergii S. Wats.
Aphis maidiradicis Forbes. Vickery, 1910, p. 103.

P. pennsylvanicum L.
Aphis sp. Williams, 1891, p. 16.
Schizoneura corni (Fab.) Williams, 1910, p. 19.

P. persicaria L. Lady's Thumb.
Aphis dianthi Schrank. Walker, 1850a, p. 394.
Aphis maidi-radicis Forbes. Davis, 1909b, p. 124.
Aphis maidi-radicis Forbes. Vickery, 1910, p. 104.
Aphis maidis Fitch. Williams, 1891, p. 16.
Aphis rumicis Linn. (fabae Kirby) (genistae Scop.) (ulicis Fab?) (euphorbiae Kalt.?) (dahliae Mosley) (Cinara rumicis Mosley) (Rumicifex Amyot) (Genistifex Amyot). Buckton, 2, p. 84.
Aphis transiens Walker. Walker, 1849c, p. 44.
Phorodon galeopsidis (Kalt.) Pass. Buckton, 1, p. 173.
Schizoneura corni (Fab.) Williams, 1910, p. 19.
Siphonophora cerealis Koch (Aphis cerealis Kalt.) (A. avenae Walker *non* Schrank). Passerini, 1863, p. 11.
Siphonophora dirhoda Walker. Buckton, 1, p. 133.
Siphonophora granaria Kirby (avenae Fab?) (hordei Kyber) (cerealis Kalt.) (Bromaphis Amyot) Buckton, 1, p. 116.
Siphonophora polygoni Buckton. Buckton, 1, p. 123.
Siphonophora polygoni (Walker). Thomas, 1879, p. 62.

P. sp.
Amycla albicornis Koch. Koch, p. 305.
Aphis polygoni Licht. Lichtenstein, Flore Supplement.
Schizoneura panicola Thos. Hart, 1891 and 1892, p. 87.

RHEUM.

R. Rhaponticum L. Rhubarb.

Aphis rumicis Linn. (fabae Kirby) (genistae Scop.) (ulicis Fab?) (euphorbiae Kalt?) (dahliae Mosley) (Cinara rumicis Mosley) (Rumicifex Amyot) (Genistifex Amyot). Buckton, 2, p. 82.

Aphis rhei Koch? Theobald, 1911-12.

R. sp.

Aphis rhei Koch. Koch, p. 127.

RUMEX. Dock.

R. acetosa L. Garden Sorrel.

Aphis acetosae Buckton. (molluginis Koch?). Buckton, 2, p. 81.

Aphis rumicis Linn. Thomas, 1879, p. 88.

R. acutifolius.

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

R. altissimus Wood. Pale Dock.

Aphis atriplicis Linn. Williams, 1891, p. 10.

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

Aphis rumicis Linn. Williams, 1891, p. 10.

R. conglomeratus Murr.

Aphis acetosae Fab. Kaltenbach, 1874, p. 519.

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

R. crispus L. Yellow Dock.

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

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

Aphis rumicis Linn. Sanborn, 1904, p. 47.

Aphis rumicis Linn. (fabae Kirby) (genistae Scop.) (ulicis Fab?) (euphorbiae Kalt?) (dahliae Mosley) (Rumicifex Amyot) (Genistifex Amyot). Buckton, 2, p. 83.

Nectarophora tabaci Pergande. Pergande, 1898, p. 300.

R. obtusifolius L.

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

R. occidentalis S. Wats.

Pemphigus bètae Doane. Davidson, 1909, p. 299.

R. pulcher L.

Aphis rumicis Linn. Macchiati, 1883, p. 257.

R. venosus Pursh.

Aphis rumicis Linn. Williams, 1891, p. 10.

R. sp.

Aphis carbocolor Gillette. Gillette, 1907a, p. 391.

Aphis malvae Walker. Buckton, 2, p. 43.

Aphis ochropus Koch. Theobald, 1913, Journ. Bd. Agr. Vol. 19. Feb.

Aphis relata Walker. Walker, 1849c, p. 44.

Aphis rumicis? L. (euonymi Fab.). Hayhurst, 1909b, p. 98.

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

CHENOPODIACEAE. GOOSEFOOT FAMILY.

ATRIPLEX. Orach.

A. babingtoni.

Aphis atriplicis Linn. Theobald, 1913. Journ. Bd. Agr. 19. Feb.

A. canescens James (Obione tetraptera).

Aphis tetrapteralis Cockerell. Cockerell, 1902.

A. hastata L. (latifolia.)

Aphis atriplicis Linn. (A. chenopodii Schrank) (A. atriplicis Pass.?). Buckton, 2, p. 88.

Aphis papaveris Fb. Kaltenbach, 1874, p. 269.

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

A. hortensis L.

Aphis rumicis Linn. (cracae Linn.) (fabae Scop.) (genistae Scop.) (acetosae Linn.) (euonymi Fab.) (papaveris Fab.) (hortensis Fab.) (viciae Fab.) (chenopodii Schrank) (thlaspeos Schrank) (armata Hausm.) (laburni Kalt.) (dahliae Mosley) (viburni Scop.). Hunter, 1901, 1. 104.

A. littoralis.

Aphis atriplicis Linn. Theobald, 1913. Journ. Bd. Agr. 19. Feb.

A. patula L. (angustifolia)

Aphis atomaria Walker. Walker, 1849c, p. 50.

Aphis atriplicis L. (Chenopodii Schrank). Passerini, 1863, p. 47.

Aphis atriplicis L. (Uraphis-Hayhurstia atriplicis Del G.) Hayhurst, 1909b, p. 88.

Aphis chenopodii Schrank (A. atriplicis Linn ist nicht A. atriplicis Fab.). Kaltenbach, 1843, p. 107.

Aphis papaveris Fab. Kaltenbach, 1874, p. 508.

A. portulacoides L.

Aphis atriplicis Linn. (not Buckton). Theobald, 1911-12.

BETA.

B. vulgaris L. (maritima) Cultivated Beet.

Aphis atriplicis L. (Uraphis-Hayhurstia atriplicis Del G.) Hayhurst, 1909b, p. 88. Theobald, 1911-12.

Aphis brevisiphona Theobald. Theobald, 1913. Journ. Bd. Agr. Vol. 19. Feb.

Aphis chaerophyllii Koch? Theobald, 1911-12.

Aphis cucumeris Forbes. Williams, 1891, p. 6.

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

Aphis papaveris Fab. Kaltenbach, 1874, p. 510.

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

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

Nectarophora erigeronensis Thomas. Hunter, 1901, p. 114.

Pemphigus betae Doane. Jackson, 1908, p. 218.
Pemphigus betae Doane. (populicaulis Fitch?). Clarke, 1903, p. 248.
Siphonophora pisi (Licht.) Williams. Williams, 1891, p. 6.
Smynthurodes betae Westwood. Kirkaldy, 1906, p. 9.
Trifidaphis radicicola Essig. Essig, 1912a, p. 699.

CHENOPODIUM. Goosefoot.

C. album L. Lamb's Quarters. Pigweed.
Aphis atriplicis L. (Uraphis-Hayhurstia atriplicis Del Guercio) Hayhurst, 1909b, p. 88. Theobald, 1911-12.
Aphis atriplicis L. (chenopodii Schrank). Passerini, 1863, p. 47.
Aphis chenopodii Cowen. Cowen, 1895, p. 119.
Aphis gossypii Glover (citrifolii Ashmead. In part) (citrulli Ashmead) (cucumeris Forbes) (forbesi Weed?). Pergande, 1895, p. 313.
Aphis maidiradicis Forbes. Vickery, 1910, p. 101, 103.
Aphis papaveris Fab. Kaltenbach, 1874, p. 269.
Aphis rumicis? L. (euonymi Fab.). Hayhurst, 1909, p. 98.
Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 36.
Pemphigus betae Doane. Gillette, 1909a, p. 354.
Pemphigus lactucarius Pass. (Amycla fuscicornis Koch). Buckton, 3, p. 125.

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

C. hybridum L. Maple-leaved Goosefoot.
Aphis atriplicis Linn. Williams, 1891, p. 20. Theobald, 1913. Journ. Bd. Agr. Vol. 19. Feb.
Aphis rumicis Linn. Williams, 1891, p. 20.

C. murale L.
Aphis atriplicis Linn. Davidson, 1912. p. 408.

C. polyspermum L.
Aphis atriplicis Linn. Davidson, 1912, p. 408.
Aphis atriplicis Linn. (not Buckton). Theobald, 1911-12.

C. vulvaria L.
Aphis atriplicis Linn. Theobald, 1913.

C. urbicum.
Aphis atriplicis Linn. Theobald, 1913.

C. sp.
Aphis atriplicis Linn. (A. chenopodii Cowen). Gillette, 1910, p. 405.
Aphis chenopodii Schrank. Lichtenstein, La Flore.
Aphis (*Amycla*) *fuscicornis* Koch. Kaltenbach, 1874, p. 342.
Aphis ochropus Koch. Kaltenbach, 1874, p. 505.
Aphis rumicis Linn. Thomas, 1879, p. 88.

SALSOLA. Saltwort.

S. Kali L. (Tragus). Common Saltwort.
Aphis arundinis Walker. Buckton, 2, p. 112.
Aphis rufula Walker. Walker, 1849c, p. 47.
Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 35.

SPINACIA.

S. oleracea Will. Spinach.
Aphis gossypii Glover (citrifolii Ashm. in part) (citrulli Ashm.) (cucumeris Forbes) (forbesi Weed?). Pergande, 1895, p. 314.
Aphis rumicis Linn. Walker, 1850a, p. 19.

S. sp.
Aphis brassicae Linn. Lichtenstein, Flore Supplement.
Aphis papaveris Fab. Lichtenstein, Flore Supplement.
Rhopalosiphum persicae Sulzer. Lichtenstein, Flore Supplement.

AMARANTHACEAE. AMARANTH FAMILY.

ACHYRANTHES.

A. sp.
Myzus achyrantes (Monell) (M. malvae Oestlund). Oestlund, 1887, p. 74.
Myzus persicae Sulzer (Siphonophora achyrantes Mon.?). Gillette and Taylor, 1908, p. 34.

ALTERNANTHERA.

A. sp.
Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 35.

AMARANTHUS. Amaranth.

A. graecizans L. (albus L.) Tumble Weed.
Aphis papaveris Fab. (thlaspeos Schrk.) (aparines) (fabae Scopoli) Ferrari, 1872, p. 71.
Aphis sp. Weed. Weed, 1888, p. 125.

A. hybridus L. Green Amaranth, Pigweed.
Aphis maidi-radicis Forbes. Davis, 1909b, p. 124.

A. retroflexus L. Green Amaranth, Pigweed.
Aphis gillettei Cowen. Cowen, 1895, p. 120.
Aphis maidi-radicis Forbes. Vickery, 1910, p. 102.
Tetraneura phaseoli (Pass.). Essig, 1909, p. 75.
Trifidaphis (*Pemphigus*) *radicicola* (Essig) Del Guercio. Essig 1909, p. 75.
Tychea phaseoli Pass. Passerini, 1860, p. 40.

A. spinosus L. Thorny Amaranth.

Aphis maidi-radicis Forbes. Vickery, 1910, p. 102.

A. sp.

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

Myzus achyrantes (Monell). Williams, 1891, p. 5.

Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 35.

Iresine.

I. Lindeni Van Houtte (Achyranthes).

Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 35.

NYCTAGINACEAE. FOUR O'CLOCK FAMILY.

BOUGAINVILLAEA.

B. brasiliensis Willd.

Aphis papaveris Fab. var. Del Guercio, 1909 (1910) Redia VII, p. 297.

OXYBAPHUS. (Allionia)

O. linearis (Pursh) Robinson. (Allionia linearis) (angustifolius).

Aphis oxybaphi Oestlund. Oestlund, 1887, p. 62.

O. nyctagineus (Michx).

Aphis oxybaphi Oestlund. Williams, 1891, p. 20.

AIZOACEAE.

MESEMBRIANTHEMUM.

M. sp.

Rhopalosiphum dianthi (Schrank) Koch (persicae, Purceron du pecher Morren) (rapae Curtis) (floris rapae Curtis) (dubia? Curtis) (vastator Smee) (persicaecola Boisduval) (persicae Pass. *not* Boyer, *not* Sulzer, *not* Kalt.). Buckton, 2, p. 17.

Rhopalosiphum persicae Sulzer. Lichtenstein, La Flore.

CARYOPHYLLACEAE. PINK FAMILY.

Arenaria.

A. peploides L.

Aphis aucta Walker. Walker, 1849c, p. 33.

CERASTIUM. Mouse-ear Chickweed.

C. arvense L. Field Mouse-ear Chickweed.
Aphis cerastii Kalt. Kaltenbach, 1874, p. 58.
C. triviale Link.
Brachycolus stellariae Hardy. (holci Hardy). Buckton, 2, p. 148.

CUCUBALUS.

C. sp.
Aphis lychnidis Linn. Lichtenstein, Flore Supplement.

DIANTHUS. Pink.

D. Caryophyllus L.
Phorodon cynoglossi Williams. Williams, 1910, p. 88.
Rhopalosiphum dianthi (Schr.) Koch. (persicae, Puceron du pecher Morren) (rapae Curtis (floris rapae Curtis) (dubia? Curtis) (vastator Smee) (persicaecola Boisduval) (R. persicae Pass.) Buckton, 2, p. 17.
Rhopalosiphum persicae (Sulzer) Pass. (dianthi Schrank) (A. vulgaris Kyber) (A. rapae Curtis) (A. dubia Curtis) (A. vastator Smee). Passerini, 1863, p. 20 and Passerini, Flora.
D. plumarius L.
Aphis subterranea Walker. (A. carotae Koch).. Buckton, 2, p. 38.
D. prolifer. See Tunica prolifera Scop.

LYCHNIS. (Agrostemma) Campion.

L. dioica L. (diurna). Red Campion.
Aphis lychnidis Linn. Buckton, 2, p. 74.
Aphis plantaginis Schrank (A. dauci Fab.). Kaltenbach, 1843, p. 59.
Aphis plantaginis Fab. Kaltenbach, 1874, p. 56.
L. divaricata Reichb. (vespertina).
Aphis lychnidis Linn. Buckton, 2, p. 74.
L. Githago L. (Agrostemma Githago L.)
Siphonophora cichorii Koch. Buckton, 1, p. 164.
L. Viscaria Linn.
Aphis lychnidis Linn. Buckton, 2, p. 74.

SILENE. Catchfly.

S. italica Pers.
Myzus lychnidis Koch (Aphis). Ferrari, 1872, p. 61.
S. latifolia (Mill.) (inflata Sm.) (cucubalus Wibel). Bladder Campion.
Anuraphis lychnidis (Linn). Del Guercio, 1909 (1910) Redia VII, p. 297.

Aphis cucubali Pass. Kaltenbach, 1874, p. 772.
Aphis silenea Ferrari. Ferrari, 1872, p. 72.
Hyalopterus melanocephalus Buck. Buckton, 2, p. 117.
Myzus lychnidis Koch (Aphis). Ferrari, 1872, p. 61.
Pemphigus inflatae Del Guercio. Del Guercio, 1909 (1910) Redia VII, p. 298.

Spergula Spurry.

S. maritima With.
Aphis cardiva Walker. Walker, 1849c, p. 32.
S. arvensis Linn. Corn Spurry.
Aphis dianthi Schrank. Walker, 1850a, p. 394.

STELLARIA. (Alsine) Chickweed.

S. aquatica (L.) Scop. (Cerastium aquaticum).
Aphis nasturtii Kalt. Kaltenbach, 1874, p. 57.
S. graminea L.
Brachycolus stellariae (Hardy) Buckton (A. holci Hardy). Buckton, 2, p. 148.
Macrosiphum stellariae Schrank. Theobald, 1911-12.
S. holostea L.
Aphis pisi Kalt. Kaltenbach, 1874, p. 60.
Brachycolus stellariae (Hardy) Buckton (A. holci Hardy). Buckton, 2, p. 148.
S. (Alsine) media (L.) Cyrill. Common Chickweed.
Aphis gossypii Glover (citrifolii Ashm. In part) (citrulli Ashm.) (cucumeris Forbes) (forbesi Weed?) Pergande, 1895, p. 313.
Myzus persicae Sulzer. Gillette and Taylor, 1908, p. 35.
S. sp.
Aphis cerastii Kalt. Kaltenbach, 1874, p. 60.

TUNICA.

T. prolifera Scop. (Dianthus prolifer.)
Aphis dianthi Schrank. Walker, 1850a, p. 394.

PORTULACACEAE. PURSLANE FAMILY.

PORTULACA. Purslane.

P. oleracea L. Common Purslane.
Aphis gossypii Glover (citrifolii Ashm. in part) (citrulli Ashm.) (cucumeris Forbes) (forbesi Weed?). Pergande, 1895, p. 313.
?*Aphis gossypii* Glover. Fullaway, 1909, p. 39.
Aphis laburni Kaltenbach. Del Guercio, 1909 (1910) Redia VII, p. 297.

Aphis maidi-radicis Forbes. Davis, 1909b, p. 124.
Aphis portulacae Pass. (Ined.) . Lichtenstein, Flore Supplement. Del Guercio, 1909 (1910) Redia VII, p. 297.
Myzus portulacae Macchiati. Macchiati, 1883, p. 280.

NYMPHAEACEAE. WATER LILY FAMILY.

NELUMBO. Sacred Bean.

N. lutea Willd. Yellow Nelumbo, Water Chinquapin.
Aphis nymphaeae Linn. Kaltenbach, 1874, p. 20.

NUPHAR.

N. luteum. See Nelumbo lutea.

NYMPHAEA. Yellow Pond Lily.

N. alba L.
Rhopalosiphum nymphaeae (Linn.) Koch. Buckton, 2, p. 13.
N. lutea.
Rhopalosiphum nympharae (L.) Koch (A. butomi Schrank) (R. najadum Koch). Passerini, 1863, p. 21.
N. odorata Dry. (Castalia)
Rhopalosiphum nymphaeae Linn. (Aphis aquaticus Jackson). Davis, 1910a, p. 245.

RANUNCULACEAE. CROWFOOT FAMILY.

ACONITUM. Aconite. Monkshood.

A. Cammarum L.
Myzus junackianus Karsch. Karsch, 1887, p. XXI.
A. Napellus L.
Aphis napelli Schrank. Kaltenbach, 1874, p. 15.

AQUILEGIA. Columbine.

A. canadensis L. Wild Columbine.
Aphis (Adactynus) aquilegia-canadensis Raf. Rafinesque, 1817.
A. vulgaris L. Garden Columbine.
Aphis dianthi Schrank. Walker, 1850a, p. 394.
Hyalopterus aquilegiae Koch. Koch, p. 19.
Hyalopterus aquilegiae-flavus (Kittel) (Aphis) (flavus Schouteden) (aquilegiae Koch) (trirhoda Walker). Hayhurst, 1909a, p. 112.
Hyalopterus equilegiae Koch. Koch, p. 19.
Hyalopterus aquilegiae-flavus (Kittel) (Aphis) (flavus Schonteden) (aquilegiae Koch) (trirhoda Walker). Hayhurst, 1909a, p. 112.

Hyadaphis flavus Kittel. (aquilegiae Koch) (trirhodus Walker). Schouteden, 1906a, p. 230.
Hyalopterus trirhoda (Walker) Pass. (H. aquilegiae Koch). Buckton, 2, p. 115.

A. sp.
Aphis malvae Walker (A. malvae Pass. *not* S. malvae Pass.) Buckton, 2, p. 43.

CALTHA. Marsh Marigold.

C. palustris L.
Aphis calthae Koch. Koch, p. 48. Theobald, 1911-12.

CLEMATIS. Virgin's Bower.

C. Flammula L.
Aphis clematidis Ferrari. Del Guercio, 1900, p. 140.

C. ligusticifolia Nutt.
Myzus varians Davidson. Davidson, 1912, p. 411.

C. recta L. (erecta.)
Aphis clematidis Koch. Kaltenbach, 1874, p. 5.

C. Vitalba L.
Aphis clematidis Koch. Kaltenbach, 1874, p. 5.
Aphis urticae Fab. (urticaria Kalt.). Ferrari, 1872, p. 65.
Aphis vitalbae Ferrari. Lichtenstein, La Flore.

C. sp.
Toxoptera clematidis Del Guercio. Phillips and Davis, 1912, p. 8.

DELPHINIUM. Larkspur.

D. sapellonis.
Aphis rociadae Cockerell. Cockerell, 1903b, p. 115.

RANUNCULUS. Crowfoot.

R. àcris L. Tall Crowfoot or Buttercup.
Aphis dianthi Schrank. Walker, 1850a, p. 394.
Aphis ranunculi Kalt. Kaltenbach, 1874, p. 10.

R. bulbosus L. Bulbous Crowfoot or Buttercup.
Pemphigus ranunculi Kalt. Kaltenbach, 1874, p. 10.
Rhopalosiphum dianthi (Schrank) Koch (persicae, Puceron du pecher, Morren) (rapae Curtis) (A. floris rapae Curtis) (dubia? Curtis) (vastator Smee) (persicaecola Boisduval) (Rh. persicae Pass.) Buckton, 2, p. 17.
Rhopalosiphum persicae (Sulzer) Pass. (A. dianthi Schrank) (A. vulgaris Kyber) (A. rapae Curtis) (A. dubia Curtis) (A. vastator Smee). Passerini, 1863, p. 20.

R. californicus Benth.
Pemphigus (*californicus* Davidson) (*ranunculi* Davidson). Davidson, 1910, p. 373 and 1911, p. 414. Essig, 1912a, p. 703.

R. Flammula L. Smaller Spearwort.
Thecabius (*Pemphigus*) *affinis* Kalt. (ranunculi Kalt.). Tullgren, 1909, p. 110.

R. muricatus L.
Aphis ranunculi Kalt. Macchiati, 1883, p. 257.

R. sardous Crantz (hirsutus).
Aphis dianthi Schrank, Walker, 1850a, p. 394.

R. repens L. Creeping Buttercup.
Aphis dianthi Schrank. Walker, 1850a, p. 394.
Aphis ranunculi Kalt. Kaltenbach, 1874, p. 10.
Thecabius (*Pemphigus*) *affinis* Kalt. (ranunculi Kalt.). Tullgren, 1909, pp. 110-111.

R. sceleratus L. Cursed Crowfoot.
Rhopalosiphum nymphaeae (L.) Koch. (A. butomi Schrank) (R. najadum Koch). Passerini, 1863, p. 21.

R. velutinus Ten.
Myzus ranunculi Del Guercio. Del Guercio, 1900, p. 151.
Pemphigus ranunculi Kalt. Passerini, Flora.
Trama ranunculi Del Guercio (*radicis* Kaltenbach?) (*flavescens* Koch?) Del Guercio, 1907 (1908) Redia V, pp. 248, 344.

R. sp.
Aphis ranunculina Walker. Walker, 1852, p. 1046.

THALICTRUM. Meadow Rue.

T. minus L.
Aphis dianthi Schrank. Walker, 1850a, p. 394.
Aphis thalictri Koch. Kach, p. 81.

T. polygamum Muhl. Tall Meadow Rue.
Myzus thalictri Williams. Williams, 1910, p. 69.

T. revolutum DC. (purpurascens L.)
Myzus thalictri Williams. Williams, 1891, p. 17.
Nectarophora purpurascens Oestlund. Oestlund, 1887, p. 81.

T. sp.
Aphis thalictri Koch. Kaltenbach, 1874, p. 6.

MAGNOLIACEAE. MAGNOLIA FAMILY.

LIRIODENDRON. Tulip Tree.

L. tulipifera L.
Macrosiphum liriodendri (Monell). Davis, 1909a, p. 36.
Macrosiphum liriodendri var. rufa (Monell). Davis, 1909a, p. 36.

MAGNOLIA.

M. grandiflora L.
Aphis magnoliae Macchiati. Macchiati, 1883, p. 254.

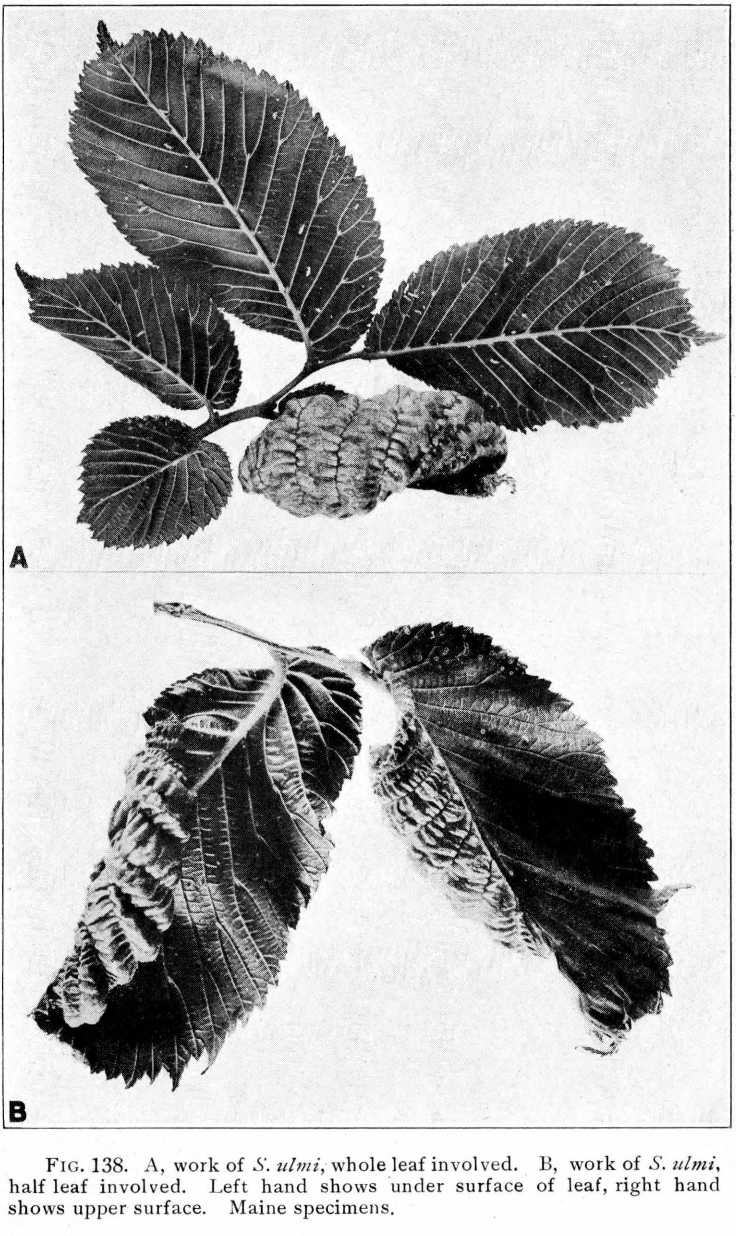


FIG. 138. A, work of *S. ulmi*, whole leaf involved. B, work of *S. ulmi*, half leaf involved. Left hand shows under surface of leaf, right hand shows upper surface. Maine specimens.

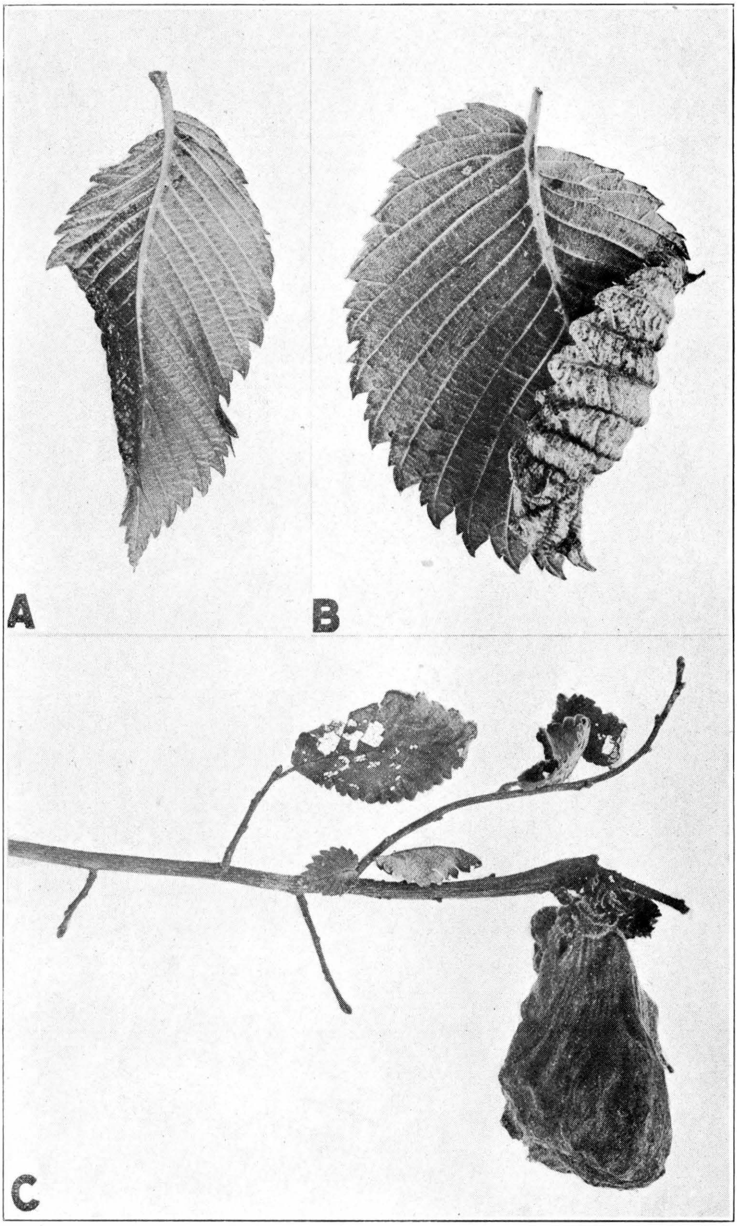


FIG. 139. A, work of *S. americana* in part of authors, young roll containing stem female. B, same species, old roll just deserted by migrants. Maine specimens. C, *S. lanuginosa*? Connecticut specimen.

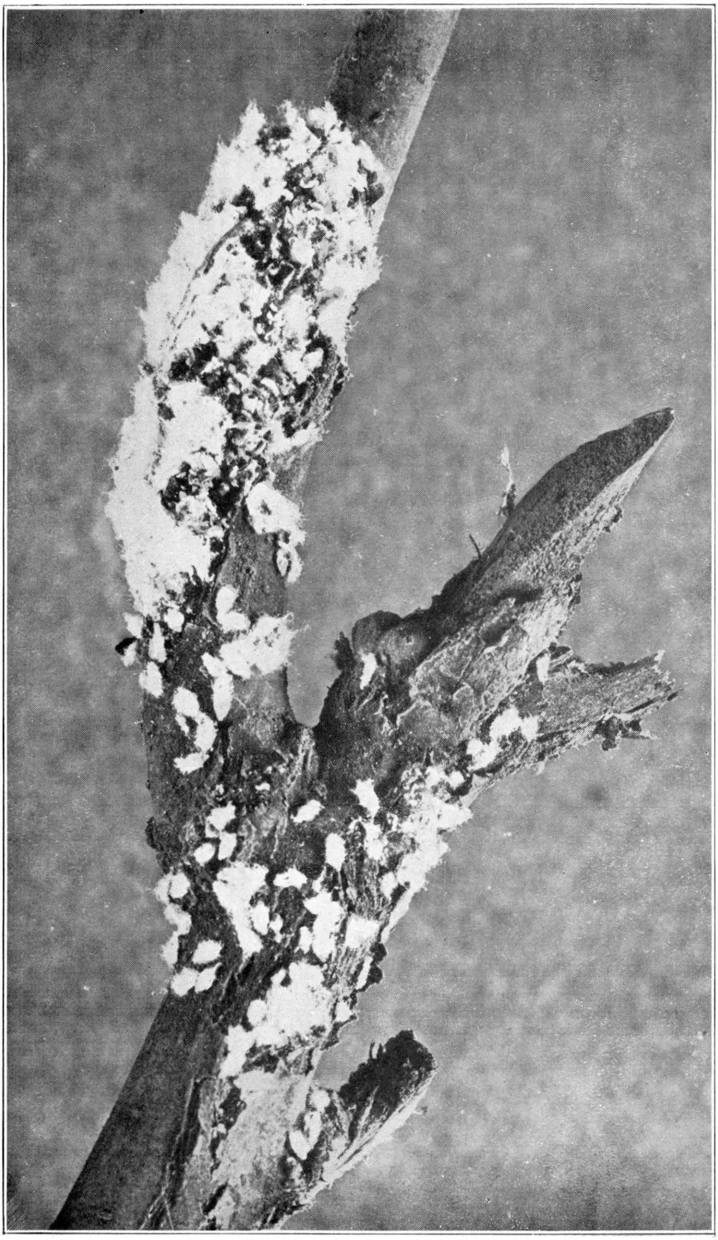


Fig. 140. *S. rileyi.*

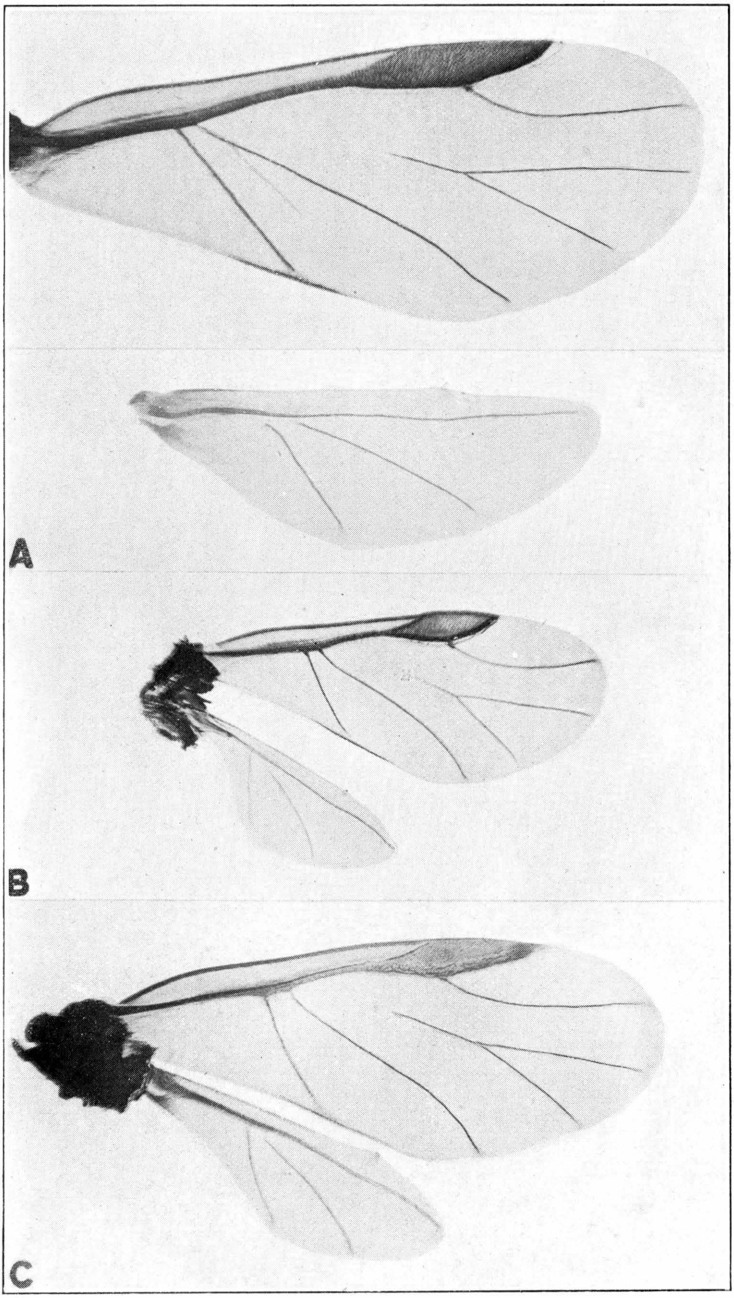
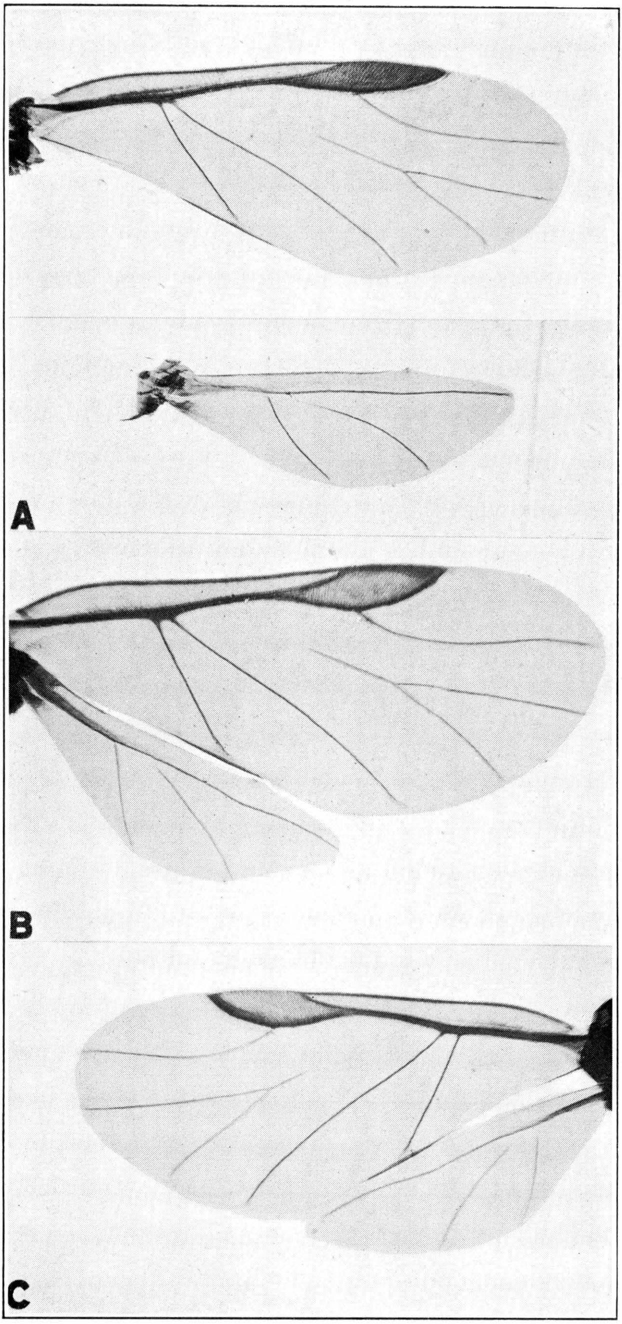


FIG. 141. A, *S. ulmi*, wings of spring migrant, (89–13). B, *S. lanigera*, wings of fall migrant (9-12 Sub. 1) reared on apple, the spring progenitors being migrants from elm leaves. C, *S. rileyi* (7–08).



A

B

C

FIG. 142. A, *S. americana* in part, of authors. Wings of migrant from "roll" like Fig. 139 B. (68–13).

B, *S. lanigera* (*americana* in part of authors). Wings of spring migrant from elm "rosette" like Fig. 71 in Bulletin 217.

C, *S. lanigera* wings of fall migrant from mountain ash, *Pyrus* sp. (63–11).

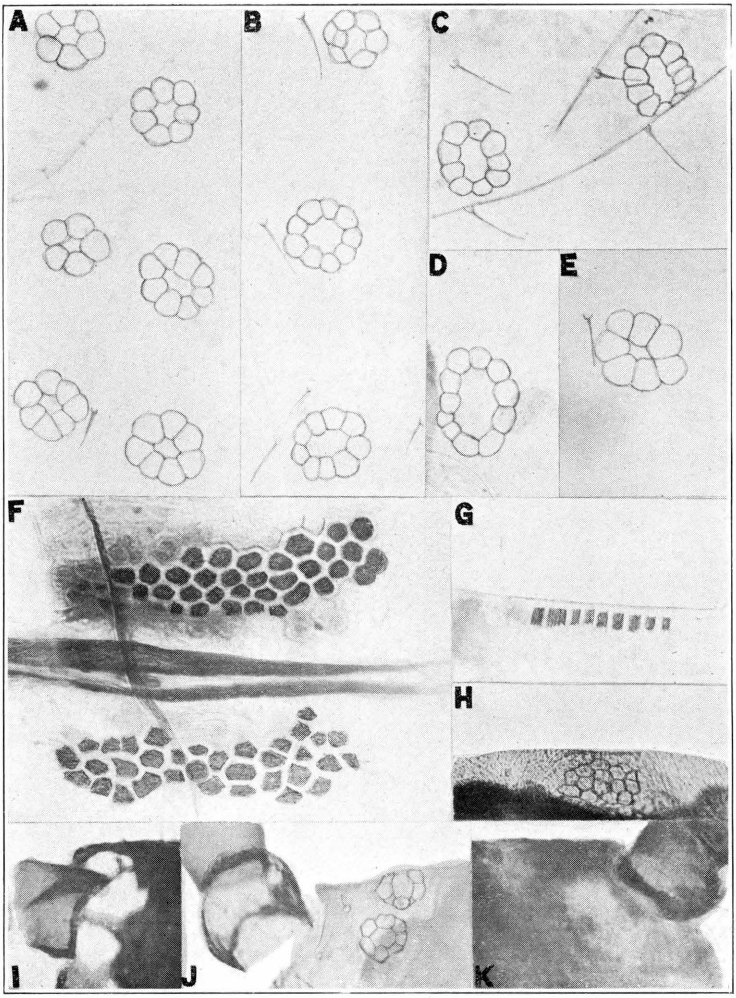


FIG. 143. Wax glands of *Schizoneura*. A–H, abdominal glands. I–K, head glands. A, *S. lanigera* (9–12) reared on apple from elm leaf progenitors. B and C, *S. rileyi*, pupal glands. D, *S. lanigera*, second generation from elm "rosette." E, *S. lanigera*, pupa from apple. F, *S. rileyi* stem female (52–13). G and H, *S. americana* in part. (20–13) wax glands of stem female from roll like Fig. 139 A. G, lateral aspect, H, dorsal aspect. I, same species as G and H stem female. J, *S. lanigera* second generation from "rosette." K, *S. lanigera* stem female from "rosette."

BULLETIN 221.

I. CONSTANTS FOR NORMAL VARIATION IN THE FAT CONTENT OF MIXED MILK.[1]

By RAYMOND PEARL.

The fundamental variation constants of characters which are to be the object of genetic study are certainly highly desirable, if not absolutely necessary. On this account the constants to be presented here have been worked out, in connection with the studies of the inheritance of milk production now in progress in this laboratory. It is expected that from time to time further reports will be published recording normal variation constants for other elements of milk and of milk production.

The present paper deals with the variation in fat content, both absolute and relative, of the mixed or composite milk produced by a large herd of cows. It is, of course, a well known fact that the fat content of the milk of any individual cow fluctuates, within usually rather narrow limits, from day to day. Sometimes the range of such variation in the performance of a single cow may be very wide. An example of this has recently been furnished by Fraser[2] in which he cites the case of a cow on an official two-day test, where, within a period of 48 hours, the butter fat varied from 2.7 per cent to 6.7 per cent, and the absolute amount of butter fat from .08 to .9 of a pound.

The causes of such fluctuations in the fat content of the milk from an individual cow are various. Many of them belong in the general category of immediate environmental circumstances, including such things as kind and amount of food,

[1]Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 57.

[2]Fraser, W. J. Variation in Milk Yield. Breeder's Gazette, Vol. LXIV, p. 562, 1913.

weather conditions, etc. In addition there are undoubtedly many internal factors involved, such as, for example, the nervous condition of the cow, the general state of metabolism, etc.

There is a widespread belief, which has indeed found its expresson in legislation, that in spite of the variation in the milk of the individual, if all the milk of the cows of a large herd be put together and thoroughly mixed, the resulting composite will not vary significantly from day to day in its fat content. It seems to be a matter of considerable importance, as a basic datum in milk production studies, to know the actual facts regarding the daily fluctuations in fat content of the mixed milk of a large herd.

The problem has recently been studied by Klose[3] for a herd of 70 cattle at the Milchwirtschaftliches Institut in Proskau. Only rather crude and inadequate statistical methods are used by Klose in the analysis of his data. Under these circumstances, and because of the valuable character of the raw data which are fully given in the paper, it has seemed desirable to apply biometric methods to these figures with a view to getting an accurate and trustworthy measure of the degree of variability shown. It is the purpose of this paper to present the results of such an analysis of Klose's data.

It may be said briefly that the records analyzed come from a herd of 70 animals (breeds not specified) and cover the milk of 30 consecutive days in each of four periods of the year. The cows were milked three times a day, morning, mid-day, and evening, and a separate record kept of the milk from each milking. The data include the following items; (a) The weight of milk produced at each milking, in kilograms: (b) the specific gravity of the milk; and (c) the fat percentage of milk. All of these figures are given for the three milkings of each day separately, and then for the total milk of the whole day. The four periods chosen for the records comprised practically the calendar months of March, May, July and October. The reason for choosing these particular months was to get the greatest possible contrast in regard to feeding and

[3]Klose. Untersuchungen über die täglichen Schwankungen im spezifischen Gewicht und im Fettgehalt der Milch einer grösseren Herde. Milchw. Centralbl.-Milch-Zeitg. Jahrg. 42, pp. 385-392, 1913.

environmental conditions. During each of the months of March and July there was no change in the character of the food or the method of handling the animals. But in March the cows were in the barn (that is stall fed) all the time, whereas in July they were on pasture continuously. May and October represent months in which there were marked changes in the feed. In the course of the month of May the cows were put on pasture. In the month of October they were partly stall fed and partly on pasture, and other changes were made in the ration as well. In this way a contrast was afforded between the months of uniform feeding and months of varying feeding. The details as to the actual feed used may be found in the original paper.

From the data described the constants of variation given in Table 1 and 2 of this paper have been calculated, under my direction, by Mr. John Rice Miner, the staff computer of this laboratory. The constants were calculated directly from the raw data without grouping. In one case, namely the evening milk during the month of May, it is evident that there are some errors in the records as printed in the original paper. Some of these are clearly typographical. Such we have been able to correct from internal evidence in the paper itself. Even after this partial correction, however, there are evidently still left some undetected errors, either in the original determinations of the fat percentages, or in the recording and printing of these. The variation shown in the milk of this milking in *per cent* of fat is so very much greater than that of any of the other data, that it can only mean some uncorrected error. In the case of the absolute amount of fat, the errors in per cent are apparently compensated for to a considerable degree (cf. Table 2). In the case of variation in fat per cent the variation constants for the evening milk of May are given first for the data exactly as they stand, and then for the data after correction of the obvious errors.

TABLE 1.

VARIATION CONSTANTS FOR FAT PERCENTAGE.

MONTH.	Milking.	Mean.	Standard deviation.	Coefficient of variation
March......	Morning................	2.717±.018	0.149±.013	5.487±.479
	Midday................	3.210±.020	.166±.014	5.156±.450
	Evening................	2.922±.015	.125±.011	4.295±.374
	Total day..............	2.916±.015	.126±.011	4.311±.376
May........	Morning................	2.772±.017	0.136±.012	4.899±.427
	Midday................	3.215±.017	.138±.012	4.292±.374
	Evening (as given)......	3.318±.038	.305±.027	9.195±.808
	Evening (partially corrected)................	3.352±.030	.246±.021	7.354±.644
	Total day..........	3.031±.013	.103±.009	3.408±.297
July........	Morning................	3.092±.021	0.168±.015	5.415±.473
	Midday................	3.162±.017	.135±.012	4.257±.371
	Evening................	3.448±.024	.197±.017	5.722±.500
	Total day..........	3.196±.013	.104±.009	3.238±.282
October....	Morning................	3.305±.023	0.184±.016	5.573±.487
	Midday................	3.570±.019	.156±.014	4.364±.381
	Evening................	3.572±.021	.168±.015	4.695±.410
	Total day..........	3.445±.016	.131±.011	3.797±.331

TABLE 2.

VARIATION CONSTANTS FOR AMOUNT OF FAT.

MONTH.	Milking.	Mean.	Standard Deviation.	Coefficient of variation.
March......	Morning................	6.205±.069	0.560±.049	9.019±.792
	Midday................	5.634±.108	.876±.076	15.548±1.387
	Evening................	3.910±.092	.745±.065	19.059±1.719
	Total day..........	15.691±.210	1.701±.148	10.843±.995
May........	Morning................	8.159±.089	0.723±.063	8.859±.778
	Midday................	6.592±.109	.883±.077	13.395±1.187
	Evening................	4.810±.084	.680±.059	14.139±1.256
	Total day..........	19.494±.247	2.005±.175	10.287±.905
July........	Morning................	7.904±.098	0.797±.069	10.082±.887
	Midday................	6.276±.073	.595±.052	9.481±.833
	Evening................	5.034±.070	.568±.049	11.279±.995
	Total day..........	19.283±.217	1.761±.153	9.132±.802
October....	Morning................	8.286±.071	0.579±.050	6.990±.612
	Midday................	5.958±.079	.644±.056	10.811±.953
	Evening................	4.658±.092	.749±.065	16.080±1.436
	Total day..........	18.939±.197	1.602±.139	8.458±.742

From these tables the following points clearly appear:

1. In general the *percentage* content of fat is lowest in the morning milk. The fat percentage is higher in the other two

milkings of the day, and usually is highest in the evening milk, although the month of March forms an exception to this rule. That this diurnal change in percentage fat content is significant is shown by table 3, which compares the differences with their probable errors.

TABLE 3.

SHOWING THE DIFFERENCES BETWEEN MORNING AND EVENING MILK IN MEAN PERCENTAGE OF FAT.

MONTH.	Difference between mean fat percent of morning and evening milk.	Difference divided by its probable error.
March	$.205 \pm .023$	8.9
May (as given)	$.546 \pm .042$	13.0
May (partially corrected)	$.580 \pm .034$	17.6
July	$.353 \pm .032$	11.0
October	$.267 \pm .031$	8.6

The probability that the percentage fat content of the evening milk is really higher than that of the morning milk is obviously so great as to amount to certainty for all practical purposes. This result agrees with the findings of Richmond.[4]

2. Without exception the *absolute* amount of fat is greatest in the morning milk, least in the evening milk, and intermediate in amount at the midday milking. This, of course, means that the amount of milk produced in the long interval between milkings is greater than in the short intervals. The differences are large and significant.

8. The difference between morning and evening milk in percentage fat content is significantly smaller in March and October, than in May and July. Owing to the uncertainty respecting the May evening milk constants stress cannot be laid on the very high difference in that month. July, however, shows the same relation, though to a less marked degree. It would on general grounds be expected that this difference would be greater on pasture than on the more exactly controlled stall feeding.

4. Taking into consideration the total day's milk it is seen that the *percentage* fat content rises steadily from March through October. The milk of this herd was a little over one-half of a per cent richer in fat in October than it was in March.

[4]Cf. Analyst, Vol. 37, pp. 298-302, 1912.

This was not due to a progressively diminishing flow. The greater part of this increase in mean fat percentage occurred between July and October. This would indicate that pasture conditions (not necessarily feed alone) were a significant factor in producing the result.

5. The greatest *absolute* mean fat production per day was in May. There is, however, no significant difference in this respect between May, July and October. The influence of pasture conditions in stimulating the flow seems clear here.

6. Turning now to the variation constants, we note first that, contrary to common opinion, the *percentage* fat content of the mixed milk of a large herd exhibits a considerable variation from day to day. The standard deviations and coefficients of variation for this character in every case are more than 10 times as large as their probable errors. Certainly they cannot be considered insignificant.

7. The milk of this herd was most variable in percentage fat content in March and October and least variable in May and July. But none of the differences are significant in comparison with their probable errors. In general, it appears from these data that the degree or amount of daily *variation* in the percentage fat content of mixed milk is not significantly affected by such changes in feed and other conditions as are here involved.

8. The *absolute* amount of fat produced per day is roughly about twice as variable (compare coefficients of variation) relatively as is the percentage fat content of the milk. This result is of particular interest in relation to the rather widespread view that the variations in fat *percentage* of milk are to be accounted for in the main by fluctuations in the water content. It should be remembered that the result here set forth is for the *mixed* milk of a whole herd.

9. The relative variation in absolute fat produced, as measured by the coefficient, decreases steadily from March on through October. The amount of this decrease is, however, rather small, and in the extreme case is not certainly significant in comparison with its probable error.

10. There is no indication that the milk of any particular milking of the day is, either absolutely or relatively, significantly more variable in percentage fat content than the milk

of any other milking of the day. The total day's milk is, as would be expected, relatively somewhat less variable in fat percentage than the milk from any single milking.

11. In absolute amount of fat, the evening milk is relatively much more variable than the morning's milk. The mid-day milk occupies an intermediate position in this respect. This result would appear to indicate that during the night, when the cows are at rest, fat production in the udder is a more uniform process from cow to cow and from day to day, than during the day time when the cows are in some degree active.

While the foregoing constants and their discussion were obtained primarily for their significance in connection with further scientific studies, it is clear that they have some points of practical interest to the farmer selling milk to the creamery, to the creameryman buying milk, and to the dairy inspector enforcing a minimum fat content milk law.

II. A PEDIGREE SYSTEM FOR USE IN BREEDING GUINEA-PIGS AND RABBITS.[1]

By FRANK M. SURFACE.

For use in experimental breeding an adequate yet simple method of recording pedigrees is indispensable. Further, to one who has once used pedigreed material for physiological experiments the advantages of such material are very evident. In many of the delicate biological reactions for which small mammals are extensively used it is often clearly evident that all animals do not react alike. In many cases it can be supposed that such idiosyncrasies are a matter of heredity. Accurately pedigreed material will often aid in solving otherwise very puzzling results. On the other hand, experimental breeding is just beginning to recognize the heritability of physiological characters. The keeping of accurate records for a period of time will undoubtedly throw much light upon this phase of heredity.

With this two-fold object in view the writer recently devised a system of pedigree and other records for use with small mammals. These records have been in use for a number of months and their adequacy and simplicity have been clearly demonstrated. It seems not unlikely that a description of these methods may be of interest to investigators in several fields.

The chief requirements of any pedigree system are (1) accuracy, and (2) simplicity. This simplicity should include a minimum of operations in recording an animal and an easy accessibility to all the data for any individual. So far as my

[1]Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 58.

The experiments reported in this paper were carried out while the writer was connected with the Kentucky Agricultural Experiment Station.

own experience goes, these requirements are best met by a system similar to that described some years ago by Dr. Pearl and myself[2] for use with poultry. Methods involving the same fundamental principles have also been described by Cole[3] for use in pigeon breeding.

Marking the Animals.

The chief factor in establishing a reliable pedigree system is to mark the animals in such a way that there is no danger of mistaking them. About two years ago I corresponded with a number of breeders and laboratories using small mammals in an attempt to find what means were used for marking these animals. For physiological experiments it seemed to be almost universal to rely upon a description of color markings or in the case of solid color animals to mark them with spots of various anilin dyes. These together with cage records constitute the chief means of distinguishing the animals. A number of experimental breeders rely upon various combinations of punch marks in the ears to distinguish individuals.

None of these systems is satisfactory. Color markings, even conceding that two animals are not marked alike, require a considerable amount of time to compare the marks of the animal with the description. Any system of ear punches or anilin spots necessitates access to a key and again requires time and energy to decipher their meaning. Further, the combinations of punches and spots are quite limited so that it is very difficult to run a continuous series for any considerable number of individuals. Besides, dyes are not permanent and the ears are likely to be torn or pierced in fighting and so give trouble in reading the numbers.

Undoubtedly the most satisfactory method is to have a metal tag or band bearing a stamped number, in which case there can

[2]Pearl, Raymond, and Surface, F. M.—Appliances and Methods for Pedigree Poultry Breeding, Maine Agricultural Experiment Station, Bulletin No. 159, pp. 239-275. 1908, Cf., also Zeit. f. Biol. Tech. u Method Bd. 1, pp. 285-295, 1909.

[3]Cole, Leon J.—Methods of Keeping Pedigree Records in use at the Rhode Island Agricultural Experiment Station. Ann. Rpt. R. I. Exper. Station, 1908, pp. 317-324.

be no mistake, and the time and energy required in reading the record are reduced to a minimum. After a considerable number of experiments and many inquiries I obtained an ear tag made by T. Cadwallader at Salem, Ohio, for use with rabbits. Subsequent experiments have shown that this tag can be used very satisfactorily with guinea-pigs. A slightly different form might very well be adopted to use on even smaller mammals.

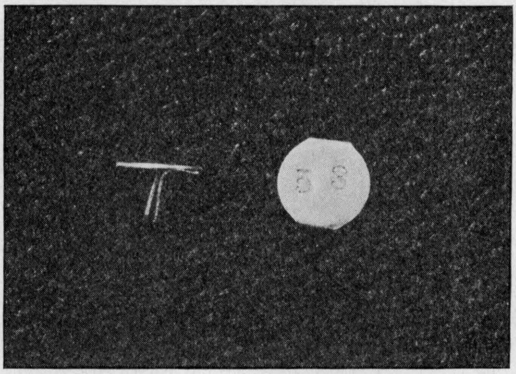


FIG. 144. Ear tags described in text.

The character of this tag is seen from figure 144. A small chick punch, such as can be obtained from any poultry supply house, is used to pierce the ear. The tag is then inserted and the points spread.

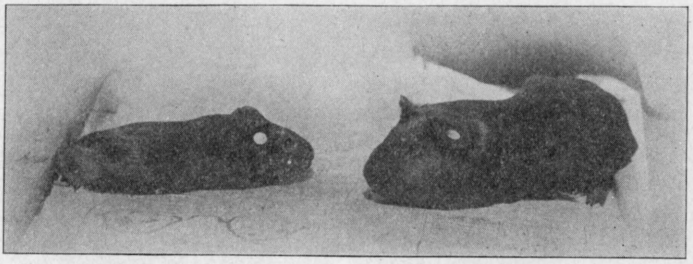


FIG. 145. Showing ear tags in place.

Figure 145 shows the ear tag in place on a young and an adult guinea pig. The tag does not inconvenience the animal in any way and if properly inserted they do not tear out. If desired the tags may be used in duplicate, one in either ear.

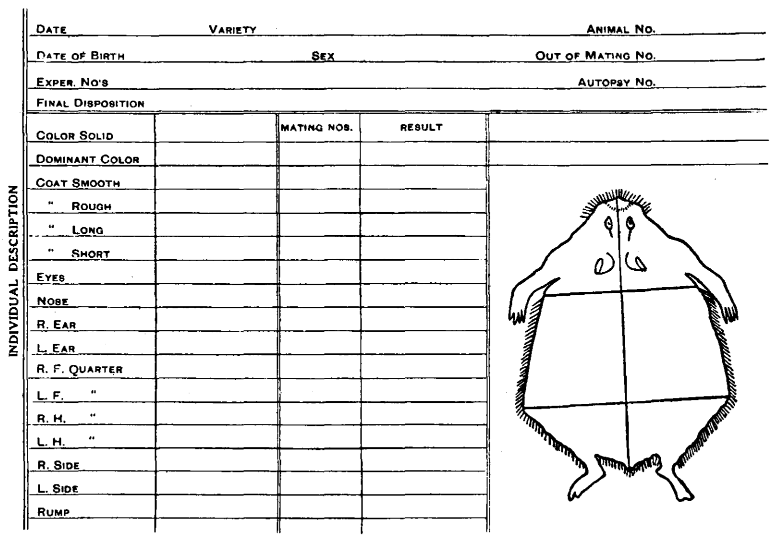
In our first experiment with this tag on guinea-pigs we made the mistake of putting it too close to the head and bending the points too far back. If these points are pressed too firmly against the skin they often cause a slight irrigation which may end in suppuration. In a few cases such tags were lost in the course of three or four months. However if the tag is placed just outside the heavy cartilage in the ear and the points are not pressed down too firmly we have never had any trouble of this kind. The difficulty would be entirely eliminated if the points of the tag were made a little longer.

The young guinea-pigs are so well developed at birth that they can be labeled at once without causing them any inconvenience. As a matter of fact, however, we find it more convenient to have the attendant place the pregnant females in separate cages a few days before parturition. He can then mark on the cage the date of birth and the number of young. About once a week we can then go through and label the young and make the necessary records. This involves but very little time and trouble. In the case of rabbits it is better to let the young get three or four weeks old before labeling them.

Since the principal object in growing guinea-pigs at the Kentucky Station was to furnish a sufficient supply for physiological and bacteriological work it was necessary to handle them by slightly different methods than are used by the experimental breeder. Most of the breeding is done in pens rather than in hutches. It has been found that better results are obtained if not more than 6 or 7 females are mated with one male. The pens are sub-divided by removable partitions into small areas about 2x4 feet. One male is kept in each of these pens and the females are placed in them, together with their young as soon as these latter have been tagged. When the young are about three weeks old they are removed to separate pens and the sexes separated. One pen contains surplus males which may be desirable for use in breeding. Two or more larger pens 4x4 feet), contain the surplus animals for experimental purposes. The sexes are separated, except that one male is placed in each pen of females so that if any females should remain long enough to bear young the pedigree system will remain intact.

Pedigree Records.

For the pedigree records printed loose leaf sheets of uniform size (5x8 inches) were used. These sheets are made by the J. C. Moore Co., and are adapted to their type of binder. The sheets are readily removed or inserted when desired but at other times they are securely held in place. For the pedigree records proper, two forms are used. These are known respectively as the "Individual Description Record" and the "Mating Record."


DATE VARIETY ANIMAL NO.
DATE OF BIRTH SEX OUT OF MATING NO.
EXPER. NO'S AUTOPSY NO.
FINAL DISPOSITION

INDIVIDUAL DESCRIPTION

		MATING NOS.	RESULT
COLOR SOLID			
DOMINANT COLOR			
COAT SMOOTH			
" ROUGH			
" LONG			
" SHORT			
EYES			
NOSE			
R. EAR			
L. EAR			
R. F. QUARTER			
L. F. "			
R. H. "			
L. H. "			
R. SIDE			
L. SIDE			
RUMP			

FIG. 146. Description sheet for guinea-pigs.

Figure 146 shows, in facsimile, the individual description sheet used for guinea-pigs. At the top of this sheet are spaces for the date on which the description was made, the variety, if it is a pure bred animal, and the animal number which is the one on its ear tag. The date of birth, sex and the number of the mating from which it came are also given. Additional spaces are provided for the numbers of the experiments in which the animal may be used and for its autopsy number or final disposition if it does not come to autopsy.

On the lower portion of the sheet there is, on the left, a list of coat and color characters which it is desired to record. On the right is a space for stamping the outline figure of a guinea pig. On this outline the limits of the principal color areas are marked. This is a great aid not only to the accuracy of description but also to the ease in referring to an animal's characters. Finally in the center of the sheet there are two columns in which are recorded the matings in which this animal enters and a brief summary of the results of each. This sheet thus provides a brief but relatively complete history of the individual.

If it is desired a record could be made of the number of the pen or hutch in which each animal is kept. This would often be a convenience in locating a particular individual. It involves the additional trouble of making a record every time an animal is transferred from one pen to another. So far we have not found this record necessary.

It should be said that the numbers are given the animals in a continuous series approximately in the order of their birth. The ear labels are purchased already numbered and for convenience in reference are used in consecutive order. No attempt is made to make the number show the pedigree. This is established through the "mating number" described below. The description sheets are arranged consecutively in the book. Thus if we should pick up guinea-pig number 124 we simply turn to page 124 and find the description and other data concerning this animal. The pedigree and breeding history of the individual are found by reference to the mating number from which it came and to the matings into which it enters as a parent.

Mating Record.

The key to this pedigree system is the "mating number." Every time a particular male and female are placed together an arbitrary number is given to that mating. These mating numbers are assigned in a continuous series in the order in which the matings are made. The "mating number" in itself is no indication of the pedigree but is simply an index by which the pedigree can be determined. Printed sheets similar to those described above are used for the mating records. A facsimile of one of these sheets is shown in figure 147.

MATING RECORD

DATE PARENTAGE ♂ ♀ MATING NO.

ANIMAL NO.	DATE OF BIRTH	SEX	ENTERED IN MATING NOS.	EXPER. NO.	AUT. NO.	REMARKS

FIG. 147. Mating record sheet.

At the top of this sheet there is space for the date on which the mating was made; a record of the individual numbers of the male and female entering into this mating and the mating number. Below are spaces for recording each offspring. The number, date of birth and sex of each offspring are entered at the time the young animal is given its ear tag. Spaces are also provided for giving references to its subsequent history.

Guinea-pigs have from one to four or more young in a litter. If the same mating is continued we stamp below the number of the last offspring the date at which the female was again placed with the male and the subsequent litter is recorded below. If the female is mated with another male this mating receives a new number and is recorded on another page. All the mating numbers of any individual are recorded on its description sheet.

Still born or aborted offspring are recorded with the date and sex but are not given individual numbers.

The mating sheets are arranged in the binder in consecutive order so that if we are referred to mating number 79 we can at once turn to this page.

INDICES.

The above two record sheets are all that are necessary in this pedigree system. However it is convenient to have at least one index. This is an index to the matings into which any animal has entered. For this the numbers of the animals are stamped in consecutive order in alternate columns on loose leaf sheets. When any animal is mated the number of this mating is entered opposite the number of the animal. Thus we can see at once all the matings into which an animal has entered without having to look up its individual description sheet.

For some purposes it is also convenient to have an index showing the mating *from* which each individual arose. Neither of these indices is necessary for the completeness of the record.

The operation of this pedigree system may be illustrated by an example. Thus we may pick up the guinea-pig bearing the number 231 on its ear tag and we wish to know its family and breeding record. We first turn to page 231 of the individual description book. This gives the animal's description, sex, date of birth, etc. The description can be verified, if we wish, by glancing at the marks on the outline figure (cf. fig. 146). This page also shows that this animal came from mating number 81 and that it has entered twice in mating number 114 and once in mating number 147. On page 81 of the mating book are given the numbers of the parents of this individual as well as its full brothers and sisters. The more remote ancestors may be traced through the parent numbers. On pages 114 and 147 of the mating book will be found all the offspring of this individual as well as the numbers of the individuals with which it was mated. If any of these offspring have been mated, such mating numbers will appear in the proper columns on these pages. In this way the grandchildren and more remote offspring can be traced at once. Reference to the experiment number and autopsy number makes the record complete at every point.

The operations in describing and recording an individual are relatively simple. Several cross references must be made but this involves but little time. The indices mentioned above aid in the ease with which this can be done.

III. ON THE ABILITY OF CHICKENS TO DIGEST SMALL PIECES OF ALUMINUM.[1]

By Maynie R. Curtis.

It is a matter of common observation that chicks will peck at, and sometimes swallow, small pieces of bright metal. If these have sharp points or corners, they may puncture the wall of the alimentary tract allowing the escape of some of the contents into the body cavity, and may thus indirectly cause peritonitis.

Among the several cases of peritonitis in the Maine Agricultural Experiment Station flock in the last five years four have been observed where at autopsy a sharp metal article was found still protruding from the puncture it had made in the gizzard wall. The articles were a small nail, a tack, a pin and a piece of steel watch spring. In these cases it was the sharpness of the metal which caused the difficulty. However, on account of the interposition of the gizzard a bird is less able to pass out a large indigestible article than is an animal which masticates its food. Such an article which is too large to pass through must either remain in the gizzard or must be ground up or dissolved by the digestive fluids.

The purpose of the present note is to record some observations on the fate of certain pieces of metal which when swallowed by chickens cause no disturbance in their physiological processes. The pieces of metal were aluminum leg bands. They were practically pure aluminum showing only the slightest trace of iron.[2]

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[1]Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 59.

[2]It is a pleasure to acknowledge my indebtedness to Prof. James M. Bartlett, Chemist of the Maine Agricultural Experiment Station, for the analysis on which this statement is based.

When chicks are taken from the pedigree incubator baskets at this Station each one is banded with an aluminum band. This is a flat strip of metal with rounded corners which is bent into a ring around the chick's leg. As the bird grows this ring is enlarged from time to time, but when the chick is six to eight weeks old it has outgrown this band altogether and is then rebanded with another type of aluminum band. This second band is adjustable. The portion of the band not used is snipped off. The size of these snips varies greatly with the size of the chickens' legs. As the chicks are rebanded the discarded bands and snips are dropped on the range. It is not unusual to see chickens pecking at them. Figure 148 shows at the top a random sample of fifteen snips cut from the second bands and at the bottom two of the discarded first bands. The one of these to the left is opened out flat and the one to the right is bent double. It may be seen from this figure that the snips are narrower than the bands.

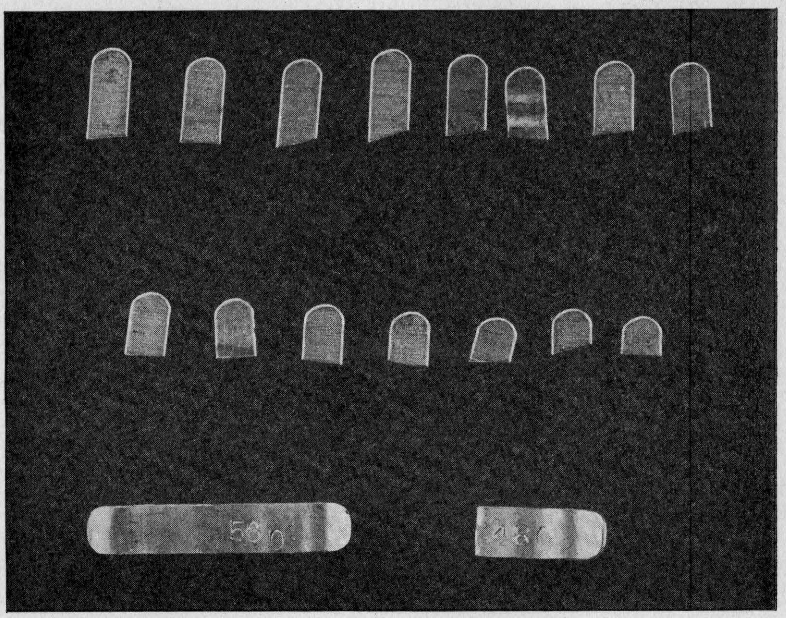

FIG. 148. Shownig band snips and whole chick bands.

August 6, 1913, a fine strong Barred Plymouth Rock pullet, normal in all respects, was killed for material. In the gizzard contents of this bird a bright glimmer of metal was noticed. The whole gizzard contents were then examined and found to contain fourteen aluminum leg bands or pieces of leg bands. A photograph of these is shown in Figure 149. They are in varying stages of dissolution and it is not possible to tell accu-

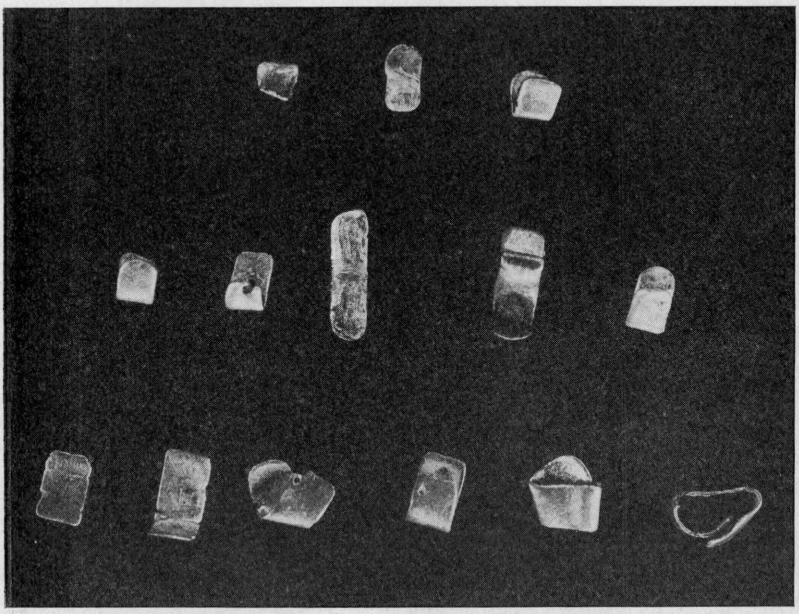

FIG. 149. Partly digested bands and snips from gizzard of B. P. R. ♀.

rately how many bands the bird had swallowed, as it is probable that in some cases two or more of the pieces are from the same band. Some of the fragments are undoubtedly snips. The number swallowed may be conservatively estimated as four bands and six snips. One band is still all together but is nearly separated at one point. Other pieces are very small and thin. Some have holes through them. The dissolution has evidently been accomplished by a combination of the mechanical grinding of the gizzard and the action of the hydrochloric acid of the gastric juice. The outer surfaces of the bands are covered with fine scratches while the inner surfaces show fewer scratches and more evidence of solution. After careful cleaning this entire collection of bands weighed 0.857 grams. The mean weight of one band as it comes from a chick's leg is 0.2545 grams. The mean weight of a snip (calculated from the fifteen snips shown in Figure 148) is .0421 grams. The weight of five bands and six snips would be approximately 1.2706 grams. The difference between this and 0.957 or 0.3136 would be a rough estimate of the loss due to the digestion of the metal. This is a loss of 24.69 per cent.

This case shows that a chick may pick up a considerable quantity of aluminum and use it somewhat as it does grit, gradually wearing and dissolving it away until it becomes small enough to pass out with the feces. Aluminum is soluble in dilute hydrochloric acid. A leg band placed in a .5 per cent solution shows hydrogen bubbles on the surface, although the action is not very rapid. Further the aluminum salt formed (aluminum chloride) is non-poisonous. If the metal swallowed were not attacked by the gastric juice it would still be worn away by the grinding action. On the other hand if it were attacked and the resulting salt were poisonous (as for example zinc chloride) the result might be death from poisoning.

Two further questions suggested themselves. One was: how long had it taken the bands to reach their present state of decomposition? Secondly: was the swallowing of the bands a personal idiosyncrasy of this individual bird?

There are, of course, no data on the time the bird began to swallow bands but the rebanding of the chicks in that yard was begun the first of June or about nine weeks before the bird was killed. Therefore, some of the bands may have been in the gizzard for that length of time, but not longer.

Since the observation of the above case the gizzard contents of six other normal, healthy birds of approximately the same age as this bird running on the same range have been examined. Five of these contained no leg bands. One contained the bands and parts of bands and snips shown in Figure 150.

There are probably fewer bands and more snips in this case than in the other but the process of dissolution has evidently advanced farther and it is even more difficult to tell how many there are. The number swallowed is estimated as one band and ten snips. The weight of these at the time of swallowing would have been 0.6755 grams. Their weight after removal from the gizzard was .301 grams. That is, the loss was .3745 grams or 55.44 per cent.

It thus seems evident that birds possess a considerable individuality in regard to the tendency to swallow pieces of bright

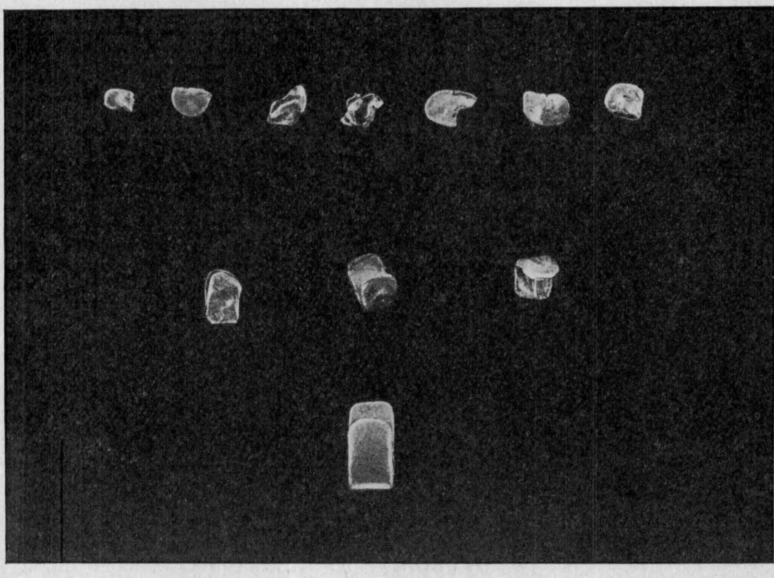

FIG. 150. Leg bands and snips from gizzard of B. P. R. ♀.

metal, since with equal opportunity only two of the seven birds examined had swallowed leg bands. However, in a careful search of the yards where the rebanding had been completed several weeks before, a single snip and very few first bands were found. While it is possible that some of them were completely buried in the dirt, the soil in these yards is very hard and it is probable that most of them had been eaten by the chicks.

BULLETIN 222.

METEOROLOGICAL OBSERVATIONS.

For many years the meteorological apparatus was located in the Experiment Station building and the observations were made by members of the Station Staff. June 1, 1911, the meteorological apparatus was removed to Wingate Hall and the observations are in charge of Mr. James S. Stevens, professor of physics in the University of Maine.

The instruments used were at Lat. 44° 54′ 2″ N. Lon. 64° 40′ 5″ W. Elevation 135 feet.

The instruments used are the same as those used in preceding years, and include: Wet and dry bulk thermometers; maximum and minimum thermometers; rain-gauge; self-recording anemometer; vane; and barometer. The observations at Orono now form an almost unbroken record of forty-five years.

METEOROLOGICAL SUMMARY FOR 1913.

OBSERVATIONS MADE AT THE UNIVERSITY OF MAINE.

1913.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Not stated.	Total.
Highest temperature	58	51	65	85	79	87	91	93	90	77	66	51	......	......
Lowest temperature	-5	-19	-7	9	26	34	48	34	29	29	9	-11	......	......
Mean temperature	27.0	16.1	33.5	44.7	50.1	61.3	67.9	65.2	56.8	54.2	40.5	28.1	45.45	......
Mean temperature in 45 years	16.51	18.72	28.50	40.97	52.88	62.08	67.21	65.27	57.53	45.54	34.60	21.97	42.57	......
Total precipitation in inches	2.81	1.66	4.42	3.54	3.55	1.38	5.86	3.15	4.42	7.35	3.39	2.87	......	44.00
Mean precipitation in 45 years	4.06	3.75	4.22	2.91	3.57	3.40	3.34	3.45	3.50	3.87	3.60	3.68	......	43.33
Number of days with precipitation of .01 or more	8	4	15	11	8	8	15	7	9	16	6	5	......	112
Snow fall in inches	1.25	14.0	9	......	......	......	......	......	......	......	......	10	......	34.3
Mean snow fall in 45 years	22.0	21.5	15.6	5.3	0.19	......	......	......	......	0.72	7.1	16.3	......	90.4
Number of clear days	5	12	6	10	8	15	7	14	17	6	15	11	......	126
Number of fair days	8	6	8	5	10	10	12	10	7	6	8	9	......	99
Number of cloudy days	18	10	17	15	13	5	12	7	6	19	7	11	......	140
Total movement of wind in miles	5320	4802	6212	4698	4091	4289	4255	3542	3087	4416	4364	3408	4374	52484

REPORT OF TREASURER FOR FISCAL YEAR ENDING JUNE 30, 1913.

RECEIPTS.	Hatch fund.	Adams fund.	General account.	Inspections.
Balance July 1, 1911	....	....	....	*$6,993 98
Treasurer of United States	$15,000 00	$15,000 00	....	....
State	....	....	....	9,000 00
Sales, etc	....	....	11,410 95	....
Analysis fees	....	....	....	13,039 24
Total	$15,000 00	$15,000 00	$11,410 95	$29,033 22
DISBURSEMENTS.				
Salaries	$5,149 81	$11,551 27	$1,418 35	$13,664 48
Labor	3,663 41	130 71	2,475 09	....
Publications	72 32	....	....	....
Postage and stationery	497 65	48 75	106 99	665 23
Freight and express	317 82	153 72	836 39	143 65
Heat, light and power	271 81	181 04	247 10	241 81
Chemical supplies	185 33	4 22	5 61	637 06
Seeds, plants and sundry supplies	736 14	491 15	1,667 27	64 78
Fertilizers	918 03	....	12 90	....
Feeding stuffs	1,352 53	817 43	182 74	....
Library	739 91	82 27	78 78	....
Tools, implements and machinery	502 12	187 39	58 53	....
Furniture and fixtures	91 68	40	60 50	396 17
Scientific apparatus	3 00	512 84	....	123 04
Live stock	98 27	97 00	617 10	....
Traveling expenses	212 99	463 16	81 13	2,632 87
Contingent expenses	....	....	91 72	79 47
Buildings	187 18	278 65	1,312 99	2,843 98
Deficit June 30, 1912	....	....	673 88	....
Balance June 30, 1913	....	....	1,483 88	*7,540 68
Total	$15,000 00	$15,000 00	$11,410 95	$29,033 22

* The large balance is due to the fact that fees are paid in advance for the whole year and the State year ends December 31.

The classified report does not include $1,000.00 paid for services and feeding stuffs in poultry investigations by the U. S. Department of Agriculture, an appropriation of $4,500 from the State for printing Station publications, nor $863.25 expended for Animal Husbandry investigations in anticipation of the receipt of the appropriation from the State.

INDEX.

APPENDIX

Official Inspections

46 to 55

POULTRY MANAGEMENT AT THE MAINE STATION

SPECIAL REPORT FOR 1912

SUMMARY OF STATION WORK, NO. 1

CONTENTS.

January, 1913.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

ANALYSTS

James M. Bartlett	Herman H. Hanson
Royden L. Hammond	Edward E. Sawyer
Helen W. Averill	Elmer R. Tobey

Official Inspections

46

SEED INSPECTION.

The first law regulating the sale of seeds was enacted by the Legislature of 1897. This was revised by the legislature of 1905. This was again revised by the legislature of 1911 so as to conform with the requirements recommended by the Association of Official Seed Analysts and agreed to by the American Seed Dealers Association. The chief requirements of the law follow. The full text of the law will be sent on request.

The Chief Requirements of the Law.

The following are the chief points of the law and the rules and regulations for carrying out the law regulating the sale of agricultural seeds which, as directed by the law, the Director of the Station, has made.

1. *Kind of seeds coming under the law.* The law applies to the sale, distribution, transportation, or the offering or exposing for sale, distribution, or transportation of the seeds of alfalfa, barley, Canadian blue grass, Kentucky blue grass, brome grass, buckwheat, alsike clover, crimson clover, red clover, medium

clover, white clover, field corn, Kaffir corn, meadow fescue, flax, hungarian, millet, oats, orchard grass, rape, redtop, rye, sorghum, timothy and wheat for seeding purposes.

2. *The brand.* Each lot or package shall be plainly marked with the name of the seed and its minimum percentage of purity.

3. *Mixtures.* Mixtures must be plainly marked with the name of the seed and the percentage of purity. In case the mixtures contain seeds not included in 1 these need not be named. (e. g., a mixture consisting of half redtop, 90 per cent pure, quarter Kentucky blue grass, 85 per cent pure and the remainder seeds not named in the law, could be marked "Redtop 45 per cent pure, Kentucky blue grass 21 per cent pure." The statement of the remaining constituents may or may not be named.)

4. *Adulteration.* A seed is adulterated if its purity falls below its guaranty or if it contains the seed of any poisonous plant.

5. *Misbranding.* A seed is misbranded if the package or label bears any statement, design or device which is false or disleading in any particular, or if it does not carry the statements named in 2.

6. *Free analysis.* Free analysis of seeds on sale in Maine will be made of samples taken in accordance with directions furnished by the Station. Samples not so taken may be refused examination. Blanks with full directions will be furnished on request.

7. *Paid analysis.* As an accommodation to residents of Maine samples of seeds not on sale in Maine will be examined at cost, and the results will not be published. The cost of the analysis of blue grass or redtop is $1.00 per sample and for other seeds 50 cents. Remittance should accompany the sample.

8. *Written guaranty.* No prosecution will lie against any person handling agricultural seeds provided he obtains at the time of purchase a written guaranty signed by the person residing in the United States, from whom the purchase was made, to the effect that the seeds are not adulterated or misbranded within the meaning of the Maine law regulating the sale of agricultural seeds. After a person has been notified by the Director of the Maine Agricultural Experiment Station that an article of

agricultural seed appears to be adulterated or misbranded the written guaranty will not protect further sales.

9. *Hearings.* The person who is believed to have violated the law regulating the sale of seeds will be granted a hearing at which he may appear in person or by attorney or by letter. The notice of the hearing will name the time and place of the hearing and a copy of the charge. Failure to appear will not prejudice the case. The hearing will be private and every opportunity will be given for explanation and establishment of innocence. If the time appointed is not a convenient one, postponement within reasonable limit will be granted.

The Maine Jobber and the Seed Trade.

At present it is usually impossible for the Maine dealer, wholesale or retail, to obtain guaranteed seeds from outside of the State. The retail dealer can purchase guaranteed seed from Maine wholesale houses, and the Station advises him so to do. The wholesale dealer must look to the outside. Four years ago the Director of the Station assumed a certain responsibility as to the statement of analysis given by two or three of the leading seed houses of the country. It however does not seem wise for him to continue this practice. Therefore any guaranties which a Maine dealer places upon seeds based upon out-of-state firms statements as to their purity is entirely at the risk of the Maine dealer. After consulting with some of the larger houses within the State the following suggestions were made to importing houses by the Director of the Station.

"I suggest that when a car of seed goes forward to you that you request your shipper to send you a type sample of the car stating the name of the shipper, the kind of seed and its special brand if any, the analysis which they place upon it if any, the lot number, and car number. When this sample is received by you send it to me. I will then have it examined. This analysis will be made at your expense (usually 50 cents to $1.00) and the results will be reported to you. I will retain the sample here to check up with the samples to be sent to us from the car.

As soon as the car is received by you or by your customer, have a sample taken from not less than six packages and sent to us, also accompanied by the name of the shipper, the kind of seed and its special brand, the lot number and car number. This sample we will give prompt, free analysis and report the results to you. If there is a discrepancy between the analysis of the type sample submitted and the samples taken directly from the car, the guaranty, of course, would have to be changed before the goods could be sold, but it would give you a basis upon which to make a claim against the shipper as to quality.

My reason for writing the above is that it is my desire not only to enforce the provisions of the Maine seed law, but to protect, as far as possible, Maine wholesale handlers of seed against the irresponsibility which cleaners of seed profess."

Testing Seeds at Home.

It is important to the user of seeds not only to know their percentage of purity and what kind of weeds they carry, but to also know something of their vitality. In the case of seeds there are at least three ways whereby the user may be injured. A seed which carries foreign matter of any kind, in any considerable amount, is correspondingly lowered in value. But there is another reason which is more important than the money consideration, and that is that the weed seeds which the seeds contain may be pernicious. For example,—clover seed frequently carries plaintain seed. If this plaintain seed is the door-yard variety which is present practically all over Maine, there would be comparatively little harm from using clover seed which contained it. On the other hand—lance leaved plaintain or rib grass is not abundant in Maine. It is an undesirable plant and using seed carrying it might introduce a weed into land which is at present free from it. It is important that the farmer should know the vitality as well as the purity of the seed that he is to use. No matter how pure a seed may be, if half of it will not sprout it has no more value than if the seed were half chaff.

While it is not easy to make an exact purity test, it is not difficult for a farmer to so acquaint himself with the seeds that he is ordinarily using that by the help of an ordinary reading or magnifying glass he will be able to tell whether the seed in question contains any considerable amount of impurities. If the seed is spread out upon a white plate, a little practice will enable a farmer to see whether a given seed is reasonably pure or not, and he will soon learn to detect the more common foreign seeds.

Vitality of Seeds.

It is much easier for the farmer to test the vitality of seed than to make a purity examination. The following simple instructions for performing germination tests at home without any special apparatus will enable the farmer to learn for himself whether the seed that he is using has good vitality or not. Germination tests may be made in two ways,—the so-called blotting paper methods, and the sand method. In making the germination test with blotting paper, blue blotting paper of common weight, cut into strips about 6 x 19 inches, should be used. This is laid folded twice so as to get a piece of three thicknesses and about six inches square, on an ordinary dinner plate or platter. The seeds if small are placed on the top of the paper and if large between the folds. The paper is kept moist (not soaked) and at a temperature of 70 to 80 degrees F.

If only a vitality test is desired the blotting paper method is preferable, but if it is desired to know how many seeds may be expected to grow, the sand method is in some ways preferable. In this method a thin layer of fine sand is sprinkled on the bottom of a flat dish and the seeds to be tested placed on it under a thin covering of sand. This must be kept moist and well shaded and at a somewhat higher temperature than in the first case.

At the end of every second day in the case of some seeds, and the third day in the case of those germinating more slowly, the sprouted seeds should be removed from the blotters or the sand and counted, the per cent being readily found by referring back to the number of seeds which were taken for the test. If 100 seeds are used, the number that sprout give the vitality per cent.

The Results of Inspection.

The inspection of grass seed sold in Maine in 1912 was made almost entirely by the seed analyst whose experience makes it possible for him to tell almost at a glance whether a seed is or is not what it is guaranteed. In all suspicious cases in which he was in doubt samples were taken. It therefore happens that most of the samples, the analyses of which are here reported, are the doubtful ones that were found within the State and represent a selection made from very many hundred lots.

Table showing the result of the inspection of seed in lots at dealers in 1912. These seeds were all examined at the dealers to see if they were in accord with guarantees upon them. In doubtful cases samples were taken to the laboratory.

Names of Seeds and Number of Lots of Each Inspected.													
Timothy.	Red clover.	Alsike clover.	Mammoth clover.	White clover.	Redtop.	Hungarian.	Japanese millet.	German millett.	Kentucky blue grass.	Orchard grass.	Alfalfa.	Total number of lots.	Number of dealers visited.
258	206	182	12	8	147	110	53	2	2	4	3	993	285

A list of weed seeds found in seeds examined in 1912.

NOMENCLATURE, GRAY'S MANUAL, 17TH EDITION, 1908.

Common Name.	Scientific Name.
American pennyroyal	Hedeoma pulegioides (L.) Pers.
Apetalous peppergrass	Lepidium apetalum Willd.
Barnyard grass	Echinochloa crusgalli (L). Beauv.
Bird's foot trefoil	Lotus corniculatus L.
Black medick	Medicago lupulina L.
Blue field madder	Sherardia arvensis L.
Blue vervain	Verbena hastata L.
Bracted plantain	Plantago aristata Michx.
Canada thistle	Cirsium arvense (L.) Scop.
Catnip	Nepeta cataria L.
Cat's ear	Hypochaeris glabra L.
Charlock	Brassica arvensis L.
Chicory	Cichorium intybus L.
Cinquefoil	Potentilla canadensis L.
Clover dodder	Cuscuta epithymum Murr.
Common chickweed	Stellaria media (L.) Cyrill.
Common mallow	Malva rotundifolia L.
Common nightshade	Solanum nigrum L.
Common speedwell	Veronica officinalis L.
Corn mayweed	Matricaria inodora L.
Corn spurry	Spergula arvensis L.
Crabgrass	Digitaria sanguinalis (L.) Scop.
Crane's bill	Geranium maculatum L.
Dock	Rumex Sp.
Evening primrose	Oenothera biennis L.
Ergot	*Claviceps purpurea (Fr.) Tul.
False flax	Camelina microcarpa Andrz.

*Sclerotia of the fungus.

A list of weed seeds found in seeds examined in 1912—Concluded.

Common Name.	Scientific Name.
Field peppergrass	Lepidium campestre (L.) R. Br.
Five finger	Potentilla monspeliensis L.
Flax dodder	Cuscuta epilinum Weihe.
Fowl-meadow grass	Glyceria nervata (Willd.) Trin.
Goosefoot	Chenopodium album L.
Green foxtail	Setaria viridis (L.) Beauv.
Heal-all	Prunella vulgaris L.
Hedge mustard	Sisymbrium officinale (L.) Scop.
Knot-grass	Polygonum aviculare L.
Lady's thumb	Polygonum persicaria L.
Mayweed	Anthemis cotula L.
Mint	Mentha Sp.
Moth mullein	Verbascum blattaria L.
Mouse-ear chickweed	Cerastium vulgatum L.
Mustard	Brassica nigra (L.) Koch.
Night-flowering catchfly	Silene noctiflora L.
Old-witch grass	Panicum capillare L.
Ovoid spike rush	Eleocharis ovata (Roth.) R. & S.
Ox-eye daisy	Chrysanthemum leucanthemum L.
Ox-tongue	Picris echioides L.
Pennsylvania persicaria	Polygonum pennsylvanicum L.
Penny cress	Thlaspi arvense L.
Peppergrass	Lepidium virginicum L.
Pigweed	Amaranthus retroflexus L.
Pimpernel	Anagallis arvensis L.
Plantain	Plantago major L.
Purslane	Portulaca oleracea L.
Ragweed	Ambrosia artemisiifolia L.
Ribgrass	Plantago lanceolata L.
Rugel's plantain	Plantago rugelii Done.
Sedge	Carex unidentified.
Sheep sorrel	Rumex acetosella L.
Shepherd's purse	Capsella bursa-pastoris (L.) Medic.
Slender crabgrass	Digitaria filiformis (L.) Koeler.
Slender paspalum	Paspalum setaceum Michx.
Spiny sida	Sida spinosa L.
Sprouting crabgrass	Panicum dichotomiflorum Michx.
Spurge	Euphorbia preslii Guss.
Sunflower	Helianthus annuus L.
Tumble-weed	Amaranthus graecizans L.
Virginia three-seeded mercury	Acalypha virginica L.
Wall speedwell	Veronica arvensis L.
White vervain	Verbena urticaefolia L.
Wild buckwheat	Polygonum convolvulus L.
Wild carrot	Daucus carota L.
Wild madder	Galium mollugo L.
Wormseed mustard	Erysimum cherianthoides L.
Yarrow	Achillea millefolium L.
Yellow daisy	Rudbeckia hirta L.
Yellow foxtail	Setaria glauca (L.) Beauv.
Yellow rocket	Barbarea vulgaris R. Br.
Yellow-wood sorrel	Oxalis corniculata L.

Table showing results of examination of samples of seed in 1912.

Names of Weeds.	Kind of Seed and Number of Samples.									
	Red clover.	Alsike clover.	Mammoth clover.	Canadian blue grass.	Timothy.	Redtop.	Kentucky blue grass.	Hungarian.	Millet.	Orchard grass.
Number of samples examined	35	31	1	1	35	12	3	12	7	4
American pennyroyal	1	–	–	–	–	–	–	–	–	–
Apetalous peppergrass	1	–	–	–	–	–	–	–	–	–
Barnyard grass	–	–	–	–	–	–	–	5	–	–
Bird's foot trefoil	6	–	–	–	–	–	–	–	–	–
Black medick	7	23	–	–	1	–	–	–	1	–
Blue field madder	2	–	–	–	–	–	–	–	–	–
Blue vervain	2	–	–	–	2	1	–	1	–	–
Bracted plantain	3	1	–	–	–	–	–	–	–	–
Canada thistle	–	4	–	–	1	–	–	2	–	–
Catnip	1	–	–	–	1	–	–	–	–	–
Cat's ear	–	–	–	–	–	–	–	–	–	1
Charlock	–	–	–	–	–	–	–	–	1	–
Chicory	4	–	–	–	–	–	–	–	–	–
Cinquefoil	–	–	–	–	1	–	–	–	–	–
*Clover dodder	–	–	–	–	–	–	–	–	–	–
Common chickweed	–	2	–	–	–	–	–	–	–	–
Common mallow	1	–	–	–	–	–	–	–	–	–
Common nightshade	–	–	–	–	–	–	–	2	–	–
Common speedwell	–	1	–	–	1	1	–	–	–	–
*Corn mayweed	–	–	–	–	–	–	–	–	–	–
†Corn spurry	–	–	–	–	–	–	–	–	–	–
Crabgrass	1	–	1	–	1	–	–	3	2	–
Crane's bill	2	–	–	–	–	–	–	–	–	–
Dock	18	18	1	–	6	–	–	2	1	2
Evening primrose	–	1	–	–	[illegible]	–	–	–	–	–
Ergot	–	–	–	–	3	10	–	1	–	–
False flax	2	9	–	–	1	–	–	1	–	–
Field peppergrass	2	–	–	–	–	–	–	–	–	–
Five finger	–	9	–	–	24	2	–	–	–	–
Flax dodder	3	–	–	–	–	–	–	–	–	–
Fowl-meadow grass	–	–	–	1	3	–	–	–	–	–
Goosefoot	4	7	–	–	12	–	–		3	–
Green foxtail	13	9	1	–	12	–	–	12	3	–
Heal-all	10	4	–	–	4	–	–	–	–	–
Hedge mustard	–	–	–	–	4	–	1	–	–	–
Knot grass	1	1	–	–	–	–	–	2	–	–
Lady's thumb	2	1	–	–	–	–	–	6	5	–
Mayweed	–	4	–	1	4	–	–	1	–	–

* In lawn mixture. † In white clover.

Table showing results of examination of samples of seed in 1912.—Concluded.

Names of Weeds.	Kind of Seed and Number of Samples.									
	Red clover.	Alsike clover.	Mammoth clover.	Canadian blue grass.	Timothy.	Redtop.	Kentucky blue grass.	Hungarian.	Millet.	Orchard grass.
Mint	–	–	–	–	1	9	–	–	–	–
Moth mullein	–	–	–	–	3	3	–	–	–	–
Mouse-ear chickweed	–	11	–	1	2	4	1	–	–	–
Mustard	1	–	–	–	–	–	–	1	–	–
Night flowering catchfly	3	20	–	–	2	–	–	–	–	–
Old-witch grass	1	2	–	1	13	4	1	4	2	–
Ovoid spike rush	–	–	–	–	2	–	–	–	–	–
Ox-eye daisy	–	1	–	–	–	–	–	–	–	–
Ox-tongue	1	–	–	–	–	–	–	–	–	–
Pennsylvania persicaria	–	–	–	–	–	–	–	1	3	–
†Penny cress	–	–	–	–	–	–	–	–	–	–
Peppergrass	2	8	–	–	25	–	2	–	–	–
Pigweed	–	1	–	–	2	–	–	2	1	–
Pimpernel	1	–	–	–	–	–	–	–	–	–
Plantain	–	4	–	–	2	6	1	–	–	–
Purslane	–	1	–	–	1	–	–	–	–	–
Ragweed	2	–	–	–	–	–	–	6	4	–
Ribgrass	26	9	–	–	3	–	1	1	–	–
Rugel's plantain	13	9	1	–	16	1	–	–	–	–
Sedge	–	5	–	–	21	11	3	–	–	2
Sheep sorrel	3	20	1	–	24	4	1	–	–	2
Shepherd's purse	–	4	–	–	2	–	1	–	–	–
Slender crabgrass	1	1	–	–	–	–	–	4	3	–
Slender paspalum	3	–	–	–	–	–	–	–	–	–
Spiny sida	–	–	–	–	–	–	–	–	1	–
Sprouting crabgrass	1	–	–	–	–	–	–	–	–	–
Spurge	1	–	–	–	–	–	–	–	–	–
‡Sunflower	–	–	–	–	–	–	–	–	–	–
Tumbleweed	–	–	–	–	–	–	–	–	1	–
Virginia three-seeded mercury	1	–	–	–	–	–	–	–	1	–
Wall speedwell	–	–	–	–	1	–	–	–	–	–
White vervain	–	–	–	–	2	–	–	–	–	–
Wild buckwheat	–	–	–	–	–	–	–	–	3	–
Wild carrot	7	–	–	–	–	–	–	–	–	–
Wild madder	1	2	–	–	1	–	–	–	–	–
Wormseed mustard	–	2	–	–	1	–	–	2	1	–
Yarrow	–	–	–	–	9	11	–	–	–	–
Yellow daisy	–	–	–	–	6	3	–	–	–	–
Yellow foxtail	1	–	–	–	–	–	–	11	6	–
Yellow rocket	–	5	–	–	2	–	–	–	–	–
Yellow-wood sorrel	–	–	–	–	1	–	–	–	–	–

† In white clover. ‡ In Alfalfa.

Table showing the kind of seed, name and location of dealer, and the results of analysis of official samples taken in 1912.

Station number.	Kind of Seed, Name and Town of Dealer. Special Marks.	Purity.		Impurities.		
		Guaranteed.	Found.	Inert matter.	Harmless—Foreign.	Noxious—Foreign.
	ALSIKE CLOVER.	%	%	%	%	%
7064	Aroostook Co-operative Co., Presque Isle. Alsike "Hest"	99.0	98 9	0.2	0.7	0.2
7089	P. E. Craig, Ashland. Beat Alsike 20	–	87.9	1.9	8.2	2.0
7086	H. A. Gagnon, Van Buren. Alsike clover, lot 1664	–	91.6	1.9	5.2	1.3
7075	H. W. Greeley Co., Oakland. S. H. & C., Keystone Fancy Alsike	99.5	99.5	0.2	0.2	0.1
7057	Oscar Holway Co., Auburn. Ace Grade Alsike	97.0	96.2	0.8	2.5	0 5
7029	A. A. Howes & Co., Belfast. Export Alsike	98.0	95.9	1 0	2.9	0 2
7035	Judkins & Gilman, Newport. Export Alsike	98.0	93.8	1.9	3.7	0.6
7076	L. N. Littlehale Grain Co., Rockland. Export Alsike	98.0	91.2	2.6	5.7	0.5
7073	Shaw, Hammond & Carney, Portland. B. J. Alsike, No. 187.01	99 0	98.8	0.9	0.3	0.0
7078	Frank S. Wingate, Hallowell. Fancy Alsike W. E. Co	98.0	89.0	1.3	9.1	0.6
	RED CLOVER.					
7062	Aroostook Co-operative Co., Presque Isle. Clover "Moult"	99.0	98 9	0.8	0.2	0.1
7081	Caribou Grange Store, Caribou. Red clover	98.0	98.5	1 2	0.0	0 3
7087	P. E. Craig, Ashland. H. C. N. Y. Red clover	98.0	97 2	1.6	0.4	0.8
7049	E. W. Fernald, Presque Isle. Fancy clover	99.5	99.2	0.6	0.0	0.2
7084	H. A. Gagnon, Van Buren. Red clover	–	95.4	1.9	1.6	1.1
7058	Oscar Holway Co., Auburn. C 92 Red clover	99.0	99.2	0.1	0.1	0.6
7028	A. A. Howes & Co., Belfast. Pan American Red Clover	98.0	95.7	1 6	1.2	1.5
7033	Judkins & Gilman, Newport. Pan American Red Clover	98 0	95.8	1.7	0.9	1.6
7080	Putnam Hardware Co., Houlton. Medium Clover	99 0	97.2	1.5	0.4	0.9

Table showing the kind of seed, name and location of dealer, and the results of analysis of official samples taken in 1912. —Concluded.

Station number.	Kind of Seed, Name and Town of Dealer. Special Marks.	Purity. Guaranteed.	Purity. Found.	Impurities. Inert matter.	Impurities. Harmless—Foreign.	Impurities. Noxious—Foreign.
	HUNGARIAN.					
	Oscar Holway Co., Auburn.					
7060	Hungarian, Lot 80908	96.0	98.9	0.2	0.0	0.9
7061	Hungarian "M"	97.0	98.5	0.6	0.0	0.9
	A. A. Howes & Co., Belfast.					
7026	Hungarian	99.5	98.2	1.3	0.0	0.5
	Judkins & Bilman, Newport.					
7036	Hungarian	99.0	95.1	2.8	0.6	1.5
	Frank S. Wingate, Hallowell.					
7079	Hungarian 81410 & 8838 W. E. Co	99.7	96.5	1.9	0.1	1.5
	REDTOP.					
	Oscar Holway Co., Auburn.					
7059	Pine Tree Redtop	92.0	92.7	6.5	0.2	0.6
	A. A. Howes & Co., Belfast.					
7031	Redtop	95.0	94.2	5.5	0.1	0.2
	Frank S. Wingate, Hallowell.					
7077	Fancy Redtop	96.0	93.3	6.5	0.0	0.2
	TIMOTHY.					
	Aroostook Co-operative Co., Presque Isle.					
7063	Timothy, "Necter"	99.0	99.2	0.5	0.2	0.1
	Caribou Grange Store, Caribou.					
7082	Timothy	99.0	99.0	0.6	0.2	0.2
	P. E. Craig, Ashland.					
7088	Timothy, L38	99.0	99.3	0.3	0.2	0.2
	H. A. Gagnon, Van Buren.					
7085	Timothy, L33	–	99.1	0.5	0.1	0.3
	Oscar Holway Co., Auburn.					
7050	Timothy, Lot No. 62135	99.0	99.2	0.5	0.1	0.2
7051	Bison Timothy, Lot No. 62101	96.0	98.0	0.9	0.6	0.5
7052	Pine Tree Timothy, Lot No. 62011	99.0	99.6	0.2	0.1	0.1
	Oscar Holway Co., Auburn.					
7053	"Gergle" Timothy, Lot No. 62154	96.0	96.3	2.0	1.1	0.6
	A. A. Howes & Co., Belfast.					
7027	Pan American Timothy	99.5	99.3	0.4	0.2	0.1
	Judkins & Gilman, Newport.					
7034	Pan American Timothy	99.5	98.7	0.6	0.3	0.4
	F. J. Parent, Van Buren.					
7083	Timothy, L33	–	99.2	0.5	0.2	0.1
	JAPANESE MILLET.					
	A. A. Howes & Co., Belfast.					
7030	Japanese millet	95.0	92.7	0.3	0.0	7.0

FOOD AND DRUG PROSECUTIONS.

After due hearings it seemed the duty of the executive to bring prosecutions under the law in a number of cases. The following were settled as provided in the law out of court and in most cases before actual proceedings had been commenced. A number of cases are still pending.

List of drug and food cases settled without trial on payment of penalty in the quarter ending December 31, 1912.

Name and Town of Defendant.	Nature of Complaint.
Allen, Calvin W., Est., Brunswick	Adulterated ammonia water. Too strong in gaseous ammonia.
Brewster & Son, E. A., Dexter	Adulterated ammonia water. Too strong in gaseous ammonia.
Chaplin, Charles W., No. Windham	Misbranded butter. Short weight.
Coffin, William, Brunswick	Adulterated clams. Contained excess of free liquids.
Haskell, Chas., Rockland	Adulterated ice cream. Below standard in milk fat.
Jones, Chas. S., Bangor	Adulterated oysters. Contained excess of free liquids.
Jordan, S. S., Scarboro	Misbranded butter. Short weight.
Maine Creamery Assoc., Bangor	Misbranded butter. Short weight.
Portland Creamery, Portland	Misbranded butter. Short weight.
Pride Bros., Portland	Adulterated sweet spirit nitre. Low in ethyl nitrite.
Rondeau Bros., Lewiston	Adulterated Orange Julep. Artificially colored.
Skillin Bros., So. Portland	Adulterated sweet spirit nitre. Low in ethyl nitrite.
Somoar Carbonating Co., Lewiston	Adulterated soda Water. Contained dead fly.
Strout, Chas. P., Gerry	Misbranded butter. Short weight.
Thomas, Philip, Rockland	Adulterated oysters. Contained excess of free liquids.

List of food cases brought in police court, dealer fined and placed on probation for six months, in the quarter ending December 31, 1912.

Name and Town of Defendant.	Nature of Complaint.
Bercovitz, Joseph (Press & Potter), Portland	Exposing foods unprotected.
Branz, Mrs. Jennie, Portland	Exposing foods unprotected.
Dalton, A. (A. Dalton Fruit Co.), Portland	Exposing foods unprotected.

February, 1913.

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Official Inspections

47

FUNGICIDE AND INSECTICIDE INSPECTION.

The law regulating the sale of fungicides and insecticides is new and is only coming to be fully understood. During the year 1912 a large part of the work of inspection has been 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 the year 1912, 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 of the law is amply shown in the results of the first general and imperfect survey. The situation would be discouraging were it not for the fact that it is no worse than was the case with grass seed or feeding stuffs when the laws regulating those commodities were enacted.

Under the law a fungicide includes "any substance or mixture of substances intended to be used for preventing, destroying, repelling or mitigating any and all fungi which may infest vegetation or be present in any environment whatsoever."

The definition of insecticide is equally broad and includes "Paris green, lead arsenate and any substance or mixture of substances intended to be used for preventing, destroying, repelling or mitigating any insect which may infest vegetation, man, or other animals, or houses, or be present in any environment whatsoever."

Comparatively few analyses were made in 1912, but now that the law has been upon the statute books long enough so that people should be familiar with its requirements, more samples will be taken in 1913 and the requirements of the law will be more strictly enforced. With this, as with the other laws of which the Director of the Maine Agricultural Experiment Station is the executive, the attempt has been made to administer it in an educational way. Many abuses were found under the law and its need has been sufficiently demonstrated during the past year. No prosecutions have yet been made, but unless there is marked improvement it is feared that some may have to be brought in 1913.

Arsenical Poisons.

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). It is unfortunate that in the Federal Act the arsenic is stated in two ways: one in the form of arsenious and the other as arsenic oxide, because it makes it difficult to compare the strength of arsenate of lead, for instance, with Paris green from the analysis stated thereon. Inasmuch as the Federal Act requires the statement in the terms of arsenious oxide and arsenic oxide it has been held by the executive of the Maine Insecticide Law that the plainly printed statement of the chemical analysis in these terms conforms to the requirements of the law, although it would have been better if it could have been stated in terms of arsenic. A little more than 75 per cent of arsenious oxide is arsenic, and a little more than 65 per cent of arsenic oxide is arsenic.

Paris Green.

Several samples of Paris green were examined in 1912 and like all of the other greens which we have examined they carried more arsenious oxide than could be combined with the copper present. That is, the total amount of arsenic exceeded in every instance the minimum required under the law. This follows, as pointed out in earlier publications, from the fact that white arsenic is the cheapest ingredient that goes into the makeup of Paris green, and hence the manufacturers will always use as much of it as possible and still have a green of good color.

The injurious effect to foliage resulting from the use of Paris green is due not to the arsenic that is in combination with the copper but the free water soluble arsenic. Under the statute a very liberal amount, equivalent to 3.5 per cent of arsenious oxide, or 2.65 per cent arsenic is permitted in the case of water soluble Paris green.

Ansbacher's Paris Green was full weight, a half pound package carrying 8.1 ounces. Its total arsenic was 42.75 or considerably in excess of the minimum; the arsenic in the water soluble form was 2.86 per cent, or .2 per cent in excess of the maximum allowed by the law.

Herrmann's Hi-Grade Pure Paris Green, made by Morris Herrmann & Co., of Chicago, carried 42.82 per cent of arsenic and 3.14 per cent of arsenic in the water soluble form. It was, therefore, adulterated under the law because it contained too much free arsenic. The goods were full weight, as the half pound package contained 8.4 ounces of Paris green.

The Lion Brand Strictly Pure Paris Green made by the Jas. A. Blanchard Co., of New York, was not registered; was short weight, a pound package carrying 15.1 ounces; and it carried

4.25 per cent of water soluble arsenic and hence would have been a dangerous Paris green to have used on foliage. These goods were shipped out of the State, and no case was made against the man handling them.

Pfeiffer's Strictly Pure Paris Green, manufactured by I. Pfeiffer of New York, was found to be full weight as the pound package carried 16.3 per cent ounces. It was up in total arsenic but it carried 4.65 per cent of water soluble arsenic which is equivalent to 6.15 per cent of soluble arsenious oxide, or nearly double the amount permitted under the law. Because of its high content of water soluble arsenic it is an unsafe green to use on fruit trees or potatoes by itself, but applied with bordeaux mixture or slacked lime it would not burn foliage.

C. T. Reynold's Strictly Pure Paris Green, manufactured by F. W. Devoe & C. T. Reynolds, of New York, was full weight goods, a half pound package carrying 8.1 ounces. They, however, carried 3.24 per cent of arsenic in the water soluble form, equivalent to 4.27 per cent of soluble arsenious oxide. No prosecution was brought for these goods in Maine, but under Insecticide Act Judgment No. 3, issued by the United States Department of Agriculture, this company was fined for selling Paris green adulterated because it contained an excessive amount of water soluble arsenic.

The Sherwin-Williams Strictly Pure Paris Green carried 2.49 per cent of arsenic in the water soluble form and was, therefore, within the maximum permitted under the law. The goods were, however, short weight, as a pound package carried only 15.5 ounces. This short weight seems to have been characteristic of this company's goods. According to Insecticide Act Judgment No. 2, issued by the Department of Agriculture, under date of December 20, 1912, the court condemned 3000 cases of Paris green made by the Sherwin-Williams Company from 4 per cent to 13 per cent short weight.

Arsenate of Lead Paste.

Arsenate of lead paste may carry not more than 50 per cent of water, and not less than 12.5 per cent of arsenic oxide, equivalent to 8 15 per cent of arsenic, and water soluble arsenic equivalent to not more than .75 per cent arsenious oxide, or .49 per cent arsenic.

Grasselli's Arsenate of Lead Paste. A one pound package and a five pound package were examined. The one pound package was full weight, carrying 16.5 ounces. The pastes themselves analyzed very much alike. They carried about ten per cent of arsenic and nearly three times the permitted amount of soluble arsenic, containing 1.28 per cent arsenic soluble in water.

The Orchard Brand Arsenate of Lead, made by the Thomsen Chemical Co., Baltimore, Md., was full weight, a five pound package carrying 89 ounces of lead arsenate. It carried about ten per cent of total arsenic and 1.18, or two and a half times too much water soluble arsenic.

The P. W. R. Lead Arsenate Paste, made by the Powers-Weightman-Rosengarten Co., Philadelphia, was short weight, the one pound package containing 15.4 ounces. It carried about 10 per cent of total arsenic and .92 per cent of arsenic soluble in water, or practically double the amount permitted under the law.

New process Neutral Arsenate of Lead, made by the Sherwin-Williams Company was short weight, the one pound package having 14.2 ounces of lead arsenate. It just barely passed the requirements for the total arsenic, carrying about 8.25 per cent total arsenic. The water soluble arsenic was .51 per cent and practically the same as that permitted under the law.

Swift's Arsenate of Lead, made by the Merrimac Chemical Co., Boston, was full weight, the one pound package containing 17.1 ounces of arsenate of lead. It contained about 10 per cent of total arsenic and .63 per cent water soluble arsenic.

The United States Department of Agriculture maintained successful cases against the Sherwin-Williams Company because of their lead arsenate containing less than the claimed total arsenic, and more than the minimum of the water soluble arsenic. Judgment was also found against the F. W. Devoe & C. T. Reynolds Company of Chicago, Ill., for lead arsenate which was deficient in total arsenic and high in water soluble arsenic.

Miscellaneous Arsenic Materials.

Watson's Soluble Arsenoid distributed by John Watson and Company, Houlton was over weight. The two pound package contained 2.6 pounds of the material. It was guaranteed to carry 40.4 per cent metallic arsenic in soluble form. It actually carried, however, only 37.47 per cent. Because of the overweight, the package actually contained .90 pound metallic arsenic soluble in water. Two pounds of the guaranteed composition would have carried only .81 pounds metallic arsenic.

Orchard Brand Arsenite of Zinc Combined with Atomic Sulphur, made by the Thomsen Chemical Co., Baltimore, Md., was full weight, a five pound package containing 81.4 ounces of the material. According to the label the active ingredients should be, sulphur from 34 to 40 per cent, arsenic of zinc 25 to 30 per cent, soluble arsenic as metallic arsenic .08 to .4 per cent, water 42 to 52 per cent. The sample examined was well within these limits, carrying 40 per cent of water, 8.54 per cent of total arsenic, except that its water soluble arsenic was double the claimed amount, being .98 per cent. The sulphur was 36.6 per cent.

Bowker's Pyrox, made by the Bowker Insecticide Co., Boston, Mass., analysis claimed; lead oxide 17 to 21 per cent, cupric hydroxide 2.55 to 3.55 per cent, arsenic oxide 6.75 to 8.43 per cent. equivalent to metallic arsenic 4.40 to 5.50 per cent, water soluble arsenic none to .40 per cent, essential inert ingredients 61.12 to 69.30 per cent. The sample examined carried 4.98 per cent metallic arsenic and was above the minimum guarantee of 4.4 per cent. The package was full weight, containing 16.3 ounces for one pound.

Cooper's Sheep Dipping Powder, M. R. C. V. S. Chemical Works, Berkhamstead, England. Guaranteed to contain 16.7 per cent of metallic arsenic in water soluble form. On analysis it was found to carry 8.76 per cent of arsenic, equivalent to 36.25 per cent of arsenate of soda. As the goods carried 64 per cent of sulphur there was no possibility of their being as much metallic arsenic as is claimed. There was probably a mistake in calculating the formula in some way. This would probably be an effective powder, but withall a rather dangerous one on account of the large amount of soluble arsenic which it carries.

The I. X. L. Poison Fly Paper, claimed to carry 21.6 grains of arsenate of soda. The sample examined was approximately up to that, carrying 20.37 grains.

Seibert's Poison Fly Paper was guaranteed to contain 5 to 7 per cent metallic arsenic in the form of sodium arsenate. The sample examined carried a trifle over 7 per cent of metallic arsenic in water soluble form.

Rough on Rats, registered because of its claim for a roach exterminator was guaranteed to contain 56 per cent metallic arsenic. The sample examined carried a trifle more than that.

The situation with regards the arsenical poisons is not as good as it should be, and shows full well the need of a law regulating their sale. While there is little trouble from their being deficient in arsenic, there is a large amount of trouble owing to the fact that the arsenic is poorly combined. This is particularly true in the Paris greens.

Although no prosecutions have been made in Maine the present year, dealers must be exceedingly careful in the purchase of arsenical goods that they get from the parties from whom they buy full guarantees that the goods are in conformity with the requirements of the Maine Insecticide law. Otherwise they run great risk of having cases brought against them.

Nearly every arsenic compound, particularly those that are used directly in agriculture, were either short weight or contained too much water soluble arsenic or else were deficient in total arsenic.

Miscellaneous Insecticides and Fungicides.

Something over a hundred samples of fungicides and insecticides were purchased and examined to see if they were seriously different from their claimed composition. The law does not require the disclosure of the formula except as the goods may carry arsenic or inert matter. All of these goods were examined for arsenic, and it is not very readily ascertained what materials might be classed as "inert." A practical experiment with the materials, following directions, is better for that purpose than a chemical, or even microscopical examination. All of the samples were examined for arsenic and were found to be free, or practically free, from that material. Some of them would seem to be of very little value as an insecticide from their general appearance and chemical composition. However, this matter was not tested out, but it is hoped that we will be able to make practical tests following the directions claimed for the various fungicides and insecticides in 1913.

THE FEDERAL LAW.

The Maine law in its requirements is based upon the national law. An insecticide that is in accord with the requirements of the National law and that is registered in Maine can be lawfully sold. The enforcement of the National law which has been well begun will materially aid in the enforcement of the law within this State. The following quoted from the Annual Report of the Insecticide and Fungicide Board of the U. S. Department of Agriculture about publicity under the federal law is encouraging in its bearing upon the sale of insecticides in this in common with other states.

"The advantage of carrying on a campaign of education through which the trade, State officials, and the consuming public might acquire a familiar knowledge of the insecticide law, its purposes, and the methods of its enforcement has not been overlooked. Necessary information has been disseminated throughout the United States by means of form letters to State officials and dealers and by the distribution of copies of the law, regulations issued thereunder, and insecticide decisions, to members of scientific societies, official representatives of foreign countries, and to those directly and indirectly connected with the manufacture and sale of insecticides, Paris greens, lead arsenates, and fungicides. Approximately 65,000 public documents of the character above described have been distributed, while information has been further conveyed through the medium of press notices summarizing insecticide decisions and other matters of general interest. A voluminous correspondence has been conducted with persons who have been sufficiently interested in the law to make special inquiries. From the tenor of the correspondence received at this department and from the oral hearings which have been held it is evident that an overwhelming majority of the manufacturers, jobbers, and dealers of this country desire to conform to the provisions of the act and to accede to the opinions of this department respecting its construction. It is hoped, therefore, that the publication of the opinions and decisions of the department will give to manufacturers the information necessary to enable them to comply with the law and thus avoid litigation."

March, 1913.

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Official Inspections

48

DRUGS

CONTENTS.

INSPECTION OF DRUG STORES AND ANALYSES OF DRUGS.

During the year 1912 practically all of the drug stores of the state were visited and inspected. The reports of these inspections are on file in the office. Almost without exception these reports show that first class sanitary conditions prevail in the drug stores of the State, behind the prescription counters and in the back stores as well as in the front, which is the only part usually seen by the customer. There are, of course, conditions which might be improved in some of these stores, for example, the method of cleansing and washing the glasses at soda fountains is not always the best. Occasionally a benzoate of soda card is not displayed at the fountain, and sometimes shelf bottles containing drugs are found without the percentage of alcohol appearing upon them.

A number of samples of various kinds of drugs were collected and the results of the examination of these samples will be discussed in the following pages.

AMMONIA WATER.

Fourteen samples of Ammonia Water were collected during the latter part of 1912 in various towns of the State. The name "Ammonia Water" is recognized in the United States' Pharmacopœia as a synonym for Aqua Ammoniæ which should contain 10 per cent of gaseous ammonia. Another preparation of Ammonia recognized in the United States Pharmacopœia is called Stronger Ammonia Water, which is a synonym for Aqua Ammoniæ Fortior, and which contains 28 per cent of gaseous ammonia. A great deal of confusion seems to prevail in regard to these two preparations. Some druggists write us that they have practically no call for the weaker, or Ammonia Water, but that nearly all of the ammonia sold is the Stronger Ammonia Water. In some of the cases it develops, too, that not sufficient care is observed in the keeping of Ammonia Water, and as a result it deteriorates by losing Ammonia gas. Although in each case Ammonia Water was called for, in a number of cases Stronger Ammonia Water or something approaching Stronger Ammonia Water was delivered. In two of the cases noted the sample was marked upon the label "Stronger Ammonia" or "Aqua Ammonia Fort," and while these cases were passed neither preparation corresponded to the exact strength of Stronger Ammonia Water which should carry 28 per cent of gaseous Ammonia. Solutions of Ammonia should be kept in a cool place in tightly stoppered containers. One preparation should not be sold for the other, and care should be taken that the preparations are labeled according to the Pharmacopœia name. In the purchase of this as well as of other drugs a written guarantee should be obtained from the dealer, unless the goods are guaranteed under the National Food and Drugs Act and carry a serial number. The table which follows gives the results of the examinations of the samples purchased. Keeping in mind the fact that Ammonia Water should carry 10 per cent of gaseous Ammonia the table is self explanatory.

Table showing results of analyses of Ammonia Water purchased in October and November 1912. Arranged alphabetically by towns.

Station number.	Town and Dealer.	Per cent. gaseous ammonia.	Per cent. U. S. P. standard.	Remarks.
10921	Bridgton. F. P. Bennett	25.67	256.7	"Aqua Ammonia Fort."
10920	Bridgton. Dunn Bros	9.16	91.6	"Aqua Ammonia."
10914	Brunswick. C. W. Allen	25.58	255.8	"Aqua Ammonia." Dealer fined.
10904	Dexter. E. A. Brewster & Son	24.47	244.7	"Aqua Ammonia." Dealer fined.
10917	Foxcroft. E. H. Nickerson	7.01	70.1	"Ammonia water."
10923	Guilford. Genthner Bros	9.18	91.8	"Ammonia water."
10991	Sanford. Demers Bros	25.48	254.8	"Ammonia water."
10992	Sanford. Earle Drug Co., Inc	6.28	62.8	"Ammonia water."
10990	Sanford. E. J. Morin	20.90	209.0	"Stronger ammonia, 28%."
10989	Sanford. W. H. Wood	9.31	93.1	"Ammonia water."
10930	Skowhegan. F. W. Bucknam	3.51	35.1	"Ammonia water."
10932	Skowhegan. Sampson & Avore	25.37	253.7	"Aqua Ammonia."
10974	Waterville. Daviau's Red Cross Pharmacy	8.69	86.9	"Aqua Ammonia, 10%."
10973	Waterville. Larkin Drug Co	7.11	71.1	"Aqua Ammonia."

Hydrogen Peroxide.

Several samples of hydrogen peroxide obtained in various places, including department stores and ten cent stores, have been examined at various times. Practically all of these were found to contain acetanilid, but the presence of that drug was stated upon the labels. So far as examined these various samples appeared to be either in accord with the Pharmacopœia standard, or in accord with the claims made upon the labels. As hydrogen peroxide deteriorates with age only fresh stock should be carried, and it should be kept and dispensed strictly in accord with the recommendations and requirements of the U. S. Pharmacopœia. While all the samples examined have been passed, the public is advised to obtain hydrogen peroxide as also other drugs which rapidly deteriorate only from regular drug stores.

Fowler's Solution.

Several samples of Fowler's Solution were obtained because in other parts of the country drug officials had noted that this preparation was often found not to be in accord with the Pharmacopœia standard. This preparation should contain, according to the Pharmacopœia, one per cent of arsenious oxide. All the samples examined were passed, although two of them ran lower in arsenic than should have been the case. With the exception of these two samples all were as near the standard as a preparation containing such a slight amount of arsenic could reasonably be supposed to run.

Glycerine.

According to reports from some drug officials glycerine sometimes contains arsenic. A number of samples of glycerine were therefore obtained in the various towns of Maine in order to see how the material was dispensed in this State. All samples were tested for arsenic and none was found. The United States Pharmacopœia states that glycerine should have a specific gravity of not less than 1.24 at 25 degrees C. The specific gravity of all the samples obtained was taken, and all were found to run above the standard, and all the samples were passed.

Table showing results of analyses of samples of Fowler's Solution purchased in October and November 1912. Arranged alphabetically by towns.

Station number.	Town and Dealer.	Per cent. arsenious oxide.	Per cent. U. S. P. standard.	Remarks.
10936	Anson. F. A. Manter	0.97	97.0	Passed.
10906	Brunswick. P. J. Meserve	1.10	110.0	Passed.
10908	Brunswick. F. H. Wilson	0.96	96.0	Passed.
10929	Bucksport. R. B. Stover	0.95	95.0	Passed.
10983	Cornish. Geo. H. Parker	1.02	102.0	Passed.
10916	Foxcroft. Cole & Co	0.84	84.0	Passed.
10924	Guilford. Packard & Ross	1.04	104.0	Passed.
11004	Lisbon. P. L. Cotton	1.06	106.0	Passed.
11003	Lisbon Falls. A. N. Beal	0.84	84.0	Passed.
11002	Lisbon Falls. E. H. Webber	0.97	97.0	Passed.
10988	Sanford. M. H. Goodwin	1.01	101.0	Passed.
10960	South Paris. A. E. Shurtleff Co	1.02	102.0	Passed.

Table showing the results of analyses of samples of Glycerine purchased in October and November 1912. Arranged alphabetically by towns.

Station number.	Town and Dealer.	Specific gravity.	Arsenic.	Remarks.
10922	Bridgton. Dr. F. E. Stevens	1.250	None.	Passed.
10907	Brunswick. Drapeau's Pharmacy	1.256	None.	Passed.
10911	Dexter. Davis & Wright	1.254	None.	Passed.
10918	Foxcroft. Wm. Buck & Co	1.250	None.	Passed.
10919	Fryeburg. C. T. Ladd	1.248	None.	Passed.
10935	Madison. H. H. Haynes	1.253	None.	Passed.
10934	Madison. E. W. Wright	1.248	None.	Passed.
10958	Norway. Noyes Drug Store	1.256	None.	Passed.
10957	Norway. F. P. Stone	1.258	None.	Passed.
10970	Pittsfield. Libby's Pharmacy	1.256	None.	Passed.
10931	Skowhegan. Fuller Drug Store, W. G. Lord, Proprietor	1.248	None.	Passed.
10959	South Paris. Chas. H. Howard Co	1.257	None.	Passed.
10961	South Paris. A. E. Shurtleff Co	1.246	None.	Passed.

Spirit of Nitrous Ether.

As would be supposed from past experiences the situation with regard to the Spirit of Nitrous Ether, or Sweet Spirit of Nitre, is perhaps as bad as with any drug dispensed as a medicine. The samples reported in the following table represent, however, unusual conditions in that eight of the twelve were samples which were put up not by the dealer who sold them, but by manufacturers making a business of putting up drugs and extracts, and guaranteeing them under a serial number. Most of these eight were goods which were evidently very old, as indicated either by the carton in which the goods were contained, or information obtained by following up the shipment. Although some of these were found to be seriously below, the standard, the dealers from the samples were taken were found in most cases to be entirely blameless in the matter as the goods were guaranteed and there were no statements on the labels as to when the goods were made or how long they should be kept. Of course, these matters were taken up with the manufacturers, and it is gratifying to note that in each one of these cases either the manufacture of the goods was discontinued, or a plain statement prepared to be placed upon these goods in future stating plainly the date of manufacture, and recommending that they should not be kept or used after a certain date. In two of the cases of goods guaranteed under a serial number it is noted that the dealers were fined. In these cases there were upon the goods plain statements that the goods could not be guaranteed after a certain date. The date of purchase of the samples was long after this, and therefore the manufacturers could not be held responsible and the dealer was clearly at fault.

By taking up these cases in this way a great advance has been made as now probably all of the Sweet Spirit of Nitre placed on the market by wholesalers, and guaranteed under a serial number, carries on the outside of the carton a statement of the date when manufactured and a limiting date after which the goods should not be used.

Preparing and Keeping Sweet Spirit of Nitre.

If spirit of nitrous ether is prepared, kept and dispensed in accord with the following directions that were published in 1908 by the Executive of the Drug Law it will be of perfect strength.

Concentrated nitrous ether. Purchase concentrated nitrous ether from a reliable house. If the label does not carry the U. S. serial number, obtain a written guaranty from the seller as to its strength.

Buy in small sealed packages so that the spirit of nitrous ether made therefrom will under ordinary conditions be sold inside of one month.*

Preparing spirit of nitrous ether. This may be prepared according to the U. S. P. Eighth Edition or may be made from concentrated nitrous ether.

If the latter method is used, follow directions for preparation as given by the manufacturer as regards the proportions of concentrated nitrous ether and alcohol to be used.

Thoroughly chill both the concentrated nitrous ether and the alcohol. Use a towel or other nonconducting material in handling the concentrated nitrous ether container. Do not pour through the air more than absolutely necessary.

Keeping spirit of nitrous ether. Store in small, amber colored, glass bottle, stoppered with tight fitting cork stopper. Do not use a ground glass stopper.

Keep the bottle in a cool place. Room temperature is not cool enough.

Put the date of manufacture on the bottle.

Do not sell after six weeks from preparation without testing strength by assay. If weak bring up to strength by adding concentrated nitrous ether q. s. and put new date on bottle.

Put date of manufacture on bottle given to customer.

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* Concentrated nitrous ether in small-sealed tubes or other packages may be purchased and when added to one pint of alcohol will make a trifle more than one pint of spirit of nitrous ether of U. S. P. strength.

A cautionary statement on the label of the dispensing bottle advising the customer of the volatile nature of sweet spirit of nitre and that it should be kept tightly stoppered in a cool place and not used more than 12 weeks after date of manufacture is advised.

Table showing results of analyses of samples of Spirit of Nitrous Ether (Sweet Spirit of Nitre) purchased in 1912. Arranged alphabetically by towns.

Station number.	Town and Dealer.	Per cent. ethyl nitrite.	Per cent. U. S. P. standard.	Remarks.
10937	Anson. F. A. Manter	4.57	114.25	Passed.
10470	Castine. W. A. Walker	0.51	12.75	Dealer fined.
10453	Newport. L. Buckley	2.31	57.75	Dealer fined.
10952	Portland. Andrew Hawes	2.86	71.50	Guaranteed under serial No. 685.
10947	Portland. Geo. W. Parker & Co.	0.00	00.00	Guaranteed under serial No. 685.
10955	Portland. Pride Bros	0.49	12.20	Guaranteed under serial No 1510. Dealer fined.
10944	South Portland. C. E. Cash	2.09	52.10	Guaranteed under serial No. 56.
10943	South Portland. C. E. Cash	4.11	102.70	Guaranteed under serial No. 1510.
10942	South Portland. G. W. Cash	0.00	00.00	Guaranteed under serial No. 685.
10941	South Portland. M. B. Fuller & Sons	0.01	00.25	Guaranteed under serial No. 685.
10946	South Portland. Skillin Bros	3.11	77.80	Guaranteed under serial No. 1510. Dealer fined.
10509	Winthrop. F. S. Jackson	2.25	56.25	Dealer fined.

Both the spirit and the letter of the Maine Inspection laws demand freedom from adulteration and truthful labeling.

April, 1913.

MAINE
AGRICULTURAL EXPERIMENT STATION
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49

PROTECTION OF FOOD OFFERED FOR SALE.

When the first Food Laws were passed there were in the minds of the people two distinct kinds of abuses to be corrected. One, the adulteration of foods with poisonous, harmful, and deleterious substances, and the other the substitution of inferior materials and the extravagant claims and false statements made upon the labels. One was a fraud against the health, the other against the pocket book of the consumer. Since that time, however, and comparatively recently, a third feature has come to be recognized under the Food Laws, and this is the question of sanitation in connection with the exposure and sale of foods. This third feature is perhaps the most important point which can be considered under the Food Laws of this or any other state. The actual mixing with foods of harmful, deleterious and poisonous substances was comparatively rare and has been practically stopped; the use of extravagant and untruthful statements upon labels has been very much reduced, but unsanitary conditions have been and are a constant source of contamination.

The Requirements of the Law.

In Section 119 of the Public Laws of 1911 will be found the following paragraph: "For the purpose of this act an article shall be deemed to be adulterated, in case of food, if in the manufacture, sale, distribution or transportation, or in the offering or exposing for sale, distribution or transportation, it is not at all times securely protected from filth, flies, dust or other contamination, or other unclean, unhealthful or unsanitary conditions." Rulings under this paragraph have brought about a change in the display of foods during the past eighteen months which is very gratifying to observe. It is, of course, true that violations may still be observed, but a wonderful change has occurred. Foods of various kinds including meat, fruit, berries, cooked foods, confectionery, shelled nuts and others are now being protected in a large proportion of the stores of the State as never before. Foods of various kinds which were formerly displayed upon the sidewalks exposed to all kinds of contamination have been taken within the store and placed in show cases and under glass coverings. This change has been accomplished by patient, persistent effort on the part of the executive, with little trouble. Great credit is due a large number of the dealers of the State who have manifested their appreciation of the necessity of better protection of their public and who have expended in the aggregate thousands of dollars for new show cases and covers.

Natural Protective Coverings of Foods.

In the consideration of the various kinds of food in connection with the paragraph quoted from the law it is noticeable that they fall naturally into three distinct classes which, of course, merge into each other at various points. On the one hand there is that class which includes potatoes, turnips, beets and other vegetables which are always thoroughly washed and cooked before they are eaten. Also in this same class we find certain fruits like bananas and oranges naturally protected by an inedible covering which must be removed before the fruit is eaten. The natural protection of this class of food is apparently sufficient, and such foods may under the law be exposed for sale without further covering. Another class of foods, the direct opposite of this, is that which has already been prepared for eating purposes, is not further cooked or washed, but is taken directly from the store or shop and placed in the mouth. This class includes among others all kinds of bakery products such as bread, cake, pies, doughnuts, cookies, crackers; all kinds of confectionery; sticky fruits such as dates and figs; soft berries like raspberries, blackberries, and strawberries; shelled nuts of various kinds including salted peanuts; popcorn, corn balls, and corn crisp under various names and in various forms; and other kinds of food, which should be protected adequately from all contamination when they are offered or exposed for sale. Between these two classes there is another intermediate class which has a natural skin or protection which should be either removed or thoroughly washed before the food is taken into the mouth. In this class are such fruits as grapes, apples, pears, and plums which should never be eaten as they come from the store as the smooth and comparatively solid skin makes it easy for them to be prepared either by thorough washing or by removal of the skin. Until further notice, therefore, this middle class will not be required to be covered by glass or protected otherwise than by a mosquito bar or netting which should be raised sufficiently above the food so that flies cannot obtain access through the meshes.

Cooking After Purchase Reduces Danger.

In the consideration of these different classes of foods the reader will bear in mind that in actual danger to the consumer there is a great difference between the foods which are already cooked and prepared for eating purposes, and those which after purchase must be thoroughly cooked. For example, the dried fruits like prunes, apricots and apples for aesthetic reasons as well as those which involve real danger should be protected in some way from possible contamination. At the same time it may be borne in mind that these foods are never eaten as they are purchased but they are always thoroughly cooked, and that this thorough cooking, of course, usually destroys the vitality of any disease germs which may be present. This is also in the main true of the cuts of meat which may be exposed. While the exposure of cuts of meats in the markets of the State is filthy, and disgusting still the actual danger to be encountered in the meat is practically negligible when compared to a loaf of bread exposed without protection.

Why Such a Law is Necessary.

Some of the reasons for this paragraph on sanitation in the law and the regulations under this paragraph are here explained. There are three particular reasons why a law protecting food materials from exposure is essential to public health. They are The Fly, Dust of Streets, and Man Himself.

THE DANGEROUS FLY.

The fly long considered a nuisance has now come to be recognized as the most dangerous animal with which we come in contact. Breeding only in filth and excreta, obtaining its living alike from this filth and from foods intended for man, dividing its time, if not prevented, between the garbage can, the horse stable, the privy box, the milk pitcher, the sugar bowl, fruits, confectionery, and other foods which may be exposed unprotected, it has been demonstrated for a fact that the fly in the capacity of a disease carrier causes more suffering than any other one factor with which the physician has to contend, and more deaths than war.

The house fly is the one great factor in the spread of typhoid fever and may also at times carry tuberculosis, cholera, dysentery and summer complaint. When we realize that one single fly can carry upon its body millions of bacteria any one of which may be capable of causing disease the importance of keeping all foods covered and protected from flies becomes at once apparent. These statements are not the result of imagination or theory, but of facts demonstrated beyond the possibility of a doubt. Example after example can be found in the records of the medical profession and the Boards of Health where epidemics of typhoid fever have been traced directly to the spread of the disease by flies. Only a few years ago an epidemic in Colorado in which fifty-five cases of typhoid fever occurred, causing three deaths, resulted beyond a doubt from a milk supply which was contaminated by germs conveyed from an open vault to milk by flies. Only last year in Newark, Deleware a severe epidemic of the same disease occurred which, according to the physicians and bacteriologists who studied the situation, was spread directly by the flies. Only recently it has been demonstrated that the stable fly which looks very much like the house fly is one of the important factors in the spread of infantile paralysis.

DISEASE LADEN DUST.

A second important reason for the covering of foods is the fact that the dust of the streets of our cities and towns is dangerous. The composition of numerous samples of street dust has been studied and it has been found that this dust is made up of a great variety of materials. Ordinarily it comprises particles of sand, bits of straw, hairs, threads of wool and cotton, soot, decaying animal and vegetable matter, finely powdered horse manure, sputum from human beings, in which are recognized the germs responsible for tuberculosis, pneumonia, influenza and other infectious diseases. Plaster, stone dust, cement, dirt from excavations, ashes, house sweepings, dried garbage, chimney soot, cinders, and almost every imaginable kind of material that can be ground into a fine powder. Not only is the dust dangerous because of the pathogenic bacteria which are nearly always present, but because of the additional fact that the dust itself being composed of fine irregular, jagged particles is a severe irritant to the membranes of the mouth, nose and throat, and may of itself produce inflammatory conditions which are not only disagreeable in themselves, but which predispose these delicate tissues to the attacks of dangerous disease germs. While the organisms responsible for various diseases cannot as a rule long survive the drying out process which the dust undergoes it has been demonstrated that the germs of tuberculosis can live for a long time under very adverse conditions, and as a consequence the germs of this most dangerous disease are nearly always present in the dust of the city streets. Foods displayed upon the sidewalks or even in the store unprotected are unavoidably receiving the dust which blows in clouds with the almost constant winds or as it is shifted about by the draughts of opening doors and windows and the moving of crowds.

DISEASE LADEN BREATH AND DIRTY HANDS.

Perhaps the most important reason of all for the protection of food is not the possibility of contamination through the flies and the dust, but through human beings. It is a disagreeable fact that people cannot talk or laugh without spraying from their mouths fine particles of sputum. These fine particles float in the air and fall upon the foods which may be openly displayed. If the person in question happens to be suffering from any form of throat or lung affection ranging in severity from a slight cold to tuberculosis the germs of these diseases are spread broadcast over whatever may be in the vicinity. Physicians state that the germs of diphtheria are sometimes retained in the throats of patients for several weeks after apparent complete recovery. The danger from "typhoid carriers" is now too well known to necessitate further discussion of that subject in this connection. Of course it can never be demonstrated how large a proportion of the epidemics of colds, "grippes," tonsilitis, diphtheria and such diseases have been brought about just exactly through these means. That such epidemics are spread in this way, however, is a fact beyond dispute. Aside from the contamination through the spray from the mouths of people suffering from diseases the exposure of foods unprotected is likely to lead to the handling of these foods by shoppers and prospective customers. An investigation a short time ago revealed the astonishing fact that out of every hundred people taken at random in towns and cities, upon the hands of from five to ten would be found the colon bacillus. Now this organism may not of itself be harmful, but its source is the intestines of man and other animals, particularly man. Its presence upon the hands indicates fecal matter. It can be there from no other source. This investigation demonstrated the difficulty of keeping the hands absolutely clean, and further the importance of protecting food from the possibility of handling by customers. Such diseases as typhoid fever are spread only from contamination through fecal matter. Other diseases may be spread by the same means. The practice of handling various cuts of meat in the market, to determine their quality, the handling of bread in the bakery and the store in order to ascertain its freshness, the habit of sampling candy, salted peanuts, crackers, etc., becomes disgusting in the light of the facts revealed in this investigation. It is not only disgusting, but it is absolutely dangerous to public health. A short time ago in one of the five and ten cent stores in the State a man was observed wetting his finger in his mouth, placing his finger in the salted peanuts there exposed, and withdrawing those which stuck to the finger and eating them. The salted peanuts which did not receive enough sputum to stick to the finger, of course, were left for the next person to eat. The reader is asked to consider whether or not he would prefer to have the foods of this description which he buys in the future protected from the possibility of such a custom. At a food sale held in connection with a church fair not long ago bread, cakes, pies, cookies, doughnuts, candy, popcorn, etc., were placed upon tables in a crowded room with no protection whatever. People brushed against the food, handled it with their hands, talked, laughed, and coughed over it, and it was finally purchased and eaten among the various families in the town. As stated above it is unfortunate that it can never be known to what extent diseases are spread by these means. That they are spread in these ways is beyond dispute.

Most Dealers are Ready to Coöperate.

It is a pleasure to be able to say that almost everyone dealing in foods who is approached on this subject is ready and indeed glad to comply with the requirements for protection from every possible unsanitary condition. There are occasionally people who persist in violation, and even prosecutions may at times be necessary in order to bring about the desired changes. These changes and improvements, while apparently being occasioned by the requirements of the law, are really being brought about by a growing public sentiment occasioned by increasing knowledge, and which is in fact responsible for the passage of the law. It is not difficult to see that within a comparatively short time food which is prepared or exposed for sale under unsanitary conditions will be rare within the State. The shop-keeper who protects his food from possible contamination will not do so alone because the law requires it, but because the public demands it and will not buy his food unless it is protected.

Important Suggestions.

The sanitation paragraph of the Food Law states that foods are adulterated if they are not at all times securely protected from unsanitary conditions. The law does not state how this protection shall be brought about. Neither has it been thought best to make any rulings as to the exact methods for the protection of the various kinds of foods. The following suggestions, however, are given for those who care to be advised and are important both for the dealer and the consumer.

All foods of whatever class or kind should if displayed outside the store be raised a sufficient distance from the sidewalk so that there will be no possibility of contamination from dogs.

Foods of various kinds which have a natural protection or which from their nature must be washed, pared, and thoroughly cooked before being eaten are thereby already protected from unsanitary conditions, and need not be further protected by any artificial means. Examples of this class are bananas, oranges, lemons, potatoes, beets, turnips, nuts in the shell, cucumbers, etc.

A class of foods the direct opposite of the above should at all times be thoroughly protected by artificial means. This class includes, as examples, confectionery, sticky fruits like figs and dates, bakery products such as bread, cakes, pies, doughnuts, cookies, etc., shelled nuts, popcorn, corncakes, corn balls, all dairy products such as cheese, butter, milk and cream; and the most adequate protection of this class of food that occurs to the executive is by the use of glass cases. Such cases may be properly ventilated, or if necessary they may be refrigerated, but the protection should be absolute against the entrance of flies, dust, and any other possible contamination by dangerous disease germs.

Another class of foods already discussed, which lies midway between the last two, consists in the main of such materials as apples, pears, plums, peaches, grapes, etc., which have a natural skin or covering which is easily removed and which should be either removed or thoroughly washed before the food is eaten. Such foods may until further notice be exposed for sale without covering other than a good quality mosquito bar or netting which should be raised sufficiently above the food so that flies can have no access through the meshes.

May, 1913.

MAINE
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Official Inspections

50

FEEDING STUFF INSPECTION.

In reporting the results of the inspection and examination of feeding stuffs for the fall, winter, and spring of 1912 and 1913 but little comment is necessary. The results of the analyses of samples taken are given in the following pages. The samples include those taken by the regular inspectors, also those sent to the Station by dealers and consumers. Protein was determined in all these samples. A complete analysis was made of at least one sample of every brand if an official sample was available. A complete analysis was not made of samples sent by correspondents.

It is a matter for gratification that almost without exception the dealers of the State are working in hearty coöperation with the efforts of this Station to improve the feeding stuffs situation in Maine. New brands of feeding stuffs coming into the State are almost immediately referred to the Station for examination. Almost every shipment of concentrated feeding stuffs coming into this State is also immediately sampled and referred to the Station. This has resulted in a great improvement in the quality of the feeds which are sent to Maine.

Occasionally brands of unregistered feeding stuffs are found on sale in the State. This usually comes about because salesmen offer their goods to the local dealers thinking that the companies they represent have already taken care of the requirements of the law. The local dealers do not at times give sufficient attention to the requirements for written guarantees to protect themselves in this respect, and it therefore sometimes happens that they unintentionally violate the law in this respect. Usually such brands are promptly registered by the manufacturers or shippers upon our calling their attention to the oversight. Dealers should always ascertain before purchase whether or not the brands offered for sale are registered in Maine, and a written guaranty should be obtained stating that the feeding stuffs in question conforms in all respects to the requirements of the Maine Feeding Stuffs Law. On the receipt of every new shipment of goods the dealer should take a sample according to directions which are furnished by the Station, and send at once for analysis.

During the past season there have been several occasions to refer the consideration of low grade goods to the Federal Board of Food and Drug Inspection for investigation under the National Law. Whenever a lot of goods which do not come up to the guarantees is found an official sample is obtained if possible together with papers to prove the interstate shipment. The results of the examination and these papers are at once referred to the Board of Food and Drug Inspection, and if the Board deems this important a case is commenced against the shipper. During the last season a number of cases, particularly of low grade cottonseed meal, have thus been referred to the authorities acting under the National Law.

Chief Requirements of Feeding Stuff Law.

Kinds of feeding stuffs coming under the law. The law applies to the sale, distribution, transportation, or the offering or exposing for sale, distribution, or transportation of all articles of food used for feeding live stock and poultry, except hays and straws, the whole seeds, and the unmixed meals made directly from the entire grains of wheat, rye, barley, oats, Indian corn, buckwheat, flax seed and broom corn.

The offals from the milling of wheat and the mixed meals, chops, etc., made by grinding two or more kinds of whole grains together come under the requirements of the law.

The Brand. Every lot or package shall be plainly marked with:

The number of net pounds in the package.

The name, brand or trademark under which the article is sold.

The name and principal address of the manufacturer or shipper.

The maximum percentage of crude fiber.

The minimum percentage of crude fat.

The minimum percentage of crude protein.

If the feeding stuff is a compound feed the name of each ingredient contained therein.

If artificially colored, the name of the material used for that purpose.

If the feeding stuff is sold in bulk or put up in packages belonging to the purchaser, the seller, upon the request of the purchaser, shall furnish him with a copy of the statements named above.

All of the foregoing make up the brand and any difference in statement constitutes a distinct brand.

Manufacturer's certificate. Before manufacturing, selling or distributing, a certified copy of the statements named shall be filed with the Director of the Maine Agricultural Experiment Station.

Registration fee. A registration fee of $10.00 is assessed on any brand offered for sale, distribution or transportation in the State. If the sales of a brand be less than 50 tons, the feeding stuff may be reregistered without payment of fee. The filing of the certificate and the payment of the fee is required of only one person for a given brand.

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
COTTONSEED MEALS.		
American Cotton Oil Co.,		
New York City.		
Choice Cottonseed Meal	D	4344
	D	4345
Blakeslee, Harry J.,		
Little Rock, Ark.		
Old Reliable Cottonseed Meal	O	4612
	O	4838
Brode & Co., F. W.,		
Memphis, Tenn.		
Cub Brand Cottonseed Meal	D	4423
Brode & Co., F. W.,		
Memphis, Tenn.		
Dove Brand Cottonseed Meal	D	4300
	D	4303
	D	4304
	D	4329
	D	4333
	D	4357
	D	4365
	D	4402
	D	4407
	D	4409
	D	4420
	D	4428
	D	4429
	D	4433
	D	4440
	D	4456
	D	4560
	D	4630
	D	4667
	D	4688
	D	4693
	D	4766
	D	4767
	O	4810
	D	4858
Brode & Co., F. W.,		
Memphis, Tenn.		
Owl Brand High Grade Cottonseed Meal	D	4309
	D	4324
	O	4326
	D	4332
	D	4336
	D	4340
	D	4341
	D	4342
	D	4348
	D	4350
	D	4353
	D	4355
	D	4356
	D	4359
	D	4367

* Samples marked D are from dealer and those marked O were taken by the inspector.

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4344	–	–	40.50	41.00	–	9.00	–	10.50	–	0
4345	–	–	40.75	41.00	–	9.00	–	10.50	–	0
4612	8.07	6.43	40.81	41.00	7.25	6.00	11.16	10.50	26.28	0
4838	–	–	41.93	41.00	–	6.00	–	10.50	–	0
4423	–	–	41.43	40.00	–	6.00	–	10.00	–	0
4300	–	–	40.18	38.63	–	6.00	–	10.00	–	0
4303	–	–	38.99	38.63	–	6.00	–	10.00	–	0
4304	–	–	40.75	38.63	–	6.00	–	10.00	–	0
4329	–	–	38.93	38.63	–	6.00	–	10.00	–	0
4333	–	–	39.37	38.63	–	6.00	–	10.00	–	0
4357	–	–	39.37	38.63	–	6.00	–	10.00	–	0
4365	–	–	40.00	38.63	–	6.00	–	10.00	–	0
4402	–	–	39.12	38.63	–	6.00	–	10.00	–	0
4407	–	–	38.31	38.63	–	6.00	–	10.00	–	0
4409	–	–	38.12	38.63	–	6.00	–	10.00	–	0
4420	–	–	35.93	38.63	–	6.00	–	10.00	–	0
4428	–	–	39.25	38.63	–	6.00	–	10.00	–	0
4429	–	–	38.93	38.63	–	6.00	–	10.00	–	0
4433	–	–	38.93	38.63	–	6.00	–	10.00	–	0
4440	–	–	40.43	38.63	–	6.00	–	10.00	–	0
4456	–	–	41.37	38.63	–	6.00	–	10.00	–	0
4560	–	–	38.01	38.63	–	6.00	–	10.00	–	0
4630	–	–	38.84	38.63	–	6.00	–	10.00	–	0
4667	–	–	38.75	38.63	–	6.00	–	10.00	–	0
4688	–	–	39.34	38.63	–	6.00	–	10.00	–	0
4693	–	–	38.65	38.63	–	6.00	–	10.00	–	0
4766	–	–	37.37	38.63	–	6.00	–	10.00	–	0
4767	–	–	38.06	38.63	–	6.00	–	10.00	–	0
4810	6.22	6.64	39.12	38.63	7.20	6.00	11.90	10.00	28.92	0
4858	–	–	39.37	38.63	–	6.00	–	10.00	–	0
4309	–	–	43.62	41.00	–	6.00	–	10.00	–	0
4324	–	–	39.00	41.00	–	6.00	–	10.00	–	0
4326	–	–	41.50	41.00	–	6.00	–	10.00	–	0
4332	–	–	44.12	41.00	–	6.00	–	10.00	–	0
4336	–	–	39.62	41.00	–	6.00	–	10.00	–	0
4340	–	–	42.32	41.00	–	6.00	–	10.00	–	0
4341	–	–	39.87	41.00	–	6.00	–	10.00	–	0
4342	–	–	42.00	41.00	–	6.00	–	10.00	–	0
4348	–	–	41.56	41.00	–	6.00	–	10.00	–	0
4350	–	–	41.56	41.00	–	6.00	–	10.00	–	0
4353	–	–	42.32	41.00	–	6.00	–	10.00	–	0
4355	–	–	42.06	41.00	–	6.00	–	10.00	–	0
4356	–	–	43.62	41.00	–	6.00	–	10.00	–	0
4359	–	–	44.81	41.00	–	6.00	–	10.00	–	0
4367	–	–	40.13	41.00	–	6.00	–	10.00	–	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

MANUFACTURER OR SHIPPER AND BRAND.	*Source of sample.	Station number.
Owl Brand High Grade Cottonseed Meal	D	4372
	D	4383
	D	4425
	D	4427
	D	4432
	D	4434
	D	4435
	D	4441
	D	4454
	D	4455
	D	4466
	D	4467
	D	4472
	D	4473
	D	4474
	D	4476
	D	4479
	O	4495
	O	4503
	O	4509
	O	4541
	O	4545
	D	4595
	O	4605
	D	4621
	O	4632
	O	4640
	O	4648
	O	4649
	O	4650
	D	4659
	D	4660
	D	4669
	D	4670
	D	4672
	D	4675
	D	4677
	D	4684
	D	4685
	D	4686
	D	4687
	D	4689
	D	4696
	D	4697
	D	4698
	D	4699
	O	4704
	O	4737
	D	4751
	D	4752
	O	4768
	O	4785
	O	4789
	O	4799
	D	4802
	D	4805
	D	4807
	D	4843
	D	4846
	D	4850
	D	4852
	D	4854
	D	4857
	D	4860
	O	4886

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4372	–	–	42.32	41.00	–	6.00	–	10.00	–	0
4383	–	–	41.25	41.00	–	6.00	–	10.00	–	0
4425	–	–	43.56	41.00	–	6.00	–	10.00	–	0
4427	–	–	38.75	41.00	–	6.00	–	10.00	–	0
4432	–	–	42.18	41.00	–	6.00	–	10.00	–	0
4434	–	–	39.5	41.00	–	6.00	–	10.00	–	0
4435	–	–	39.81	41.00	–	6.00	–	10.00	–	0
4441	–	–	40.23	41.00	–	6.00	–	10.00	–	0
4454	–	–	40.87	41.00	–	6.00	–	10.00	–	0
4455	–	–	43.43	41.00	–	6.00	–	10.00	–	0
4466	–	–	42.12	41.00	–	6.00	–	10.00	–	0
4467	–	–	42.93	41.00	–	6.00	–	10.00	–	0
4472	–	–	41.43	41.00	–	6.00	–	10.00	–	0
4473	–	–	40.87	41.00	–	6.00	–	22.00	–	0
4474	–	–	41.43	41.00	–	6.00	–	22.00	–	0
4476	–	–	43.09	41.00	–	6.00	–	10.00	–	0
4479	–	–	40.31	41.00	–	6.00	–	10.00	–	0
4495	–	–	40.18	41.00	–	6.00	–	10.00	–	0
4503	7.44	7.69	43.37	41.00	9.35	6.00	8.85	10.00	23.60	0
4509	–	–	40.56	41.00	–	6.00	–	10.00	–	0
4541	–	–	39.84	41.00	–	6.00	–	10.00	–	0
4545	–	–	41.38	41.00	–	6.00	–	10.00	–	0
4595	–	–	39.57	41.00	–	6.00	–	10.00	–	0
4605	–	–	41.03	41.00	–	6.00	–	10.00	–	0
4621	–	–	39.90	41.00	–	6.00	–	10.00	–	0
4632	–	–	40.72	41.00	–	6.00	–	10.00	–	0
4640	–	–	41.13	41.00	–	6.00	–	10.00	–	0
4648	–	–	41.64	41.00	–	6.00	–	10.00	–	0
4649	–	–	41.06	41.00	–	6.00	–	10.00	–	0
4650	–	–	41.02	41.00	–	6.00	–	10.00	–	0
4659	–	–	41.43	41.00	–	6.00	–	10.00	–	0
4660	–	–	39.43	41.00	–	6.00	–	10.00	–	0
4669	–	–	42.03	41.00	–	6.00	–	10.00	–	0
4670	–	–	38.87	41.00	–	6.00	–	10.00	–	0
4672	–	–	39.15	41.00	–	6.00	–	10.00	–	0
4675	–	–	39.84	41.00	–	6.00	–	10.00	–	0
4677	–	–	42.37	41.00	–	6.00	–	10.00	–	0
4684	–	–	41.34	41.00	–	6.00	–	10.00	–	0
4685	–	–	41.25	41.00	–	6.00	–	10.00	–	0
4686	–	–	39.52	41.00	–	6.00	–	10.00	–	0
4687	–	–	39.90	41.00	–	6.00	–	10.00	–	0
4689	–	–	41.21	41.00	–	6.00	–	10.00	–	0
4696	–	–	41.31	41.00	–	6.00	–	10.00	–	0
4697	–	–	41.09	41.00	–	6.00	–	10.00	–	0
4698	–	–	44.18	41.00	–	6.00	–	10.00	–	0
4699	–	–	41.03	41.00	–	6.00	–	10.00	–	0
4704	–	–	40.56	41.00	–	6.00	–	10.00	–	0
4737	–	–	41.18	41.00	–	6.00	–	10.00	–	0
4751	–	–	41.06	41.00	–	6.00	–	10.00	–	0
4752	–	–	40.94	41.00	–	6.00	–	10.00	–	0
4768	–	–	38.31	41.00	–	6.00	–	10.00	–	0
4785	–	–	42.06	41.00	–	6.00	–	10.00	–	0
4789	–	–	40.56	41.00	–	6.00	–	10.00	–	0
4799	–	–	41.06	41.00	–	6.00	–	10.00	–	0
4802	–	–	41.56	41.00	–	6.00	–	10.00	–	0
4805	–	–	41.81	41.00	–	6.00	–	10.00	–	0
4807	–	–	41.56	41.00	–	6.00	–	10.00	–	0
4843	–	–	41.31	41.00	–	6.00	–	10.00	–	0
4846	–	–	41.12	41.00	–	6.00	–	10.00	–	0
4850	–	–	36.69	41.00	–	6.00	–	10.00	–	0
4852	–	–	43.81	41.00	–	6.00	–	10.00	–	0
4854	–	–	39.81	41.00	–	6.00	–	10.00	–	0
4857	–	–	38.93	41.00	–	6.00	–	10.00	–	0
4860	–	–	42.74	41.00	–	6.00	–	10.00	–	0
4886	9.58	6.32	33.31	41.00	6.72	6.00	13.27	10.00	30.80	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Buckeye Cotton Oil Co.,		
Cincinnati, O.		
Buckeye Prime Cottonseed Meal..	D	4315
	D	4318
	D	4319
	D	4364
	D	4369
	D	4375
	D	4378
	D	4380
	D	4382
	D	4390
	D	4391
	D	4411
	D	4412
	D	4431
	D	4439
	O	4445
	D	4452
	D	4453
	D	4457
	D	4480
	D	4483
	O	4496
	D	4505
	D	4506
	O	4508
	O	4515
	D	4529
	D	4530
	D	4543
	D	4553
	D	4554
	D	4557
	D	4559
	O	4569
	O	4577
	D	4593
	O	4596
	O	4598
	O	4603
	O	4608
	O	4615
	O	4617
	O	4618
	O	4622
	O	4661
	D	4662
	D	4666
	D	4676
	O	4682
	O	4683
	O	4695
	D	4750
	O	4753
	O	4759
	O	4820
	O	4825
	D	4847
	D	4853
Bunch Commission Co., T. H.,		
Little Rock, Ark.		
Old Gold Cottonseed Meal.	D	4292
	D	4405

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4315	–	–	39.37	38.50	–	6.50	–	10.00	–	0
4318	–	–	40.62	38.50	–	6.50	–	10.00	–	0
4319	–	–	40.87	38.50	–	6.50	–	10.00	–	0
4364	–	–	41.37	38.50	–	6.50	–	10.00	–	0
4369	–	–	39.25	38.50	–	6.50	–	10.00	–	0
4375	–	–	38.87	38.50	–	6.50	–	10.00	–	0
4378	–	–	40.18	38.50	–	6.50	–	10.00	–	0
4380	–	–	40.81	38.50	–	6.50	–	10.00	–	0
4382	–	–	40.00	38.50	–	6.50	–	10.00	–	0
4390	–	–	37.70	38.50	–	6.50	–	10.00	–	0
4391	–	–	39.62	38.50	–	6.50	–	10.00	–	0
4411	–	–	38.12	38.50	–	6.50	–	10.00	–	0
4412	–	–	39.37	38.50	–	6.50	–	10.00	–	0
4431	–	–	40.5	28.50	–	6.50	–	10.00	–	0
4439	–	–	40.31	38.50	–	6.50	–	10.00	–	0
4445	–	–	35.12	38.50	–	6.50	–	10.00	–	0
4452	–	–	40.37	38.50	–	6.50	–	10.00	–	0
4453	–	–	38.93	38.50	–	6.50	–	10.00	–	0
4457	–	–	41.56	38.50	–	6.50	–	10.00	–	0
4480	–	–	38.93	38.50	–	6.50	–	10.00	–	0
4483	–	–	38.43	38.50	–	6.50	–	12.00	–	0
4496	–	–	41.25	38.00	–	6.00	–	10.00	–	0
4505	–	–	37.62	38.50	–	6.50	–	12.00	–	0
4506	–	–	39.81	38.50	–	6.50	–	10.00	–	0
4508	–	–	39.43	39.00	–	6.50	–	10.00	–	0
4515	7.36	6.71	39.68	38.50	7.88	6.50	13.04	10.00	25.33	0
4529	–	–	37.00	38.50	–	6.50	–	12.00	–	0
4530	–	–	36.94	38.50	–	6.50	–	12.00	–	0
4543	–	–	39.5	38.50	–	6.50	–	12.00	–	0
4553	–	–	39.27	38.50	–	6.50	–	12.00	–	0
4554	–	–	39.06	39.00	–	6.50	–	10.00	–	0
4557	–	–	39.94	38.50	–	6.50	–	12.00	–	0
4559	–	–	40.71	39.00	–	6.50	–	10.00	–	0
4569	–	–	40.59	39.00	–	6.50	–	8.00	–	0
4577	–	–	40.59	39.00	–	6.50	–	10.00	–	0
4593	–	–	39.00	38.50	–	6.50	–	10.00	–	0
4596	8.34	6.07	36.56	38.50	7.26	6.50	13.25	10.00	28.59	0
4598	–	–	37.75	38.50	–	6.50	–	12.00	–	0
4603	–	–	39.75	39.00	–	6.50	–	10.00	–	0
4608	–	–	40.81	39.00	–	6.50	–	10.00	–	0
4615	–	–	40.52	39.00	–	6.50	–	10.00	–	0
4617	–	–	41.15	39.00	–	6.50	–	10.00	–	0
4618	–	–	40.62	39.00	–	6.50	–	10.00	–	0
4622	–	–	40.40	38.50	–	6.50	–	12.00	–	0
4661	–	–	36.90	38.50	–	6.50	–	12.00	–	0
4662	–	–	38.44	38.50	–	6.50	–	10.00	–	0
4666	–	–	37.93	38.50	–	6.50	–	10.00	–	0
4676	–	–	39.12	39.00	–	6.50	–	8.00	–	0
4682	–	–	37.56	38.50	–	6.50	–	10.00	–	0
4683	–	–	37.62	38.50	–	6.50	–	12.00	–	0
4695	–	–	36.38	38.50	–	6.50	–	10.00	–	0
4750	–	–	38.56	38.50	–	6.50	–	10.00	–	0
4753	–	–	37.47	38.50	–	6.50	–	10.00	–	0
4759	–	–	43.21	39.00	–	6.50	–	8.00	–	0
4820	–	–	38.68	38.50	–	6.50	–	12.00	–	0
4825	–	–	37.42	39.00	–	6.50	–	10.00	–	0
4847	–	–	39.81	39.00	–	6.50	–	10.00	–	0
4853	–	–	39.24	38.50	–	6.50	–	10.00	–	0
4292	–	–	41.00	41.00	–	9.00	–	9.00	–	0
4405	–	–	42.12	41.00	–	9.00	–	9.00	–	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
	D	4475
Old Gold Cottonseed Meal	O	4502
	D	4523
	D	4526
	O	4535
	O	4539
	O	4635
	D	4653
	D	4654
	D	4668
	D	4755
	D	4848
Bunch Commission Co., T. H.,		
Little Rock, Ark.		
Acme Brand Pure Cottonseed Meal	O	4573
	O	4645
	D	4757
Chapin & Co.,		
Hammond, Ind.		
Green Diamond Brand Cottonseed Meal	O	4626
Davis, S. P.,		
Little Rock, Ark.		
Good Luck Brand Cottonseed Meal	D	4307
	D	4334
	D	4338
	D	4354
	D	4387
Humphreys-Godwin Co.,		
Memphis, Tenn.		
Dixie Brand Cottonseed Meal	D	4302
	D	4320
	D	4328
	D	4331
	D	4337
	D	4343
	D	4347
	D	4358
	D	4362
	D	4370
	D	4373
	D	4374
	O	4379
	D	4381
	D	4384
	D	4385
	D	4388
	D	4389
	D	4392
	D	4393
	D	4394
	D	4396
	D	4397
	D	4398
	D	4399
	D	4400
	D	4403
	D	4404
	D	4413
	D	4414
	D	4415

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4475	–	–	42.27	41.00	–	9.00	–	9.00	–	0
4502	7.02	6.65	43.12	41.00	7.50	9.00	10.57	9.00	25.14	0
4523	–	–	42.5	41.00	–	9.00	–	9.00	–	0
4526	–	–	40.68	41.00	–	9.00	–	9.00	–	0
4535	–	–	44.52	41.00	–	9.00	–	9.00	–	0
4539	–	–	44.59	41.00	–	9.00	–	9.00	–	0
4635	–	–	41.34	41.00	–	9.00	–	9.00	–	0
4653	–	–	41.00	41.00	–	9.00	–	9.00	–	0
4654	–	–	41.03	41.00	–	9.00	–	9.00	–	0
4668	–	–	40.66	41.00	–	9.00	–	9.00	–	0
4755	–	–	44.06	41.00	–	9.00	–	9.00	–	0
4848	–	–	45.18	41.00	–	6.00	–	10.00	–	0
4573	7.92	6.17	38.10	38.60	7.44	7.00	13.24	12.00	27.13	0
4645	–	–	40.06	38.60	–	7.00	–	12.00	–	0
4757	–	–	39.31	38.60	–	7.00	–	8.00	–	0
4626	7.89	6.86	41.43	41.00	8.33	8.00	10.00	10.00	25.46	0
4307	–	–	43.56	41.00	–	7.00	–	10.50	–	0
4334	–	–	41.62	41.00	–	7.00	–	10.50	–	0
4338	–	–	43.25	41.00	–	7.00	–	10.50	–	0
4354	–	–	41.25	41.00	–	7.00	–	10.50	–	0
4387	–	–	41.12	41.00	–	7.00	–	10.50	–	0
4302	–	–	42.00	38.62	–	6.00	–	12.00	–	0
4320	–	–	42.94	38.62	–	6.00	–	12.00	–	0
4328	–	–	38.75	38.62	–	6.00	–	12.00	–	0
4331	–	–	41.25	38.62	–	6.00	–	12.00	–	0
4337	–	–	43.12	38.62	–	6.00	–	12.00	–	0
4343	–	–	41.68	38.62	–	6.00	–	12.00	–	0
4347	–	–	42.06	38.62	–	6.00	–	12.00	–	0
4358	–	–	40.75	38.62	–	6.00	–	12.00	–	0
4362	–	–	40.30	38.62	–	6.00	–	12.00	–	0
4370	–	–	39.50	38.62	–	6.00	–	12.00	–	0
4373	–	–	41.00	38.62	–	6.00	–	12.00	–	0
4374	–	–	35.50	38.62	–	6.00	–	12.00	–	0
4379	7.01	6.40	34.06	38.62	7.25	6.00	15.05	12.00	30.23	0
4381	–	–	39.87	38.62	–	6.00	–	12.00	–	0
4384	–	–	41.87	38.62	–	6.00	–	12.00	–	0
4385	–	–	39.31	38.62	–	6.00	–	12.00	–	0
4388	–	–	37.70	38.62	–	6.00	–	12.00	–	0
4389	–	–	41.11	38.62	–	6.00	–	12.00	–	0
4392	–	–	41.56	38.62	–	6.00	–	12.00	–	0
4393	–	–	38.81	38.62	–	6.00	–	12.00	–	0
4394	–	–	38.25	38.62	–	6.00	–	12.00	–	0
4396	–	–	42.25	38.62	–	6.00	–	12.00	–	0
4397	–	–	41.37	38.62	–	6.00	–	12.00	–	0
4398	–	–	39.81	38.62	–	6.00	–	12.00	–	0
4399	–	–	40.88	38.62	–	6.00	–	12.00	–	0
4400	–	–	41.87	38.62	–	6.00	–	12.00	–	0
4403	–	–	40.37	38.62	–	6.00	–	12.00	–	0
4404	–	–	39.68	38.62	–	6.00	–	12.00	–	0
4413	–	–	38.42	38.62	–	6.00	–	12.00	–	0
4414	–	–	37.81	38.62	–	6.00	–	12.00	–	0
4415	–	–	36.31	38.62	–	6.00	–	12.00	–	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Dixie Brand Cottonseed Meal	D	4419
	D	4421
	D	4422
	D	4430
	D	4437
	D	4442
	D	4458
	D	4464
	D	4516
	D	4517
	D	4518
	O	4519
	D	4524
	D	4528
	O	4533
	D	4555
	D	4556
	D	4558
	D	4561
	D	4563
	O	4599
	O	4610
	D	4642
	D	4692
	O	4775
	O	4780
	O	4790
	D	4801
	D	4806
	D	4809
	D	4822
	O	4824
	D	4841
	D	4842
	D	4844
	D	4845
	D	4849
	D	4849
	D	4855
	D	4859
	O	4470
Humphreys-Godwin Co., Memphis, Tenn. Forfat Brand Cottonseed Meal	D	4658
	D	4694
	O	4708
	D	4754
	O	4804
Imperial Cotto Milling Co., Chicago, Ill. Imperial Cotton Brand Cottonseed Meal	O	4778
	D	4700
	D	4851
Keeton-Krueger Co., Atlanta, Ga. Peacock Brand Choice Cottonseed Meal	D	4321
Kemper Mill & Elevator Co., Kansas City, Mo. Anchor Brand Choice Cottonseed Meal	D	4294
	D	4301

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4419	–	–	39.43	38.62	–	6.00	–	12.00	–	0
4421	–	–	37.78	38.62	–	6.00	–	12.00	–	0
4422	–	–	38.75	38.62	–	6.00	–	12.00	–	0
4430	–	–	40.00	38.62	–	6.00	–	12.00	–	0
4437	–	–	41.87	38.62	–	6.00	–	12.00	–	0
4442	–	–	39.18	38.5	–	7.00	–	13.00	–	0
4458	–	–	36.62	38.62	–	6.00	–	12.00	–	0
4464	–	–	42.81	38.62	–	6.00	–	12.00	–	0
4516	–	–	41.06	38.62	–	6.00	–	12.00	–	0
4517	–	–	38.31	38.62	–	6.00	–	12.00	–	0
4518	–	–	40.93	38.62	–	6.00	–	12.00	–	0
4519	–	–	39.06	38.62	–	6.00	–	12.00	–	0
4524	–	–	38.81	38.62	–	6.00	–	12.00	–	0
4528	–	–	38.87	38.62	–	6.00	–	12.00	–	0
4533	–	–	39.37	38.62	–	6.00	–	8.00	–	0
4555	–	–	39.24	38.62	–	6.00	–	12.00	–	0
4556	–	–	39.34	38.62	–	6.00	–	12.00	–	0
4558	–	–	39.43	38.62	–	6.00	–	12.00	–	0
4561	–	–	39.37	38.62	–	6.00	–	12.00	–	0
4563	–	–	38.97	38.62	–	6.00	–	12.00	–	0
4599	–	–	37.95	38.60	–	6.00	–	12.00	–	0
4610	–	–	41.12	38.62	–	6.00	–	12.00	–	0
4642	–	–	39.62	38.62	–	6.00	–	8.00	–	0
4692	–	–	38.44	38.62	–	6.00	–	8.00	–	0
4775	–	–	38.56	38.62	–	6.00	–	12.00	–	0
4780	–	–	39.74	38.62	–	6.00	–	12.00	–	0
4790	–	–	39.24	38.62	–	6.00	–	12.00	–	0
4801	–	–	38.68	38.62	–	6.00	–	8.00	–	0
4806	–	–	40.06	38.62	–	6.00	–	8.00	–	0
4809	–	–	39.16	38.62	–	6.00	–	8.00	–	0
4822	–	–	40.43	38.62	–	6.00	–	8.00	–	0
4824	–	–	41.49	38.62	–	6.00	–	12.00	–	0
4841	–	–	42.12	38.62	–	6.00	–	8.00	–	0
4842	–	–	38.93	38.62	–	6.00	–	8.00	–	0
4844	–	–	38.63	38.62	–	6.00	–	12.00	–	0
4845	–	–	38.87	38.62	–	6.00	–	12.00	–	0
4849	–	–	43.06	38.62	–	6.00	–	8.00	–	0
4855	–	–	37.0	38.62	–	6.00	–	12.00	–	0
4859	–	–	40.46	38.62	–	6.00	–	8.00	–	0
4470	7.44	6.28	38.62	38.62	8.22	6.00	11.10	12.00	28.34	0
4658	–	–	39.21	38.62	–	6.00	–	12.00	–	0
4694	–	–	39.24	38.62	–	6.00	–	8.00	–	0
4708	–	–	37.25	38.62	–	6.00	–	12.00	–	0
4754	–	–	37.19	38.62	–	6.00	–	8.00	–	0
4804	8.25	6.16	36.06	38.62	6.45	6.00	12.84	12.00	30.24	0
4778	7.71	6.07	39.56	38.62	6.42	7.00	12.86	12.00	27.35	0
4700	–	–	42.81	41.00	–	8.00	–	9.00	–	0
4851	–	–	43.56	41.00	–	8.00	–	9.00	–	0
4321	–	–	41.94	41.00	–	6.00	–	10.00	–	0
4294	–	–	41.44	41.00	–	7.50	–	10.00	–	0
4301	–	–	39.94	41.00	–	7.50	–	10.00	–	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Anchor Brand Choice Cottonseed Meal	D	4305
	D	4308
	D	4317
Memphis Cottonseed Products Co., Memphis, Tenn. Selden Cottonseed Meal	D	4408
	D	4465
Nothern, W. C., Little Rock, Ark. Bee Brand Cottonseed Meal	D	4756
Soper Co., J. E., Boston, Mass. Pioneer Cottonseed Meal	D	4295
	D	4296
	D	4297
	D	4298
	D	4312
	D	4360
	D	4363
	D	4368
	D	4386
	D	4481
	D	4482
	O	4537
	O	4600
	O	4624
	D	4673
	O	4791
	O	4811
Soper Co., J. E., Boston, Mass. Pilgrim Brand Cottonseed Meal	D	4436
	D	4507
	D	4644
	D	4655
Southern Cotton Oil Co., Memphis, Tenn. Aurora Brand Cottonseed Meal	D	4316
Wells Co., J. Lindsay, Memphis, Tenn. Sun Brand Cottonseed Meal	D	4293
	D	4346

COTTONSEED FEEDS.

Humphreys-Godwin Co., Memphis, Tenn. Creamo Brand Cottonseed Feed	D	4299
	D	4306
	D	4339
	O	4774

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4305	–	–	38.94	41.00	–	7.50	–	10.00	–	0
4308	–	–	39.94	41.00	–	7.50	–	10.00	–	0
4317	–	–	38.50	41.00	–	7.50	–	10.00	–	0
4408	–	–	40.40	41.00	–	6.00	–	10.00	–	0
4465	–	–	40.81	41.00	–	6.00	–	10.00	–	0
4756	–	–	41.37	41.00	–	6.00	–	10.00	–	0
4295	–	–	41.37	41.00	–	7.00	–	10.00	–	0
4296	–	–	41.18	41.00	–	7.00	–	10.00	–	0
4297	–	–	41.94	41.00	–	7.00	–	10.00	–	0
4298	–	–	42.25	41.00	–	7.00	–	10.00	–	0
4312	–	–	42.75	41.00	–	7.00	–	10.00	–	0
4360	–	–	41.50	41.00	–	7.00	–	10.00	–	0
4363	–	–	41.37	41.00	–	7.00	–	10.00	–	0
4368	–	–	41.25	41.00	–	7.00	–	10.00	–	0
4386	–	–	39.81	41.00	–	7.00	–	10.00	–	0
4481	–	–	40.53	41.00	–	7.00	–	10.00	–	0
4482	–	–	41.06	41.00	–	7.00	–	10.00	–	0
4537	–	–	40.06	41.00	–	7.00	–	10.00	–	0
4600	8.00	7.07	40.84	41.00	7.83	7.00	9.57	10.00	26.69	0
4624	–	–	39.65	41.00	–	7.00	–	10.00	–	0
4673	–	–	41.37	41.00	–	7.00	–	10.00	–	0
4791	–	–	40.47	41.00	–	7.00	–	10.00	–	0
48[illegible]	–	–	41.00	41.00	–	7.00	–	10.00	–	0
4433	–	–	39.50	38.50	–	5.00	–	10.00	–	0
4507	–	–	39.00	38.50	–	5.00	–	10.00	–	0
4644	–	–	38.89	38.50	–	5.00	–	10.00	–	0
4655	–	–	39.09	38.50	–	5.00	–	10.00	–	0
4310	–	–	41.25	41.00	–	6.00	–	10.00	–	0
4293	–	–	39.50	41.00	–	7.00	–	10.00	–	0
4346	–	–	40.50	41.00	–	7.00	–	10.00	–	0

4299	–	–	20.69	20.00	–	5.00	–	22.00	–	0
4306	–	–	22.50	20.00	–	5.00	–	22.00	–	0
4339	–	–	22.25	20.00	–	5.00	–	22.00	–	0
4774	9.50	4.37	22.44	20.00	4.21	5.00	23.03	22.00	36.45	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
GLUTEN MEALS.		
Corn Products Refining Co., New York City. Diamond Gluten Meal	D	4351
	D	4594
	O	4747
GLUTEN FEEDS.		
Clinton Sugar Refining Co., Clinton, Iowa. Clinton Gluten Feed	D	4395
	D	4477
Corn Products Refining Co., New York City. Buffalo Gluten Feed	O	4463
	D	4401
	D	4406
	D	4478
	O	4513
	O	4616
	O	4813
Corn Products Refining Co., New York City. Crescent Gluten Feed	D	4352
Huron Milling Co., Harbor Beach, Mich. Jenks Gluten Feed	O	4733
Staley Mfg. Co., A. E., Decatur, Ill. Staley's Gluten Feed	O	4487
LINSEED OIL MEAL.		
American Linseed Co., Chicago, Ill. Linseed Oil Meal	O	4500
	O	4521
American Linseed Co., Chicago, Ill. Old Process Oil Meal	O	4567
Major Co., Guy G., Toledo, O. Old Process Oil Meal	D	4527
	O	4550
	O	4726

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4351	–	–	42.68	40.00	–	1.50	–	4.00	–	0
4594	–	–	43.78	40.00	–	1.50	–	4.00	–	0
4747	7.46	1.22	40.00	40.00	1.10	1.50	3.13	4.00	47.09	0
4395	–	–	25.00	20.00	–	3.00	–	8.00	–	0
4477	–	–	26.53	20.00	–	3.00	–	8.00	–	0
4463	8.66	3.76	25.78	23.00	4.64	2.00	6.25	8.50	51.91	0
4401	–	–	26.50	23.00	–	2.00	–	8.50	–	0
4406	–	–	26.21	23.00	–	2.00	–	8.50	–	0
4478	–	–	27.06	23.00	–	2.00	–	8.50	–	0
4513	–	–	29.25	23.00	–	2.00	–	8.50	–	0
4616	–	–	25.49	23.00	–	2.00	–	8.50	–	0
4813	–	–	27.56	23.00	–	2.00	–	8.50	–	0
4352	–	–	26.62	23.00	–	2.00	–	8.50	–	0
4733	8.09	2.58	23.74	23.00	4.67	3.00	7.84	8.00	53.08	0
4487	8.25	3.77	27.18	23.00	2.97	2.50	6.51	12.00	51.31	0
4500	–	–	36.81	36.00	–	1.00	–	7.50	–	0
4521	9.35	5.29	37.43	36.00	2.92	1.00	11.59	7.50	33.52	0
4567	8.90	5.17	34.03	34.00	5.22	5.00	9.47	8.00	37.21	0
4527	–	–	30.88	30.00	–	5.00	–	10.00	–	0
4550	9.19	4.88	31.09	30.00	6.16	5.00	9.76	10.00	38.92	0
4726	9.79	5.14	30.62	30.00	5.84	5.00	10.17	10.00	39.44	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

MANUFACTURER OR SHIPPER AND BRAND.	*Source of sample.	Station number.
DISTILLERS GRAINS.		
Ajax Milling & Feed Co., New York City, N. Y. Ajax Flakes	O D O	4607 4643 4823
Biles Co., J. W., Cincinnati, O. Fourex Grains	O	4812
Griswold & Mackinnon, St. Johnsbury, Vt. Xtragood Distillers Grains	O	4773
WHEAT OFFALS, FEED FLOUR.		
Bay State Milling Co., Winona, Minn. Pure Spring Wheat Reddog Flour	O	4703
Gwinn Milling Co., Columbus, O. Gwinn's Red Dog Flour	O	4568
Pillsbury Flour Mills Co., Minneapolis, Minn. Pillsbury's XX Daisy	O	4724
Washburn-Crosby Co., Minneapolis, Minn. Adrian Red Dog Flour	O	4832
WHEAT OFFALS, MIDDLINGS.		
Allen & Wheeler Co., Troy, O. Trojan Middlings	O	4629
Ansted & Burk Co., Springfield, O. William Tell Middlings	O O O	4451 4625 4818
Detroit Milling Co., Detroit, Mich. Tiger Pure Wheat Middlings	D	4330
Edwardsville Milling Co., Edwardsville, Ill. Eaco Winged Horse Middlings	O	4549
Federal Milling Co., Lockport, N. Y. Lucky Winter Flour Middlings	O	4614

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4607	6.27	4.09	31.09	30.00	13.85	11.00	13.82	14.00	30.82	0
4643	–	–	31.15	30.00	–	11 00	–	14.00	–	0
4823	–	–	31.68	30.00	–	11.00	–	14.00	–	0
4812	6.60	1.67	31.56	31.00	12 56	12.00	17.30	13.00	30.61	0
4773	6.28	1.98	31.81	30.00	11.22	10.00	15.65	14.00	33.07	0
4703	10.72	4.91	18.00	17.00	4.75	3.00	2.05	3.00	59.57	0
4568	10.56	1.35	16.81	16.19	2.42	4.70	1.61	4.20	67.25	0
4724	10.88	3.57	18.25	16.00	4.70	4.50	3.70	4.00	58.90	0
4832	10.27	3.94	20.06	17.00	6.24	5.00	3.46	4.00	55.73	0
4629	11.18	5.38	15.09	15.00	4.21	4.00	6.02	6.00	58.13	0
4451	11.58	4.74	16.12	14.50	4.51	4.00	11.33	–	51.73	0
4625	11.07	4.55	16.49	14.50	4.28	4.00	5.73	7.50	57.88	0
4818	–	–	16.75	14.50	–	4.00	–	7.50	–	0
4330	–	–	16.44	16.00	–	5.00	–	7 00	–	–
4549	9.90	4.92	17.24	15.00	6.03	3.00	10.03	10.00	51.88	0
4614	9.78	4.40	17.25	16.00	5.23	5.00	6.64	6.50	56.70	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

MANUFACTURER OR SHIPPER AND BRAND.	*Source of sample.	Station number.
Federal Milling Co., Lockport, N. Y. Lucky Spring Flour Middlings	O	4741
Great Western Mill Co., Dundas, Minn. Standard Middlings	O	4716
Gwinn Milling Co., Columbus, O. Gwinn's Wheat Middlings	O	4782
Huron Milling Co., Harbor Beach, Mich. Fine White Middlings	O	4732
Kemper Mill & Elevator Co., Kansas City, Mo. Carnation Gray Middlings	O	4758
Kemper Mill & Elevator Co., Kansas City, Mo. Crescent Middlings	O	4761
Lansford Mill Co., Lansford, N. D. Lansford Mill Co. Middlings	O	4571
Marshall Milling Co., Shorts	O	4720
Northwestern Consolidated Milling Co., Minneapolis, Minn. Flour Middlings	O	4606
Northwestern Consolidated Milling Co., Minneapolis, Minn. Pure Wheat Middlings	O	4784
Northwestern Elevator & Mill Co., Toledo, O. Taylor's Middlings	O	4746
Pillsbury Flour Mills Co., Minneapolis, Minn. Pillsbury's "A" Middlings	O	4712
Pillsbury Flour Mills Co., Minneapolis, Minn. Pillsbury's "B" Middlings	O	4788
Stock & Sons, F. W., Hillsdale, Mich. Middlings	D	4581
Russell-Miller Milling Co., Minneapolis, Minn. Standard Middlings	O	4839
Valley City Milling Co., Grand Rapids, Mich. Farmers' Favorite Choice Wheat Middlings	O	4531

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4741	9.80	4.30	17.13	18.00	5.33	5.00	6.51	9.00	56.93	0
4716	10.15	5.14	18.03	16.00	5.79	5.00	7.41	11.00	53.48	0
4782	10.39	3.60	16.82	17.00	5.09	4.60	5.02	8.00	59.08	0
4732	10.98	2.02	12.87	13.00	2.92	3.50	1.95	2.50	69.26	0
4758	9.64	4.04	18.31	16.00	5.14	4.30	5.83	6.00	57.04	0
4761	9.35	5.22	19.25	16.00	4.47	4.25	7.43	8.00	54.28	0
4571	10.40	4.19	19.12	–	5.39	–	6.56	–	54.34	0
4720	10.01	5.35	19.19	17.00	6.02	5.04	8.69	9.44	50.74	0
4606	11.04	4.36	17.71	15.50	5.80	4.50	5.06	6.00	56.03	0
4784	9.85	4.01	17.50	15.00	4.92	4.50	5.69	10.00	58.03	0
4746	9.42	4.60	17.25	15.00	4.43	4.00	6.65	6.00	57.65	0
4712	10.74	4.40	16.78	15.00	5.10	4.50	5.94	8.00	57.04	0
4788	9.51	5.48	17.12	15.00	5.08	4.50	9.62	8.00	53.19	0
4581	–	–	16.56	17.00	–	4.50	–	6.00	52.34	0
4839	9.93	5.[illegible]	19.37	15.00	6.05	4.00	7.15	9.00	47.66	0
4531	11.25	[illegible]	[illegible]	[illegible]	4.64	4.66	6.90	8.33	57.37	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Washburn-Crosby Co., Minneapolis, Minn. Pure Hard Wheat Standard Middlings	O O O	4449 4609 4729

WHEAT OFFALS, BRAN.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Allen & Wheeler Co., Troy, O. Trojan Bran	O O	4591 4787
Bay State Milling Co., Winona, Minn. Winona Fancy Bran	O	4552
Christian Milling Co., Geo. C., Jersey Brann	O	4786
Colton Bros. Co., Bellefontaine, O. Bran	O	4579
Davis Co., J. G., Rochester, N. Y. Choice Clean Bran	O	4721
Eldred Mill Co., Jackson, Mich. Pure Bran	O	4627
Everett-Aughenbaugh Co., Waseca, Minn. Eaco Winged Horse Bran	O	4771
Federal Milling Co., Lockport, N. Y. Lucky Bran	O	4619
Federal Milling Co., Lockport, N. Y. Lucky Spring Bran	O	4740
Gwinn Milling Co., Columbus, O. Gwinn's Wheat Bran	O O O	4578 4763 4772
Kemper Mill & Elevator Co., Kansas City, Mo. Anchor Bran	O	4601
Kemper Mill & Elevator Co., Kansas City, Mo. Diamond Bran	O	4817
Lansford Mill Co., Lansford, N. D. Bran	O	4570

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4449	11.19	5.33	16.87	15.00	5.21	4.00	9.54	–	51.86	0
4609	–	–	16.96	15.00	–	4.00	–	8.00	–	0
4729	10.26	5.37	18.00	15.00	5.36	4.00	8.26	8.00	52.75	0
4591	–	–	14.54	14.50	–	4.00	–	9.00	–	0
4787	9.85	6.27	15.69	14.50	3.96	4.00	10.44	9.50	53.79	Few
4552	8.95	7.02	16.09	15.00	5.20	4.70	10.83	11.00	51.91	Few
4786	9.56	6.09	16.25	15.00	5.16	4.00	10.71	11.50	52.23	Few
4579	10.21	6.35	14.62	14.50	3.87	4.00	10.57	9.50	54.38	Few
4721	–	–	16.44	16.00	3.87	3.50	9.31	10.00	–	Few
4627	10.72	6.80	15.15	16.62	4.55	3.65	9.02	10.32	53.76	Few
4771	10.52	6.68	14.69	14.00	4.81	3.00	11.83	12.00	51.47	Few
4619	10.20	6.62	15.24	12.00	4.02	4.00	9.28	10.00	54.64	Many
4740	10.40	6.10	17.06	17.00	5.00	4.50	10.61	9.00	50.83	Many
4578	9.01	5.93	15.68	15.78	4.22	4.40	9.48	1.80	55.68	0
4763	–	–	15.81	15.78	–	4.40	–	1.80	–	0
4772	–	–	15.38	15.78	–	4.40	–	1.80	–	0
4601	9.91	6.72	15.84	14.50	4.42	4.00	10.07	10.00	53.04	Few
4817	9.79	5.72	14.56	14.50	3.84	4.00	10.11	9.50	55.98	Few
4570	6.86	5.91	16.31	–	4.91	–	10.90	–	55.11	Many

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Madison Milling Co., Madison, Minn. Coarse Bran	O	4575
Maple Leaf Milling Co., Canada. Bran	O	4826
Northwestern Consolidated Milling Co., Minneapolis, Minn. Bran	O	4497
	O	4681
Pillsbury Flour Mills Co., Minneapolis, Minn. Pillsbury's Bran	O	4542
	O	4840
Star & Crescent Milling Co., Chicago, Ill. Bran	O	4718
Urban Milling Co., Geo., Buffalo, N. Y. Wheat Bran	O	4709
Valley City Milling Co., Grand Rapids, Mich. Farmers' Favorite Choice Wheat Bran	O	4730
Voight Milling Co., Grand Rapids, Mich. Voight's Bran	O	4540
Wabasha Roller Mill Co., Wabasha, Minn. Bigjo Bran	O	4792
Washburn-Crosby Co., Minneapolis, Minn. Pure Hard Wheat Coarse Bran	O	4469
	O	4493
Western Flour Mills Co., Davenport, Iowa. Black Hawk Bran	O	4647

WHEAT OFFALS, MIXED FEED.

Allen & Wheeler Co., Troy, O. Trojan Mixed Feed	O	4597
Acme-Evans Co., Indianapolis, Ind. Acme Feed	O	4638
Bernet, Craft & Kaufman Co., Mt. Carmel, Ill. Pure Wheat Mixed Feed	O	4565

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4575	8.79	6.63	15.90	14.40	5.08	4.10	11.06	13.30	52.54	0
4826	8.97	6.18	15.94	15.50	4.97	4.00	10.50	9.50	53.44	Many
4497	9.49	6.32	16.31	14.50	5.59	4.00	10.30	11.00	51.99	Many
4681	–	–	15.87	14.50	–	4.00	–	11.00	–	Few
4542	9.53	6.36	16.09	14.50	4.86	4.00	11.25	11.00	51.91	Many
4840	–	–	17.31	14.50	–	4.00	–	11.00	–	Many
4718	9.49	6.67	16.37	15.00	4.91	4.00	10.92	10.00	51.64	Many
4709	10.02	6.03	15.88	15.00	5.35	4.00	10.68	11.50	52.04	Many
4730	10.47	6.34	17.83	17.75	4.40	3.43	10.23	10.93	50.73	0
4540	10.21	5.59	16.09	17.00	4.38	6.50	7.93	7.50	55.80	0
4792	9.84	7.25	17.28	16.00	5.02	4.62	9.32	10.44	51.29	0
4469	9.95	6.17	17.46	14.50	5.18	4.00	9.69	11.00	51.55	Few
4493	–	–	15.43	14.50	–	4.00	–	11.00	–	0
4647	9.86	6.75	14.99	13.50	4.64	4.00	9.40	11.50	54.36	0

4597	10.33	5.04	15.97	14.50	4.17	4.00	7.76	8.00	56.73	Few
4638	10.88	5.14	16.55	16.50	3.98	4.00	7.33	9.00	56.12	Few
4565	7.22	5.20	16.65	14.30	4.29	3.55	9.25	9.50	57.39	Few

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

MANUFACTURER OR SHIPPER AND BRAND.	*Source of sample.	Station number.
Blish Milling Co., Seymour, Ind. Blish's Bull's Eye Mixed Feed	O O	4468 4551
Claro Milling Co., Waseca, Minn. Claro Mixed Feed	O	4819
Colton Bros. Co., Bellefontaine, O. Mixed Feed	O	4602
Duluth-Superior Milling Co., Duluth, Minn. Boston Mixed Feed	O O	4499 4705
Edwardsville, Milling Co., Edwardsville, Ill. Emco Winter Wheat Mixed Feed	O O	4510 4590
Everett Aughenbaugh Co., Waseca, Minn. Eaco Winged Horse Mixed Feed	O O	4572 4722
Federal Milling Co., Lockport, N. Y. Lucky Winter Mixed Feed	O	4816
Grafton Roller Mill Co., Grafton, N. D. Grafton Mixed Feed	O O	4717 4762
Griswold & Mackinnon, St. Johnsbury, Vt. Xtragood Mixed Feed	O	4679
Hale & Sons, J., Lyons, Mich. Acme Mixed Feed	O O	4646 4748
Halliday Milling Co., H. L., Cairo, Ill. Halliday's Choice Mixed Feed	O O	4447 4723
Huron Milling Co., Harbor Beach, Mich. Mixed Feed	O	4701
Kemper Mill & Elevator Co., Kansas City, Mo. Anchor Mixed Feed	O	4836
Kemper Mill & Elevator Co., Kansas City, Mo. Crescent Mixed Feed	O	4620

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4468	9.95	5.62	16.62	16.50	4.41	4.50	6.46	9.10	56.94	0
4551	–	–	15.34	16.50	–	4.50	–	9.10	–	Few
4819	10.03	5.05	17.69	15.00	5.24	3.00	8.37	11.00	53.62	0
4602	10.13	5.34	15.94	14.50	4.18	4.00	7.65	8.00	57.36	0
4499	10.51	5.30	16.56	16.00	5.62	4.50	8.60	8.50	53.41	Few
4705	–	–	16.13	16.00	–	4.50	–	8.50	–	0
4510	9.92	5.68	16.56	16.00	4.68	4.00	9.22	4.20	53.94	Few
4590	–	–	16.06	16.00	–	4.00	–	4.20	–	0
4572	9.89	5.34	17.37	15.00	5.45	3.00	8.28	12.00	53.67	Few
4722	–	–	17.75	15.00	–	3.00	–	12.00	–	0
4816	10.69	4.83	17.56	17.50	4.35	4.50	8.23	8.50	54.34	Few
4717	10.94	4.56	16.47	15.50	5.13	6.10	9.14	11.90	53.76	0
4762	–	–	16.75	15.00	–	6.00	–	11.00	–	0
4679	11.32	5.12	16.99	16.00	5.12	4.00	7.65	7.00	53.80	0
4646	–	–	14.97	14.53	–	3.60	–	7.40	–	0
4748	–	–	14.18	14.53	–	3.60	–	7.40	–	Few
4447	8.94	5.91	15.49	14.50	4.43	4.00	8.63	8.00	56.61	Few
4723	–	–	15.94	14.50	–	4.00	–	8.00	–	Few
4701	10.38	4.68	13.25	12.00	4.51	4.60	8.42	5.85	58.76	0
4836	10.29	5.80	16.31	16.00	4.28	4.00	7.17	10.00	56.15	0
4620	9.78	5.54	16.41	16.00	4.41	4.00	8.39	5.00	55.47	Few

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Lawrenceburg Roller Mills Co., Lawrenceburg, Ind. Snow Flake Mixed Feed	O	4448
	O	4498
	O	4511
	O	4834
Noblesville Milling Co., Noblesville, Ind. N. M. Co.'s Mixed Feed	O	4512
	O	4835
Pillsbury Flour Mills Co., Minneapolis, Minn. Pillsbury's Mixed Feed	D	4584
	O	4798
Portland Milling Co., Portland, Mich. Champion Mixed Feed	O	4491
	O	4520
	O	4828
Quaker Oats Co., Chicago, Ill. Buckeye Mixed Feed	O	4485
	O	4731
Russell-Miller Milling Co., Minneapolis, Minn. Occident Mixed Feed	D	4564
Russell-Miller Milling Co., Minneapolis, Minn. Occident Wheat Feed	O	4738
Sheffield-King Milling Co., Minneapolis, Minn. Gold Mine Mixed Feed	O	4492
	O	4815
Sparks Milling Co., Alton, Ill. Try Me Winter Mixed Feed	O	4443
	O	4546
	O	4707
Stanard-Tilton Milling Co., Alton, Ill. Bran and Middlings Run together or Mixed Feed	O	4446
Stock & Sons, F. W., Hillsdale, Mich. Monarch Wheat Feed	O	4459
	O	4489
	D	4583
Stock & Sons, F. W., Hillsdale, Mich. Superior Pure Wheat Feed	O	4461
	D	4525
	O	4576
	D	4580
	O	4585
	O	4611
	O	4628

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4448	9.47	5.14	15.68	15.20	4.46	4.30	7.73	8.00	57.52	Many
4498	–	–	15.75	15.20	–	4.30	–	8.00	–	Few
4511	–	–	15.87	15.20	–	4.30	–	8.00	–	Few
4834	–	–	15.75	15.20	–	4.30	–	8.00	–	Few
4512	10.80	5.19	15.62	15.00	4.19	4.00	10.07	–	54.13	Few
4835	–	–	16.31	15.00	–	4.00	–	–	–	Few
4584	–	–	16.68	16.00	–	4.50	–	8.00	–	0
4798	11.18	4.92	16.62	16.00	5.10	4.50	7.86	8.00	54.32	Many
4491	10.25	5.29	15.56	15.84	4.64	4.15	8.36	9.40	55.90	0
4520	–	–	14.87	15.84	–	4.15	–	9.40	–	0
4828	–	–	15.94	15.80	–	4.15	–	9.40	–	0
4485	9.58	5.88	16.87	13.00	4.79	4.00	8.98	8.00	53.90	Many
4731	–	–	16.81	13.00	–	4.00	–	8.00	–	Few
4564	–	–	16.43	15.00	–	4.50	–	10.00	–	0
4738	9.64	4.96	16.63	15.00	5.28	4.50	7.97	5.28	55.52	0
4492	9.41	5.38	17.43	15.00	5.38	4.80	9.17	10.00	53.23	0
4815	–	–	17.06	15.9	–	4.90	–	8.90	–	0
4443	9.33	5.34	17.37	10.00	4.63	4.50	7.65	8.00	55.68	Many
4546	–	–	16.72	16.00	–	4.50	–	8.00	–	Many
4707	–	–	18.13	16.00	–	4.50	–	8.00	–	Many
4446	9.77	6.01	17.81	15.00	4.81	4.00	8.24	–	53.36	Few
4459	9.82	5.24	16.96	17.00	5.50	4.00	7.42	10.00	55.16	Few
4489	–	–	17.37	17.00	–	4.50	–	8.00	–	Few
4583	–	–	17.28	17.00	–	4.50	–	9.00	–	0
4461	–	–	16.18	18.00	–	5.00	–	7.00	–	Few
4525	–	–	16.56	18.00	–	5.00	–	7.00	–	0
4576	–	–	16.84	18.00	–	5.00	–	7.00	–	Few
4580	–	–	16.59	18.00	–	5.00	–	7.00	–	0
4585	11.47	4.76	16.50	18.00	5.08	5.00	7.10	7.00	55.09	Few
4611	10.59	5.08	16.69	18.00	4.69	5.00	6.65	7.00	56.40	Many
4628	10.96	4.16	16.79	18.00	4.76	5.00	5.97	7.00	57.46	Few

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Stott, David,		
Detroit, Mich.		
Stott's Honest Mixed Feed	O	4592
Urban Milling Co., Geo.,		
Buffalo, N. Y.		
Mixed Feed	O	4633
	O	4725
Valley City Milling Co.,		
Grand Rapids, Mich.		
Farmers Favorite Choice Wheat Cow Feed	O	4604
Voigt Milling Co.,		
Grand Rapids, Mich.		
Voigt's Pure Wheat Mixed Feed	O	4566
	O	4702
Waggoner-Gates Milling Co.,		
Mixed Feed	O	4613
Washburn-Crosby Co.,		
Minneapolis, Minn.		
Superior Mixed Feed	D	4327
	O	4634

ADULTERATED WHEAT OFFALS.

Indiana Milling Co.,		
Terre Haute, Ind.		
Sterling Feed	O	4460
	O	4501
	O	4514

MISCELLANEOUS COMPOUND FEEDS. Protein over 20 per cent.

Biles Co., J. W.,		
Cincinnati, O.		
Union Grains, Ubiko	O	4325
	O	4444
	O	4488
	O	4534
	D	4641
	O	4706
	O	4764
Blatchford Calf Meal Co.,		
Waukegan, Ill.		
Blatchford's Calf Meal	O	4490
Chapin & Co.,		
Hammond, Ind.		
Unicorn Dairy Ration	O	4450
	O	4833
Husted Milling Co.,		
Buffalo, N. Y.		
Husted Molasses Feed	O	4745

ANALYSES OF FEEDING STUFFS.

Station numb	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4592	9.87	5.48	15.84	16.50	4.73	5.00	8.54	8.00	55.54	Few
4633	10.84	5.71	16.71	16.00	5.35	4.00	7.54	10.50	53.82	0
4725	–	–	16.56	15.00	–	4.00	–	10.50	–	Few
4604	10.75	5.83	16.12	14.79	4.50	7.50	7.61	4.25	55.19	0
4566	7.86	5.36	16.25	16.50	4.44	5.50	8.42	5.00	–	0
4702	10.68	5.29	15.10	16.50	4.30	5.00	8.19	5.00	56.44	0
4613	9.78	6.24	15.90	15.00	4.57	3.00	7.40	9.00	56.11	0
4327	–	–	15.63	16.00	–	4.50	–	9.00	–	0
4634	10.79	5.23	17.44	16.00	5.71	4.50	7.92	9.00	53.01	Few
4460	8.98	4.10	11.03	9.80	3.60	2.75	15.83	14.00	56.45	0
4501	–	–	10.81	9.80	–	2.75	–	16.00	–	Many
4514	–	–	10.06	9.80	–	2.75	–	16.00	–	Many
4325	–	–	22.44	24.00	–	7.00	–	9.00	–	0
4444	8.23	5.77	24.06	24.00	7.52	7.00	8.86	9.00	45.56	Many
4488	–	–	25.12	24.00	–	7.00	–	9.00	–	Few
4534	–	–	24.68	24.00	–	7.00	–	9.00	–	Few
4641	–	–	24.41	24.00	–	7.00	–	9.00	–	0
4706	7.53	6.41	25.09	24.00	7.08	7.00	10.62	9.00	43.29	Few
4764	–	–	24.06	24.00	–	7.00	–	9.00	–	Few
4490	9.95	5.41	24.68	25.00	5.76	5.00	4.39	5.00	49.91	0
4450	6.88	5.38	28.37	26.00	6.72	5.50	9.30	10.00	43.35	Few
4833	–	–	26.06	25.00	–	5.50	–	10.00	–	Few
4745	9.53	7.58	20.50	18.00	5.05	4.00	8.94	9.00	48.40	Few

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Quaker Oats Co., Chicago, Ill. Blue Ribbon Dairy Feed	O	4639

MISCELLANEOUS COMPOUND FEEDS. Protein 15-20 per cent.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
American Hominy Co., Indianapolis, Ind. Homcoline Feed	D	4310
Dickinson Co., Albert, Chicago, Ill. Alfalfa Meal	O	4776
K. B. R. Milling Co., Marquette, Kans. Bran and Wheat Screenings	O	4548
Northwestern Consolidated Milling Co., Minneapolis, Minn. XXX Comet (Wheat Product)	O	4831
Quaker Oats Co., Chicago, Ill. Schumacher Calf Meal	O	4777

MISCELLANEOUS COMPOUND FEEDS. Protein 10-15 per cent.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
American Hominy Co., Indianapolis, Ind. Homco Feed	D	4424
Buffalo Cereal Co., Buffalo, N. Y. Bufceco Hominy Feed	O	4[illegible]15
Buffalo Cereal Co., Buffalo, N. Y. Bufceco Horse Feed	O	4714
Cox Co., Chas. M., Boston, Mass. Wirthmore Hominy	D O	4349 4830
Cox Co., Chas. M., Boston, Mass. Wirthmore Stock Feed	O	4711
Griswold & Mackinnon, St. Johnsbury, Vt. Xtragood Stock Feed	O	4680
Haskell & Co., W. H., Toledo, O. Haskell's Stock Feed	O O	4536 4736

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4639	8.87	7.82	25.38	25.00	5.25	4.00	11.39	9.00	41.29	Few
4310	–	–	19.88	17.00	–	5.00	–	7.00	–	0
4776	7.61	8.34	15.25	12.00	1.96	1.00	36.34	35.00	30.50	0
4548	9.61	6.10	17.18	14.50	4.05	4.00	10.37	–	52.69	0
4831	10.40	3.94	18.69	16.50	5.47	4.00	2.13	3.00	59.37	0
4777	8.65	4.12	19.00	19.00	7.77	8.00	2.78	3.00	57.68	0
4424	–	–	12.78	9.50	7.57	7.00	5.73	7.00	–	0
4715	9.95	2.64	11.26	10.00	7.87	7.00	5.15	4.00	63.13	0
4714	9.68	3.36	10.72	10.00	4.65	4.00	10.50	8.00	61.10	Few
4349	–	–	10.50	9.50	–	7.50	–	5.00	–	0
4830	11.45	2.40	10.56	9.50	7.44	7.50	5.09	5.00	63.06	0
4711	8.70	3.07	10.39	9.00	5.70	4.00	9.07	7.00	63.15	0
4680	10.22	3.41	10.90	10.00	3.81	3.25	10.27	10.00	61.42	0
4536	8.05	3.20	10.03	8.00	6.47	4.00	8.72	8.00	63.53	0
4736	–	–	10.31	10.00	–	3.00	–	8.00	–	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Husted Milling Co., Buffalo, N. Y. Husted Stock Feed	O	4743
Husted Milling Co., Buffalo, N. Y. Mayflower Stock Feed	D O O	4322 4547 4760
Husted Milling Co., Buffalo, N. Y. Zenith Stock Feed	D	4690
Marks, E. M., Monmouth, Me. Monmouth Pure Corn and Oat Feed	O	4637
Merrill & Mayo Co., Waterville, Me. Corn and Oat Chop	O	4821
Ohio Cereal Co., Circleville, O. Esmeralda Special Feed	O	4588
Quaker Oats Co., Chicago, Ill. Schumacher Stock Feed	O O O O	4522 4538 4589 4827
Suffern, Hunt & Co., Acme Hominy Feed	O	4837

MISCELLANEOUS COMPOUND FEEDS. Protein under 10 percent.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Baringer, M. F., Philadelphia, Pa. Keystone Hominy Feed	O	4829
Buffalo, Cereal Co., Buffalo, N. Y. Bufceco Stock Feed	O O	4587 4719
Grandin Milling Co., Jamestown, N. Y. Grandin's Stock Food	O O O	4486 4728 4880
Husted Milling Co., Buffalo, N. Y. Zenith Stock Feed	O	4800
McLeod Milling Co., A. H., St. Johnsbury, Vt. Brook's Fancy Corn and Oat Stock Feed	O	4779

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4743	9.64	3.54	10.25	8.00	5.45	4.00	7.19	9.00	63.93	0
4322	–	–	10.88	7.50	–	3.60	–	7.00	–	0
4547	10.76	6.54	9.59	7.50	5.11	3.50	7.01	7.00	60.90	Few
4760	–	–	10.62	7.50	–	3.50	–	7.00	–	Few
4690	–	–	10.00	10.00	–	4.00	–	7.00	–	0
4637	13.68	1.90	10.46	10.00	4.36	5.00	5.33	8.00	64.27	Few
4621	11.94	2.03	10.94	10.00	4.91	5.00	5.85	6.00	64.33	0
4588	10.56	1.88	11.62	13.00	5.60	5.00	5.13	4.00	65.21	0
4522	9.72	3.61	10.93	10.00	3.80	3.25	10.51	10.00	61.43	0
4538	–	–	12.38	10.00	–	3.25	–	10.00	–	Many
4589	–	–	11.31	10.00	–	3.25	–	10.00	–	Few
4827	–	–	11.79	10.00	–	3.25	–	10.00	–	0
4837	9.47	2.64	11.56	9.30	8.40	7.10	5.26	10.00	62.60	0
4829	11.03	1.83	9.13	9.00	5.49	6.00	2.61	10.00	69.91	0
4587	10.34	3.36	8.90	8.00	4.94	4.00	9.77	9.00	62.69	Few
4719	–	–	8.69	8.00	–	4.00	–	9.00	–	Few
4486	8.39	3.57	9.87	8.50	6.24	3.50	7.28	9.00	64.73	Few
4728	–	–	8.56	8.50	–	3.50	–	10.00	–	Few
4880	7.80	4.45	7.81	8.50	4.76	3.50	14.09	10.00	61.09	0
4800	12.07	3.23	9.32	10.00	3.18	4.00	4.77	9.00	67.43	Few
4779	10.57	2.41	9.37	9.21	3.72	3.00	9.21	8.50	64.72	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Quaker Oats Co., Chicago, Ill. Victor Feed	O	4574

POULTRY FEEDS.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Bowker Fertilizer Co., Boston, Mass. Bowker's Animal Meal	O	4795
Bowker Fertilizer Co., Boston, Mass. Bowker's Fresh Ground Beef Scraps	O	4794
Brastow, F. H., South Brewer, Me. Monarch Poultry Mash	O	4504
Buffalo Cereal Co., Buffalo, N. Y. Bufceco Scratching Grains	O	4713
Clark & Co., E. A., Portland, Me. Peerless Poultry Mash	O	4735
Clark & Co., E. A., Portland, Me. Peerless Screened Scratch Feed	O	4734
Clark, O. L., Freeport, Me. Yankee Intermediate Chick Feed	O	4361
Dickinson Co., Albert, Chicago, Ill. Queen Poultry Mash	O	4471
Dow Co., John C., Boston, Mass. Dow's Favorite Poultry Meal	O	4484
Grandin Milling Co., D. H., Jamestown, N. Y. Grandin's Scratch Feed	O O	4494 4783
Husted Milling Co., Buffalo, N. Y. Competition Scratch Feed	O	4462
Husted Milling Co., Buffalo, N. Y. Husted Laying Mash	D	4691
Husted Milling Co., Buffalo, N. Y. Husted Poultry Feed	O	4797
International Glue Co., Boston, Mass. Coarse Fish Scrap	D	4417

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4574	9.40	3.09	8.90	8.00	4.21	3.00	9.61	12.00	–	Few
4795	5.42	42.45	40.18	40.00	9.88	5.00	3.31	15.00	–	0
4794	6.87	33.67	42.31	40.00	12.79	8.00	2.73	5.00	–	0
4504	7.97	9.75	20.43	22.00	6.74	5.50	7.61	7.00	47.50	Few
4713	12.59	1.68	11.16	10.00	2.91	3.00	2.54	5.00	29.12	Few
4735	10.17	8.18	20.38	20.00	4.07	3.00	7.51	5.00	49.69	Many
4734	12.92	1.64	11.00	10.00	2.65	3.00	3.57	5.00	68.22	Few
4361	12.71	1.64	9.75	10.00	2.85	3.00	2.09	5.00	70.96	0
4471	10.00	3.47	12.09	11.00	4.15	2.50	7.44	10.00	62.86	0
4484	5.25	41.37	31.06	30.00	12.81	10.00	2.36	–	–	0
4494	11.96	1.75	11.06	8.00	2.99	31.20	4.86	8.00	67.44	Many
4783	–	–	10.44	8.00	–	3.50	–	8.00	–	Few
4462	11.40	1.64	11.34	10.00	3.28	2.00	3.00	6.00	69.34	Few
4691	–	–	15 15	15.00	–	3.00	–	6.00	–	0
4797	10.95	3.90	14.56	12.00	4.83	4.00	8.29	8.00	58.28	0
4417	–	–	44.87	45.00	–	2.00	–	–	–	0

DESCRIPTIVE LIST OF FEEDING STUFFS SAMPLES.

Manufacturer or Shipper and Brand.	*Source of sample.	Station number.
Marks, E. M., Monmouth, Me. Monmouth Dry Mash	O	4636
Park & Pollard Co., Boston, Mass. Park & Pollard's Dry Mash	O	4739
Park & Pollard Co., Boston, Mass. Park & Pollard's Screened Scratch Feed	O	4814
Portland Rendering Co., Portland, Me. Portland Poultry Food. Cooked Meat Scrap	O	4781
Quaker Oats Co., Chicago, Ill. American Poultry Feed	O	4710
Quaker Oats Co., Chicago, Ill. Schumacher Scratching Grains	O	4793
Ralston Purina Co., St. Louis, Mo. Purina Chicken Chowder	O	4796
Ralston Purina Co., St. Louis, Mo. Purina Mill Feed, Scratch Size	O	4742
Swift & Co., Boston, Mass. Swift's Digester Tankage	O	4586
Waldron & Son, F. A., Portland, Me. Star Scratch Feed	O	4727

ANALYSES OF FEEDING STUFFS.

Station number.	Moisture.	Ash.	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.	Fiber. Found.	Fiber. Guaranteed.	Nitrogen free extract.	Weed seeds.
4636	10.56	9.24	19.96	18.00	4.97	5.00	7.28	8.00	48.99	Few
4739	9.57	11.76	20.56	18.00	3.10	3.50	6.60	5.00	48.41	Few
4814	12.92	1.60	10.81	10.00	2.99	3.50	3.86	5.00	67.82	Few
4781	5.45	36.39	46.87	40.00	10.55	8.00	1.53	–	–	0
4710	10.60	2.76	13.75	12.00	4.98	3.50	5.12	9.00	62.79	Few
4793	11.47	1.56	11.13	10.00	3.20	2.50	2.16	5.00	–	Few
4796	10.01	5.39	19.12	17.00	4.38	3.00	7.21	9.00	70.48	0
4742	12.43	1.39	11.19	11.00	2.80	3.00	4.20	4.00	67.99	Many
4586	8.16	19.19	60.44	60.00	9.21	8.00	2.04	–	–	0
4727	12.10	1.70	10.75	10.50	3.03	3.50	4.05	4.00	68.37	Many

Condimental Remedies.

No recent examinations of condimental remedies have been made at the Station. Condimental foods are remedies and not food, and come under the requirements of the Food and Drug Law. They are, so far as our observation goes, sold lawfully. From time to time the Station has called the attention of feeders to the uselessness of this class of remedies. The following or similar statements have been published every little while and are as true today as when they were first written.

Facts to be Remembered.

The mixture of ingredients contained in the ordinary foods comprises all that are known either to practice or science as useful to animal life.

The ordinary cattle foods supply animal nutrition in the most useful and economical forms.

Condimental foods are absurd as medicines. If an animal is well no medicine is needed, if ill, remedies adapted to the case should be administered.

It is to be hoped that the manufacturers of this class of materials flourish not on the ignorance of farmers but on that lingering remnant of old times, which made saltpeter and sulphur the universal cure-all for horses and cattle.

The farmer can manufacture his own "condimental" food at a fraction of the usual cost, by mixing a small amount of such common substances as salt, sulphur, saltpeter, fenugreek, caraway, etc., with the daily ration.

The full text of the law will be sent on request. All correspondence relative to work of inspection should be addressed to Director Chas. D. Woods, Orono, Maine.

June, 1913.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

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Official Inspections

51

WEIGHT OF BUTTER

CONTENTS.

SHORT WEIGHT BUTTER.

In Official Inspection 44 issued in October 1912 will be found the results of an investigation of the weight of butter found upon sale in this State. Since that publication was issued an extended investigation of the weight of butter actually found on sale in thirty-five towns and cities has been made, and the results of the various weighings made will be found in the following pages. The butter investigated includes creamery butter made both in Maine and other states, dairy or country butter and a few lots of renovated or process butter, On the whole an improvement is noted in the butter situation throughout the State, for while the figures given in the following tables show much short weight butter on sale, manufacturers, dealers, and consumers are interested in the question, and all are working in harmony with a view to having all the butter found on sale in the State hold up to standard weight. A number of prosecutions have been commenced under the Food Law, taking up the most flagrant cases of violations. In the cases of those butters coming into Maine from outside the facts have been given to the National Board of Food and Drug Inspection for investigation under the National Law. Several cases have been commenced because of the facts presented. Of those cases taken up under the State Laws all have been settled without trial, and in several instances fines have been paid. In the table of creamery butter, several cases of double stars referring to the text will be noted in the columns giving the number of bricks weighed, and the number found short weight. In two instances no figures are given in either column, and these refer to cases where the figures have been given to the National Board for further investigation under the Federal Law. In two instances, however, it will be noted that thirty bricks were weighed, and no number is given in the second column. In the first instance there were thirty prints in the entire lot. These weighed, cartons and all, exactly thirty pounds. The average weight of the cartons was found to be one ounce each. Deducting therefore thirty ounces for the thirty cartons we find that this lot would weight twenty-eight pounds and two ounces net. In the second case the whole lot consisted of thirty prints. These weighed thirty-one and one-half pounds gross. Allowing thirty ounces again for the weight of the cartons the net weight of butter would be twenty-nine and five-eighths pounds for thirty prints.

But little comment is necessary. The figures in the table for the most part explain themselves. No butter was considered short weight unless the shortage was more than a quarter ounce. In all instances where samples were obtained and cases commenced analyses were made to show the content of water, milk fat, casein, and salt, and no cases have been commenced where it was found that the milk fat of the butter was in such large proportion that the shortage could be accounted for by a drying out and loss of water only. To explain this point more fully it should be noted that butter should contain 82.5 per cent. of milk fat. That is, 82.5 per cent. of the pound should be milk fat, and 82.5 per cent. of sixteen ounces is thirteen and two-tenths ounces. If therefore the milk fat content of the butter was high enough so that there were actually thirteen and two-tenths ounces present the butter would pass as a lawful butter even though the weight of the print fell below sixteen ounces. Such cases are, however, quite rare, and in almost every case investigated the shortage was found to be due to a lack of milk fat itself, and not because of a drying out and loss of water. One or two instances of unusual over-salting have been discovered so that the butter might with propriety have been called adulterated with salt. Average butter contains from three to five per cent. of salt. One or two cases were discovered where ten per cent. or over was present.

It is such an easy matter to ascertain whether or not butter is full weight that there does not seem to be much excuse for either the manufacturer or dealer for selling short weight butter. The following recommendations to the manufacturer, jobber, retailer, and consumer were printed in a leaflet and distributed to the public in March. These recommendations are important and should be carefully studied.

Manufacturer. The manufacturer of butter whether creameryman or dairyman should know absolutely that he is putting out both a standard butter and a full weight butter, even if this necessitates weighing every print which goes out from his establishment.

Jobber. The jobbers who handle butter in lots should buy and sell by weight as well as by count. The butter should be billed for exactly what it weighs. If there is a discrepancy between the number of prints and the total weight that fact should be stated in the invoice.

Retailer. The retailer will be held strictly responsible for the weight of the butter he sells. He is advised to insist that all butter purchased be full weight, but if he should have short weight butter for sale every print should be sold for exactly what it weighs and the customer informed of the fact. It is not allowable to sell short weight butter by the *print* and not give information that it is short weight.

Consumer. The consumer is urged to weigh butter purchased and insist upon receiving full weight. The consumer as well as the dealer is urged to communicate with this office whenever short weight butter is found.

Table giving report of butter weighed by the inspectors at dealers. The samples are arranged as creamery and dairy butter alphabetically by the name of the makers.

CREAMERY BUTTER.

MAKER, AND BRAND, IF ANY.	Where Found.	Number bricks weighed.	†Number bricks short weight.
Ames, S. K. Boston. "Oakland Print Butter"	S. K. Ames, Portland	12	None.
Ames, S. K., Boston. "Oakland Print Butter"	S. K. Ames, Portland	12	1
Ames, S. K., Boston. "A. A Fancy Premium"	S. K. Ames, Portland	5	None
Ames, S. K., Boston. "Fancy Print"	S. K. Ames, Portland	12	1
Ames, S. K., Boston. "Oakland Print"	S. K. Ames, Portland	11	None
Ames, S. K., Boston	S. K. Ames, Portland	9	None
Ames, S. K., Boston	S. K. Ames, Portland	12	None
Armour & Co., Chicago, Ill. "Highest Grade Cloverbloom Creamery Butter"	W. T. Howe, Portland	5	None

† No brick considered short weight unless shortage was more than one-quarter ounce.

Table giving report of butter weighed by the inspectors at dealers. —Continued.

Maker, and Brand, if Any.	Where Found.	Number bricks weighed.	†Number bricks short weight.
Brighton Creamery, Island Pond, Vt., "Green Mountain Creamery Butter"	Geo. C. Shaw, Portland..........	5	1
Brighton Creamery, Island Pond, Vt. "B-C Butter"....................	Geo. C. Shaw Co., Portland......	††	††
Brighton Creamery, Island Pond, Vt. "B-C Butter"....................	J. A. Moreshead Portland.........	6	None.
Brighton Creamery, Island Pond, Vt. "B-C Butter"....................	J. A. Moreshead, Portland........	††	††
Brighton Creamery, Island Pond, Vt. "C-B Butter"....................	C. H. Kilby, So. Portland.......	9	None.
Brighton Creamery, Island Pond, Vt. "C-B Butter"....................	So. Portland Co-operative Store, So. Portland.................	11	None.
Brighton Creamery, Island Pond, Vt. "C-B Butter"....................	Cummings Bros., Portland	30††	††
Brighton Creamery, Island Pond, Vt. "C-B Butter"....................	Ellery Starbird, Portland	6	3
Brighton Creamery, Island Pond, Vt. "C-B Butter"....................	W. E. Dyer, So. Portland........	3	2
Brighton Creamery, Island Pond, Vt. "B-C Butter"....................	W. S. Jordan & Co., Portland....	14	14
Brighton Creamery, Island Pond, Vt. "B-C Butter"....................	Cummings Bros., Portland	30††	††
Brighton Creamery, Island Pond, Vt. "Pure Creamery Butter C-B".....	Cummings Bros., Portland........	60††	None.
Corinth Creamery Assoc., E. Corinth, Me............................	E. J. Peters, Orono.............	10	None.
Cudahy Packing Co., Kansas City, Mo.	Arthur Davieu, Watervil'e	5	None.
Fox River Butter Co., "Beechwood Creamery Butter"	G. H. Philbrook, Portland.......	6	None.
Fox River Butter Co., "Meadow Gold Butter"	B. R. Jordan, Brunswick........	5	None.
Fox River Butter Co., "Meadow Gold Butter"	B. Spaulding & Sons, Buckfield..	5	None.
Fox River Butter Co., "Meadow Gold Butter"	F. H. Freese, Portland..........	4	None.
Fox River Butter Co., ' Meadow Gold Butter"	E. F. Ridlon, Portland..........	3	None.
Fox River Butter Co., "Meadow Gold Butter"	H. L. Starbird, Portland.	1	None.
Fox River Butter Co., "Meadow Gold Butter"	N. S. Burnham, Portland	2	None.

† No brick considered short weight unless shortage was more than one-quarter ounce.
†† See text.

Table giving report of butter weighed by the inspectors at dealers. —Continued.

Maker, and Brand, if Any.	Where Found.	Number bricks weighed.	†Number bricks short weight.
Hillside Creamery, Bangor, Me. "Hillside Butter"	E. F. Piper, Bangor	5	None.
Hillside Creamery, Bangor, Me. "Hillside Butter"	Beaulieu Bros., Oldtown	6	None.
Hillside Creamery, Bangor, Me. "Hillside Butter"	C. T. Page, Orono	3	None.
Hillside Creamery, Bangor, Me. "Hillside Butter"	F. S. Jones & Co., Bangor	5	5
Hillside Creamery, Bangor, Me. "Hill side Butter"	Spruce Bros. & Co., Milford	8	8
Hillside Creamery, Bangor, Me. "Hillside Butter	W. L. Butterfield, Greatworks	13	13
Lewis, Mears & Co., Boston. "Standard Creamery Butter"	Geo. E. Beauchesne, Portland	6	None.
Lewis, Mears & Co., Boston. "Standard Creamery Butter"	N. Tetreault, Biddeford	9	1
Lewis, Mears & Co., Boston. "Standard Creamery Butter"	F. H. Verrill, Portland	5	1
Maine Creamery Assoc., Bangor, Me. "Kineo Butter"	W. D. Matheson, Bangor	3	1
Maine Creamery Assoc., Bangor, Me. "Kineo Butter"	W. H. Tribeau, Hampden	4	None.
Maine Creamery Assoc., Bangor, Me. "Kineo Butter"	Gallagher Bros., Bangor	8	1
Maine Creamery Assoc., Bangor, Me. "Kineo Butter"	James I. Park, Orono	15	11
Maine Creamery Assoc., Bangor, Me. "Kineo Butter"	Beaulieu Bros., Oldtown	6	5
Maine Creamery Assoc., Bangor, Me. "Kineo Butter"	C. T. Page, Orono	5	None.
Maine Creamery Assoc., Bangor. Me. "Kineo Butter"	Doyle & Carter, Brewer	1	None.
Maine Creamery Assoc., Bangor, Me. "Kineo Butter"	Lord Bros., Bangor	4	None.
New England Creamery Co., Livermore Falls, Me	Nap. L. Hereaux, Chisholm	6	None.
New England Creamery Co., Livermore Falls, Me	S. B. Ellis, Canton	4	None.
New England Creamery Co., Livermore Falls, Me	J. S. Barker, Canton	5	None.
Oxford County Creamery	James N. Tubbs, Norway	5	None.

† No brick considered short weight unless shortage was more than one-quarter ounce.

Table giving report of butter weighed by the inspectors at dealers. —Continued.

Maker, and Brand, if Any.	Where Found.	Number bricks weighed.	†Number bricks short weight.
Poland Dairy Co., Poland, Me. "Finest Grade Creamery Butter"	M. P. Frank, Bangor	6	None.
Poland Dairy Co., Poland, Me., "Finest Grade Creamery Butter"	Henry Gagnon, Biddeford	7	None.
Poland Dairy Co., Poland, Me. "Finest Grade Creamery Butter"	J. A. Garneau & Co., Waldo	11	None.
Poland Dairy Co., Poland, Me. "Finest Grade Creamery Butter"	Gautier Bros., Rumford	2	None.
Poland Creamery, Poland, Me. "Shaw's St. Lambert Butter"	Geo. C. Shaw Co., Portland	7	None.
Portland Creamery, Portland, Me. "P-C Brand"	J. C. Collins, Portland	3	3
Portland Creamery, Portland, Me. "Sweet Butter"	B. Cohen, Portland	5	3
Portland Creamery, Portland, Me. "P-C Brand"	A. Menard, Biddeford	8	None.
Portland Creamery, Portland, Me.. "P-C Brand"	L. A. Talbot, Biddeford	9	None.
Portland Creamery, Portland, Me. "P-C Brand"	Rowe & Meserve, Portland	12	1
Portland Creamery, Portland, Me. "P-C Brand"	A. G. Todd, Portland	4	1
Portland Creamery, Portland, Me. "P-C Brand"	C. H. Stowell, Portland	5	3
Portland Creamery, Portland, Me. "P-C Brand"	L. J. Bettey, Westbrook	7	None.
Portland Creamery, Portland, Me. "P-C Brand"	F. N. Tucker, Portland	12	None.
Portland Creamery, Portland, Me. "P-C Brand"	T. L. Callan, Portland	9	None.
Portland Creamery, Portland, Me. "P-C Brand"	Henry F. Owen, Portland	13	None.
Portland Creamery, Portland, Me. "P-C Brand"	W. S. Dunn & Co., Portland	9	None.
Portland Creamery, Portland, Me. "North Stratford"	W. S. Dunn & Co., Portland	1	None.
Portland Creamery, Portland, Me. "P-C Brand"	James DeWolfe & Co., Portland	3	None.
Portland Creamery, Portland, Me. "P-C Brand"	M. J. Flaherty, Portland	5	4
Portland Creamery, Portland, Me. "P-C Brand"	M. J. Flaherty, Portland	3	3

† No brick considered short weight unless shortage was more than one-quarter ounce.

Table giving report of butter weighed by the inspectors at dealers.
—Continued.

MAKER, AND BRAND, IF ANY.	Where Found.	Number bricks weighed.	†Number bricks short weight.
Portland Creamery, Portland, Me. "P-C Brand"	C. M. Bowker Co., Portland	4	1
Portland Creamery Co., Portland, Me. "P-C Brand"	Smith Specialty Co., Portland	4	None.
Portland Creamery, Portland, Me. "P-C Brand"	L. P. Senter & Co., Portland	7	None.
Portland Creamery, Portland, Me. "North Stratford"	Fred B. Estes, Portland	6	None.
Portland Creamery, Portland, Me. "P-C Brand"	Fred B. Estes, Portland	5	4
Portland Creamery, Portland, Me. "P-C Brand"	O. C. Elwell, Portland	12	2
Portland Creamery, Portland, Me. "P-C Brand"	Tuttle Bros., Portland	6	None.
Portland Creamery, Portland, Me. "P-C Brand"	Albert Dingley, Portland	3	1
Portland Creamery, Portland, Me. "P-C Brand"	A. C. Noyes, Portland	3	None.
Portland Creamery, Portland, Me. "P-C Brand"	Ellery Starbird, Portland	6	2
Portland Creamery, Portland, Me. "North Stratford"	W. S. Bailey, Portland	5	None.
Portland Creamery, Portland, Me. "P-C Brand"	E. F. Ridlon, Portland	3	1
Portland Creamery, Portland, Me.. "P-C Brand"	N. S. Burnham, Portland	5	2
Portland Creamery, Portland, Me	E. D. Leonard, Portland	2	1
Portland Creamery, Portland, Me	H. S. Starbird, Portland	2	None.
Portland Creamery, Portland, Me	A. F. Archibald, Portland	1	None.
Portland Creamery, Portland, Me	J. A. Small, Portland	1	None.
Portland Creamery, Portland, Me. "P-C Brand"	John Slimas, Portland	2	1
Portland Creamery, Portland, Me. "P-C Brand"	W. J. Lucas, Portland	6	None.
Portland Creamery, Portland, Me. "P-C Brand"	A. J. Curtis & Co., Portland	6	2
Portland Creamery, Portland, Me. "P-C Brand"	D. A. Dufresne, Portland	8	None.
Portland Creamery, Portland, Me. "P-C Brand"	John Quinn, Portland	4	None.

† No brick considered short weight unless shortage was more than one-quarter ounce.

Table giving report of butter weighed by the inspectors at dealers.
—Continued.

Maker, and Brand if Any.	Where Found.	Number bricks weighed.	†Number bricks short weight.
Portland Creamery, Portland, Me. "P-C Brand"	James J. McCartney, Portland	9	None.
Portland Creamery, Portland, Me. "P-C Brand"	Patrick Bannigan, Portland	2	None.
Portland Creamery, Portland, Me. "P-C Brand"	J. T. Dougherty, Portland	5	None.
Portland Creamery, Portland, Me. "P-C Brand"	Carl P. Christenson, Portland	1	None.
Portland Creamery, Portland, Me. "P-C Brand"	Littlefield & Co., Portland	8	None.
Portland Creamery, Portland, Me. "P-C Brand"	C. T. Swett & Co., Portland	9	3
S. & S. Bangor	F. W. Wentworth, So. Brewer	5	None.
Skowhegan Jersey Creamery, Skowhegan, Me	Frank E. McCullum, Waterville	14	5
Skowhegan Jersey Creamery, Skowhegan, Me	Tondreau Bros. Co., Brunswick	5	1
John P. Squire & Co	S. S. Herrick & Co., So. Brewer	5	None.
John P. Squire & Co. "Arlington Creamery Butter"	D. Rooney, Brewer	4	2
John P. Squire & Co. "Arlington Creamery Butter"	C. G. Hamilton, Orono	2	2
Swift & Co. "Brookfield Extra Creamery Butter"	E. J. Peters, Orono	5	None.
Swift & Co. "Brookfield Extra Creamery Butter"	W. T. Howe, Portland	3	None.
Swift & Co., "Brookfield Extra Creamery Butter"	C. E. Parker, Portland	6	None.
Swift & Co., "Brookfield Extra Creamery Butter"	O. C. Elwell, Portland	3	None.
Swift & Co., "Brookfield Extra Creamery Butter"	F. H. Freese, Portland	4	2
Swift & Co., "Brookfield Extra Creamery Butter"	Wallace Frank, Portland	5	None.
Turner Center Creamery, Auburn, Me.	Chas. Champine, Waterville	5	None.
Turner Center Creamery, Auburn, Me.	L. D. Snow, Brunswick	4	None.
Turner Center Creamery, Auburn, Me.	J. W. Cornish, Topsham	12	None.
Turner Center Creamery, Auburn, Me.	C. E. Allen, West Minot	5	None.
Turner Center Creamery, Auburn, Me. Guaranteed Pure Butter.	C. C. Elwell, Portland	5	None.

† No brick considered short weight unless shortage was more than one-quarter ounce.

Table giving report of butter weighed by the inspectors at dealers.
—Continued.

Maker, and Brand, if Any.	Where Found.	Number bricks weighed.	†Number bricks short weight.
Waterford Creamery Co., So. Waterford., "Pure Creamery Butter"	Greene & Barrett, Portland	14	5
Waterford Creamery Co., So. Waterford, "Pure Creamery Butter"	R. H. Merrow, Saco	7	None.
Waterford Creamery Co., So. Waterford	Greene & Barrett, Portland	21	9
Yorkshire Creamery Co	James I. Park, Orono, Maine	6	5
Yorkshire Creamery Co	Roussin & Poirier, Biddeford	4	None.

Dairy or Country Butter—Source Known.

Geo. Adjutant, So. Windham	A. G. Peabody & Son, So. Windham	5	None.
Mrs. K. C. Allen, Hampden, Me	J. A. Stuart, Bangor	4	1
Harry Anderson, Brunswick	W. F. McFadden, Brunswick	1	None.
Steve Anderson, Gorham	S. F. Hopkinson, Westbrook	4	None.
Ed. Batcheldor, Corinth	F. S. Jones & Co., Bangor	6	1
Chas. F. Berry, Raymond	Cornwall Cash Grocery Co., Portland	9	None.
W. E. Bowen, Cornish	H. H. Hickson Sons, Bangor	5	None.
W. D. Bowley, Scarborough	V. T. Shaw, Scarborough	2	None.
Mrs. J. Breau, Lee	C. F. Anderson, Bangor	5	None.
F. B. Burnhan, Buxton Center	H. L. Starbird, Portland	3	None.
L. N. Burnham, Bonny Eagle	A. C. Mann, Portland	12	None.
L. E. Burnham, Bonny Eagle	W. S. Dunn & Co., Portland	3	None.
L. E. Burnham, Bonny Eagle	W. S. Dunn & Co., Portland	5	1
L. N. Burnham, Standish, Me	W. S. Dunn & Co., Portland	8	1
C. L. Burrell, Amherst	J. F. Flemming, Bangor	3	None.
C. J. Chandler, East Corinth	H. E. McDonald, Bangor	5	None.
C. W. Chaplin, No. Gorham	L. P. Senter & Co., Portland	5	5
W. A. Chipman, Gray	J. Saunders & Son	19	None.
Geo. Clark	B. K. Meservey, Waterville	5	1
Alfred Clifford, Brunswick	H. T. Nason, Brunswick	5	None.
Geo. F. Crockett, Durham	B. R. Jordan, Brunswick	3	None.

† No brick considered short weight unless shortage was more than one-quarter ounce.

Table giving report of butter weighed by the inspectors at dealers. —Continued.

Maker, and Brand, if Any.	Where Found.	Number bricks weighed.	†Number bricks short weight.
Mr. Day, Day's Mills	J. E. Hobbins, Biddeford	5	5
Davis Dow Co., Bridgton	J. H. Charles & Co., Portland	6	None.
L. Decker & Son, Hinckley	John Fitts & Son, Portland	6	None.
L. Decker & Son, Hinckley	J. F. Flemming, Bangor	5	None.
L. Decker & Son, Hinckley	C. A. Mills, Oldtown	4	None.
L. Decker & Son, Hinckley	John Fitts & Son, Portland	6	None.
L. Decker & Son, Hinckley	E. R. Ridlon, Portland	7	2
E. C. Dow, Bradford	C. G. Hamilton, Orono	61	48
E. C. Dow, Bradford	C. G. Hamilton, Orono	9	9
E. C. Dow, Bradford	Pearl Clark, Orono	10	10
Mr. Dow, West Levant	F. S. Jones & Co., Bangor	6	None.
Mr. Dow, Orono	W. O. Lutes, Stillwater	5	None.
Dow & Libby, W. Pownal	C. W. Horton, Portland	9	None.
Dow & Libby, W. Pownal	Mrs. G. Reardon, Portland	20	3
Dow & Libby, W. Pownal	Mrs. G. Reardon, Portland	16	None.
C. S. Ellis, Levant	Lord Brothers, Bangor	5	None.
Mr. Walter Emery, Standish	Butler & Barrows, Portland	4	None.
Mr. Walter Emery, Standish	Butler & Barrows, Portland	6	None.
C. E. Foster, East Corinth	H. E. McDonald, Bangor	6	None.
Mr. Forsyth, Bradley	F. C. Barton, Bradley	3	None.
Sherman French, Levant	F. S. Jones & Co., Bangor	6	1
Sherman French, Levant	Leighton's Market, Bangor	6	None.
Elmer Frost	F. E. Mayo, Pittsfield	2	None.
C. A. Gerry, E. Corinth	H. E. McDonald, Bangor	4	None.
I. B. Gilman, No. Gorham	L. P. Senter & Co., Portland	6	None.
Mr. Gilsland, Falmouth Foreside	O. C. Elwell, Portland	5	None.
Mrs. Hamilton, Gorham	A. G. Peabody & Son, S. Windham	4	4
M. L. Grant, Bradley	F. C. Barton, Bradley	4	None.
Richard O. Grant, No. Saco	John A. Libby, Saco	2	None.
Geo. Gray, Six Mile Falls, Me	W. L. Clark, Bangor	4	None.
Mr. Green	Hersom & Bonsall, Waterville	8	5
Harry Griffin, Brunswick	S. A. Walker, Brunswick	3	None.

† No brick considered short weight unless shortage was more than one-quarter ounce.

Table giving report of butter weighed by the inspectors at dealers. —Continued.

Maker, and Brand, if Any.	Where Found.	Number bricks weighed.	†Number bricks short weight.
Mr. Hammond, E. Eddington	A. F. Anderson, Bangor	4	None.
D. W. Higgins, Levant	Lord Bros., Bangor	10	8
J. C. Hodgkins, Hampden	Lennan & Nickerson, Hampden	6	None.
Mr. Hayford, Hampden	M. K. Pomery, Hampden	4	4
R. B. Jellerson, Goodwin's Mill	Victor Beaudette, Biddeford	5	None.
R. B. Jellerson, Goodwin's Mill	Andre Poirier, Biddeford	12	None.
Randall Johnson, Walnut Hill	Paul Blumenthal, Portland	8	None.
Sam Jordan, Scarborough, "Jersey Butter"	W. S. Dunn & Co., Portland	10	10
Sam Jordan, Scarborough. "Jersey Butter"	W. S. Dunn & Co., Portland	10	1
Chas. Kincaid, E. Brunswick	A. I. Snow, Brunswick	4	None.
C. W. Kincaid, New Meadows	C. A. Pierce & Son, Brunswick	6	None.
Mr. Knights, Gray	H. Leighton, Portland	5	None.
Will Lord	Robinson & Davison, Waterville	6	6
Edward Loring, Walnut Hill	J. M. Mulkern, Portland	18	None.
Mrs. Clem Lowell, Lee	A. F. Anderson, Bangor	8	None.
F. C. Luce, New Vineyard	J. M. Edwards & Son, Portland	6	5
Mr. Mace, Orrington	D. Rooney, Brewer	4	None.
Geo. Means, Clinton	H. M. Bean, Clinton	6	None.
Frank March	H. B. Blake & Co., Monmouth	9	None.
C. M. Marshall, Bowdoin	E. M. Alexander, Brunswick	3	None.
Frank Marston, Yarmouth	V. B. Fuller, Portland	4	None.
F. E. Mayo	W. O. Blake, Portland	10	None.
Chas. McLaughlin, Portland.	Chas. Maloney, Portland	6	None.
Edward Merrill, North Saco	John A. Libby, Saco	13	13
H. N. Merrill, Buxton	B. L. Johnson, Portland	14	14
H. N. Merrill, Buxton	Cummings Bros., Portland	80	None.
H. N. Merrill, Buxton	Browne & Bishop, Portland	12	5
J. C. Merrill, St. Albans	E. A. Haley, Bangor	3	None.

† No brick considered short weight unless shortage was more than one-quarter ounce.

Table giving report of butter weighed by the inspectors at dealers. —Continued.

MAKER, AND BRAND, IF ANY.	Where Found.	Number bricks weighed.	†Number bricks short weight.
Herbert Morrill	F. C. Webb, Brunswick	3	None.
Geo. Palmer, Levant	F. S. Jones & Co., Bangor	9	5
Mr. Parker, Cornish	West End Cash Market, Westbrook	12	None.
Mr. Pease, No. Parsonfield	W. L. Wilson & Co., Portland	12	8
A. R. Peavey	E. L. Craig, Waterville	8	3
H. M. Peterson, Woodfords Sta	C. O. Lund & Co., Portland	6	None.
Chas. Philbrook, Hampden Highlands	A. Z. Cowan, Hampden	3	None.
Mrs. Geo. Phillips, Hampden	W. H. Tribeau, Hampden	1	None.
Perkins Creamery, Kennebunk	Roussin & Poirier, Biddeford	6	None.
A. H. Randall	City Market, Waterville	9	4
Ida Roberts	F. E. Mayo, Pittsfield	3	None.
Everett Rogers, Topsham	A. W. McMillen, Topsham	3	None.
Mr. Rogers, Topsham	W. F. McFadden, Brunswick	4	None.
Frank Rowe, Oakland	Collins' Market, Waterville	7	None.
Geo. Rowe, China	Harry Pomerleau, Waterville	6	None.
Geo. Rowe, China	Libby & Pooler, Waterville	12	6
George Rowe, China	Gideon Mahew, Waterville	6	3
Peter Ryan, Orono	W. S. Averill, Orono	1	None.
F. C. Sanborn, Gorham	W. H. Pullen, Portland	3	None.
Mrs. Frank Sawyer, So. Windham	A. G. Peabody & Son, S. Windham	5	None.
Mr. Sawyer, W. Buxton	W. C. Lamb, Portland	3	None.
E. Y. Shaw, Topsham	C. A. Lemieux, Brunswick	1	1
E. Y. Shaw, Topsham	C. A. Lemieux, Brunswick	6	6
W. H. Sherman, Liberty	A. H. Kane, Bangor	6	None.
Shorey Bros., Eddington	Harlow Bros., Brewer	8	None.
Geo. T. Libby, Scarborough	Fred N. Newcomb, Scarborough	11	None.
Mr. Evans Libby, No. Saco	John A. Libby, Saco	5	None.
C. R. Smith, E. Exeter	Fred McAvey, Bangor	5	None.
J. B. Smith	G. A. Kennison, Waterville	5	5
A. D. Stillson, Parkman	E. A. Haley, Bangor	3	None.
Mr. Sylvester, Scarborough	A. G. Todd, Portland	3	None.

† No brick considered short weight unless shortage was more than one-quarter ounce.

Table giving report of butter weighed by the inspectors at dealers. —Continued.

Maker, and Brand, if Any.	Where Found.	Number bricks weighed.	†Number bricks short weight.
Harvey Tarr, Brunswick	A. D. Snow, Brunswick	4	None.
N. P. Thims, Falmouth	C. O. Lund & Co., Portland	6	None.
Rose B. Tuck, Lee	A. F. Anderson, Bangor	4	None.
J. H. Tufts, Intervale	T. G. Moran, Portland	7	None.
Herbert Turner, Topsham	M. G. Powers, Topsham	4	None.
A. A. Tuttle, Carmel	S. E. Rudman, Bangor	10	10
University of Maine	E. H. White, Orono	4	None.
R. L. Varnum	F. E. Mayo, Pittsfield	3	None.
Lewis M. Verrill, W. Gray	W. C. Lamb, Portland	6	4
Frank Ward, Ea. Monmouth	C. A. Whitehouse, Monmouth	6	None.
Mr. Waterman, W. Buxton	S. F. Hopkinson, Westbrook	24	17
F. L. Wescott, Sebago Lake	Geo. C. Shaw Co., Portland	11	11
Willis Wheeman, Standish	N. S. Burnham, Portland	4	None.
Willis Wheeman, Standish	N. S. Burnham, Portland	18	18
Fred Wiggin, Levant	J. F. Flemming, Bangor	7	6
Osborne Woodard, Brunswick	H. T. Nason, Brunswick	4	None.
Jack Worster, Carmel	J. E. Foley, Bangor	6	None.

Country or Dairy Butter—Source Not Known.

Not known	Mary F. Ayer, So. Brewer	2	None.
" "	Valliere & Baillargeon, Biddeford	6	None.
" "	Joseph Beauchesne, Waterville	8	3
" "	M. Belaire, Biddeford	6	None.
" "	C. J. Blom, Portland	4	None.
" "	F. I. Brown, Readfield	5	None.
" "	Browne & Bishop Co., Portland	12	None.
" "	Butler & Barrows, Portland	5	None.
" "	Casseboom & Thompson, Saco	4	None.
" "	J. H. Charles, Portland	9	6
" "	J. H. Charles, Portland	6	6

† No brick considered short weight unless shortage was more than one-quarter ounce.

Table giving report of butter weighed by the inspectors at dealers. —Continued.

Maker, and Brand, if Any.	Where Found.	Number bricks weighed.	†Number bricks short weight.
Not known	S. E. Rudman, Bangor	5	None.
" "	E. F. Cote, Waterville	12	None.
" "	F. L. Daggett, S. Portland	6	5
" "	Albert Dingley, Portland	4	None.
" "	W. H. Dow, Bangor	2	None.
" "	Thomas Dyer, Portland	11	6
" "	William Emery, Saco	5	5
" "	J. E. Foley, Bangor	4	None.
" "	J. E. Foley, Bangor	4	None.
" "	A. H. Gilman, Veazie	12	12
' "	C. W. T. Goding, Portland	8	None.
" "	O. O. Gould, Dixfield	4	None.
" "	E. L. Gove, Waterville	6	1
" "	Scott Hefler, Portland	4	None.
" "	H. H. Hickson & Son, Bangor	5	None.
" "	J. W. Hines, West Farmington	6	None.
" "	John E. Hobbins, Biddeford	4	4
" "	G. F. Horner, Portland	10	None.
" "	John D. Johnson, Portland	5	None.
" "	W. A. Johnson, Portland	24	17
" "	R. A. Jones, Portland	12	6
" "	B. R. Jordan, Brunswick	3	None.
" "	Littlefield & Co., Portland	10	None.
" "	A. D. Lovell, Portland	10	10
" "	F. E. Mayo, Pittsfield	2	None.
" "	John A. Moreshead, Portland	18	11
" "	J. A. Moreshead, Portland	8	None.
" "	H. A. Morrison, Livermore Falls	6	1
" "	E. H. Mosher, Belgrade	5	None.
" "	Oxford Market, Portland	1	1
" "	M. Parent, Brunswick	6	None.

† No brick considered short weight unless shortage was more than one-quarter ounce.

Table giving report of butter weighed by the inspectors at dealers. —Continued.

MAKER, AND BRAND, IF ANY.	Where Found.	Number bricks weighed.	†Number bricks short weight.
Not known	C. E. Parker, Portland	3	1
" "	Chas. Pomerleau, Waterville	11	5
" "	Pride Bros,. Portland	3	None.
" "	H. E. Purington, No. Jay	5	None.
" "	Ray & Stevenson, Bangor	4	None.
" "	Remich & Blow, Saco	5	None.
" "	W. E. Rideout, Bowdoinham	6	1
" "	Frank Robinson, Hampden	4	None.
" "	C. A. Rounds, Portland	2	None.
" "	Rounds & Stanton, Mechanic Falls	4	1
" "	Serunian-Amergian Co., Portland	3	None.
" "	W. W. Small Co., Farmington	6	None.
" "	A. L. Welch, Wilton	6	None.
" "	S. E. Whitcomb Co., Waterville	6	4
" "	A. A. Woodsum, Mechanic Falls	7	None.
COUNTY OR DAIRY BUTTER FROM OUT OF STATE.			
Mr. Keating, New Hampshire	A. C. Mann, Portland	6	None.
Vermont Dairy, Vermont,	A. F. Archibald, Portland	3	None.
C. F. Eddy & Co., Montpelier, Vt.	Sullivan & Osgood Co., Portland	30	9
PROCESS BUTTER.			
Hannaford Brothers, Portland, "Process Butter"	A. F. Archibald, Portland	1	None.
Swift & Co., Bangor, "Cold Rock"	F. W. Kyer, So. Brewer	4	None.
S. &. S. Co., Bangor, "Process Butter"	D. W. Matheson, Bangor	4	None.
J. P. Squire, Portland, "Renovated Butter"	O. J. Pelletier, Waterville	6	None.

† No brick considered short weight unless shortage was more than one-quarter ounce.

July, 1913.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

ANALYSTS

James M. Bartlett
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Official Inspections

52

SEED INSPECTION.

The first law regulating the sale of seeds was enacted by the Legislature of 1897. This was revised by the Legislature of 1905. This was again revised by the Legislature of 1911 so as to conform with the requirements recommended by the Association of Official Seed Analysts and agreed to by the American Seed Dealers Association. The chief requirements of the law follow. The full text of the law will be sent on request.

The Chief Requirements of the Law.

The following are the chief points of the law and the rules and regulations for carrying out the law regulating the sale of agricultural seeds which, as directed by the law, the Director of the Station, has made.

1. *Kind of seeds coming under the law.* The law applies to the sale, distribution, transportation, or the offering or exposing

for sale, distribution, or transportation of the seeds of alfalfa, barley, Canadian blue grass, Kentucky blue grass, brome grass, buckwheat, alsike clover, crimson clover, red clover, medium clover, white clover, field corn, Kaffir corn, meadow fescue, flax, hungarian, millet, oats, orchard grass, rape, redtop, rye, sorghum, timothy and wheat for seeding purposes.

2. *The brand.* Each lot or package shall be plainly marked with the name of the seed and its minimum percentage of purity.

3. *Mixtures.* Mixtures must be plainly marked with the name of the seed and the percentage of purity. In case the mixtures contain seeds not included in 1 these need not be named. (e. g., a mixture consisting of half redtop, 90 per cent pure, quarter Kentucky blue grass, 85 per cent pure and the remainder seeds not named in the law, could be marked "Redtop 45 per cent pure, Kentucky blue grass 21 per cent pure." The statement of the remaining constituents may or may not be named.)

4. *Adulteration.* A seed is adulterated if its purity falls below its guaranty or if it contains the seed of any poisonous plant.

5. *Misbranding.* A seed is misbranded if the package or label bears ony statement, design or device which is false or misleading in any particular, or if it does not carry the statements named in 2.

6. *Free analysis.* Free analysis of seeds on sale in Maine will be made of samples taken in accordance with directions furnished by the Station. Samples not so taken may be refused examination. Blanks with full directions will be furnished on request.

7. *Paid analysis.* As an accommodation to residents of Maine samples of seeds not on sale in Maine will be examined at cost, and the results will not be published. The cost of the analysis of blue grass or redtop is $1.00 per sample and for other seeds 50 cents. Remittance should accompany the sample.

8. *Written guaranty.* No prosecution will lie against any person handling agricultural seeds provided he obtains at the time of purchase a written guaranty signed by the person residing in the United States, from whom the purchase was made,

to the effect that the seeds are not adulterated or misbranded within the meaning of the Maine law regulating the sale of agricultural seeds. After a person has been notified by the Director of the Maine Agricultural Experiment Station that an article of agricultural seeds appears to be adulterated or misbranded the written guaranty will not protect further sales.

9. *Hearings.* The person who is believed to have violated the law regulating the sale of seeds will be granted a hearing at which he may appear in person or by attorney or by letter. The notice of the hearing will name the time and place of the hearing and a copy of the charge. Failure to appear will not prejudice the case. The hearing will be private and every opportunity will be given for explanation and establishment of innocence. If the time appointed is not a convenient one, postponement within reasonable limit will be granted.

The Maine Jobber and the Seed Trade.

For many years it was practically impossible for the Maine dealer in seeds, either wholesale or retail, to obtain seeds guaranteed as to their purity from without the State. The wholesale seed trade had assumed a position of non-guaranty probably unequaled in trade practice. If the same attitude had been assumed toward any commodity such as fertilizers, feeding stuffs or foods, the public would not have tolerated it. Because of education along the lines of seed purity and the enactment of laws requiring purity guaranty by so many states it is now more or less possible to purchase seeds from the large centers under a guaranty of purity.

Nevertheless it is still advisable for the dealer importing into this State seeds for sale to observe the practice suggested by the Station five years ago. In brief this is as follows: When a car of seed is ordered forward, request the shipper to send a type sample of the car together with the name of the shipper, the kind of seed and its special brand, the guaranty they place upon it, the lot number and the car number. Forward a portion of this type sample to the Station with remittance of one dollar for a sample of red top or fifty cents for other seeds to cover cost of analysis. The analysis will be promptly made and results reported. As soon as the car is received in the State take a sample from not less than six packages and forward to the Station. This sample should be accompanied by the name of the shipper, the kind of seed, the brand, the guaranty, the lot number and the car number. This will be regarded as an official sample and prompt, free analysis will be made and the results reported. In case of a discrepancy between the analysis of the type sample and the car sample the guaranty can be changed to correspond with fact, and a basis furnished upon which to make a claim against the shipper as to the quality of the seed.

The Seed Dealer and the Seed Distributor.

Most of the seed used in this State is bought by farmers locally. For the past few years complaints have been received by the Station from dealers in some localities that they were having what they considered to be unfair competition in the seed business from farmers, coöperative and grange stores, who acted as purchasing agents, taking the orders for seed and sending them nearly always to some out of the State seed house to be filled and shipped directly to individuals. It is perfectly lawful for a person within the State to act as purchasing agent for others and distribute seeds direct from the car without conforming to the requirements of the seed law. To buy seeds, deliver them and collect money at the time they are delivered is to put the seeds under the requirements of the State law and such a handler of seeds must conform to all of the requirements of the law. To receive paid orders for seeds, have them shipped to one address, and delivered direct from the car or railroad station to the person who placed the paid order exempts the seeds from the requirements of the State law. How many seeds are purchased in this latter way it is impossible to estimate. The farmer should however bear in mind that when he receives unguaranteed seeds he may be getting a very low grade seed instead of a seed equal to that sold at home and plainly guaranteed to be of a certain percentage of purity.

In 1912 it was reported that some lots of these seeds arrived without any guarantees whatever upon them of the percentage of purity. In 1913 a few lots of this seed from out of the State jobbers were found in the hands of farmers and retail dealers. Contrary to past reports this seed was all plainly guaranteed on bags and in some cases on bills also. In most cases it was either in accordance with guarantees or only slightly below. In the vicinity of Canton a man acting as purchasing agent ordered seed from N. Wertheimer & Sons of Ligonier, Indiana, and had them shipped direct to the consumers. The seed inspector drew samples of timothy, redtop and alsike clover from baggs received by a farmer at Canton Point. In each case the tags had printed on the backs: "Guaranteed 99% pure. N. Wertheimer & Sons." By analysis the timothy was found to be 98.5 per cent pure, the redtop 95.8 per cent pure and the alsike clover 97.4 per cent pure.

In another locality a coöperative association had seed from N. Wertheimer & Sons which were carried in stock and retailed. The lots carried were mammoth clover, alsike clover, timothy and redtop. The tags, except the ones of the redtop, had written on the backs: "Guaranteed 99% pure. N. Wertheimer & Sons." The tags on the redtop had written on the backs: "Guaranteed 98½% pure. N. Wertheimer & Sons." Samples of these seeds were drawn and taken to the laboratory. By analysis the mammoth clover was found to be 99.4 per cent pure, the alsike clover 97.1 per cent pure, the timothy 98.6 per cent pure and the redtop 97.1 per cent pure. N. Wertheimer & Sons write that they did not intend to guarantee their redtops but their guarantees were based on analyses of samples at other seed laboratories.

The Results of Inspection.

For several years the grass seeds on sale in the State have been inspected by the seed analyst. His experience makes it possible to tell by observation in most instances whether a seed is or is not up to its guaranteed purity. In 1913 he visited 348 dealers and examined 1211 samples of seeds. The varieties examined are given in the table on page 99. Of all this large number of lots of seed he found only 9 samples that seemed at all doubtful as to their quality. On examination at the Station

4 of these were passed as being in substanital accord with the guaranty. All parts of the State were visited. The stock in the hands of dealers, large and small, were generally examined. Out of over 1200 samples only 5 were appreciably below the guaranteed percentage of purity. Not only were the seeds practically all up to guaranty but for the most part all of the seeds sold in the State carry a high percentage of purity. The improvement in the quality of seed used in Maine in the past fifteen years is as gratifying as it is marvelous. It is safe to say that no other State is uniformly using as good seed as Maine. In fact the wholesale dealers and cleaners of seed claim that if all the States were as particular in their demands for seed of high quality there would not be enough to go around.

SEEDS SOLD UNLAWFULLY.

A few instances of unguaranteed seeds on sale were found and 5 lots were sufficiently below guaranty to warrant taking up the matter of adulteration. After investigation it was found necessary to prosecute in a few instances. The fines were paid and the cases are closed.

At a store in Aroostook county seed was found which came from W. H. Small & Co. of Evansville, Indiana. The bags were all marked with guarantees of purity. A seed branded "Climax Alsike. Guaranteed 95 to 98 per cent pure" might be a little misleading to a purchaser as the high mark of 98 appears and yet the seed might only be 95 per cent pure. In fact it is not guaranteed to be above 95 per cent pure. A sample of this alsike was taken to the laboratory and found to be 93.5 per cent pure, which is below the guaranty.

A dealer in the western part of the State had seeds which he bought from the Whitney-Eckstein Seed Co. of Buffalo, N. Y., and which at the time the inspector called were unguaranteed. The dealer sent to the Station a price list from this seed house which had printed on it: "Increase your sales by handling our leading brands. Their purity is considerably above any legislative requirement." This means nothing to the Maine trade as there are no standards. The law simply requires that seeds shall be marked plainly with the names of seeds and the guaranteed percentages of purity. Since these seeds were not so marked they were not in accord with the Maine requirements. Later the dealer received advice from the seed house that Pan American Red Clover would run 98 per cent pure, hungarian 97.5 per cent pure and strictly prime timothy 90 per cent pure. Samples of the seed were drawn by an inspector and sent to the laboratory where the red clover was found to be 88.3 per cent pure, the timothy 98.6 per cent pure and the hungarian 95.5 per cent pure.

The table (pages 100-102) showing the number and kinds of weed seeds found is based upon the examination made for dealers which are not here reported as well as upon a few official samples examined. Most of the samples here reported were drawn by the dealers.

Table showing the result of the inspection of seed in lots at dealers in 1913. These seeds were all examined at the dealers to see if they were in accord with guarantees upon them. In doubtful cases samples were taken to the laboratory.

Names of Seeds and Number of Lots of Each Inspected.												Total number of lots.	Number of dealers visited.
Timothy.	Red clover.	Alsike clover.	Mammoth clover.	Crimson clover.	White clover.	Redtop.	Hungarian.	Japanese millet.	German millet.	Kentucky blue grass.	Alfalfa.		
387	245	205	35	1	5	183	93	48	3	2	4	1211	348

A list of weed seeds found in seeds examined in 1913.

NOMENCLATURE, GRAY'S MANUAL, 17th EDITION 1908.

COMMON NAME.	SCIENTIFIC NAME.
American pennyroyal	Hedeoma pulegioides (L.) Pers.
American wild mint	Mentha canadensis (L.) Brig.
Barnyard grass	Echinochloa crusgalli (L.) Beauv.
Bird's foot trefoil	Lotus corniculatus L.
Black medick	Medicago lupulina L.
Blue field madder	Sherardia arvensis L.
Bracted plantain	Plantago aristata Michx.
Bull thistle	Cirsium lanceolatum (L.) Hill.
Canada thistle	Cirsium arvense (L.) Scop.
Catnip	Nepeta cataria L.
Common chickweed	Stellaria media (L.) Cyrill.
Common nightshade	Solanum nigrum L.
Common speedwell	Veronica officinalis L.
Crabgrass	Digitaria sanguinalis (L.) Scop.
Crane's bill	Geranium macutatum L.
Dock	Rumex sp.
Evening primrose	Oenothera biennis L.
Ergot	†Claviceps purpurea (Fr.) Tul.
False flax	Camelina microcarpa Andrz.
Five finger	Potentilla monspeliensis L.
Flax dodder	Cuscuta epilinum Weihe.
Goosefoot	Chenopodium album L.
Green foxtail	Setaria viridis (L.) Beauv.
Heal-all	Prunella vulgaris L.
Hedge mustard	Sisymbrium officinale (L.) Scop.
Indian mallow	Abutilon theophrasti Medic.
Knot grass	Polygonum aviculare L.
Lady's thumb	Polygonum persicaria L.
Mayweed	Anthemis cotula L.
Mint	Mentha sp.
Moth mullein	Verbascum blatteria L.
Mouse-ear chickweed	Cerastium vulgatum L.
Night-flowering catchfly	Silene noctiflora L.
Old-witch grass	Panicum capillare L.
Ovoid spike rush	Eleocharis ovata (Roth.) R. & S.
Ox-eye daisy	Chrysanthemum leucanthemum L.
Ox-tongue	Picris echioides L.
Pennsylvania persicaria	Polygonum pennsylvanicum L.
Peppergrass	Lepidium virginicum L.
Pigweed	Amaranthus retroflexus L.
Plantain	Plantago major L.
Purslane	Portulaca oleracea L.
Ragweed	Ambrosia artemisiifolia L.
Ribgrass	Plantago lanceolata L.
Rugel's plantain	Plantago rugelii Done.
Sedge	Carex, unidentified.
Sheep sorrel	Rumex acetosella L.
Shepherd's purse	Capsella bursa-pastoris (L.) Medic.
Slender crabgrass	Digitaria filiformis (L.) Koeler.
Spurge	Euphorbia preslii Guss.
Tumble-weed	Amaranthus graecizans L.
Virginia three-seeded mercury	Acalypha virginica L.
White vervain	Verbena urticaefolia L.
Wild madder	Galium mollugo L.
Winged pigweed	Cycloloma atriplicifolium (Spreng.) Coult.
Wormseed mustard	Erysimum cherianthoides L.
Yarrow	Achillea millefolium L.
Yellow daisy	Rudbeckia hirta L.
Yellow foxtail	Setaria glauca (L.) Beauv.
Yellow rocket	Barbarea vulgaris R. Br.

†Sclerotia of the fungus.

Table showing results of examination of samples of seed in 1913.

Names of Weeds.	Kind of Seed and Number of Samples.							
	Red clover.	Alsike clover.	Mammoth clover.	Timothy.	Redtop.	Kentucky blue grass.	Millet.	Hungarian.
Number of samples examined	31	23	8	41	9	4	1	7
American pennyroyal	–	1	–	–	–	–	–	–
American wild mint	–	–	–	1	–	–	–	–
Barnyard grass	3	–	–	–	–	–	–	1
Bird's foot trefoil	1	–	–	–	–	–	–	–
Black medick	2	18	2	–	–	–	–	–
Blue field madder	1	–	–	–	–	–	–	–
Bracted plantain	3	–	–	2	–	–	–	–
Bull thistle	1	–	–	–	–	–	–	–
Canada thistle	1	2	–	1	–	–	–	–
Catnip	–	–	1	–	–	–	–	–
Common chickweed	–	1	–	1	–	–	–	–
Common nightshade	1	1	–	–	–	–	–	–
Common speedwell	–	–	–	–	–	3	–	–
Crabgrass	1	–	–	1	–	–	–	3
Crane's bill	2	–	1	–	–	–	–	–
Dock	13	9	4	4	–	–	–	–
Evening primrose	–	–	–	6	–	–	–	–
Ergot	–	–	–	9	9	1	–	–
False flax	–	8	–	1	–	–	–	–
Five finger	1	3	–	27	2	–	–	–
Flax dodder	1	–	–	–	–	–	–	–
Goosefoot	5	14	1	16	–	–	–	4
Green foxtail	25	2	7	4	–	–	–	7
Heal-all	1	1	–	1	–	–	–	–
Hedge mustard	–	–	–	6	–	–	–	–
Indian mallow	–	–	–	–	–	–	1	1
Knot grass	6	–	–	1	–	–	–	1
Lady's thumb	8	–	6	–	–	–	–	5

Table showing results of examination of samples of seed in 1913—Continued.

Names of Weeds.	Kind of Seed and Number of Samples.							
	Red clover.	Alsike clover.	Mammoth clover.	Timothy.	Redtop.	Kentucky blue grass.	Millet.	Hungarian.
Mayweed	3	2	1	9	1	–	–	–
Mint	–	–	–	–	7	–	–	–
Moth mullein	–	–	–	1	3	–	–	–
Mouse-ear chickweed	–	8	–	2	3	3	–	–
Night flowering catchfly	2	19	1	–	–	–	–	–
Old-witch grass	10	5	2	6	–	–	1	4
Ovoid spike rush	–	–	–	1		–	–	–
Ox-eye daisy	–	1	–	1	–	–	–	–
Ox-tongue	2	–	–	–	–	–	–	–
Pennsylvania persicaria	–	–	–	–	–	–	1	–
Peppergrass	2	10	–	37	2	–	–	–
Pigweed	1	2	–	3	–	–	–	–
Plantain	–	2	–	4	3	–	–	–
Purslane	–	1	–	2	–	2	–	–
Ragweed	13	–	6	–	–	–	1	–
Ribgrass	18	3	2	5	–	1	–	–
Rugel's plantain	19	7	7	24	–	–	–	–
Sedge	–	1	–	17	6	4	–	–
Sheep sorrel	13	19	4	22	2	2	–	–
Shepherd's purse	–	3	–	4	–	1	–	–
Slender crabgrass	9	1	1	–	–	–	–	3
Spurge	3	1	3	–	–	–	–	–
Tumble-weed	1	–	–	2	–	–	–	3
Virginia three-seeded mercury	8	–	3	1	–	–	–	1
White vervain	1	–	1	–	–	–	–	–
Wild madder	–	–	1	1	–	–	–	–
Winged pigweed	–	–	–	–	–	–	1	–
Wormseed mustard	–	3	–	1	–	–	–	–
Yarrow	–	–	–	5	9	–	–	–
Yellow daisy	–	–	–	5	1	–	–	–
Yellow foxtail	1	–	1	–	–	–	–	6
Yellow rocket	–	2	–	1	–	–	–	–

Table showing the kind of seed, name and location of dealer, and the results of analysis of official samples taken in 1913.

Station number.	Kind of Seed, Name and Town of Dealer Special Marks.	Purity.		Impurities.		
		Guaranteed.	Found.	Inert matter.	Harmless—Foreign.	Noxious—Foreign.
		%	%	%	%	%
	Central Maine Co-operative Association, Dover.					
7222	"Alsike, N. Wortheimer & Sons"	99.0	97.1	0.6	1.6	0.7
	Haskell Implement & Seed Co., Lewiston.					
7151	"XXX Alsike, Choice No. 86672"	–	97.5	0.6	1.2	0.7
7153	"XXXX Alsike, No. 86661"	98.0	98.1	0.1	0.9	0.9
	S. Nightingale & Son, Fort Fairfield.					
7237	"Climax Alsike 8005, 95 to 98% pure"	95.0	93.5	1.8	4.1	0.6
	H. L. Worden, Canton Point.					
7240	"Alsike 60, N. Wortheimer & Sons"	99.0	97.4	0.6	1.5	0.5
	RED CLOVER.					
	Haskell Implement & Seed Co., Lewiston.					
7148	"XX Clover, Prime No. 78243"	96.0	96.7	0.9	0.6	1.8
7149	"XXX Clover, Choice No. 78266"	98.0	97.9	0.8	0.2	1.1
7150	"XXXX Clover, Purity No. 78290"	99.0	99.3	0.5	0.1	0.1
	A. A. Howes & Co., Belfast.					
7212	"Choice Red Clover"	97.0	96.2	1.9	0.6	1.3
	H. A. Smith, Litchfield.					
7209	Red clover	–	96.9	1.0	0.6	1.5
	F. A. Webster & Son, South Berwick.					
7231	"Pan American Red clover"	98.0	88.3	2.3	7.6	1.8
	HUNGARIAN.					
	Haskell Implement & Seed Co., Lewiston.					
7117	"Prime Hungarian"	98.0	97.9	0.8	0.0	1.3
	F. A. Webster & Son, South Berwick.					
7233	Hungarian	97.5	95.5	4.1	0.0	0.4
	REDTOP.					
	Central Maine Co-operative Association, Dover.					
7223	"Red Top, N. Wortheimer & Sons"	98.5	97.1	1.7	0.6	0.6
	Haskell Implement & Seed Co., Lewiston.					
7154	"XXX Red Top, No. 92094"	93.0	92.7	6.0	0.8	0.5
7155	"XXXX Red Top, No. 92058"	97.0	97.8	1.9	0.0	0.3
	A. A. Howes & Co., Belfast.					
7214	"Fancy Red Top"	96.2	96.0	2.8	0.9	0.3
	H. L. Worden, Canton Point.					
7241	"Red Top, No. 28, N. Wortheimer & Sons"	99.0	95.8	1.8	1.7	0.7

Table showing the kind of seed, name and location of dealer, and the results of analysis of official samples taken in 1913—Concluded.

Station number.	KIND OF SEED, NAME AND TOWN OF DEALER. SPECIAL MARKS.	PURITY. Guaranteed.	PURITY. Found.	IMPURITIES. Inert matter.	IMPURITIES. Harmless—Foreign.	IMPURITIES. Noxious—Foreign.
	TIMOTHY.					
	Central Maine Co-operative Association, Dover.					
7224	"Timothy, N. Wortheimer & Sons"..........	99.0	98.6	0.6	0.6	0.2
	E. P. Ham, Lewiston.					
7105	"Pan American Timothy"..................	99.0	97.4	0.8	1.3	0.5
	Haskell Implement & Seed Co., Lewiston.					
7121	"Bison Timothy, No. 63468"..............	97.0	98.1	1.1	0.5	0.3
7125	"XXXX Timothy, No. 62612".............	99.6	99.7	0.2	0.1	0.0
	A. A. Howes & Co., Belfast.					
7211	"Bay State Timothy"....................	99.5	99.4	0.3	0.2	0.1
	G. J. Kuhn, Waldoboro.					
7106	"Pan American Timothy"..................	99.5	98.7	0.6	0.4	0.3
	G. H. Ryder, Brooks.					
7216	"Timothy"..............................	99.0	99.2	0.3	0.1	0.4
7217	"Timothy"..............................	99.0	99.1	0.3	0.1	0.5
	H. A. Smith, Litchfield.					
7207	Timothy................................	–	98.8	0.6	0.4	0.2
	H. A. Smith, Litchfield.					
7208	Timothy................................	–	98.6	0.8	0.4	0.2
7210	Timothy................................	–	98.9	0.6	0.4	0.1
	F. A. Webster & Son, South Berwick.					
7232	"Strictly Prime Timothy"................	90.0	98.6	0.4	0.5	0.5
	H. L. Worden, Canton Point.					
7239	Timothy, N. Wortheimer & Son.............	99.0	98.5	0.7	0.7	0.1
	MAMMOTH CLOVER.					
	Central Manie Co-operative Association, Dover.					
7225	"Mammoth clover, N. Wortheimer & Sons"...	99.0	99.4	0.2	0.1	0.3

September, 1913.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

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Official Inspections

53

FERTILIZER INSPECTION.

The reports of the analyses of the samples collected by the inspectors of the fertilizers found on sale in Maine in 1912 are here published together with such other information as seems pertinent.

Chief Requirements of the Law.

The following are the chief points of the law and the regulations. The full text of the law will be sent on application made to the Director of the Maine Agricultural Experiment Station, Orono, Maine.

1. *Kind of materials coming under the law.* The law applies to the sale, distribution, transportation, or the offering or exposing for sale, distribution or transportation, any materials used for fertilizing purposes the price of which exceeds $10 per ton.

The legislature of 1913 amended the fertilizer law so that after January 1, 1914, "Lime, marl or wood ashes intended for fertilizing purposes, and without regard to the price at which it is sold or offered for sale, shall be classed as a commercial fertilizer." All of the requirements and penalties relative to commercial fertilizers apply equally to lime, marl and wood ashes.

For many years the sale of materials other than mixed goods was so small that no notice was taken of it. As time went on, however, with the propagation of the ideas of home mixing, the demand for chemicals increased. For the last few years the most common chemicals such as acid phosphate, ground bone, nitrate of soda and the various potash salts are regularly registered by the companies handling them. In the case chiefly of companies manufacturing in the State it happens that other fertilizing constituents are sold in small amounts and primarily for experimental purposes. While the law is explicit there will until further notice, be no prosecutions made by the Director of the Maine Agricultural Experiment Station for the sale without registration of small amounts of these more unusual fertilizing constituents, provided the company can show that these goods were sold in good faith for experimental purposes. As a part of the indication that the goods were thus sold it should be explained to the customer exactly under what conditions the goods are sold; that they are unregistered; that they have not been or are not likely to be analyzed by the Director of the Maine Experiment Station and that the Director holds himself in no way responsible for the quality of these unlicensed goods sold for experimental purposes. Their sale is allowed because the Director does not regard it as the purposes of the law to either hamper ordinary business or hinder experiments on the part of the farmer. Whenever any goods thus offered experimentally come to be sold in considerable amount they must be registered the same as other fertilizing materials.

2. *The Brand.* Every lot or package shall be plainly marked with:

The number of net pounds in the package.

The name or trade mark under which it is sold.

The name and principal address of the manufacturer or shipper.

The minimum percentage of nitrogen, or its equivalent in ammonia, in available form.

The minimum percentage of available phosphoric acid (soluble and reverted).

The minimum percentage of total phosphoric acid.

The minimum percentage of potash soluble in water.

In the case of lime, marl and wood ashes each package shall, in addition to the above be plainly marked with:

The minimum and maximum percentage of total lime (Calcium oxide.)

The minimum and maximum percentage of total magnesia (magnesium oxide.)

The minimum and maximum percentage of lime combined as carbonate (Calcium carbonate).

The minimum and maximum percentage of magnesium combined as carbonate (magnesium carbonate.)

The minimum percentage of lime-sulphur (calcium sulphate) in gypsum or land plaster.

If a fertilizer (including lime, marl and wood ashes) is sold in bulk or put up in packages belonging to the purchaser, upon the request of the purchaser he shall be furnished with a copy of the statements named above.

3. *Manufacturers' certificate.* Before manufacturing, selling or distributing a commercial fertilizer a certified copy of the statements named in 2 shall be filed with the Director of the Maine Experiment Station.

4. *Manufacturers' sample.* When the Director shall so request, the manufacturer shall furnish a sealed package containing not less than two pounds of the commercial fertilizer.

5. *Registration fee.* A registration fee is assessed on any brand offered for sale, distribution or transportation in the State as follows: $10 for the nitrogen, $10 for the phosphoric acid and $5 for the potash contained or said to be contained in the fertilizer. The filing of the certificate and the payment of the fee is required from only one person for a given brand.

6. *Registration may be refused or canceled.* The Director of the Station may refuse to register any commercial fertilizer which bears a name that is misleading or deceptive or which would tend to mislead or deceive as to the materials of which it is composed. The Director also has power to cancel the regis-

tration of a fertilizer manufactured, sold, distributed or transported in violation of any of the provisions of the law.

7. *Adulteration.* A fertilizer is adulterated if its weight, composition, quality, strength or purity varies from its fixed guaranty or if it contains any materials deleterious to growing plants.

8. *Misbranding.* A fertilizer is misbranded if: the package or label carries any statement, design or device that is false or misleading in any particular; the container does not carry the statements named in 2; the printed statements attached to the container differ from the statements in the certificate; and if the registration fee has not been paid.

9. *Analysis for correspondents.* A special law provides that the station shall analyze samples of fertilizers on sale in Maine taken in accordance with the law and the 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 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.

13. *Executive.* The Director of the Station is directed to collect and analyze samples of fertilizers on sale in the State; to publish the results of the analyses together with additional information of public benefit; and to diligently enforce the provisions of the law.

After January 1, 1914 it will be the duty of the Commissioner of Agriculture to collect samples of fertilizers on sale in the State, to attend to the registration, and see that the provisions of the law are complied with. The analyses will be made by the Station and it will still be the duty of the Director to publish the results of the analyses together with additional information of public benefit.

Valuation of Fertilizers.

The agricultural value of any fertilizing constituent is measured by the value of the increase of the crop produced by its use, and is, of course, a variable factor, depending upon the availability of the constituent, and the value of the crop produced. The form of the materials used must be carefully considered in the use of manures. Slow-acting materials cannot be expected to give profitable returns upon quick-growing crops, nor expensive materials profitable returns when used for crops of relatively low value.

The agricultural value is distinct from what is termed "commercial value,' or cost in market. This last is determined by market and trade conditions, as cost of production of the crude material, methods of manipulation required, etc. Since there is no strict relation between agricultural and commercial or market value, it may happen that an element in its most available form, and under ordinary conditions of high agricultural value, costs less in market than the same element in less available forms and of a lower agricultural value. The commercial value has reference to the material as an article of commerce, hence commercial ratings of various fertilizers have reference to their relative cost and are used largely as a means by which the different materials may be compared.

The commercial valuation of a fertilizer consists in calculating the retail trade-value or cash-cost at freight centers (in raw materials of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer. Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates and similar articles, for which $20 to $75 per ton are paid, depend for their trade value exclusively on the substances, nitrogen, phosphoric acid and potash, which are comparatively costly and steady in price. The trade value per pound of the ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce. The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the trade-value of the above-named ingredients a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use.

For many years this Station has not printed an estimate of the commercial value of the different brands licensed in the State. If any one wishes to calculate the commercial value he can do so by using the trade values adopted for 1913 by the Experiment Stations of Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, Rhode Island and Vermont. These valuations represent the average retail prices at which these ingredients could be purchased during the three months preceding March 1, 1913, in ton lots at tide water in southern New England. On account of the greater distance from the large markets the prices for Maine at tide water would probably be somewhat higher than those quoted.

TRADE VALUES OF FERTILIZING INGREDIENTS FOR 1913.

	Cents per pound.
Nitrogen in nitrates	18½
in ammonia salts	18½
Organic nitrogen in dry and fine ground fish and blood	20
in cottonseed meal and castor pomace	20
in fine bone and tankage and in mixed fertilizers	19
in coarse bone and tankage	15

Phosphoric acid,	water-soluble	$4\frac{1}{2}$
	citrate-soluble	4
	in fine ground bone and tankage	4
	in cottonseed meal, castor pomace	4
	in coarse bone, tankage and ashes	$3\frac{1}{2}$
	in mixed fertilizers, if insoluble in ammonium citrate	2
Potash	as high grade sulphate and in forms free from muriate (chloride)	$5\frac{1}{4}$
	as muriate	$4\frac{1}{4}$
	in cottonseed meal and castor pomace	5

RULES FOR CALCULATING VALUATION OF FERTILIZERS.

The commercial valuation will be accurate enough as a means of comparison if the following rule is adopted:

Multiply 3.8 by the percentage of nitrogen.

Multiply 0.8 by the percentage of available phosphoric acid.

Multiply 0.4 by the percentage of insoluble phosphoric acid.

Multiply 1.05 by the percentage of potash.

The sum of these 4 products will be the commercial valuation per ton on the basis taken.

Illustration. The table of analyses shows a certain fertilizer to have the following composition: Nitrogen 3.30 per cent; Available phosphoric acid 8.00 per cent; Insoluble phosphoric acid 1.00 per cent; Potash 6.00 per cent. The valuation in this case will be computed thus:

Nitrogen,	3.8×3.30	$12 54
Available phosphoric acid,	0.8×8.00	6 40
Insoluble phosphoric acid,	0.4×1.00	40
Potash,	1.05×6.00	6 30
		$25 64

Since this rule assumes all the nitrogen to be organic and all the potash to be in the form of the sulphate, it is evident that the valuations thus calculated must not be taken as the only guide in the choice of a fertilizer. In every case the farmer should consider the needs of his soil before he begins to consider the cost. In many instances a little careful experimenting will show him that materials containing either nitrogen, potash, or phosphoric acid alone will serve his purpose as fully as a "complete fertilizer," in which he must pay for all three constituents, whether needed or not.

Available Nitrogen.

The availability of mineral nitrogen is well known and also that of the best forms of organic nitrogen. With the great increase in demand and consequent increase in price, and in accord with the modern idea of conservation, it has been necessary to press into use all obtainable forms of organic nitrogen. Under existing conditions if no examination of the quality of the organic nitrogen were made there would be a chance that low grade materials might be rated as high grade with a consequent injustice to both the consumer and honest manufacturer. Nitrogen from such sources as garbage tankage, leather waste, hair, etc., is usually of low availability and only slowly taken up by the plant.

For several years chemists have recognized this condition and many attempts have been made to devise practical laboratory methods for determining the quality of the nitrogen in mixed goods. Some of these methods while fairly accurate are too time consuming to admit of their use in inspection work. The method which seems to promise to be quite satisfactory is the so-called alkalin permanganate method which was suggested from the use of this chemical to determine albuminoid nitrogen in water analyses. As far back as 1893-4 some work was done with permanganate of potash in this laboratory in an attempt to use it to determine whether leather waste was being used in some fertilizers. Later Mr. S. H. T. Hayes, a former assistant in this Station, worked out the method while a post-graduate student at Cornell University. Mr. Hayes' paper was published in Bulletin 47 of the Bureau of Chemistry, U. S. Department of Agriculture, in which is given both the alkaline and acid permanganate methods. Since that time a few experiment stations have continued investigations in this line.

At a meeting of the directors of the New England States, New York and New Jersey, held in Boston in March 1910, the whole question of the quality of the organic nitrogen in commercial fertilizers was thoroughly discussed and the urgent need of an adequate discriminatory method was generally recognized. A committee was appointed, consisting of the chemists of the Vermont, Connecticut (State) and Rhode Island Stations to further investigate the applicability of chemical methods to the determination of availability of organic nitrogen and report at a similar meeting in March, 1911. As a result of this investigation the alkaline permanganate method, somewhat modified, was adopted to be used by the several states represented in determining the grade of organic nitrogen in fertilizers inspected.

The alkaline permanganate method adopted is open to some criticism. It is assumed in this method that all organic nitrogen soluble in water is available or active. This assumption is probably generally correct, but may not be always, as it has been found that some soluble forms of leather treated with alkali are not more available than the raw material. Again in the case of a high grade fertilizer such as is generally used in the potato growing region of this State, often not more than 0.3 per cent of water insoluble nitrogen is found to be present. In order to follow the method exactly it is sometimes necessary to take 16 or more grams of the material, an impracticable amount with which to work. In using such large amounts more than 15 grams, so much organic matter other than the nitrogen is introduced that the permanganate is very quickly used up and too low results may be obtained. For this reason in this laboratory whenever the amount of insoluble nitrogen in the fertilizer was so small that more than 15 grams would need to be taken to follow the method, the determinations have not been made.

Not enough vegetation tests in comparison with the laboratory methods have been made to warrant drawing too close an application of the results to mixed goods. It is not claimed that it will show absolute agricultural value but vegetation tests carried on at the Rhode Island Experiment Station on materials subjected to both tests indicate a quite close agreement. It is, however, far better than no method and in a general way makes it possible to compare the availability of the nitrogen from different sources and in different brands of mixed fertilizers. Its adoption by the States named is a distinct progress in fertilizer control work. As time goes on the method will be checked up with more vegetative tests and it will doubtless be possible to more correctly apply the results obtained in the laboratory as a check upon the results that may be expected in the field.

Explanation of the Tables.

Under the head of "Nitrogen" in the tables are found eight columns of figures under the following headings:

1. *The nitrogen from nitrates.* In this column is given the percentage of nitrogen present as nitrate. Nitrate nitrogen is wholly and quickly available.

2. *Nitrogen from ammonia salts.* In this column is given the nitrogen from ammonium salts, chiefly sulphate. Ammonia nitrogen while not usually as quickly available to the growing plant as nitrate nitrogen is completely available.

3. *Water soluble organic nitrogen.* This is the soluble nitrogen from organic materials, such as dried blood, dried fish or meat, tankage, cottonseed meal, etc. It dissolves in water and is supposed to be quickly and completely available to the plant.

4. *Active water insoluble organic nitrogen.* The nitrogen in this column is that portion of the organc nitrogen which is insoluble in water but is converted into ammonia by the action of the permanganate of potash solution. This is probably quite readily available to plants.

5. *Inactive organic nitrogen.* This is the portion of the organic nitrogen that is not converted into ammonia by the action of the permanganate solution. It is probably only slowly available to plants.

6. *Available or active nitrogen.* In this column is given the sum of the percentages found in the first four columns, viz: nitrate nitrogen, ammonia nitrogen, water soluble organic nitrogen and active water insoluble organic nitrogen.

7. *Total nitrogen found.*

8. *Total nitrogen guaranteed.*

Phosphoric Acid. Under the head of "phosphoric acid" are given the usual columns with the excepton that inverted and insoluble phosphoric acids are this year omitted. If it is desired to know what the insoluble phosphoric acid is it may be found by subtracting the available from the total as given in the table If it is desired to know what the reverted phosphoric acid is for a given sample this may be found by subtracting the soluble phosphoric acid from the available.

Potash. No change is made in the arrangement of the potash results.

THE MEANING OF THE RESULTS FOUND FOR NITROGEN.

In order to obtain an idea of the value of the organic nitrogen in any given brand from the figures given in the table, it is necessary to compare the columns of active insoluble and inactive insoluble nitrogen, and also take into consideration the amount of soluble organic nitrogen. That is, the organic nitrogen is valuable in proportion as the percentage of the active is greater than the inactive, and the amount of water soluble is large or small. A fertilizer showing more than twice as much active as inactive insoluble nitrogen would be rated as high grade. Also in one carrying a quite large percentage of water soluble and small amounts of active and inactive water insoluble the nitrogen would be likewise rated as high grade. One showing a small amount of water soluble and a larger amount of inactive than active would be classed as a poor grade of organic nitrogen. The percentage of inactive as compared with the total organic is the measure of the value of the organic nitrogen in the goods. With a fair amount of organic nitrogen soluble in water, a large per cent of active and a small amount of inactive, the organic nitrogen is considered good. If but a small amount is soluble in water and less active than inactive is found the organic nitrogen would be considered low grade.

The column headed "available nitrogen" is somewhat analogous to the available phosphoric acid column which has been used for years. It cannot, however, be relied upon without reference to the other results reported in the table. While as a general rule the nearer the figures in the available column approach to the figures in the total nitrogen column the better the grade of nitrogen in the goods this must be construed in connection with the other preceding figures The mineral nitrogen is all available and consequently must be taken into consideration in estimating the availability of the organic nitrogen. While the additional data obtained by the determinations of the different forms of organic nitrogen aid materially in interpreting the results of the analysis, the methods are not all that could be desired. The results are comparative rather than absolute.

Descriptive List of Fertilizer Samples, 1913.

Station number.	Manufacturer, place of business and brand.
	AMERICAN AGRICULTURAL CHEMICAL COMPANY, NEW YORK CITY
2263	A. A. Potato Grower
2064	A. A. Potato Grower
2226	A. A. C. Co.'s Aroostook Complete Manure
2113	A. A. C. Co.'s Aroostook Complete Manure
2251	A. A. C. Co.'s Aroostook High Grade
2046	A. A. C. Co.'s Aroostook High Grade
2234	A. A. C. Co.'s Grass and Oats Fertilizer
2028	A. A. C. Co.'s Grass and Oats Fertilizer
2261	A. A. C. Co.'s Northern Maine Potato Special
2248	A. A. C. Co.'s Peerless Potato Manure
2054	A. A. C. Co.'s Peerless Potato Manure
2258	A. A. C. Co.'s Sweet Corn Special
2030	A. A. C. Co.'s Sweet Corn Special
2262	Bradley's Alkaline Bone with Potash
2158	Bradley's Alkaline Bone with Potash
2408	Bradley's Complete Manure for Corn and Grain
2185	Bradley's Complete Manure for Potatoes and Vegetables
2245	Bradley's Complete Manure for Potatoes and Vegetables
2492	Bradley's Complete Manure for Top Dressing Grass and Grain
2184	Bradley's Complete Manure with 10% Potash
2243	Bradley's Complete Manure with 10% Potash
2050	Bradley's Corn Phosphate
2155	Bradley's Corn Phosphate
2247	Bradley's Eureka Fertilizer
2156	Bradley's Eureka Fertilizer
2494	Bradley's High Grade Potato and Root Special
2495	Bradley's High Grade Potato and Root Special
2239	Bradley's Niagara Phosphate
2159	Bradley's Niagara Phosphate
2218	Bradley's Potato Fertilizer
2157	Bradley's Potato Fertilizer
2257	Bradley's Potato Manure
2152	Bradley's Potato Manure
2217	Bradley's X L Super-Phosphate of Lime
2160	Bradley's X L Super-Phosphate of Lime
2091	Clark's Cove Bay State Fertilizer
2147	Clark's Cove Bay State Fertilizer
2092	Clark's Cove Bay State Fertilizer GG
2135	Clark's Cove Bay State Fertilizer GG
2088	Clark's Cove Great Planet Manure AA
2151	Clark's Cove King Philip Alkaline Guano for All Crops
2112	Clark's Cove Potato Fertilizer
2139	Clark's Cove Potato Fertilizer
2080	Clark's Cove Potato Manure
2259	Complete Manure with 10% Potash
2063	Complete Manure with 10% Potash

Analysis of Fertilizer Samples, 1913.

Station number.	Nitrogen.							Phosphoric Acid.						Potash.	
			Organic.			Total.				Available		Total.			
	As nitrate.	As ammonia.	As water soluble.	As active insoluble.	As inactive insoluble.	Found.	Guaranteed	Soluble.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
2263	2.23	0.92	0.42	.....	.....	3.90	3.70	5.09	0.92	7.51	7.0	8.33	8.0	9.21	10.0
2064	0.48	1.46	0.35	1.17	0.22	3.68	3.70	5.33	1.59	7.10	7.0	8.69	8.0	10.29	10.0
2226	0.34	1.12	0.30	0.50	0.22	2.48	2.47	2.87	1.66	6.15	6.0	7.81	7.0	10.34	10.0
2113	0.78	1.32	.....	.....	.....	2.22	2.47	4.48	1.19	6.42	6.0	7.61	7.0	10.34	10 0
2251	1.66	0.72	0.12	1.28	0.52	4.30	4.11	4 55	1.62	7.25	7.0	8.87	8.0	7.28	7.0
2046	0.88	1.60	0.06	1.14	0.32	4.00	4.11	5.66	1.24	7.39	7.0	8.63	8.0	7.04	7.0
2234	.....	.....	.....	.....	.....	.....	.....	7.23	0.87	10.00	11.0	10.87	12.0	2.40	2.0
2028	.....	.....	.....	.....	.....	.....	.....	7.66	0.64	10.35	11.0	10.99	12.0	2.08	2.0
2261	2.07	0.88	0.10	.....	.....	3.43	3.70	4.99	1.10	7.35	7.0	8.45	8.0	9.82	10.0
2248	0.39	1.31	0.49	0.77	0.33	3.29	3.29	3.96	1.89	7.64	8.0	9.53	9.0	7.79	7.0
2054	0.84	1.66	0.07	0.33	0.18	3.08	3.29	5.68	1.76	7.67	8.0	9.43	9.0	6.68	7.0
2258	0.40	0.28	0.60	0.61	0.31	2.20	2.06	5.34	2.26	8.98	8.0	11.24	9.0	4.54	6.0
2030	0.22	1.08	0.03	0.38	0.26	1.97	2.06	6.12	1.12	9.65	8.0	10.77	9.0	6.50	6.0
2262	.....	.....	.....	.....	.....	.....	.....	7.50	0.88	10.41	11.0	11.29	12.0	2.13	2.0
2158	.....	.....	.....	.....	.....	.....	.....	6.73	0.56	9.80	11.0	10.36	12.0	3.59	2.0
2408	1.13	1.07	0.27	0.40	0.32	3.19	3.29	5.20	1.75	8.01	8.0	9.75	9.0	7.04	7.0
2185	2.06	0.10	.....	1.07	0.29	3.48	3.29	3.89	2.03	7.34	8.0	9.37	9.0	7.97	7.0
2245	1.25	1.06	0.36	0.38	0.31	3.36	3.29	4.85	1.98	8.00	8.0	9.98	9.0	7.59	7.0
2492	1.84	2.52	.....	.....	.....	4.60	4.94	1.36	0.54	4.76	4.0	5.30	5.0	6.05	6.0
2184	1.68	0.80	0.54	0.31	0.27	3.60	3.29	3.65	1.50	6.17	6.0	7.67	7.0	9.75	10.0
2243	1.80	0.88	0.08	0.32	0.26	3.34	3.29	3.83	1.35	6.43	6.0	7.78	7.0	11.06	10.0
2050	0.41	0.67	0.18	0.42	0.24	1.92	2.06	5.28	1.91	8.07	8.0	9.98	9.0	1.58	1.5
2155	0.75	0.22	0.44	0.31	0.24	1.96	2.06	4.86	1.20	8.43	8.0	9.63	9.0	1.81	1.5
2247	.....	0.14	0.32	0.32	0.26	1.04	1.03	3.33	2.41	7.54	8.0	9.84	9.0	2.38	2.0
2156	.....	0.12	0.29	0.40	0.23	1.04	1.03	3.92	1.60	8.00	8.0	9.60	9.0	2.40	2.0
2494	0.77	0.96	.....	0.27	0.17	2.16	1.65	4.74	1.20	7.73	8.0	8.93	9.0	9.25	10.0
2495	0.58	0.66	.....	0.23	0.23	1.70	1.65	5.12	0.96	7.96	8.0	8.92	9.0	10.17	10.0
2239	.....	0.08	0.36	0.26	0.14	0.84	0.82	3.45	1.30	7.11	7.0	8.41	8.0	1.31	1.0
2159	.....	0.12	0.36	0.32	0.22	1.02	0.82	3.89	1.77	6.81	7.0	8.58	8.0	1.63	1.0
2218	0.78	0.12	0.36	0.42	0.28	1.96	2.06	3.29	1.96	7.77	8.0	9.73	9.0	3.34	3.0
2157	0.40	0.86	0.10	0.59	0.25	2.20	2.06	5.49	1.28	8.90	8.0	10.18	9.0	3.31	3.0
2257	.....	1.10	0.37	0.58	0.33	2.38	2.47	2.95	1.62	6.40	6.0	8.02	7.0	5.48	5.0
2152	0.99	0.65	0.17	0.27	0.23	2.31	2.47	3.67	1.48	6.18	6.0	7.66	7.0	5.80	5.0
2217	.....	1.15	0.49	0.44	0.26	2.34	2.47	6.12	1.29	8.86	9.0	10.15	10.0	2.31	2.0
2160	0.80	0.40	0.41	0.46	0.40	2.49	2.47	5.74	2.22	8.93	9.0	11.15	10.0	2.38	2.0
2091	.....	1,24	0.27	0.44	0.29	2.24	2.47	6.36	1.50	8.51	9.0	10.01	10.0	2.68	2.0
2147	0.80	0.28	0.56	0.49	0.37	2.50	2.47	5.17	1.34	9.47	9.0	10.81	10.0	2.40	2.0
2092	.....	0.04	1.30	0.44	0.28	2.06	2.06	5.95	1.49	8.30	8.0	9.79	9.0	2.10	1.5
2135	0.84	0.18	0.50	0.25	0.31	2.08	2.06	6.22	1.80	7.64	8.0	9.44	9.0	1.88	1.5
2088	1.54	1.18	0 18	0.27	0.20	3.26	3.29	4.42	1.15	8.58	8.0	9.73	9.0	6.64	7.0
2151	.....	0.12	0.29	0.39	0.25	1.05	1.03	3.78	1.30	8.09	8.0	9.39	9.0	2.22	2.0
2112	.....	1.06	0.27	0.38	0.25	1.96	2.06	5.53	1.18	7.89	8.0	9.01	9.0	3.29	3.0
2139	0.68	0.12	0.40	0.37	0.35	1.92	2.06	6.48	1.42	8.23	8.0	9.65	9.0	3.26	3.0
2080	0.50	1.28	0.11	0.41	0.18	2.48	2.47	4.55	1.11	6.56	6.0	7.67	7.0	5.35	5.0
2259	1.54	1.22	0.24	.....	.....	3.30	3.29	2.81	1.70	5.98	6.0	7.66	7.0	9.78	10.0
2063	0.78	1.40	0.39	0.51	0.24	3.32	3.29	3.40	1.77	6.11	6.0	7.88	7.0	10.30	10.0
2232	.....	0.88	0.43	0.37	0.18	1.86	2.06	4.53	1.38	8.05	8.0	9.47	9.0	2.04	1.5

Descriptive List of Fertilizer Samples, 1913.

Station number.	Manufacturer, place of business and brand.
2232	Crocker's Ammoniated Corn Phosphate
2057	Crocker's Ammoniated Corn Phosphate
2231	Crocker's Aroostook Potato Special
2026	Crocker's Aroostook Potato Special
2229	Crocker's New Rival Ammoniated Super-Phosphate
2045	Crocker's New Rival Ammoniated Super-Phosphate
2233	Crocker's Potato, Hop and Tobacco
2056	Crocker's Potato, Hop and Tobacco
2235	Crocker's Special Potato Manure
2027	Crocker's Special Potato Manure
2183	Darling's Blood, Bone and Potash
2081	Darling's Blood, Bone and Potash
2205	Fine Ground Bone
2497	General Crop Grower
2496	General Crop Grower
2506	Grass and Lawn Top Dressing
2222	Great Eastern General Fertilizer
2055	Great Eastern General Fertilizer
2242	Great Eastern High Grade Potato Manure
2022	Great Eastern High Grade Potato Manure
2246	Great Eastern Northern Corn Special
2053	Great Eastern Northern Corn Special
2244	Great Eastern Potato Manure
2051	Great Eastern Potato Manure
2066	High Grade Fertilizer with 10% Potash
2143	High Grade Fertilizer with 10% Potash
2520	High Grade Sulphate of Potash
2230	Lazaretto Aroostook Potato Guano
2058	Lazaretto Aroostook Potato Guano
2059	Lazaretto Corn Guano
2223	Lazaretto High Grade Potato Guano
2052	Lazaretto High Grade Potato Guano
2227	Lazaretto Propeller Potato Guano
2029	Lazaretto Propeller Potato Guano
2524	Muriate of Potash
2219	Muriate of Potash
2523	Nitrate of Soda
2220	Nitrate of Soda
2480	Otis Potato Fertilizer
2479	Otis Super-Phosphate
2079	Pacific Dissolved Bone and Potash
2110	Pacific Grass and Grain Fertilizer
2098	Pacific High Grade General Fertilizer
2111	Pacific Nobsque Guano for All Crops
2150	Pacific Nobsque Guano for All Crops
2105	Pacific Potato Special
2142	Pacific Potato Special
2225	Packers Union Animal Corn Fertilizer

Analysis of Fertilizer Samples, 1913.

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.
2057	0.18	0.85	0.17	0.43	0.24	1.88	2.06	5.31	1.71	8.02	8.0	9.73	9.0	1.87	1.5
2231	0.46	0.84	0.16	0.30	0.18	1.94	2.06	4.85	1.29	7.86	8.0	9.15	9.0	6.44	6.0
2026	.....	1.13	0.36	0.42	0.25	2.16	2.06	6.20	1.45	7.99	8.0	9.44	9.0	6.08	6.0
2229	.....	0.10	0.48	0.24	0.22	1.04	1.03	3.27	1.93	7.38	8.0	9.31	9.0	2.15	2.0
2045	0.07	0.13	0.26	0.31	0.21	0.98	1.03	4.88	1.65	7.73	8.0	9.38	9.0	2.19	2.0
2233	0.58	0.14	0.52	0.42	0.30	1.96	2.06	3.62	1.85	7.51	8.0	9.26	9.0	3.44	3.0
2056	0.06	0.96	9.12	0.52	0.24	1.90	2.06	5.63	1.67	8.52	8.0	10.19	9.0	3.43	3.0
2235	0.42	1.34	0.69	0.60	0.41	3.46	3.29	3.06	2.17	6.03	6.0	8.20	7.0	10.21	10.0
2027	0.80	1.60	0.14	0.37	0.31	3.22	3.29	3.75	1.39	5.95	6.0	7.34	7.0	10.27	10.0
2183	2.77	0.69	0.02	0.64	0.06	4.18	4.11	3.67	0.89	7.15	7.0	8.04	8.0	7.21	7.0
2081	0.63	1.41	0.44	1.11	0.45	4.04	4.11	4.99	1.49	7.06	7.0	8.55	8.0	7.33	7.0
2205	.....	.....	0.92	1.10	0.45	2.47	2.47	.....	.....	.....	.....	22.07	22.8	.....	.....
2497	0.83	0 55	0.08	0.21	0.17	1.84	1.65	4.78	1.00	7.76	8.0	8.76	9.0	5.53	5.0
2496	0.50	0.74	0.13	.....	.....	1.70	1.65	5.45	1.03	8.84	8.0	9.87	9.0	5.23	5.0
2506	1.82	1.64	.....	.....	.....	3.44	3.91	1.83	0.41	6.29	5.0	6.70	6.0	2.41	2.0
2222	.....	0.09	0.38	.....	.....	0.84	0.82	3.29	1.50	7.43	8.0	8.93	9.0	3.78	4.0
2055	0.02	0.12	0.23	0.26	0.17	0.80	0.82	5.33	1.32	7.95	8.0	9.27	9.0	4.50	4.0
2242	1.58	0.84	0.24	0.41	0.27	3.34	3.29	4.19	0.96	6.76	6.0	7.72	7.0	10.45	10.0
2022	.....	1.62	0.89	0.44	.25	3.20	3.29	3.91	1.31	6.01	6.0	7.32	7.0	10.71	10.0
2246	0.71	0.51	0.29	0.35	0.22	2.08	2.06	4.66	1.76	8.00	8.0	9.76	9.0	1.78	1.5
2053	0.14	0.88	0.19	0.43	0.24	1.89	2.06	5.06	1.80	7.55	8.0	9.33	9.0	1.89	1.5
2244	0.89	0.18	0.19	0.45	0.35	2.06	2.06	5.01	1.17	8.58	8.0	9.65	9.0	3.43	3.0
2051	0.05	1.00	0.21	0.50	0.28	2.04	2.06	5.58	1.77	8.13	8.0	9.90	9.0	3.48	3.0
2066	0.50	1.26	0.07	0.44	0.21	2.48	2.47	3.68	1.34	6.19	6.0	7.53	7.0	10.22	10.0
2143	0.74	0.92	0.54	.....	.....	2.40	2.47	3.13	1.59	6.03	6.0	7.62	7.0	10.12	10.0
2520	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	51.64	48.0
2230	.....	0.24	0.30	0.24	0.20	0.98	0.82	3.76	1.52	7.59	8.0	9.11	9.0	5.10	4.0
2058	0.08	0.12	0.19	0.22	0.15	0.76	0.82	5.33	1.39	7.90	8.0	9.29	9.0	4.05	4.0
2059	0.14	0.80	0.08	0.35	0.21	1.58	1.64	6.35	0.89	8.28	8.0	9.17	9.0	3.12	2.0
2223	.....	1.20	0.78	0.63	0.30	2.91	3.29	3.67	1.84	6.47	6.0	8.31	7.0	9.40	10.0
2052	0.88	1.86	0.02	0.42	0.24	3.42	3.29	3.88	1.46	5.50	6.0	7.16	7.0	10.13	10.0
2227	0.45	0.85	0.26	0.32	0.18	2.06	2.06	5.01	1.19	7.86	8.0	9.05	9.0	6.70	6.0
2029	0.26	1.04	1.17	.....	.....	2.02	2.06	6.22	1.17	8.16	8.0	9.33	9.0	6.42	6.0
2524	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	50.72	49.0
2219	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	51.92	49.0
2523	15.20	.....	.....	.....	.....	15.20	15.0	.....	.....	.....	.....	.....	.....	.....	.....
2220	15.20	.....	.....	.....	.....	15.20	15.0	.....	.....	.....	.....	.....	.....	.....	.....
2480	.....	0.76	0.57	0.27	0.32	1.94	2.06	4.34	1.75	7.77	8.0	9.52	9.0	3.24	3.0
2479	0.40	0.42	0.45	0.45	0.34	2.06	2.06	4.75	1.74	8.12	8.0	9.86	9.0	1.72	1.5
2079	.....	.....	.....	.....	.....	.....	.....	7.13	0.56	9.71	10.0	10.27	11.0	3.13	2.0
2110	.....	0.16	0.30	0.31	0.25	1.02	0.82	6.49	1.89	9.04	7.0	10.93	8.0	1.85	1.0
2098	0.78	1.68	0.39	0.24	0.21	3.30	3.29	5.61	1.72	7.88	8.0	9.60	9.0	6.87	7.0
2111	.....	0.12	0.33	0.29	0.23	0.97	1.03	5.12	1.69	7.51	8.0	9.20	9.0	2.57	2 0
2150	.....	0.14	0.28	0.37	0.25	1.04	1.03	3.75	1.40	8.06	8.0	9.46	9.0	2.25	2.0
2105	.....	0.89	0.07	0.51	0.31	1.78	2.06	6.11	1.94	8.03	8.0	9.97	9.0	3.86	3.0
2142	0.68	0.12	0.45	0.42	0 23	1.90	2.06	5.17	0.91	8.82	8.0	9.73	9.0	3.39	3.0
2225	.....	1.14	0.66	0.45	0.25	2.50	2.47	5.79	1.22	8.88	9.0	10.10	10.0	2.45	2.0

Descriptive List of Fertilizer Samples, 1913.

Station number.	Manufacturer, place of business and brand.
2221	Packers Union Gardeners Complete Manure
2101	Packers Union Gardeners Complete Manure
2224	Packers Union Maine Central Fertilizer
2096	Packers Union Maine Central Fertilizer
2249	Packers Union Potato Manure
2097	Packers Union Potato Manure
2228	Packers Union Universal Fertilizer
2100	Packers Union Universal Fertilizer
2206	Plain Super-Phosphate
2367	Quinnipiac Climax Phosphate for All Crops
2382	Quinnipiac Corn Manure
2358	Quinnipiac Market Garden Manure
2366	Quinnipiac Market Garden Manure
2411	Quinnipiac Potato Manure
2365	Quinnipiac Potato Phosphate
2383	Quinnipiac Potato Phosphate
2250	Read's Farmer's Friend Super-Phosphate
2087	Read's Farmer's Friend Super-Phosphate
2049	Read's High Grade Farmer's Friend Super-Phosphate
2086	Read's High Grade Farmer's Friend Super-Phosphate
2048	Read's Potato Manure
2085	Read's Potato Manure
2090	Read's Practical Potato Special Fertilizer
2482	Read's Standard Super-Phosphate
2089	Read's Sure Catch Fertilizer
2093	Read's Vegetable and Vine Fertilizer
2115	Soluble Pacific Guano
2138	Soluble Pacific Guano
2481	Special Grass and Garden Mixture
2109	Standard A Brand
2141	Standard A Brand
2078	Standard Bone and Potash
2095	Standard Complete Manure
2149	Standard Complete Manure
2107	Standard Fertilizer
2137	Standard Fertilizer
2260	Standard Guano for All Crops
2106	Standard Guano for All Crops
2145	Standard Guano for all Crops
2108	Standard Special for Potatoes
2140	Standard Special for Potatoes
2144	Williams & Clark Americus Ammoniated Bone Super-Phosphate
2136	Williams & Clark Americus Corn Phosphate
2148	Williams & Clark Americus High Grade Special for Potatoes and Vegetables
2134	Williams & Clark Americus Potato Manure
2146	Williams & Clark Royal Bone Phosphate for All Crops

Analysis of Fertilizer Samples, 1913.

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.
2221	0.39	1.15	0.20	0.56	0.20	2.50	2.47	3.41	1.70	6.24	6.0	7.94	7.0	9.97	10.0
2101	0.69	1.17	0.15	0.28	0.16	2.40	2.47	3.76	1.20	6.39	6.0	7.59	7.0	10.02	10.0
2224	0 44	1.30	0.45	0.60	0.33	3.12	3.29	4.08	1.88	6.86	6.0	8.74	7.0	8.53	10.0
2096	0.87	1.71	.....	0.26	0.24	3.16	3.29	3.89	7.26	5.78	6.0	1.48	7.0	10.12	10.0
2249	0.60	0.85	.....	0.44	0.29	2.18	2.06	4.39	1.43	7.48	8.0	8.91	9.0	7.13	6.0
2097	.....	1.04	0.32	0.35	0.28	1.99	2.06	5.53	1.23	7.70	8.0	8.93	9.0	7.36	6.0
2228	.....	0.10	0.39	.....	.....	0.86	0.82	3.67	1.54	7.55	8.0	9.19	9.0	4.08	4.0
2100	.....	0.14	0.25	0.22	0.21	0.82	0.82	5.20	1.46	7.85	8.0	9.31	9.0	4.25	4.0
2206	.....	.....	.....	.....	.....	.....	.....	9.14	0.51	13.47	14.0	13.98	15.0	.....	.....
2367	0.15	0.11	0.26	0.28	0.28	1.08	1.03	2.11	1.11	7.92	8.0	9.03	9.0	2.25	2.0
2382	0.17	0.13	0.31	0.92	0.45	1.98	2.06	2.68	2.30	7.70	8.0	10.00	9.0	2.38	1.5
2358	2.83	0.08	.....	0.54	0.25	3.70	3.29	3.80	1.66	7.69	8.0	9.35	9.0	7.68	7.0
2366	0.20	0.10	1.97	1.03	0.35	3.64	3.29	3.56	1.61	7.80	8.0	9.41	9.0	7.18	7.0
2411	1.01	.55	0.42	0.38	0.31	2.68	2.47	3.60	1.28	6.47	6.0	7.71	7.0	5.98	5.0
2365	1.29	0.80	0.21	.....	.....	2.30	2.06	4.15	1.03	7.85	8.0	8.88	9.0	3.46	3.0
2383	0.68	0.40	0.38	0.48	0.26	2.20	2.06	3.46	2.69	7.90	8.0	10.59	9.0	3.54	3.0
2250	0.74	0.10	0.66	0.37	0.29	2.16	2.06	3.62	1.89	7.33	8.0	9.22	9.0	3.37	3.0
2087	.....	1.08	0.26	0.38	0.40	2.12	2.06	5.73	1.40	8.38	8.0	9.78	9.0	3.33	3.0
2049	1.02	1.42	0.19	0.49	0.21	3.33	3.29	2.58	2.27	5.38	6.0	7.75	7.0	10.35	10.0
2086	0.82	1.32	0.33	0.40	0.32	3.19	3.29	3.46	1.52	5.71	6.0	7.23	7.0	10.42	10.0
2048	0.64	0.96	.....	0.44	0.20	2.22	2.47	3.33	2.18	6.50	6.0	8.68	7.0	10.03	10.0
2085	0.78	1.02	.....	0.40	0.19	2.38	2.47	3.92	0.89	6.30	6.0	7.19	7.0	10.11	10.0
2090	0.26	0.38	0.07	.....	0.35	1.06	0.82	2.81	0.61	4.73	4.0	5.34	5.0	7.26	8.0
2482	0.18	0.04	0.08	0.23	0.27	0.80	0.82	4.80	1.56	8.01	8.0	9.57	9.0	4.04	4.0
2089	.....	.....	.....	.....	.....	.....	.....	6.84	0.61	9.75	10.0	10.36	11.0	2.43	2.0
2093	.....	1.10	0.28	0.40	0.28	2.06	2.06	5.49	1.37	7.61	8.0	8.98	9.0	6.52	6.0
2115	.....	0.76	0.34	0.38	0.24	1.72	2.06	5.26	1.76	8.18	8.0	9.94	9.0	2.63	1.5
2138	1.08	0.18	0.18	0.24	0.28	1.96	2.06	5.33	1.82	7.61	8.0	9.43	9.0	1.71	1.5
2481	1.58	3.86	0.59	0.99	0.58	7.54	8.43	3.32	1.54	6.66	6.2	8.20	7.2	7.25	8.2
2109	.....	0.13	0.38	0.26	0.25	1.02	0.82	6.28	2.04	8.81	7.0	10.85	8.0	1.81	1.0
2141	.....	0.08	0.26	0.31	0.19	0.84	0.82	3.60	1.29	7.72	7.0	9.01	8.0	1.50	1.0
2078	.....	.....	.....	.....	.....	.....	.....	7.26	0.71	10.10	10.0	10.81	11.0	2.66	2.0
2095	0.94	1.60	0.24	0.31	0.25	3.14	3.29	5.42	1.73	7.83	8.0	9.56	9.0	7.02	7.0
2149	1.20	0.90	0.42	0.35	0.20	3.07	3.29	4.78	1.42	7.74	8.0	9.16	9.0	7.10	7.0
2107	.....	0.84	0.30	0.38	0.28	1.80	2.06	5.28	1.75	8.01	8.0	9.76	9.0	1.96	1.5
2137	0.84	0.16	0.46	0.23	0.29	1.98	2.06	5.47	1.89	7.49	8.0	9.38	9.0	1.66	1.5
2260	.....	0.10	0.54	0.24	0.26	1.10	1.03	2.79	1.84	7.28	8.0	9.12	9.0	2.19	2.0
2106	.....	0.14	0.40	0.25	0.27	1.06	1.03	4.83	1.82	7.13	8.0	8.95	9.0	2.36	2.0
2145	.....	0.12	0.29	0.37	0.26	1.04	1.03	4.07	1.51	8.73	8.0	10.24	9.0	2.20	2.0
2108	.....	0.80	0.18	0.45	0.35	1.78	2.06	4.85	0.91	8.98	8.0	9.89	9.0	3.96	3.0
2140	0.68	0.12	0.42	0.36	0.32	1.90	2.06	5.26	1.28	8.50	8.0	9.78	9.0	3.18	3.0
2144	0.74	0.40	0.39	0.48	0.30	2.31	2.47	5.61	1.25	9.64	9.0	10.89	10.0	2.47	2.0
2136	0.88	0.22	0.23	0.25	0.30	1.88	2.06	5.82	1.58	7.89	8.0	9.47	9.0	2.04	1.5
2148	1.30	0.88	0.33	0.30	0.25	3.06	3.29	4.78	1.41	7.78	8.0	9.19	9.0	7.21	7.0
2134	0.12	0.88	0.17	0.52	0.29	1.98	2.06	6.48	2.00	8.56	8.0	10.56	9.0	3.48	3.0
2146	.....	0.12	0.30	0.40	0.21	1.03	1.03	3.88	1.58	8.20	8.0	9.78	9.0	2.09	2.0

Descriptive List of Fertilizer Samples, 1913.

Station number.	Manufacturer, place of business and brand.
	ARMOUR FERTILIZER WORKS, BALTIMORE MARYLAND.
2316	All Soluble
2298	Bone, Blood and Potash
2292	Bone, Blood and Potash
2330	Complete Potato
2312	Complete Potato
2315	Corn Grower
2201	Double Value
2311	Double Value
2318	Fruit and Root Crop Special
2317	High Grade Potato
2415	High Grade Potato
2314	Wheat, Corn and Oats Special
	ATLANTIC FERTILIZER CO., BALTIMORE, MARYLAND.
2459	Corn and Grain
2426	Peerless
2425	Peerless
2328	Potato Fertilizer
2437	Rival
2458	Rival
	BAUGH & SONS CO., BALTIMORE, MARYLAND.
2301	Baugh's Aroostook 4-6-10
2299	Baugh's Aroostook 4½-7-10
2255	Baugh's Aroostook 4-8-7
2320	Baugh's Aroostook 5-8-7
2256	Baugh's Aroostook 5-8-7
2300	Baugh's Aroostook 5-7-10
2319	Baugh's Aroostook 5-7-10
	BOWKER FERTILIZER CO., BOSTON, MASS.
2069	Bowker's Blood, Bone and Potash
2177	Bowker's Blood, Bone and Potash
2283	Bowker's Blood, Bone and Potash
2033	Bowker's Bone and Potash, Square Brand
2447	Bowker's Complete Manure for Potatoes and Vegetables
2385	Bowker's Complete Manure for Potatoes and Vegetables
2334	Bowker's Complete Manure for Potatoes and Vegetables
2103	Bowker's Corn Phosphate
2167	Bowker's Corn Phosphate
2285	Bowker's Early Potato Manure
2174	Bowker's Early Potato Manure
2084	Bowker's Early Potato Manure
2104	Bowker's Farm and Garden Phosphate
2171	Bowker's Fresh Ground Bone
2172	Bowker's Hill and Drill Phosphate
2094	Bowker's Hill and Drill Phosphate
2284	Bowker's Market Garden Fertilizer
2032	Bowker's Market Garden Fertilizer

Analysis of Fertilizer Samples, 1913.

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.
2316	0.46	0.10	0.59	0.73	1.06	2.94	2.88	4.26	1.24	7.76	8.0	9.00	8.5	3.60	4.0
2298	.....	0.30	2.19	1.37	0.51	4.37	4.11	4.00	1.26	7.93	8.0	9.19	8.5	7.04	7.0
2292	.....	0.17	2.33	1.01	0.38	3.89	4.11	6.59	0.18	8.35	8.0	8.53	8.5	7.68	7.0
2330	0.87	0.75	0.21	0.85	0.50	3.18	3.29	4.53	0.36	6.29	6.0	6.65	6.5	10.60	10.0
2312	1.01	0.70	0.17	0.92	0.35	3.15	3.29	4.66	.....	6.92	6.0	6.92	6.5	10.58	10.0
2315	0.23	0.07	0.67	0.48	0.65	2.10	1.65	3.19	1.07	7.89	8.0	8.96	8.5	1.97	2.0
2201	1.72	0.92	0.42	0.86	0.34	4.26	4.11	6.97	0.46	8.55	8.0	9.01	8.5	9.39	10.0
2311	0.46	1.04	1.37	0.91	0.32	4.10	4.11	7.08	0.15	8.78	8.0	8.93	8.5	9.79	10.0
2318	0.80	0.12	0.03	0.34	0.43	1.72	1.65	5.31	1.42	8.40	8.0	9.82	8.5	4.98	5.0
2317	0.36	0.42	0.23	0.28	0.43	1.72	1.65	5.71	0.84	8.46	8.0	9.30	8.5	10.42	10.0
2415	0.36	0.43	0.21	0.30	0.35	1.65	1.65	5.14	1.05	8.23	8.0	9.28	8.5	10.50	10.0
2314	0.12	.....	0.05	0.35	0.50	1.02	0.82	3.46	0.52	7.21	7.0	7.73	7.5	1.16	1.0
2459	0.41	0.04	0.53	0.46	0.34	1.78	1.65	5.81	0.80	8.04	8.0	8.84	9.0	3.06	3.0
2426	0.54	0.50	1.65	0.70	0.58	3.67	3.71	5.57	0.33	7.66	7.0	7.99	8.0	9.62	10.0
2425	0.76	0.66	1.13	0.71	0.65	3.91	3.71	5.23	0.56	7.14	7.0	7.70	8.0	9.51	10.0
2328	0.50	0.24	1.42	0.60	0.75	3.51	3.29	5.57	0.94	8.09	8.0	9.03	9.0	7.10	7.0
2437	0.76	0.16	0.94	0.80	0.67	3.33	3.29	4.37	0.87	6.31	6.0	7.18	7.0	10.06	10.0
2458	0.76	0.10	1.16	1.05	0.38	3.45	3.29	4.19	0.69	6.82	6.0	7.51	7.0	9.97	10.0
2301	.....	2.25	0.38	0.38	0.37	3.38	3.30	5.20	0.63	6.91	6.0	7.54	7.0	10.25	10.0
2299	.....	2.87	0.18	0.46	0.29	3.70	3.70	6.03	0.63	8.00	7.0	8.64	8.0	10.07	10.0
2255	.....	2.10	0.38	0.52	0.38	3.38	3.30	7.69	0.66	9.58	8.0	10.24	9.0	6.81	7.0
2320	.....	3.14	0.34	0.29	0.39	4.18	4.12	6.83	0.60	8.48	8.0	9.08	9.0	7.74	7.0
2256	.....	3.06	0.53	0.34	0.31	4.24	4.12	6.89	0.68	8.86	8.0	9.54	9.0	7.15	7.0
2300	.....	2.94	0.46	0.44	0.34	4.18	4.12	6.09	0.57	8.06	7.0	8.63	8.0	9.22	10.0
2319	.....	3.20	0.13	0.33	0.44	4.10	4.12	6.16	0.52	8.28	7.0	8.80	8.0	9.85	10.0
2069	1.26	1.08	0.45	0.80	0.41	4.00	4.11	2.92	0.82	7.11	7.0	7.93	8.0	7.33	7.0
2177	2.34	0.72	0.25	0.48	0.39	4.18	4.11	4.10	1.65	7.14	7.0	8.79	8.0	7.67	7.0
2283	2.25	0.10	0.43	1.02	0.30	4.10	4.11	3.27	1.70	6.90	7.0	8.60	8.0	7.16	7.0
2033	0.08	0.74	0.08	0.45	0.24	1.59	1.65	4.19	1.11	6.45	6.0	7.56	7.0	2.36	2.0
2447	1.46	0.24	0.43	0.74	0.31	3.18	3.29	2.27	2.40	5.69	6.0	8.09	7.0	10.23	10.0
2385	1.57	0.27	0.18	0.77	0.37	3.16	3.29	2.70	1.56	6.11	6.0	7.67	7.0	10.56	10.0
2334	1.43	0.72	0.26	0.38	0.33	3.12	3.29	2.44	1.34	6.32	6.0	7.66	7.0	10.21	10.0
2103	.....	0.76	0.18	0.36	0.28	1.58	1.65	4.64	1.67	7.76	8.0	9.43	9.0	2.34	2.0
2167	0.58	0.12	0.49	0.24	0.23	1.66	1.65	3.46	1.79	7.37	8.0	9.16	9.0	2.40	2.0
2285	1.90	0.04	0.33	0.89	0.36	3.52	3.29	3.64	1.96	7.35	8.0	9.31	9.0	7.64	7.0
2174	1.35	0.88	0.42	0.26	0.27	3.18	3.29	4.55	1.53	7.84	8.0	9.37	9.0	7.08	7.0
2084	0.68	1.30	0.13	0.74	0.31	3.16	3.29	5.63	1.33	8.08	8.0	9.41	9.0	6.90	7.0
2104	.....	0.76	0.21	0.39	0.29	1.65	1.65	4.67	1.75	7.87	8.0	9.62	9.0	2.38	2.0
2171	.....	.....	0.67	1.31	0.66	2.64	2.47	.....	.....	.....	.....	22.97	22.9	.....	.....
2172	1.03	0.20	0.31	0.49	0.45	2.48	2.47	5.39	2.58	8.74	9.0	11.32	10.0	2.36	2.0
2094	.....	1.18	0.37	0.47	0.38	2.40	2.47	6.03	1.65	8.53	9.0	10.18	10.0	2.73	2.0
2284	0.84	0.08	0.94	0.76	0.40	3.02	2.47	1.67	1.89	5.77	6.0	7.66	7.0	10.20	10.0
2032	0.14	1.42	0.03	0.45	0.21	2.25	2.47	3.83	0.89	6.06	6.0	6.95	7.0	11.39	10.0

Descriptive List of Fertilizer Samples, 1913.

Station number.	Manufacturer, place of business and brand.
2043	Bowker's Potato and Vegetable Fertilizer
2173	Bowker's Potato and Vegetable Fertilizer
2099	Bowker's Potato and Vegetable Phosphate
2168	Bowker's Potato and Vegetable Phosphate
2083	Bowker's Potash Bone
2038	Bowker's Sure Crop Phosphate
2082	Bowker's Sure Crop Phosphate
2286	Stockbridge Manure "A" for Potatoes
2178	Stockbridge Manure "A" for Potatoes
2035	Stockbridge Manure "A" for Potatoes
2287	Stockbridge Manure "B" for Potatoes
2294	Stockbridge Special Complete Manure for Corn and All Grain Crops
2169	Stockbridge Special Complete Manure for Corn and All Grain Crops
2282	Stockbridge Special Complete Manure for Potatoes and Vegetables
2176	Stockbridge Special Complete Manure for Potatoes and Vegetables
2041	Stockbridge Special Complete Manure for Potatoes and Vegetables
2068	Stockbridge Special Complete Manure for Potatoes and Vegetables
2170	Stockbridge Special Complete Manure for Potatoes and Vegetables
2102	Stockbridge Special Complete Manure for Seeding Down, Permanent Dressing and Legumes
2034	Stockbridge Special Complete Manure for Top Dressing and for Forcing
2166	Stockbridge Special Complete Manure for Top Dressing and for Forcing
	BUFFALO FERTILIZER COMPANY, HOULTON, MAINE.
2431	Buffalo Farmers' Choice (1-8-5)
2433	Buffalo Farmers' Choice (1-8-5)
2519	Buffalo Farmers' Choice (1-8-5)
2349	Buffalo Five-Eight-Nine
2344	Buffalo Five-Eight-Nine
2290	Buffalo Five-Eight-Seven
2347	Buffalo Five-Eight-Seven
2289	Buffalo Four-Six-Ten
2355	Buffalo Four-Six-Ten
2487	Buffalo Four½-Eight-Nine
2348	Buffalo Four½-Eight-Nine
2448	Buffalo Grass Top Dressing (7-6-5)
2434	Buffalo Nine-Three
2449	Buffalo Three-Six-Ten
2291	Buffalo Three-Six-Ten
2435	Buffalo Two-Eight-Ten
2460	Buffalo Two-Eight-Two
2450	Buffalo-Two-Eight-Two
2518	Buffalo Two-Nine-Five
2436	Buffalo Two-Nine-Five
	CHESAPEAKE CHEMICAL CO., BALTIMORE, MARYLAND.
2339	C-C-Co.'s Granger Special
2387	C-C-Co.'s Maine Special Fertilizer
2490	C-C-Co.'s Maine Special Fertilizer
2340	C-C-Co.'s Potato Producer Fertilizer
2386	C-C-Co.'s Potato Producer Fertilizer

Analysis of Fertilizer Samples, 1913.

Station number.	Nitrogen.							Phosphoric Acid.						Potash.	
			Organic.			Total.				Available		Total.			
	As nitrate.	As ammonia.	As water soluble.	As active insoluble.	As inactive insoluble.	Found.	Guaranteed.	Soluble.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
2043	0.12	1.22	0.09	0.57	0.33	2.33	2.47	4.93	1.76	8.05	8.0	9.81	9.0	5.07	4.0
2173	0.74	0.70	0.10	0.46	0.21	2.21	2.47	5.30	1.85	8.28	8.0	10.13	9.0	4.82	4.0
2099	.....	0.78	0.22	0.49	0.44	1.78	1.65	4.99	1.58	8.12	8.0	9.70	9.0	2.04	2.0
2168	0.82	0.12	0.26	0.27	0.19	1.66	1.65	3.32	1.66	7.48	8.0	9.14	9.0	2.28	2.0
2083	.....	0.08	0.28	0.27	0.19	0.82	0.82	3.92	1.22	6.34	6.0	7.56	7.0	2.42	2.0
2038	0.18	0.10	0.19	0.30	0.19	0.96	0.82	4.56	1.21	8.30	8.0	9.51	9.0	2.74	2.0
2082	.....	0.18	0.24	0.29	0.18	0.89	0.82	4.98	1.67	7.60	8.0	9.26	9.0	2.48	2.0
2286	1.92	1.02	0.60	0.29	0.10	3.94	4.11	3.45	1.11	7.07	7.0	8.18	8.0	9.77	10.0
2178	2.17	0.32	0.38	0.78	0.38	4.03	4.11	3.78	1.75	6.82	7.0	8.57	8.0	10.64	10.0
2035	1.82	1.46	0.12	0.55	0.21	4.16	4.11	3.83	1.18	6.55	7.0	7.77	8.0	11.82	10.0
2287	1.53	0.78	0.22	0.58	0.19	3.30	3.29	5.79	1.82	9.03	10.0	10.85	11.0	7.42	7.0
2294	0.14	2.18	0.18	0.38	0.12	3.08	3.29	7.02	1.49	9.98	10.0	11.47	11.0	7.39	7.0
2169	1.16	1.20	0.36	0.33	0.21	3.28	3.29	6.76	0.84	10.00	10.0	10.84	11.0	7.23	7.0
2282	1.85	0.15	0.12	0.83	0.34	3.20	3.29	1.75	1.84	7.54	6.0	9.38	7.0	10.43	10.0
2176	0.55	1.42	0.16	0.80	0.45	3.38	3.29	4.55	1.56	6.65	6.0	8.21	7.0	10.13	10.0
2041	0.46	1.32	0.53	0.72	0.35	3.38	3.29	3.06	2.04	5.93	6.0	7.97	7.0	10.32	10.0
2068	1.30	1.14	0.42	0.40	0.20	3.26	3.29	3.27	1.65	6.28	6.0	7.93	7.0	10.14	10.0
2170	1.34	0.84	0.49	0.33	0.24	3.24	3.29	3.06	1.77	5.64	6.0	7.41	7.0	10.33	10.0
2102	0.68	1.00	0.12	0.58	0.24	2.62	2 47	6 71	1.42	10.61	10.0	12.03	11.0	8.78	8.0
2034	1.72	2.54	0.26	.....	.....	4.52	4.94	1.00	0.38	4.07	4.0	4.45	5.0	6.02	6.0
2166	1.06	0.95	0.49	1.62	1.38	5.50	4.94	2.97	1.80	5.12	4.0	6.92	5.0	5.67	6.0
2431	0.68	0.02	0.40	0.33	0.23	1.66	0.82	3.03	1.56	7.88	8.0	9.36	9.0	6.20	5.0
2433	0.22	0.02	0 06	0.24	0.46	1.00	0.82	6.44	1.16	8.89	8.0	10.05	9.0	5.54	5.0
2519	0.46	0.10	0.43	0.23	0.52	1.74	0.82	2.38	1.29	8.26	8.0	9.55	9.0	5.64	5.0
2349	1.41	0.73	0.68	0.66	0.56	4.08	4.10	5.28	1.96	8.17	8.0	10.13	9.0	9.06	9.0
2344	1.59	0.74	0.38	0.67	0.56	3.94	4.10	4.99	2.05	8.01	8.0	10.06	9.0	9.38	9.0
2290	1.65	0.10	0.48	0.84	0.47	3.54	4.10	5.20	2.11	8.07	8.0	10.18	9.0	8.24	7.0
2347	1.10	0.33	0.96	0.90	0.66	3.94	4.10	4.64	1.59	8.06	8.0	9.65	9.0	7.59	7.0
2289	1.32	0.12	0.62	0.80	0.36	3.22	3.28	1.32	1.40	5.78	6.0	7.18	7.0	10.50	10.0
2355	0.72	0.16	1.35	0.41	0.40	3.04	3.28	1.47	0.98	5.89	6.0	6.87	7.0	10.08	10.0
2487	1.58	0.04	1.00	0.45	0.41	3.48	3.70	2.42	1.36	7.44	8.0	8.80	9.0	9.06	9.0
2348	1.85	0.23	0.34	0.58	0.52	3.52	3.70	2.79	2.81	7.56	8.0	10.37	9.0	9.11	9.0
2448	2.26	0.74	1.39	1.07	0.34	5.80	5.74	1.53	1.52	5.94	6.0	7.46	7.0	5.68	5.0
2434	.....	.....	.....	.....	.....	.....	.....	1.29	1.80	8.52	9.0	10.32	10.0	3.51	3.0
2449	1.07	0.12	0.37	0.57	0.40	2.53	2.46	4.04	1.63	6.14	6.0	7.77	7.0	11 25	10.0
2291	1.06	0.10	0.38	0.52	0.36	2.42	2.46	1.53	1.03	8.91	6.0	9.94	7.0	10.57	10.0
2435	0.53	0.12	0.37	0.48	0.48	1.98	1.64	4.08	2.45	7.62	8.0	10.03	9.0	5.41	10.0
2460	0.58	.....	0.27	0.56	0.37	1.78	1.64	3.75	2.62	7.62	8.0	10.24	9.0	3.95	2.0
2450	0.92	0.16	0.30	0.68	0.31	2.38	1.64	3.86	1.74	8.90	8.0	10.64	9.0	3.67	2.0
2518	0.56	0.12	0.33	0.27	0.50	1.78	1.64	5.85	1.40	8.98	9.0	10.38	10.0	8.29	5.0
2436	0.79	0.16	0.18	0.32	0.43	1.88	1.64	3.64	2.04	7.83	9.0	9.79	10.0	6.24	5.0
2339	.....	1.36	0.36	0.34	0.44	2.50	2.46	2.92	1.22	7.11	6.0	8.33	7.0	10.83	10.0
2387	0.19	2.66	0.31	0.63	0.44	4.11	4.10	4.94	1.20	7.77	8.0	8.97	9.0	7.09	7.0
2490	0.24	2.45	0.23	0.61	0.51	4.08	4.10	5.02	1.20	7.51	8.0	8.71	9.0	6.93	7.0
2340	.....	2.15	0.44	0.36	0.44	3.39	3.28	2.28	0.92	5.95	6.0	6.87	7.0	10.68	10.0
2386	0.32	1.67	0.15	0.57	0.50	3.22	3.28	2.98	0.71	7.42	6.0	8.13	7.0	8.86	10.0

Descriptive List of Fertilizer Samples, 1913.

Station number.	Manufacturer, place of business and brand.
2329	C-C-Co.'s Special Compound
2488	C-C-Co.'s Special Compound
	E. D. CHITTENDEN CO., BRIDGEPORT, CONN.
2372	Chittenden's High Grade Potato
2390	Chittenden's High Grade Potato
2371	Chittenden's Potato and Grain
2370	Chittenden's 10% Potato
2391	Chittenden's 10% Potato
	E. L. CLEVELAND CO., HOULTON, MAINE.
2252	Cleveland's Aroostook Special Formula "B" Mixture
	COE-MORTIMER CO., NEW YORK CITY, N. Y.
2236	E. Frank Coe's Blood, Bone and Potash
2269	E. Frank Coe's Blood, Bone and Potash
2266	E. Frank Coe's Celebrated Special Potato Fertilizer
2509	E. Frank Coe's Celebrated Special Potato Fertilizer
2077	E. Frank Coe's Columbian Corn Fertilizer
2267	E. Frank Coe's Columbian Corn Fertilizer
2114	E. Frank Coe's Columbian Potato Fertilizer
2272	E. Frank Coe's Columbian Potato Fertilizer
2076	E. Frank Coe's Complete Manure with 10% Potash
2238	E. Frank Coe's Complete Manure with 10% Potash
2067	E. Frank Coe's Double Strength Potato Manure
2241	E. Frank Coe's Double Strength Potato Manure
2463	E. Frank Coe's Double Strength Top Dressing
2491	E. Frank Coe's Double Strength Top Dressing
2071	E. Frank Coe's Excelsior Potato Fertilizer
2288	E. Frank Coe's Excelsior Potato Fertilizer
2273	E. Frank Coe's Famous Prize Brand Grain and Grass Fertilizer
2510	E. Frank Coe's Famous Prize Brand Grain and Grass Fertilizer
2070	E. Frank Coe's Gold Brand Corn Manure
2275	E. Frank Coe's Gold Brand Corn Manure
2040	E. Frank Coe's Grass and Grain Special
2271	E. Frank Coe's Grass and Grain Special
2074	E. Frank Coe's High Grade Ammoniated Superphosphate
2274	E. Frank Coe's High Grade Ammoniated Superphosphate
2270	E. Frank Coe's High Grade Potato Fertilizer
2462	E. Frank Coe's High Grade Soluble Phosphate
2072	E. Frank Coe's Red Brand Excelsior Guano. For Market Gardening
2237	E. Frank Coe's Red Brand Excelsior Guano. For Market Gardening
2075	E. Frank Coe's Standard Potato Fertilizer
2240	E. Frank Coe's Standard Potato Fertilizer
2276	Muriate of Potash
2277	Nitrate of Soda
2512	Thomas Phosphate Powder (Basic Slag Phosphate)
	DOMINION FERTILIZER CO., ST. STEPHEN, N. B.
2124	Dominion 5-8-7
2418	Dominion 5-8-7
2125	Dominion 4-6-10
2421	Dominion 4-6-10

Analysis of Fertilizer Samples, 1913.

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.
2329	0.37	2.16	0.11	0.56	0.50	3.70	3.69	3.17	0.80	7.19	7.0	7.99	8.0	10.64	10.0
2488	0.16	2.09	.....	0.60	0.52	3.38	3.69	4.94	0.93	7.40	7.0	8.33	8.0	9.56	10.0
2372	.....	2.93	0.52	0.30	0.41	4.16	4.10	6.75	1.10	8.20	8.0	9.30	9.0	6.98	7.0
2390	.....	2.50	0.17	0.75	0.44	4.02	4.10	6.71	0.68	8.65	8.0	9.33	9.0	7.15	7.0
2371	.....	2.93	.....	.....	.....	3.37	3.30	5.63	0.92	8.33	8.0	9.25	9.0	6.12	6.0
2370	.....	2.40	.....	0.36	0.25	3.03	3.30	5.65	0.23	7.33	6.0	7.56	7.0	9.08	10.0
2391	.....	2.36	0.12	0.41	0.23	3.12	3.30	5.42	0.24	6.81	6.0	7.05	7.0	9.54	10.0
2252	0.76	2.14	0.02	0.63	0.45	4.00	4.10	4.88	0.42	8.01	8.0	9.43	9.0	7.47	7.0
2236	1.12	1.26	0.58	0.74	0.43	4.13	4.11	2.97	0.59	7.51	7.0	8.10	8.0	7.67	7.0
2269	1.93	0.78	0.63	0.58	0.29	4.20	4.11	3.25	1.58	7.38	7.0	8.96	8.0	7.02	7.0
2266	0.42	0.70	0.35	.....	.....	1.72	1.65	4.53	0.94	8.01	8.0	8.95	9.0	4.26	4.0
2509	0.21	0.84	0.46	.....	.....	1.78	1.65	3.59	1.01	9.04	8.0	10.05	9.0	4.30	4.0
2077	....	0.52	0.40.	.....	....	1.24	1.23	4.24	0.81	8.32	8.5	9.13	9.5	2.90	2.5
2267	0.14	0.54	0.37	0.22	0.16	1.43	1.23	3.16	1.34	8.63	8.5	9.97	9.5	2.67	2.5
2114	.....	0.54	0.29	0.25	0.20	1.29	1.23	3.83	0.82	8.44	8.5	9.26	9 5	2.74	2.5
2272	0.48	0.48	0.08	.....	.....	1.24	1.23	3.19	0.91	8.06	8.5	8.97	9 5	2.69	2.5
2076	0.80	0.86	0.57	0.30	0.19	2.73	2.47	1.23	0.52	5.94	6.0	6.46	7.0	10.24	10.0
2238	0.83	0.94	0.35	0.23	0.17	2.46	2.47	2.11	0.45	8.26	6.0	8.71	7.0	10.50	10.0
2067	1.18	1.18	0.37	0.49	0.28	3.50	3.70	2.76	1.56	6.68	7.0	8.24	8.0	10.97	10.0
2241	1.28	1.30	0.23	0.56	0.35	3.72	3.70	1.96	1.66	6.53	7.0	8.19	8.0	10.50	10.0
2463	1.10	4.28	0.19	1.07	0.48	7.45	8.23	3.30	1.53	7.10	7.0	8.53	8.0	8.08	8.0
2491	4.76	0.10	0.69	0.65	0.34	6.54	8.23	5.58	0.31	8.22	7.0	8.53	8.0	8.19	8.0
2071	0.80	0.80	0.27	0.25	0.24	2.36	2.47	2.53	0.64	6.89	7.0	7.53	8.0	8.29	8.0
2288	0.81	0.84	0.21	0.30	0.22	2.38	2.47	2.63	0.64	7.41	7.0	8.05	8.0	7.84	8.0
2273	.....	.....	.....	.....	.....	.....	.....	1.15	1.40	9.65	10.0	11.05	11.0	2.65	2.0
2510	.....	.....	.....	.....	.....	.....	.....	2.79	1.16	10.00	10.0	11.16	11.0	2.36	2.0
2070	0.82	1.02	0.13	0.20	0.17	2.34	2.47	3.60	0.92	8.01	8.0	8.93	9.0	6.13	6.0
2275	0.87	0.98	0.02	0.20	0.17	2.24	2.47	3.32	0.79	7.92	8.0	8.71	9.0	6.16	6.0
2040	0.22	0.76	0.06	.....	.....	1.36	0.82	4.26	0.80	8.96	8.0	9.76	9.0	3.58	2.0
2271	.....	0.48	0.24	.....	.....	0.94	0.82	3.48	0.80	8.69	8.0	9.49	9.0	3.08	2.0
2074	.....	0.80	0.31	0.39	0.38	1.88	1.85	3.24	0.93	8.26	8.0	9.19	9.0	3.05	3.0
2274	0.20	0.70	0.42	0.31	0.25	1.88	1.85	3.13	0.71	8.06	8.0	8.77	9.0	2.89	3.0
2270	0.82	0.84	0.08	0.19	0.18	2.11	2.47	3.89	0.69	8.51	8.0	9.20	9.0	6.52	6.0
2462	.....	.....	.....	.....	.....	.....	.....	11.29	0.57	14.66	14.0	15.23	15.0	.....	.....
2072	0.03	1.10	1.47	0.46	0.26	3.32	3.29	4.15	1.53	7.84	8.0	9.37	9.0	7.25	7.0
2237	1.17	1.19	0.27	0.45	0.32	3.40	3.29	3.99	1.54	7.95	8.0	9.49	9.0	7.43	7.0
2075	1.25	1.14	0.12	0.50	0.25	3.18	3.29	1.63	1.41	5.78	6.0	7.19	7.0	10.62	10.0
2240	1.13	1.11	0.16	0.51	0.39	3.30	3.29	1.31	1.25	6.28	6.0	7.53	7.0	10.27	10.0
2276	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	51.56	49.0
2277	15.40	.....	.....	.....	.....	15.40	15.0	.....	.....	.....	.....	.....	.....	.....	.....
2512	.....	.....	.....	.....	.....	.....	.....	.....	.....	14.95	15.0	17.96	17.0	.....	.....
2124	1.54	0.16	0.79	1.12	0.53	4.14	4.10	3.38	1.67	7.29	8.0	8.96	9.0	7.72	7.0
2418	1.80	0.16	0.69	0.80	0.68	4.13	4.11	2.52	1.95	7.32	8.0	9.27	9.0	7.61	7.0
2125	1.54	0.16	0.19	0.72	0.49	3.28	3.30	1.50	1.48	5.49	6.0	6.97	7.0	10.77	10.0
2421	0.04	1.23	1.19	0.53	0.32	3.30	3.28	1.44	1.03	6.07	6.0	7.10	7.0	11.96	10.0

Descriptive List of Fertilizer Samples, 1913.

Station number.	Manufacturer, place of business and brand.
2419	Dominion 4½-8-9
2420	Dominion 4½-8-9
2446	Dominion 3-6-10
2444	Dominion 2-8-2
	ESSEX FERTILIZER CO., BOSTON, MASS.
2534	Essex A1 Superphosphate
2357	Essex Complete Manure, for Potatoes, Roots and Vegetables
2374	Essex Complete Manure, for Potatoes, Roots and Vegetables
2376	Essex Grain, Grass and Potato Fertilizer
2465	Essex Grain, Grass and Potato Fertilizer
2323	Essex High Grade Special, With 10% Potash
2375	Essex Market Garden and Potato Manure
2356	Essex Peerless Potato Manure
2413	Essex Peerless Potato Manure
2467	Essex Potato Grower, With 10% Potash
2442	Essex Special Corn Fertilizer
2466	Essex Special Corn Fertilizer
2533	Essex Special Potato Phosphate, for Potatoes and Roots
2373	Essex XXXFish and Potash, for all crops
2464	Essex XXX Fish and Potash, for all crops
	GALT BLOCK WAREHOUSE CO., PORTLAND, ME.
2161	Dirigo XXXX Acid Phosphate
2379	Dirigo XXXX Acid Phosphate
	HUBBARD FERTILIZER CO., BALTIMORE, MD.
2280	Hubbard's Aroostook Special Fertilizer
2384	Hubbard's Aroostook Special Fertilizer
2182	Hubbard's Blood, Bone and Potash
2281	Hubbard's Blood, Bone and Potash
2461	Hubbard's B. & P, 10 and 2
2351	Hubbard's Farmers' I. X. L. for Grain and Grass
2181	Hubbard's Maine Potato Grower Fertilizer
2279	Hubbard's Maine Potato Grower Fertilizer
2350	Hubbard's Royal Ensign for Corn and Grain
2278	Hubbard's Special Potato Fertilizer
2354	Hubbard's Special Potato Fertilizer
2352	Hubbard's 10% Potash Guano for Potatoes
	LISTERS AGRICULTURAL CHEMICAL WORKS, NEWARK, N. J.
2131	Lister's Bone Meal
2073	Lister's 5-7-7 Potato Fertilizer
2253	Lister's 5-7-7 Potato Fertilizer
2036	Lister's Grain and Grass Fertilizer
2129	Lister's Grain and Grass Fertilizer
2522	Lister's Ground Tankage
2165	Lister's High Grade Dry Blood
2024	Lister's High Grade Special for Spring Crops
2132	Lister's High Grade Special for Spring Crops
2521	Lister's Plain Superphosphate
2061	Lister's Potato Manure
2130	Lister's Potato Manure

Analysis of Fertilizer Samples, 1913.

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.
2419	1.93	0.12	0.51	0.66	0.48	3.70	3.69	2.63	1.77	7.24	8.0	9.01	9.0	9.80	9.0
2420	0.84	0.12	1.64	0.71	0.44	3.75	4.50	2.74	1.71	7.24	8.0	8.95	9.0	10.14	9.0
2446	0.99	0.09	0.47	0.65	0.26	2.46	2.46	2.78	1.34	6.17	6.0	7.51	7.0	9.94	10.0
2444	0.62	0.07	0.34	0.30	0.19	1.52	1.64	2.84	1.57	7.78	8.0	9.25	9.0	2.11	2.0
2534	.....	0.06	0.49	0.37	0 40	1.32	1.25	4.47	0.91	7.06	7.0	7.97	8.0	2.65	2.0
2537	.....	0.10	1.58	0.85	0.77	3.30	3.28	4.04	1.15	6.22	6.0	7.37	7.0	10.38	10.0
2374	.....	0.13	1.44	0.99	0.78	3.34	3.28	3.64	0.84	8.49	6.0	9.33	7.0	10.28	10.0
2376	.....	.....	0.46	.....	.....	0.82	0.82	5.14	0.92	7.93	8.0	8.85	9.0	3.87	4.0
2465	.....	.....	0.45	.....	.....	0.80	0.82	5.36	0.89	7.75	8.0	8.64	9.0	4.04	4.0
2323	.....	1.50	0.70	0.80	0.54	3.54	3.69	4.47	1.24	6.97	7.0	8.21	8.0	10.65	10.0
2375	.....	0.10	1.24	0.37	0.35	2.06	2.00	4.67	1.59	7.90	8.0	9.49	9.0	5.63	5.0
2356	.....	0.15	1.83	1.25	1 02	4.05	4.10	4.24	1.99	7.45	7.0	9.44	8.0	8.17	8.0
2413	.....	1.00	0.98	0.92	0.82	3.72	4.10	5.31	1.20	7.49	7.0	8.69	8.0	7.76	8.0
2467	.....	0.10	1.21	0.69	0.32	2.32	2.46	4.50	1.31	6.17	6.0	7.48	7.0	9.62	10.0
2442	.....	0.09	0.97	0.58	0.36	2.00	2.00	5.17	1.86	7.92	8.0	9.78	9.0	3.33	3.0
2466	0.24	0.02	0.88	0.65	0.35	2.14	2.00	5.07	1.63	7.87	8.0	9.44	9.0	3.27	3.0
2533	....	0.09	1.23	0.77	0.65	2.74	2.46	5.69	0.88	8.53	8.0	9.41	9.0	7.02	6.0
2373	.....	0.09	0.97	0.55	0.49	2.10	2.00	4.78	1.53	7.77	8.0	9.30	9.0	3.67	3.0
2464	.....	0.10	0.96	0.77	0.27	2.10	2.00	5.28	1.70	7.58	8.0	9.28	9.0	3.03	3.0
2161	.....	.....	.....	.....	.....	.....	.....	10.46	0.92	15.05	14.2	15.97	14.2	.....	.....
2379	.....	.....	.....	.....	.....	.....	.....	11.10	0.79	15.30	14.2	16.09	14.2	.....	.....
2280	0.49	2.02	0.15	0.57	0.47	3.70	3.69	2.46	1.09	6.67	7.0	7.76	8.0	10.90	10.0
2384	0.40	2.06	0.26	0.64	0.38	3.74	3.69	2.49	0.71	7.22	7.0	7.93	8.0	11.02	10.0
2182	0.42	1.82	0.72	0.66	0.54	4.16	3.28	3.29	0.82	7.58	8.0	8.40	9.0	7.48	7.0
2281	0.67	1.34	0.25	0.62	0.46	3.34	3.28	4.12	0.79	7.78	8.0	8.57	9.0	7.71	7.0
2461	.....	.....	.....	.....	.....	.....	.....	0.83	1.93	10.62	10.0	12.55	11.0	2.18	2.0
2351	.....	0.70	0.27	0.35	0 38	1.70	1.64	2.12	1.72	8.07	8.0	9.79	9.0	3.19	2.0
2181	0.64	2.38	.....	0.70	0.49	4.19	4.10	5.71	0.64	7.95	8.0	8 59	9.0	7.62	7.0
2279	0.66	2.20	0.16	0.62	0.46	4.10	4.10	5.28	0.55	7.86	8.0	8.41	9.0	7.45	7.0
2350	.....	1 39	0.39	0.41	0 45	2.64	2.46	5.28	1.20	8.77	8.0	9.97	9.0	4.75	4.0
2278	0.38	1.56	0.33	0.59	0.44	3 30	3.28	3.00	0.57	6.46	6.0	7.03	7.0	10.02	10.0
2354	0.88	1.44	0.12	0.50	0.42	3.36	3.28	2.41	0.70	7.00	6.0	7.70	7.0	10.00	10.0
2352	0.64	1.44	0.08	0.23	0.35	2.74	2.46	3.68	0 87	7.04	6 0	7.91	7.0	9.97	10.0
2131	.....	.....	2.79	0.70	0.17	3.66	2.68	.....	.....	.....	.....	24.04	23.0	.....	.....
2073	.....	2.20	0.71	0.79	0.44	4.14	4.11	5.53	1.59	7.56	7.0	9.25	8.0	7.35	7.0
2253	1.80	1.24	0.30	0.54	0.21	4.09	4.11	3.83	1.22	7.20	7.0	8.42	8.0	8.04	7.0
2036	.....	.....	.....	.....	.....	.....	.....	5.55	0.61	10.11	10.0	10.72	11.0	2.31	2.0
2129	.....	.....	.....	.....	.....	.....	.....	6.43	0.31	10.70	10.0	11.01	11.0	2.03	2.0
2522	.....	.....	3.37	1.21	1.14	5.71	4.94	.....	.....	.....	.....	18.31	13.7	.....	.....
2165	.....	.....	0.70	7.65	2.19	10.54	9.87	.....	.....	.....	.....	.....	.....	.....	.....
2024	.....	0.22	0.40	0.50	0.42	1.55	1.65	5.30	2.05	7.73	8.0	9.78	9.0	10.81	10.0
2132	.....	0.34	0.47	0.41	0.44	1.66	1.65	5.92	1.88	8.25	8.0	10.13	9.0	9.87	10.0
2521	.....	.....	.....	.....	.....	.....	.....	11.2	0.55	14.35	4.0	14.90	15.0	.....	.....
2061	0.08	1.96	0.40	0.49	0.39	3.32	3.30	6.38	1.44	8.30	8.0	9.74	9.0	7.21	7.0
2130	.....	2.16	0.30	0.43	0.41	3.30	3.30	6.03	1.55	7.79	8.0	9.34	9.0	7.76	7.0

Descriptive List of Fertilizer Samples, 1913.

Station number.	Manufacturer, place of business and brand.
2037	Lister's Special Corn Fertilizer
2128	Lister's Special Corn Fertilizer
2065	Lister's Special Potato Fertilizer
2126	Lister's Special Potato Fertilizer
2042	Lister's Success Fertilizer
2133	Lister's Success Fertilizer
2127	Lister's 10% Potato Grower
2180	Lister's 10% Potato Grower
	LOWELL FERTILIZER CO., BOSTON, MASS.
2473	Acid Phosphate
2007	Lowell Animal Brand, For all crops
2213	Lowell Animal Brand, For all crops
2015	Lowell Bone Fertilizer, For Corn, Grain, Grass and Vegetables
2211	Lowell Bone Fertilizer, For Corn, Grain, Grass and Vegetables
2474	Lowell Bone Fertilizer, For Corn, Grain, Grass and Vegetables
2002	Lowell Corn and Vegetable
2369	Lowell Dissolved Bone and Potash
2310	Lowell Empress Brand, For Corn, Potatoes and Grain
2472	Lowell Ground Bone
2341	Lowell Perfect Potato Brand
2368	Lowell Perfect Potato Brand
2019	Lowell Potato Grower, With 10% Potash
2212	Lowell Potato Grower, With 10% Potash
2016	Lowell Potato Manure
2207	Lowell Potato Manure
2018	Lowell Potato Phosphate
2325	Lowell Potato Phosphate
2011	Lowell Special Potato Fertilizer, With 10% Potash
2210	Lowell Special Potato Fertilizer, With 10% Potash
2012	Lowell Superior Fertilizer, With 10% Potash
2013	Lowell Superior Fertilizer, With 10% Potash
2471	Muriate of Potash
2470	Nitrate of Soda
	MERROW BROTHERS & CO., AUBURN, ME.
2353	Merrow's Bone Meal
	MORISON BROTHERS, BANGOR, ME.
2117	Morison Bros.' "A" Brand Potato Fertilizer
2121	Morison Bros.' Acid Phosphate
2118	Morison Bros.' "C" Brand Fertilizer for all crops
2122	Morison Bros.' Muriate of Potash
2120	Morison Bros.' Nitrate of Soda
2116	Morison Bros.' 3-8-10
2445	Morison Bros.' 3-8-10
2123	Morison Bros.' "Xtra" High Grade Potato Fertilizer
	NATIONAL FERTILIZER CO., BOSTON, MASS.
2327	Chittenden's Ammoniated Bone Phosphate
2343	Chittenden's Aroostook Special
2389	Chittenden's Aroostook Special

Analysis of Fertilizer Samples, 1913.

	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.
2037	0.04	0.12	0.47	0.29	0.28	1.20	1.23	5.52	1.84	7.91	8.0	9.76	9.0	3.12	3.0
2128	.....	0.20	0.40	0.31	0.39	1.30	1.23	5.93	1.54	8.44	8.0	9 98	9.0	3.11	3.0
2065	.....	0.22	0.46	0.53	0.47	1.68	1.65	4.98	2.37	8.19	8.0	10.56	9.0	3.39	3.0
2126	.....	1.25	.....	0.27	0.14	1.60	1.65	5.20	1.92	7.21	8.0	9.13	9.0	3.33	3.0
2042	0.08	0.16	0.25	0.40	0.34	1.23	1.24	6.36	1.58	8.98	9.0	10.56	10.0	2.34	2.0
2133	.....	0.16	0.42	0.33	0.47	1.38	1.24	7.51	1.28	9.44	9.0	10.72	10 0	2.27	2 0
2127	.....	1.34	0.51	0.69	0.76	3.30	3.30	4.13	1.54	6.48	6.0	8.02	7.0	11.16	10.0
2180	1.58	0.18	0.42	0.73	0.43	3.34	3.30	2.82	2.20	5.69	6.0	7.89	7.0	10.42	10.0
2473	.....	.....	.....	.....	.....	.....	.....	10.45	1.89	14.86	12.0	16.75	15.0	.....	.....
2007	.....	0.12	1.16	0.91	0.39	2.58	2.46	5.20	1.76	7.89	8.9	9.65	9.0	4.57	4.0
2213	.....	0.10	1.00	0.75	0.49	2.34	2.46	5.26	1.74	7.94	8.0	9 68	9.0	4.35	4.0
2015	.....	0.12	0.85	0.39	0.28	1.64	1.64	4.53	1.34	7.08	8.0	8.42	9.0	3.09	3.0
2211	.....	0.09	0.93	0.42	0.26	1.70	1.64	4.47	1.48	7.72	8.0	9.20	9.0	2.94	3.0
2474	.....	0.06	0.94	0.55	0.21	1.76	1.64	4.71	1.43	7.96	8.0	9.39	9 0	3.13	3.0
2002	.....	0.14	1.69	0.90	0.57	3.30	3.28	5.85	1.61	8.68	8.0	10.29	9.0	7.47	7.0
2369	.....	0 09	0.58	0.53	0.58	1.78	1.64	5.23	2.35	10.25	9.0	12 60	10.0	2.23	2.0
2310	.....	0 05	0.67	0.32	0.22	1.26	1.24	4.48	0.96	6.90	7.0	7.86	8.0	2.03	2.0
2472	.....	..	1.04	1.10	0.54	2.68	2.46	.....	.....	.....	.....	26.03	23.0	.....	.....
2341	.....	0 21	1.89	1.18	0.84	4.12	4.10	4.04	2.22	6.97	7.0	9.19	8.0	8.22	8 0
2368	.....	0.16	1.85	1.24	1.01	4.25	4.10	4.42	1.96	7.42	7.0	9.38	8.0	8.22	8.0
2019	.....	0.12	1.62	1.23	0.53	3.50	3.28	4.02	1.11	6.51	6.0	7.62	7.0	10.50	10.0
2212	.....	0.09	1.59	1.31	0.49	3.48	3.28	3.89	1.35	6.54	6.0	7.89	7.0	10.34	10.0
2016	.....	0.12	0.82	0.45	0.31	1.70	1.64	3.75	1.28	6.71	7.0	8.00	8.0	4.13	4.0
2207	.....	0.10	0.74	0 50	0.30	1.64	1.64	3.89	1.45	7.19	7.0	8.64	8.0	3.73	4.0
2018	.....	0.12	1.19	0.81	0 29	2 41	2 46	5.79	0.96	8.13	8.0	9.09	9.0	6.43	6.0
2325	0.52	0.10	0.83	0.55	0.54	2.54	2.46	6.17	0.98	8.64	8.0	9.62	9.0	6.05	6.0
2011	.....	0.14	1.29	0 61	0.35	2.39	2.46	4.19	1.24	6.18	6.0	7.42	7.0	10.92	10.0
2210	.....	0.10	1.33	0.73	0.33	2.49	2.46	4.23	1.11	6 42	6 0	7.53	7.0	10.24	10.0
2012	.....	0.16	1.47	0.68	1.39	3.70	3.69	5.09	1.67	6.96	7.0	8.63	8.0	10.48	10.0
2013	.....	0.12	1.47	1.40	0.62	3.61	3.69	4.93	1.57	6.92	7.0	8.47	8.0	10.63	10.0
2471	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	.....	.....	50.12	50.0
2470	15.04	.....	.....	.....	.....	15.04	15 0	.....	.....	.....	.....	.....	.....	.....	.....
2353	.....	.....	0.49	0.50	0.47	1.46	1.25	.....	.....	.....	.....	30.75	28.0	.....	.....
2117	0.68	1.10	0.25	0.58	0.39	3.00	3.00	6.46	0.54	8.47	8.0	9.01	9.0	11.10	10.0
2121	.....	.....	.....	.....	.....	.....	.....	14.23	0.12	17.55	16 0	17.67	.....	.....	.....
2118	1.36	0.10	.....	0.48	0.27	2.20	2.20	6.97	0.27	10.18	10.0	10.45	.....	6.87	6.0
2112	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	50.72	50.0
2120	.....	.....	.....	.....	.....	14.6	15.0	.....	.....	.....	.....	.....	.....	.....	.....
2116	.....	1.72	0.39	0.56	0.46	3.13	2.47	6.64	0.45	8.18	8.0	8.63	9.0	10.11	10.0
2445	.....	1.52	0.62	0.65	0.23	3.02	2.47	6.91	0.65	8.18	8.0	8.50	9.0	10.54	10 0
2123	1.04	1.54	.....	1.23	0.39	4.20	4.12	6.00	1.16	8.95	7.0	10.11	.....	10.90	10 0
2327	0 04	1.02	0.10	0.26	0.23	1.65	1.65	4.75	1.21	8.15	8.0	9.36	9.0	2.16	2 0
2343	1.93	0.48	0.54	0.84	0.49	4.28	4.11	2.97	1.74	6.76	7.0	8.50	8 0	7.52	7 0
2389	2.13	0.42	0.64	0.64	0.34	4.17	4.11	3.40	1.76	7.01	7.0	8.77	8.0	7.54	7 0

Descriptive List of Fertilizer Samples, 1913.

Station number.	Manufacturer, place of business and brand
2363	Chittenden's Complete Root and Grain Fertilizer
2451	Chittenden's Complete Root and Grain Fertilizer
2430	Chittenden's Eureka Potato Fertilizer
2326	Chittenden's Excelsior Potato Fertilizer
2364	Chittenden's Excelsior Potato Fertilizer
2342	Chittenden's Extra High Grade Manure
2362	Chittenden's Extra High Grade Manure
2468	Chittenden's Market Garden Special
	NEW ENGLAND FERTILIZER CO., BOSTON, MASS.
2014	New England Complete Manure, With 10 % Potash
2006	New England Corn and Grain Fertilizer
2005	New England Corn Phosphate
2209	New England Corn Phosphate
2293	New England High Grade Potato Fertilizer
2439	New England High Grade Potato Fertilizer
2008	New England High Grade Special. With 10% Potash
2214	New England High Grade Special. With 10% Potash
2485	New England Market Garden Manure
2489	New England Market Garden Manure
2532	New England Potato and Vegetable Manure
2004	New England Potato Fertilizer
2438	New England Potato Fertilizer
2208	New England Potato Grower, with 10% Potash
2009	New England Potato Grower, with 10% Potash
2010	New England Superphosphate. For all crops
2215	New England Superphosphate. For all crops
	NEW MINERAL FERTILIZER CO., BOSTON, MASS.
2432	New Mineral Fertilizer or Wonder Plant Food
	NITRATE AGENCIES CO., NEW YORK CITY, N. Y.
2163	Ground Bone
2164	Ground Tankage
2377	Ground Tankage
2378	Nitrate of Soda
2380	Sulphate of Potash
2162	Thomas Phosphate Powder—"H. A." Brand
	PAN AMERICAN FERTILIZER CO., NEW YORK CITY, N. Y
2427	Special Composition
	PARMENTOR & POLSEY FERTILIZER CO., BOSTON, MASS.
2321	P. & P. A. A. Brand
2333	P. & P. A A Brand
2017	P. & P. Aroostook Special. With 10% Potash
2322	P. & P. Aroostook Special. With 10% Potash
2530	P. & P. Grain Grower
2324	P. & P. Maine Potato Fertilizer. With 10% Potash
2528	P. & P. Maine Potato Fertilizer. With 10% Potash
2003	P. & P. Plymouth Rock Brand Fertilizer
2531	P. & P. Potato Fertilizer
2527	P. & P. Potato Grower. With 10% Potash
2001	P. & P. Special Potato Fertilizer. For Potatoes and all Root Crops
2529	P. & P. Star Brand Superphosphate

Analysis of Fertilizer Samples, 1913.

Station number.	Nitrogen.							Phosphoric Acid.						Potash.	
			Organic.			Total.				Available.		Total.			
	As nitrate.	As ammonia.	As water soluble.	As active insoluble.	As inactive insoluble.	Found.	Guaranteed.	Soluble.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
2363	1.58	0.33	0.47	0.80	0.36	3.54	3.29	3.70	1.51	7.90	8.0	9.41	9.0	6.76	6.0
2451	1.82	0.08	0.03	0.87	0.44	3.24	3.29	3.72	1.61	7.91	8.0	9.51	9.0	7.81	6.0
2430	0.78	0.82	0.18	0.25	0.27	2.30	2.47	3.80	1.25	6.82	6.0	8.07	7.0	9.68	10.0
2326	1.48	0.88	0.16	0.41	0.39	3.32	3.29	2.47	1.30	6.26	6.0	7.56	7.0	10.26	10.0
2364	1.00	0.54	0.73	0.64	0.45	3.36	3.29	2.19	1.49	6.02	6.0	7.51	7.0	10.21	10.0
2342	2.13	0.47	0.44	0.77	0 35	4.16	4.11	3.11	1.58	6.97	7.0	8.55	8.0	10.14	10.0
2362	1.36	0.84	1.05	0.53	0.38	4.16	4.11	3.51	1.03	7.39	7.0	8.42	8.0	10.04	10.0
2468	1.18	0.20	0.18	0.41	0.22	2.19	2.47	2.63	1.20	5.88	6.0	7.08	7.0	5.23	5.0
2014	.....	0.16	1 43	1.27	0.56	3.42	3.28	3.75	1.03	6.29	6.0	7.32	7.0	10.58	10.0
2006	.....	0.12	0.52	0.44	0.30	1.38	1.23	4.98	1.39	7.08	7.0	8.47	8.0	2.44	2.0
2005	.....	0.70	0.80	0.42	0.24	2.16	1.64	4.91	1.37	7.56	8.0	8.93	9.0	3.12	3.0
2209	.....	0.11	0.85	0.45	0.27	1.68	1.64	4.71	1.38	9.13	8.0	10.51	9.0	2.90	3.0
2293	.....	0.15	1.39	0.70	0.35	2.59	2.46	5.42	1.39	8.74	8.0	10.13	9.0	6.51	6.0
2439	.....	0.10	1.36	0.66	0.43	2.55	2.46	5.74	1.25	8.42	8.0	9.67	9.0	6.11	6.0
2008	.....	0.14	1.38	1.31	0.72	3.74	3.69	5.07	1.66	7.64	7.0	9.30	8.0	10.51	10.0
2214	.....	0.12	1.45	1.44	0.71	3.72	3.69	4.94	1.48	7.16	7.0	8.64	8.0	9.87	10 0
2485	.....	0.12	2.12	1.11	0.77	4.12	4.10	4.94	1.62	7.23	7.0	8.83	10.0	6.75	7.0
2489	0.22	0.22	1.75	1.14	0.73	4.06	4.10	5.07	1.57	7.30	7.0	8.87	10.0	7.21	7.0
2532	.....	0.14	1.42	0.94	0.84	3.34	3.28	6.11	1.40	8.57	8.0	9.97	9.0	7.12	7.0
2004	.....	0.42	0.73	0.45	0.34	1.94	1.64	3.73	1.28	6.41	7.0	7.69	8.0	4.16	4.0
2438	.....	0.10	0.82	0.39	0.41	1.72	1.64	5.47	0.87	7.04	7.0	7.91	8.0	4.05	4.0
2208	.....	0.10	1.28	0.68	0.34	2.40	2.46	4.13	1.05	6.18	6.0	7.23	7.0	10.18	10.0
2009	.....	0.14	1.23	0.69	0.34	2.38	2.46	4.26	1.35	6.07	6.0	7.42	7.0	10.46	10.0
2010	.....	0.10	1.11	0.70	0.60	2.51	2.46	4.85	1.81	7.34	8.0	9.15	9.0	4.92	4.0
2215	.....	0.09	1.08	0.77	0.58	2.52	2.46	5.02	1.51	7.42	8.0	8.93	9.0	4.43	4.0
2432	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.25	0.23	.....	.....
2163	.....	.....	.....	.....	.....	1.72	2.50	.....	.....	.....	.....	24.72	23.0	.....	.....
2164	.....	.....	2.10	1.99	0.91	5.00	5.75	.....	.....	.....	.....	18.96	13.7	.....	.....
2377	.....	.....	2.12	1.65	1.13	4.95	5.75	.....	.....	.....	.....	18.76	13.7	.....	.....
2378	13.84	.....	.....	.....	.....	13.84	15.0	.....	.....	.....	.....	.....	.....	.....	.....
2380	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	47.48	48.0
2162	.....	.....	.....	.....	.....	....	.....	.....	.....	14.45	15.0	17.40	17.0	.....	.....
2427	.....	3.38	.....	0.40	0.32	4.10	4.10	4.98	0.61	7.60	8.0	8.21	9.0	9.78	8.0
2321	.....	0.18	1.42	1.27	1.19	4.06	4.10	4.08	1.79	7.05	7.0	8.84	8.0	6.12	8.0
2333	.....	0.18	1.61	1.17	1.17	4.13	4.10	4.19	2.25	7.10	7.0	9.35	8.0	8.25	8.0
2017	.....	0.14	1.73	1.34	0.51	3.72	3.69	4.78	1.49	7.22	7.0	8.71	8.0	10.55	10.0
2322	.....	1.50	0.64	0.77	0.58	3.49	3.69	4.47	1.17	7.00	7.0	8.17	8.0	10.12	10.0
2530	.....	0.07	0.55	0.37	0.39	1.38	1.23	4.78	0.45	8.51	7.0	8.96	8.0	2.20	2.0
2324	.....	0.12	1.41	0.84	0.75	3.12	3.28	3.96	1.02	6.75	6.0	7.77	7.0	10.38	10.0
2528	.....	0.08	1.42	0.83	0.89	3.42	3.28	3.99	1.44	6.97	6.0	8.41	7.0	10.14	10.0
2003	.....	0.12	1.16	0.77	0.51	2.56	2.46	5.81	1.62	7.91	8.0	9.53	9.0	4.42	4.0
2531	.....	0.10	0.54	0.47	0.47	1.58	1.64	4.64	0.41	7.44	6.0	7.85	7.0	6.10	6.0
2527	.....	0.14	0.85	0.78	0.69	2.46	2.46	4.35	1.03	6 83	6.0	7.86	7.0	10.16	10.0
2001	.....	0.16	1.47	0.93	0.59	3 15	3.28	5.61	1.65	7.87	8.0	9.52	9.0	7.89	7.0
2529	.....	0.12	0.83	0.30	0 32	1.57	1.64	5.07	1.02	7.00	7.0	8.02	8.0	4.13	4.0

Descriptive List of Fertilizer Samples, 1913.

Station number.	Manufacturer, place of business and brand.
	E. W. PENLEY CO., AUBURN, ME.
2306	Penley's Auburn
2307	Penley's 4-6-10
2305	Penley's Seeding Down
2304	Penley's 3-6-10
	PORTLAND RENDERING CO., PORTLAND, ME.
2526	Bone Dust Tankage
2475	Portland Animal Fertilizer
2477	Portland Animal Fertilizer
2175	Portland Ground Bone Flour
2478	Portland Ground Bone Flour
2476	Portland Potato Grower
	READING BONE FERTILIZER CO., READING, PA.
2345	Aroostook A. A. A. A
2456	Aroostook A. A. A. A
2346	Reading's Potato Special
2457	Reading's Potato Special
	ROGERS & HUBBARD CO., MIDDLETOWN, CONN.
2503	Hubbard's "Bone Base" All Soils-All Crops Phosphate
2508	Hubbard's "Bone Base" All Soils-All Crops Phosphate
2402	Hubbard's "Bone Base" Complete Phosphate
2504	Hubbard's "Bone Base" Complete Phosphate
2393	Hubbard's "Bone Base" Fertilizer for Oats and Top Dressing
2407	Hubbard's "Bone Base" Fertilizer for Oats and Top Dressing
2394	Hubbard's "Bone Base" Fertilizer for Seeding Down and Fruit
2397	Hubbard's "Bone Base" Fertilizer for Seeding Down and Fruit
2403	Hubbard's "Bone Base" New Market Garden Phosphate
2505	Hubbard's "Bone Base" New Market Garden Phosphate
2395	Hubbard's "Bone Base" Potato Phosphate
2398	Hubbard's "Bone Base" Potato Phosphate
2396	Hubbard's "Bone Base" Soluble Corn and General Crops Manure
2406	Hubbard's "Bone Base" Soluble Corn and General Crops Manure
2405	Hubbard's "Bone Base" Soluble Potato Manure
2404	Hubbard's "Bone Base" Soluble Tobacco Manure
2507	Hubbard's "Bone Base" Soluble Tobacco Manure
	SAGADAHOC FERTILIZER CO., BOWDOINHAM, ME.
2192	Acid Phosphate
2198	Muriate of Potash
2197	Nitrate of Soda
2190	Sagadahoc Aroostook Potato Manure
2186	Sagadahoc Dirigo Fertilizer
2514	Sagadahoc Fisher Formula
2191	Sagadahoc 5-8 and 7 Fertilizer
2303	Sagadahoc 5-8 and 7 Fertilizer
2193	Sagadahoc 4-6 and 10 Fertilizer
2302	Sagadahoc 4-6 and 10 Fertilizer
2188	Sagadahoc High Grade Superphosphate
2200	Sagadahoc Honeysuckle Fertilizer
2502	Sagadahoc Orchard Fertilizer

Analysis of Fertilizer Samples, 1913.

Station number.	Nitrogen.							Phosphoric Acid.						Potash.	
			Organic.			Total.				Available		Total.			
	As nitrate.	As ammonia.	As water soluble.	As active insoluble.	As inactive insoluble.	Found.	Guaranteed.	Soluble.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
2306	0.88	0.04	0.31	0.88	0.45	2.56	2.47	7.11	1.02	10.30	8.0	11.32	9 0	4.67	4.0
2307	1.36	0.10	0.16	1.00	0.45	3.07	3.29	5.12	0.96	8.55	6.0	9.51	7.0	10.68	10.0
2305	0.46	0.04	0.17	0.36	0.26	1.29	1.03	6.44	0.61	10.01	8.9	10.62	9.0	2.89	2.0
2304	0.92	0.06	0 38	0.54	0.30	2.20	2.47	6.00	0.60	9.02	6.0	9.62	7.0	7.28	10.0
2526	.....	.....	2.51	1.46	1.50	5.47	5.75	.....	.....	.....	.....	16.97	14.5	.....	.....
2475	.....	1.43	0.63	0.72	0.26	3.04	2.46	5.58	3.11	9.92	8.0	13.03	9.0	5.81	4.0
2477	.....	0.98	0.64	0.48	0.46	2.56	2.46	6.62	2.03	11.77	8.0	13.80	9.0	4.48	4.0
2175	.....	.....	0.68	1.19	0.50	2.37	2.48	.....	.....	.....	.....	27.20	23.0	.....	.....
2478	.....	.....	0.66	1.00	0.82	2.48	2 48	.....	.....	.....	.....	26.48	23.0	.....	.....
2476	.....	0.82	1.09	0.67	0.76	3.34	3.28	3.67	2.78	9.05	6.0	11.83	7.0	10.71	10.0
2345	.....	2.71	0.01	0.52	0.62	4.18	4.11	4.26	1.96	7.80	8.0	9.76	9.0	7.04	7 0
2456	.....	2.74	0.22	0.79	0.32	4.17	4.11	4.02	1.95	8.18	8.0	10.13	9.0	7.45	7.0
2346	.....	2.74	0.25	0.65	0.44	4.08	4.11	4.96	1.17	7.76	7.0	8.93	8.0	10.36	10.0
2457	.....	2.33	0.25	1.01	0.45	4.04	4.11	3.40	2.12	7.45	7.0	9.57	8.0	9.92	10.0
2503	1.99	0.13	0.20	0.44	0.35	3.11	3.30	5.31	2.83	9.13	8.0	11.96	9.0	7.48	7.0
2508	2.24	.....	0.48	0.41	0.28	3.41	3.30	5.65	2.11	8.50	8.0	10.61	9.0	7.93	7.0
2402	0.62	0.03	.....	0.36	0.53	1.54	1.50	4.63	2.30	7.60	7.0	9.90	8.0	6.15	5.0
2504	0.62	0.06	0.30	0.29	0.27	1.54	1.50	3.94	2.78	7.43	7.0	10.21	8.0	6.05	5.0
2393	6.76	0.08	0.97	0.48	0.21	8.50	8.50	.....	2.50	5.96	4.5	9.46	8.0	8.00	8.0
2407	7.24	.....	1.25	0.50	0.25	9.24	8.50	.....	3.43	5.41	4.5	8.84	8.0	6.98	8.0
2394	.....	0.09	0.66	1.04	0.49	2.28	2.20	.....	8.04	10.54	6.5	18.58	16.0	12.05	12.0
2397	.....	0.18	0.55	0.94	0.59	2.26	2.20	.....	8.19	9.72	6.5	17.91	16.0	12.00	12.0
2403	0.80	0.10	0.73	0.33	0.14	2.10	2.00	3.84	2.04	6.43	6.0	8.47	7.0	11.20	10.0
2505	0.78	0.11	.....	0.60	0.52	2 00	2.00	4.31	1.53	6.84	6.0	8.37	7.0	11.17	10 0
2395	0.88	0.10	0.30	0.49	0.33	2.10	2.00	6.00	1.90	9.14	9.0	11 04	10.0	5.95	5.0
2398	0.85	0.08	0.23	0.48	0.44	2.08	2.00	6.59	1.54	9.66	9.0	11.20	10.0	5.85	5 0
2396	1.38	0.10	0.11	0.56	0.37	2.52	2.50	0.32	2.73	7.00	6.0	9.73	8.0	9.25	8.0
2406	1.27	0.11	0.26	0.53	0.39	2.56	2.50	1.87	3.00	7.10	6.0	10.10	8.0	9.14	8.0
2405	1.77	0.42	0.90	1.32	0.69	5.10	5.00	2.44	3.78	8.66	7.0	12.44	10.0	6.48	5.0
2404	2.32	0.26	0.46	1.31	0.71	5.06	5.00	1.23	2.90	8.65	7.0	11.55	10.0	10.77	10.0
2507	2.14	0.15	0.81	1.00	0.94	5.04	5.00	1.12	3.11	7.88	7.0	10.99	10.0	12.20	10.0
2192	.....	.....	.....	.....	.....	.....	.....	12.55	0.57	16.31	16.0	16.88	17.0	.....	.....
2198	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	51.56	50.0
2197	15.24	.....	.....	.....	.....	15.24	15.0	.....	.....	.....	.....	.....	.....	.....	.....
2190	0.48	0.14	0.13	.....	.....	1.10	1.05	6.79	0.48	10.72	6.0	11.20	7.0	5.32	4.0
2186	.....	0.01	.....	0.51	0.80	1.32	1.00	7.40	2.27	11.14	5.0	13.41	7.0	3.94	2.0
2514	4.58	2.36	.....	.....	.....	7.90	6.80	.....	1.39	3.51	3.5	4.90	4.5	10.21	11.0
2191	1.91	0.44	1.06	0.40	0.37	4.18	4.12	2.47	0.57	8.63	8.0	9.20	9.0	7.77	7.0
2303	1.95	0.37	1.03	0.40	0.35	4.10	4.12	2.17	0.45	8.82	8.0	9.27	9.0	8.02	7.0
2193	1.74	0.40	0.22	0.51	0.47	3.34	3.29	1.75	0.47	7.98	6.0	8.45	7.0	10.56	10.0
2302	1.62	0.34	0.31	0.50	0.41	3.18	3.29	2.20	0.59	8.10	6.0	8.69	7.0	9.53	10.0
2188	0.54	0.30	0.13	0.25	0.18	1.40	1.50	7.13	0.60	12.08	6.0	12.68	7.0	4.01	3.0
2200	.....	.....	.....	.....	.....	.....	.....	.....	7.55	7.16	3.0	14.71	8.0	5.25	5.0
2502	.....	0.14	0.62	1.33	1 08	3.17	2.47	0.53	3.09	4.24	2.0	7.35	8.0	7.07	8.0

Descriptive List of Fertilizer Samples, 1913.

Station number.	Manufacturer, place of business and brand.
2187	Sagadahoc 6-6and 6 Fertilizer
2194	Sagadahoc Special Corn Fertilizer
2195	Sagadahoc Special Potato Fertilizer
2196	Sagadahoc 3-6 and 10 Fertilizer
2189	Sagadahoc XX Chemical Brand
2199	Sagadahoc Yankee Fertilizer
	PROF. J. W. SANBORN, PITTSFIELD, N. H.
2400	Prof. Sanborn's Chemical Fertilizer for Grass and Grain
2399	Prof. Sanborn's Chemical Fertilizer for Potatoes and Corn
2401	Prof. Sanborn's Chemical Fertilizer for use in Hill & Drill
	STANDARD GUANO CO., BALTIMORE, MD.
2254	Blue Ribbon Potato Manure
2417	Blue Ribbon Potato Manure
2429	Eclipse Potato Manure
2500	Eclipse Potato Manure
2499	Excelsior Corn & Grass Fertilizer
2501	Excelsior Corn and Grass Fertilizer
2515	Giant Potato Grower
2516	Giant Potato Grower
2360	Maine Potato Grower
	I. P. THOMAS & SON, CO., PHILADELPHIA, PA.
2361	Farmers' Union of Maine 5-8-7
2443	Farmers' Union of Maine 5-8-7
2336	Farmers' Union of Maine 4-8-7
2452	Farmers' Union of Maine 4-8-7
2335	Farmers' Union of Maine 4-8-10
2337	Farmers' Union of Maine 4-6-10
2441	Farmers' Union of Maine 4-6-10
	TUSCARORA FERTILIZER CO., BALTIMORE, MD.
2332	Complete Potato
2469	Fruit and Potato
2517	Fruit and Potato
2179	Trucker
2331	Trucker
	UNION CHEMICAL WORKS, NORTH WALES, PA.
2309	Johnson Seed Potato Company's Ideal Potato Manure (Hoeing Brand)
2308	Johnson Seed Potato Company's Ideal Potato Manure (Planting Brand)
	WHITMAN & PRATT RENDERING CO., LOWELL, MASS.
2535	Whitman & Pratt's Potash Special

Analysis of Fertilizer Samples, 1913.

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.
2187	2.58	0.44	0.63	0.66	0.18	4.49	4.94	1.10	1.07	8.32	6.0	9.39	7.0	7.91	6.0
2194	1.08	0.40	.....	.....	.....	1.74	2.20	3.27	6.21	9.17	8.0	15.38	9.0	5.60	4.0
2195	0.94	0.10	0.33	0.43	0.42	2.22	2.00	2.79	0.87	9.72	7.0	10.59	8.0	8.55	8.0
2196	1.84	0.38	0.20	0.19	0.23	2.84	2.47	1.18	0.78	8.45	6.0	9.23	7.0	10.49	10.0
2189	5.14	0.06	0.82	.....	.....	6.24	6.00	0.38	5.74	7.02	3.0	12.76	6.0	8.09	8.0
2199	0.74	0.04	.....	.....	.....	0.82	0.40	10.30	0.57	13.64	6.0	14.21	7.0	2.26	2.0
2400	4.58	0.07	2.23	.....	.....	5.22	4.75	2.89	2.40	5.14	4.5	7.56	6.0	5.90	5.75
2399	1.07	0.02	0.47	1.30	0.78	3.64	3.30	6.92	2.59	8.39	7.0	10.97	9.5	8.54	8.0
2401	1.23	0.06	0.53	0.70	0.42	2.40	2.40	6.44	3.06	8.70	7.0	11.76	11.5	4.72	4.0
2254	.....	2.48	0.31	0.74	0.47	4.00	4.11	6.46	0.71	8.38	8.0	9.09	8.5	7.23	7.0
2417	.....	2.80	0.32	0.40	0.26	3.94	4.11	7.43	0.40	8.64	8.0	9.04	8.5	6.97	7.0
2429	.....	2.46	0.53	0.31	0.15	3.45	3.28	5.14	0.31	6.34	6.0	6.65	6.5	9.44	10.0
2500	.....	2.45	0.18	0.36	0.24	3.23	3.28	5.31	0.24	7.40	6.0	7.64	7.0	9.33	10.0
2499	.....	1.27	0.06	0.15	0.20	1.68	1.64	6.86	0.61	8.85	8.0	9.46	9.0	2.89	3.0
2501	.....	1.36	.....	0.19	0.21	1.60	1.64	6.44	0.71	8.49	8.0	9.20	9.0	3.35	3.0
2515	.....	2.14	0.47	0.35	0.53	3.49	3.28	7.11	1.37	7.82	8.0	9.19	8.5	7.64	7.0
2516	.....	2.29	.....	0.30	0.51	3.10	3.28	7.96	1.00	8.57	8.0	9.57	8.5	7.11	7.0
2360	.....	2.90	0.47	0.31	0.21	3.81	3.70	6.95	0.14	8.62	7.0	8.76	7.5	7.82	10.0
2361	1.35	1.40	0.10	0.82	0.51	4.18	4.11	7.50	0.50	8.77	8.0	9.27	8.5	7.37	7.0
2443	0.92	1.50	0.36	0.93	0.42	4.13	4.11	7.42	0.54	7.96	8.0	8.50	8.5	7.77	7.0
2336	0.35	1.45	0.23	0.67	0.70	3.40	3.29	6.60	0.67	8.18	8.0	8.85	8.5	7.27	7.0
2452	0.68	0.98	0.05	1.23	0.36	3.30	3.29	6.22	0.79	8.11	8.0	8.90	8.5	7.53	7.0
2335	0.68	1.02	0.46	0.67	0.63	3.38	3.29	7.73	0.70	8.42	8.0	9.12	8.5	10.00	10.0
2337	0.83	0.92	0.47	0.69	0.60	3.51	3.29	5.07	0.82	6.25	6.0	7.07	6.5	10.00	10.0
2441	0.91	0.88	0.30	0.84	0.51	3.44	3.29	5.30	0.71	6.29	6.0	7.00	6.5	10.22	10.0
2332	0.78	0.72	0.41	0.67	0.66	3.24	3.29	4.39	0.45	6.75	6.0	7.10	6.5	10.62	10.0
2469	0.56	0.28	0.10	0.48	0.37	1.79	1.65	7.00	1.45	8.28	8.0	9.73	8.5	10.44	10.0
2517	0.53	0.42	0.14	0.30	0.60	1.99	1.65	6.71	1.08	8.59	8.0	9.67	8.5	10.17	10.0
2179	0.78	1.20	0.63	1.08	0.52	4.20	4.11	6.44	1.04	7.98	8.0	9.02	8.5	7.55	7.0
2331	0.76	1.28	0.22	0.86	0.81	3.93	4.11	7.19	0.63	8.76	8.0	9.39	8.5	7.38	7.0
2309	0.69	1.22	0.34	0.58	0.33	3.16	3.28	7.38	0.51	8.77	8.0	9.28	8.0	9.53	10.0
2308	0.16	1.84	0.16	0.52	0.37	3.06	3.28	7.34	0.14	9.06	8.0	9.20	8.0	10.30	10.0
2535	1.06	0.18	0.35	1.05	0.56	3.20	2.87	1.63	2.26	6.46	6.0	8.76	8.0	11.01	10.0

RESULTS OF INSPECTION.

A few years ago practically all of the fertilizer used in this State was distributed from a few large warehouses located at tide water. It was then comparatively an easy matter to sample practically all of the different brands of fertilizers registered for sale in the State and obtain good representative samples from large lots by visiting these large warehouses. With the rapid increase in the use of commercial fertilizers there has come to the manufacturer a realization of the importance of the Maine trade. Within the last few years many new companies have come into the State and there is great competition among the agents of these companies. With this growth in competition there has been an increase in the practice of selling goods in small lots directly to the farmers. At present a large number of the brands offered for sale are not stored in the State for any length of time, but are shipped in car lots and used within a few days after their arrival. These conditions have increased the difficulty in obtaining samples of all the different brands for analysis. A few brands were registered, samples of which were not found by the inspectors. They are, therefore, not included in the tables.

The methods used last year in determining the quality of the organic nitrogen entering into mixed goods were again used and the results are reported in the tables. It is to be remembered that these figures for inorganic nitrogen cannot be relied upon with the same certainty as those for nitrogen in the forms of ammonia (ammonium sulphate for the most part) and for nitrogen in the form of nitrate. They are, however, of value in estimating the quality of the organic constituents of the fertilizer. They also have developed certain important facts to which attention was called a year ago.

Manufacturers are still in some instances using very different sources of nitrogen in the same brand of fertilizer. It certainly does not seem to be unreasonable to insist that a high priced and high grade brand of fertilizer be as uniform in the forms of nitrogen that it carries as in its total nitrogen. For instance, it is believed to be necessary in this climate for the best results that a potato fertilizer contain about one-third of its nitrogen as nitrate. If much more is present it is liable to loss from leaching. If much less is present the plant will not have enough immediately available nitrogen. Most of the manufacturers do not appear to attach sufficient importance to this feature. They frequently substitute ammonium sulphate or organic nitrogen for nitrate nitrogen, seeming to have only the total nitrogen in mind.

Even a cursory examination of the tables will show figures that bear out the above statement. This is as true of the high as of the low priced brands of fertilizers sold in the State. And also it seems to apply to a large number of the makers. It would seem that one should have the right to expect that the goods would be uniformly made and mixed. The variations in character of the nitrogen content seem to indicate that too little importance is attached by the manufacturer to the forms of nitrogen in a definite brand.

Feeding stuffs are sold on a chemical analysis the same as are commercial fertilizers. In the case of compounded feeding stuffs the feeder has not been content with knowing the amount of protein, fat and fiber that the goods contain but he has insisted, and the law demands, that he be informed of the kinds of materials that enter into the compounded goods. The sources and the kinds of plant food entering into a fertilizer are as important to the planter as a knowledge of the kinds of materials put into a feeding stuff is to the feeder of animals. The knowledge of such facts is often as important, and in special cases more important, to the planter than are the quantities of total nitrogen. The heavy losses in crop arising a few years ago from the use of a certain brand of fertilizer, that is no longer sold within the State, was due to the make-up of the mineral sources of nitrogen rather than to a shortage of nitrogen in the fertilizer. The chief reason for many planters using home-mixed goods is the knowledge they have of their composition. Now that the attention of the planter is being called to these variations in the make-up of fertilizers he may demand changes in the fertilizer law so that the kind and amount of constituents entering into the manufacture of a given brand of fertilizer must be stated as part of the brand. It is largely up to the manufacturer to determine by his practice whether legislation will have to be sought, in order to correct this serious defect at present in the manufacture and sale of commercial fertilizers.

As will be noted from the tables, the analyses of the different brands compare very well with the guaranties. Practically every company shipping goods into the State is giving on the average more plant food that the guaranties call for on the whole. Occasional samples fall below the guaranty in one and sometimes in two constituents. But there is no evidence to indicate that any company is doing other than trying to live up to the requirements of the law.

The New Mineral Fertilizer Company have again registered the New Mineral Fertilizer which carries practically no plant food as contemplated by the law. They made a serious technical violation of the law by shipping to an Aroostook point about 600 packages, only one of which was labeled to show what the goods were. After investigation it was found that the person who had the goods in his possession at Houlton was under contract to store and deliver the goods but had nothing to do with their sale. As this person was apparently innocent of any wrong attempt, as the company had nothing to gain by this misbranding, and on the assurance of the President of the New Mineral Fertilizer Company as late as August 2, 1913, that the Company had "not received $1.00 for any of our material shipped into Aroostook County," and that it was the desire of the Company to comply in every way with the requirements of the law, the case was dropped. Field experiments by the Station with this so-called fertilizer are reported in Bulletin 209, published in January last.

October, 1913.

MAINE
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Official Inspections

54

INSECTICIDE AND FUNGICIDE INSPECTION.

The laws regulating the sale of fungicides and insecticides are broad and cover not merely materials such as Paris green, arsenate of lead, bordeaux mixture and similar materials used in agriculture, but apply equally to fungicides and insecticides that are used for other purposes.

During the year the inspectors have made pretty thorough examination of the stock in the hands of dealers in various parts of the State and have purchased samples of large numbers of the registered insecticides. At this time only the analyses of those are reported which carry arsenic or else are more directly related to agriculture. It will be noted that not all of the specimens reported upon are in accord with the law. As the law is new and the makers are evidently attempting to conform to its requirements no prosecutions have been brought.

Arsenate of Lead Paste.

According to the law arsenate of lead paste is adulterated if: it contains more than 50 per cent of water; it does not contain arsenic equivalent to 12.5 per cent of arsenic oxide; and if it contains water soluble arsenic equivalent to more than .75 per cent arsenic oxide. Arsenic oxide contains 65.2 per cent metalic arsenic.

Table showing results of analyses of arsenate of lead arranged alphabetically by manufacturers' names.

Station number.	Brand, Maker and Place, Dealer and Town.	Weight claimed. lb.	Weight found. lb.	Water.	Total arsenic. Per cent.	Water soluble arsenic. Per cent.	Remarks.
30147	"Ansbacher's Triangle Paste." A. B. Ansbacher & Co., N. Y. Haskell Implement & Seed Co., Lewiston	1	1	47.8	13.5	0.4	Above standard.
30148	"Grasselli Paste." Grasselli Chemical Co., Boston, Mass. Haskell Implement & Seed Co., Lewiston	1	1.15	47.7	10.1	0.3	Above standard.
30239	"Hemingway's." Hemingway London Purple Co., N. Y. Hovey & Wilson, Eastport	1	1.03	48.0	11.0	0.6	Contains too much water soluble arsenic.
30140	"Swift's Paste." Merrimac Chemical Co., Boston. Kendall & Whitney, Portland	1	1.10	43.0	11.7	0.4	Above standard but 0.8 % below claim on package.
30119	"Paste." Powers-Weightman-Rosengarten Co., Philadelphia, Pa. Cook, Everett & Pennell, Portland	2	2.05	41.7	8.4	0.0	Conforms with standard.
30158	"New Process." Sherwin-Williams Co., Boston, Mass. R. B. Dunning & Co., Bangor	1	1.03	49.1	9.8	0.5	Above standard.
30247	"Orchard Brand StandardPaste" Thomsen Chemical Co., Baltimore, Md. E. C. Milliken, Portland	1	0.90	42.1	11.2	0.8	Contains too much water soluble arsenic.Shortweight. Carries enough total arsenic to offset shortage in weight. Unlawful.
30195	"Orchard Brand SrandardPaste" Thomsen Chemical Co., Baltimore, Md. Milliken & Philbrook, Portland	1	0.90	40.7	11.1	0.9	Short weight but offset by total arsenic. Too high water soluble arsenic. Unlawful.

Dry Powdered Arsenate of Lead.

Only one sample was found. This was made by Corono Chemical Company and was found to weigh net 1.02 pounds and contained 0.3 per cent water, 21.10 per cent total arsenic and 3.36 water soluble arsenic. No standard has been adopted for dry powdered arsenate of lead, but on the paste basis this was above the standard so far as total arsenic is concerned and carried an excessive amount of water soluble arsenic.

Paris Green.

According to the law a paris green is adulterated if: it does not contain arsenic equivalent to at least 50 per cent of arsenious oxide; and if it contains water soluble arsenic equivalent to more than 3.5 per cent of arsenious oxide. Arsenious oxide contains 75.8 per cent of metallic arsenic.

In 1912 a sample of F. W. Devoe and C. T. Raynolds Company's brand of Paris green examined was full weight but carried water soluble arsenic equivalent to 4.27 per cent of arsenious oxide. This was reported in Official Inspections 47, page 16. After the statements of the results of the analysis the following statement was made: "No prosecution was brought for these goods in Maine, but under Insecticide Act Judgment No. 3, issued by the United States Department of Agriculture, this company was fined for selling Paris green adulterated because it contained an excessive amount of water soluble arsenic."

F. W. Devoe & C. T. Raynolds Company through their attorneys have called attention to the fact that Insecticide Act Judgment No. 3 is against Devoe & Raynolds Company of Chicago, Illinois, for the sale of adulterated Paris green branded "C. T. Raynolds & Co's, Chicago, Established in 1754, warranted perfectly pure Paris Green manufactured by Devoe and Raynolds Co., Chicago, Illinois." This firm (Devoe and Raynolds Co.) were also prosecuted, per Notice of Judgment No. 5, for the manufacture and sale of adulterated and misbranded arsenate of lead "Made by Devoe and Raynolds Co., Chicago, New York and Kansas City." In a letter to their attorneys F. W. Devoe & C. T. Raynolds Co. of New York, whose goods are registered for sale in Maine and which were found adulterated in 1912 and are passed in 1913 as being in accord with the Maine law, say in part: "In the first place let us explain that the F. W. Devoe & C. T. Raynolds Company is a corporation organized under the laws of the State of New York. Devoe & Raynolds Company is an entirely separate corporation organized under the laws of the State of Illinois. We each have certain financial interests, one with the other. We do not, however, in any way dictate what shall be their business policy nor their manufacturing methods."

Because of the similarity of the brand, of the analysis and of the name of the manufacturers, and that Devoe & Raynolds Company claimed to be in New York on their Arsenate of Lead label, the writer confounded the two concerns. The facts do not warrant the statement given in Official Inspections 47, page 16, that an action was brought against the F. W. Devoe & C. T. Raynolds Company by the United States, and that such company was fined. The purpose of this paragraph is to retract that statement. Incidentally the writer is glad to note that this year C. T. Raynolds's Strictly Pure Paris Green may by F. W. Devoe & C. T. Raynolds Company of New York is in conformity with the Maine Insecticide Law.

The injurious effect to foliage resulting from the use of Paris green is due not to the arsenic that is in combination with the copper but the free water soluble arsenic. Under the statute a very liberal amount, equivalent to 3.5 per cent of arsenious oxide, or 2.65 per cent arsenic is permitted in the case of water soluble Paris green. Several samples of Paris green were examined previous to 1913 and like all of the other greens which we have examined they carried more arsenious oxide than could be combined with the copper present. That is, the total amount of arsenic exceeded in every instance the minimum required under the law. This follows, as pointed out in earlier publications from the fact that white arsenic is the cheapest ingredient that goes into the makeup of Paris green, and hence the manufacturers will always use as much of it as possible and still have a green of good color. It is gratifying to note the marked improvement in the quality of Paris green in respect to its water soluble arsenic. Practically all of the greens made in 1913 carry less than 3.5 per cent water soluble arsenic. Most of the samples reported in the table as having an excess of water soluble arsenic were goods carried over from 1912.

Table showing the results of analyses of Paris Greens arranged alphabetically by manufacturers' names.

Station number.	Brand, Maker and Place, Dealer and Town.	Weight claimed. Ounces.	Weight found. Ounces.	Arsenoius oxide (As_2O_3) Total Per cent.	Soluble in water. Per cent.	Remarks.
30150	"Ansbacher's Paris Green." A. B. Ansbacher & Co., N. Y. Haskell Implement & Seed Co., Lewiston	16	16.7	57.2	1.85	
30235	"Lion Brand Paris Green." Jas. A. Blanchard Co., N. Y. E. W. Fernald, Presque Isle	32	34.3	55.7	3.96	
30241	"Lion Brand Paris Green." Jas. A. Blanchard Co., N. Y. E. W. Fernald, Presque Isle	32	31.3	55.6	3.50	
30118	C. T. Reynolds & Co.'s Strictly Pure Paris Green." F. W. Devoe & C. T. Reynolds Co., N. Y. Cook, Everett & Pennell, Portland	8	8.9	57.9	3.34	
30166	"Herrmann's Hi-Grade Pure Paris Green." Morris Herrmann & Co., N. Y. Knowles & Dow Co., Bangor	32	30.3	57.2	6.50	
30238	"Herrmann's Hi-Grade Pure Paris Green." Morris Herrmann & Co., N. Y. Knowles & Dow Co., Bangor	32	32.4	57.1	1.49	
30245	"Herrmann's Hi-Grade Pure Paris Green." Morris Herrmann & Co., N. Y. W. F. Libby, Gorham	16	16.4	55.7	2.14	
30161	"Star Brand Paris Green." Fred L. Lavanburg, N. Y. C. M. Conant Co., Bangor	16	16.1	59.1	2.[illegible]	
30228	"Lucas Paris Green." John Lucas & Co., Boston. James H. Glenn, Caribou	16	16.0	58.2	4.[illegible]8	
30208	"Pfeiffer's Strictly Pure Paris Green." I. Pfeiffer, N. Y. M. F. Bragdon Paint Co., Portland	16	16.1	56.5	4.07	Unregistered. Withdrawn from sale.
30246	"Pfeiffer's Strictly Pure Paris Green." I. Pfeiffer, N. Y. W. F. Libby, Gorham	16	16.0	55.2	4.94	Unregistered.
30142	"S-W Paris Green." Sherwin-Williams Co., Boston, Mass. Kendall & Whitney, Portland	16	16.4	55.9	2.90	

Arsenite of Zinc Paste.

Sample found made by the Thomsen Chemical Co., Baltimore, Md. Weight claimed 1 pound; 0.9 pound found. Carried 53.3 per cent water, 15.7 per cent total arsenic, 0.15 water soluble arsenic. Claimed to carry not more than 55 per cent inert ingredients. Found to be in accord with the law in that requirement, and also total and water soluble arsenic were within limits claimed on the label. It was short weight, however.

Table showing the results of analyses of Bordeaux Mixture.

Station number.	Brand, Maker and Place, Dealer and Town.	Weight claimed. lb.	Weight found. lb.	Water.	Arsenic. Per cent.	Copper. Per cent.
30151	"Sterlingworth Dry Bordeaux Mixture. Sterling Chemical Co., Cambridge, Mass. Haskell Implement & Seed Co., Lewiston..	1	1	4.5	3.2	14.7
30144	"Sterlingworth Liquid Bordeaux Mixture. Sterling Chemical Co., Cambridge, Mass. Kendall & Whitney, Portland............	–	2.8	51.3	–	5.9

Table showing the analyses of lime-sulphur solutions.

Station number.	Dealer and Town, Brand, Maker and Place.	Remarks.
30163	C. M. Conant Co., Bangor................ Only marks on package "Lime-Sulphor Solution."	33.29 per cent sulphur.
30157	R. B. Dunning & Co.,Bangor............. "Lime-Sulfur Solution." Sherwin-Williams Co., Boston.	34.55 per cent sulphur.
30145	Kendall & Whitney, Portland............ "Lime-Sulfur—Oil Seal Brand." "33% strength. One gal." Thos. Leyland & Co., Boston	34.22 per cent sulphur.
30127	Kendall & Whitney, Portland............. "Sterlingworth Lime & Sulphur Wash." Sterlng Chemical Co., Cambridge, Mass.	30.26 per cent sulphur.

Table showing the results of analyses of water soluble arsenical compounds.

Station number.	BRAND, MAKER AND PLACE. DEALER AND TOWN	Weight claimed. lb.	Weight found. lb.	Water. Per cent.	Total arsenic. Per cent.	Water soluble arsenic. Per cent.	Remarks.
30229	"Ansbacher's Quick Death Soluble Arsenate." A. B. Ansbacher & Co., N. Y. Shaw & Mitton, Caribou........	–	2.2	12.0	41.7	41.7	
30232	"Powdered Material for Making Arsenate of Lead." F. W. Devoe & C. T. Reynolds Co., N. Y. A. M. Smith, Presque Isle......	5	8.2	1.3	10.8	0.75	Water soluble arseenic determined. after goods were made, in accordance with directions accompanying package.
30164	"Herrmann's Arsite. Morris Herrmann & Co., N. Y. Knowles, Dow & Co., Bangor..	½ pt.	½ pt.	–	30.8	30.8†	
30227	"Watson's Soluble Arsenoid." Merrimac Chemical Co., Boston. Putnam Hardware Co., Houlton	2	2.3	14.2	39.9	30.3	
30230	"Brigg's Soluble Arsenate." Riches, Piver & Co., N. Y. S. E. Briggs & Son, Caribou....	2	2.25	6.5	40.1	40.1	

† By volume.

MISCELLANEOUS INSECTICIDES.

No. 30224, Hemingway's Caascu. Hemingway's London Purple Co., Ltd., London, England. McClaskey Bros., Houlton. Claimed analysis: Copper hydrate 12 per cent, arsenic oxide 34 per cent, calcium hydroxide 45, iron oxide, silica, etc., 9 per cent. Found: net weight 18.2 ounces; water 6.54 per cent; arsenic oxide 35.44 per cent; copper hydrate 12.33 per cent; water soluble arsenic oxide 4.19 per cent.

No. 30109, Bug Death, Danforth Chemical Company, Leominister, Mass. Cook, Everett & Pennell, Portland. Claimed analysis: Zinc oxide 47 per cent, lead oxide 5 per cent, inert ingredients 48 per cent. Found: 47.21 per cent zinc oxide and 5.41 per cent lead oxide.

No. 30106, Coopers Sheep Dipping Powder. Wm. Cooper and Nephew, Chicago. Cook, Everett & Pennell, Portland. Manufactured by M. R. C. V. S. Chemical Works, Berkhampsted, England. Claimed: 16.75 per cent total arsenic and 14 per cent in water soluble form. Found: 16.62 per cent of total arsenic and 10.08 per cent water soluble arsenic.

No. 30180, Rough on Rats. E. E. Wells, Jersey City, N. J. C. H. Davis, Bangor. Arsenic claimed 56 per cent. Arsenic found 59.6 per cent.

Table showing the results of analyses of preparations containing arsenate of lead and Bordeaux mixture.

Station number.	BRAND, MAKER AND PLACE. DEALER AND TOWN	Weight claimed. lb.	Weight found. lb.	Water. Per cent.	Total arsenic. Per cent.	Water soluble arsenic. Per cent.	Remarks.
30212	"Sterlingworth Bordeaux & Arsenate of Lead Compound." Sterling Chemical Co., Cambridge Mass. Allen, Sterling & Lothrop, Portland.......................	1	1.13	61.8	0.25	0.25	Copper 2.5. No standard for these goods. No claims of analysis made on package. Water soluble arsenic pretty high.
30133	"Bowker's Pyrox. Bowker Insecticide Co., Boston. Kendall & Whitney, Portland..	1	1.02	66.3	5.2	0.08	Copper hydrate 3.34 per cent.

Table showing results of analyses of poison fly paper and fly tins arranged alphabetically by name.

Station number.	NAME OF PAPER, MAKER AND DEALER.	SOLUBLE ARSENIC. Claimed. Per cent.	SOLUBLE ARSENIC. Claimed. Weight.	SOLUBLE ARSENIC. Found. Per cent.	SOLUBLE ARSENIC. Found. Weight
			grains		grains
30237	"Death to Flies." New York & London Drug Co. G. A. Parcher, Ellsworth.....................	7.50	–	6.55	–
30244	"Electric Poison Fly Paper." F. W. Briggs & Co. Buffalo, N. Y. B. Huberman, Portland......................	–	42.25	3.45	31.30
30120	"I. X. L. Poison Fly Paper." I. X. L. Poison Fly Paper Co., Boston, Mass. Cook, Everett & Pennell, Portland............	–	21.60	–	21.60
30188	"Seibert's Handy Fly Tin." H. E. Seibert, St. Paul, Minn. Curtis & Tupper, Bangor.....................	61.00	–	69.42	–
30189	"Seibert's Poison Fly Paper." H. E. Seibert, St. Paul, Minn. Curtis & Tupper, Bangor.....................	5.00	–	5.83	–
30240	"Sure Death Poison Fly Paper." Pfeiffer Chemical Co., Philadelphia, Pa. S. Belli, Portland..........................	2.22	–	2.91	–
30179	"Sure Kill Fly Paper." Fredk. Stearns & Co., Detroit, Mich Fifield & Co., Bangor........................	7.50	–	5.67	–
30249	"Wood's Poison Fly Paper." Nathan Wood & Son, Portland, Me. Nathan Wood & Son, Portland...............	6.00	–	6.32	–

December, 1913.

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55

CLAMS, OYSTERS, SCALLOPS.

Clams.

Practically all of the shelled clams offered for sale in Maine are produced in Maine. There seems to be somewhat different practices in the opening and handling of clams in different parts of the State. In general in the area west of the Penobscot River the practice in general is as follows:

Clams are dug during the day time, taken home by the digger and during the evening the whole family enter into the work of opening the clams. Before being opened the clams are usually washed in sea water to remove sand and mud from the outside. There are two methods employed in opening or shucking the clams. The best method is to open them cold as the clams have a better flavor than those opened hot, but this does not seem to be the general practice west of Penobscot waters. For the most part the clams are immersed in hot water so as to make them open more easily. Whichever method is practiced the clam liquor is usually thrown away. The opened clams are washed in fresh water and are often allowed to stand in this water over night until the wagon of the dealer comes around in the morning and collects the clams for the preceding day. This practice of soaking the opened clams in fresh water results in a swelling of the clam meat in a manner similar to the result obtained by the floating of oysters. The difference between the fresh clam meat and clams which have been soaked is illustrated by two analyses. Fresh clams opened in the laboratory gave in dry matter from the drained meat 24.9 per cent of total dry solids. The sample analyzed from a lot of clams which had been soaked gave 15.9 per cent total dry matter, a difference of nine per cent.

Dealers and shippers of clams in this State are practically unanimous in the thought that opened clams will not keep longer than twenty-four hours in their own liquor and it seems to be the almost universal practice to open the clams as promptly as possible after digging and throw the clam liquids away and then wash the clams in fresh water. Leaving the clams in this water results in fraud and dealers and producers were warned in Official Inspections 43 that prosecutions will be commenced where evidence is obtained that clams have been soaked or adulterated in any way.

In the early winter of 1912-13 samples of opened claims were taken from markets in Rockland. Many of them were found to carry too much free liquids and the dry matter of the clams was altogether too small. Hearings were appointed and this resulted in the executive of the law going to Rockland, meeting all of the dealers there and going over the matter with them thoroughly. They claimed that many of the clams came to them from brackish waters and that this would account for the low solid content. It was arranged so that there were sent from three different localities to the Experment Station clams representing the various types that come into Rockland. The results are given in the table. The North Haven "Rock" clams were from the open side of North Haven waters and they were exposed to the full influence of the sea. The North Haven "Mud" clams were from the sound and the harbors and were dug in the usual clam "flats." The Keag River clams were from a river back of Rockland and represent the type of clams which come from the brackish waters. According to the opinions of the dealers, these should have the largest amount of water and the smallest amount of dry matter. The liquids in both of the North Haven clams carried 2.70 per cent of common salt, or the same as sea water, which indicated that the shell content was thoroughly in contact with the ocean. In the case of the Keag River clams they carried 2.55 per cent of common salt, showing that the waters were brackish.

These clams were shipped directly to the laboratory and each lot was opened in three different ways. Twelve clams were used in each sample and they were selected so that the total weights of the 12 clams were practically the same in all three lots from the same source. The North Haven "Mud" clams were the largest and the Keag River clams were the smallest in the lot. One lot of each was opened raw, another lot was dipped for two minutes in hot salt water then immediately taken out and opened; the third lot was dipped in hot fresh water and after two minutes was removed and opened. It will be noted from the table that the highest percentages of dry solids in the clams was obtained from those that were opened raw. In general the dry solids of clams were slightly lower in hot salt water than when opened raw, and considerably lower when dipped in hot fresh water than in the case of either of the others. The Keag River clams which were opened in hot salt water carried 20.7 per cent of dry solids of clams. When allowed to soak over night in salt water the solids fell in the clams to 15.3 per cent.

Liquids and dry matter of clams opened raw compared with clams dipped for two minutes in boiling salt water and boiling fresh water before opening.

Stotion Number.	Source of Claims.	Opened Raw.		Dipped in Hot Salt Water.		Dipped in Hot Fresh Water.	
		Liquids.	Dry solids of clams.	Liquids.	Dry solids of clams.	Liquids.	Dry solids of clams.
		%	%	%	%	%	%
11079	North Haven "Rock"	53.2	21.2	58.1	19.8	59.2	19.7
11080	North Haven "Mud"	46.7	19.8	45.8	19.2	50.8	18.6
11081	Keag River..........	40.9	22.4	40.2	20.7	54.0	20.4

As a result of this investigation the following regulations were adopted and sent to the fish dealers in the State relative to the sale of opened clams:

In accordance with the law regulating the sale of food I hereby publish the following regulations concerning the sale of opened clams:

In the food standards fixed for Maine "Opened shellfish are from unpolluted beds and are opened, packed and shipped under sanitary conditions in sanitary containers without the addition of water or direct contact with ice." This means that opened clams, oysters, scallops, etc., must not be in contact with either water or ice.

Opened clams must be sold drained and without any surplus liquid.

Clams that are opened raw must be drained. They may be rinsed in water but must not remain in water more than one minute.

When it is desired to heat clams before they are opened they may be immersed in hot water not more than two minutes. They may then be immediately put into cold water for not more than two minutes. The clams then should be opened, drained and handled exactly the same as raw opened clams.

Natural clam liquid or juice may be sold as such but cannot be mixed with opened clams and the mixture sold as clams.

The solids and liquids of clams are quite constant. By laboratory methods it is readily ascertained whether the above conditions have been complied with.

The above regulations do not apply to clams sold in the shell. In some of the shore towns customers of the fish dealers desire clams with the natural liquids. These can be readily accommodated by selling unopened clams and then afterwards opening and delivering both the clams and the liquids.

The results of the examination of clams on sale in Maine are given in the table that follows.

Results of Examination of Clams Purchased and Examined in 1912 and 1913.

Station Number.	Town and Dealer.	Price per pint.	Weight as purchased.	Weight drained clams.	Free liquids.	Dry solids.	Remarks.
		Cts.	Ozs.	Ozs.	%	%	
11222	Biddeford, Andrews & Horrigan	13	16.5	15.0	9.09	15.40	
11246	Biddeford, F. F. Beauregard Co.	9	14.0	14.0	none	17.69	Warning short measure.
11220	Biddeford, Gartland & Dunn....	13	21.6	14.1	35.18	10.88	Adulterated, dealer fined.
11223	Biddeford, John F. Hannaway..	8	18.0	17.0	5.55	11.74	
11244	Biddeford, G. A. Landry.......	10	16.0	14.7	8.12	18.55	
11247	Biddeford, Jos. Menard.........	13	14.0	13.9	1.07	18.98	Short measure, dealer warned.
11243	Biddeford, L. A. Talbot.........	10	17.3	14.4	16.76	12.76	
11005	Brunswick, Wm. Coffin.........	10	16.8	10.6	36.57	17.73	Adulterated, dealer fined.
11095	Portland, Cobb & Trefethen.....	10	15.1	13.3	11.62	13.19	
11212	Portland, W. L. Daggett & Co..	10	16.3	16.0	1.84	17.96	
11091	Portland, Doughty & Jewett.....	10	16.8	16.3	3.32	14.91	
11215	Portland, Doughty & Jewett.....	10	15.7	14.6	7.00	15.36	
11082	Portland, E. C. Dyer...........	10	24.2	21.3	11.98	14.55	
11214	Portland, E. C. Dyer...........	10	17.5	14.9	14.85	20.42	
11216	Portland, Gem Market..........	13	18.0	16.2	10.00	17.24	
11087	Portland, D. J. Hamilton & Co..	10	17.3	15.6	9.44	21.82	
11210	Portland, D. J. Hamilton & Co...	10	16.3	15.0	7.69	23.88	
11211	Portland, D. J. Hamilton & Co...	10	15.7	12.9	17.83	23.37	
11085	Portland, R. D. Hamilton Co.....	14	15.8	14.9	5.21	18.43	
11094	Portland, A. L. Littlejohn.......	12	16.7	16.0	4.13	20.03	
11084	Portland, Jas. H. McDonald.....	10	15.1	13.5	10.47	10.25	
11092	Portland, Munjoy Fish Market...	10	16.0	13.5	15.62	10.65	
11083	Portland, George Wilcox........	10	17.8	15.9	10.78	12.76	
11088	Portland, George Wilcox........	10	17.1	14.6	14.59	18.97	
11213	Portland, George Wilcox........	10	17.5	16.5	6.00	20.08	
11090	Portland, A. H. Worden.........	13	12.7	12.4	2.44	16.73	
11038	Rockland, H. L. Higgins........	13	16.7	12.6	24.38	8.58	*
11040	Rockland, Linscott's Market.....	10	15.2	7.8	12.60	8.50	
11037	Rockland, Mason's Park St. Market	10	16.9	10.0	41.13	8.68	*
11041	Rockland, Mason's Park St. Market	10	17.8	7.7	56.65	7.27	
11039	Rockland, Thomas Fish Market	12	17.2	12.3	28.32	8.49	*
11224	Saco, F. S. Wallace............	13	16.0	15.3	4.37	15.62	
11077	Sanford, H. A. Roberts.........	-	13.9	11.0	20.75	13.39	Dealers sample.
11625	Waterville, B. K. Meservey......	13	14.3	-	11.60	12.01	

* Hearings were appointed at which all Rockland dealers in clams were present. The investigation and rulings given on page 152 followed.

OYSTERS.

The situation as regards oysters has steadily and markedly improved during the past five years. Five years ago oysters not only carried large amount of free liquids but they had been "floated" in fresh water so that the dry matter of the oysters themselves was greatly reduced. On the average oysters have increased in price about ten cents per quart. But this is more than offset by the increased weight of oysters in a quart due to the less amount of liquids and water in the oysters themselves.

Results of Examination of Oysters Purchased and Examin d in 1912 and 1913.

Station Number.	Town and Dealer.	Price per pint.	Weight as purchased.	Weight drained oysters.	Free liquids.	Dry solids.	Remarks.
		Cts.	Ozs.	Ozs.	%	%	
10978	Bangor, W. L. Clark	25	–	–	12.96	18.58	
10976	Bangor, Eureka Market	25	–	–	9.45	17.59	
10994	Bangor, Eureka Market	25	–	–	12.32	19.61	
10995	Bangor, F. F. Foster	20	–	–	4.20	18.61	
10977	Bangor, F. L. Frank & Co.	25	–	–	16.60	17.84	Too much water Dealer warned
10997	Bangor, F. L. Frank & Co.	25	–	–	9.78	15.34	
10999	Bangor, Gallagher Bros	25	–	–	7.30	15.52	
10979	Bangor, R. Hickson	25	–	–	8.28	19.08	
10975	Bangor, Chas. S. Jones & Co.	25	–	–	30.18	12.83	Adulterated. Dealer fined.
10993	Bangor, Chas. S. Jones & Co.	25	–	–	11.35	21.54	
10998	Bangor, H. E. McDonald	25	–	–	9.74	14.81	
10996	Bangor, D. J. McGrath	25	–	–	4.04	17.15	
10980	Bangor Wentworth's Market	25	–	–	2.32	22.55	
11221	Biddeford, J. B. E. Tartre	23	16.5	15.8	4.54	12.35	
11007	Brunswick, F. C. Webb	25	17.2	15.0	12.88	18.26	
10962	Lewiston, Harvey's Market	20	–	–	7.59	14.70	
10963	Lewiston, Walker Bros. Co.	20	–	–	20.69	17.10	Too much water Dealer warned
11006	Lewiston, Walker Bros. Co.	20	16.9	15.5	10.21	19.80	
11102	Portland, Dennison & Partridge.	23	18.6	17.5	6.01	20.54	
11101	Portland, Doughty & Jewett	20	17.8	16.1	4.22	20.20	
11217	Portand, Gem Market	23	17.2	16.0	6.97	15.76	
11105	Portland Gribbin Bros	23	16.0	15.8	1.56	21.70	
11099	Portland, D. J. Hamilton & Co.	20	16.3	13.6	16.16	11.79	Too much water Dealer warned
11100	Portland, Jas. H. McDonald	23	20.3	20.0	1.47	18.82	
11093	Portland, Munjoy Fish Market	23	16.8	16.6	1.13	21.66	
11017	Rockland, Philip Thomas	38	17.3	12.0	30.76	23.06	Adulterated. Dealer fined.
11250	Saco, F. S. Wallace	25	17.6	16.9	3.97	16.48	
11249	Saco, W. H. Whitehead	25	16.0	15.4	3.45	17.64	
10986	Sanford, Forbes Fish Market	20	–	–	17.15	13.89	Too much water
10984	Sanford, Ideal Cash Market	20	–	–	8.79	17.85	
10987	Sanford, Robert's Market	20			10.95	16.62	
11627	Waterville, City Market	23	14.2		7.43	16.62	
11626	Waterville, H. J. Collins	23	21.1	–	7.71	14.86	
11628	Waterville, E. L. Gove	23	16.9	–	2.49	18.28	
11624	Waterville, Hersom & Bonsell	23	17.3	–	10.22	14.98	
10971	Waterville, F. E. McCallum	23	–	–	9.50	21.00	
11623	Waterville, F. E. McCallum	23	16.6	–	5.31	16.69	
10972	Waterville, Robinson-Davison Co.	20	–	–	6.70	18.45	
11629	Waterville, Robinson-Davison Co.	23	15.8	–	5.78	16.59	
11622	Waterville, S. E. Whitcomb Co.	23	16.5	–	4.52	19.36	

SCALLOPS.

Scallops as sold in the market consist of the large muscle that holds the two shells together. The remainder of the scallop is thrown away as unfit for food. There are two species of scallop, the giant scallop which is the one that is fished in Maine waters, and the ordinary scallop of more southern waters.

No investigation of any amount has ever been made as to the methods of handling the scallop. As is to be noted from the table, there are large differences in the amount of dry solids in the scallops. Most of the samples which were examined had apparently been adulterated by soaking in fresh water.

One of these samples, carrying more water than it should, was furnished the dealer by Simmons, White Company, large handlers of scallops in Rockland. This led to something of an investigation of the methods used by the fishermen in handling scallops. We were greatly assisted in this by the Simmons, White Company.

The scallops grow in deep water and are obtained by dredging. The Maine fishing grounds extend from Penobscot Bay east. As a rule the fishermen open and "cut" their scallops the night of the day of fishing. As soon as the scallops are "cut" the edible portion, or muscle is put in a tub with salt water. They are usually delivered to the shippers in this condition. When the shippers receive the scallops they pour them into wire baskets, resting on the scales and weigh them. Each wire basket has a mesh of nearly three-quarters of an inch. After the scallops are weighed they are usually washed with fresh water, by using a hose, from the city service. They are then allowed to drain and are put into galvanized iron pails which hold about ten gallons. To each pail about a gallon of sea water is added. The scallops are left in these pails over night. In the morning they are poured into a tub which contains fresh water in order to give them a second washing. The scallops are bailed out from this tub into bags by the use of a dip net so that no water is bailed into the bag. This is usually done early in the morning. They are allowed to drain for an hour, are weighed, tied up and put into tubs containing chopped ice for shipment.

The shippers claim that the scallop is covered with a slime and that it is necessary to thoroughly wash them in fresh water or else the scallops will not keep. They also claim that packing the bags in cracked ice is far better for the scallops than shipping either in closed tin vessels with ice packed around them or in the so-called Sealshipt packages which are used for shipping oysters.

The two last samples given in the table are scallops that never had fresh water near them. They, however, had been rinsed and probably soaked more or less in salt water. It is probable that Maine scallops treated as outlined above would carry not less than 20 per cent dry matter in the scallops, with an average higher than that figure.

The sample of scallops, 11117 in the table, were from southern waters and were shipped into the State. These had unquestionably been soaked in water. The Federal authorities are now prosecuting the case.

Results of Examination of Scallops Purchased and Examined in 1912 and 1913.

Station Number.	Town and Dealer.	Price per pint.	Weight as purchased.	Weight drained scallops.	Free liquids.	Dry solids. of scollops.	Remarks.
		Cts.	Ozs.	Ozs.	%	%	
11089	Portland, W. L. Daggett & Co..	25	15.8	15.7	0.39	26.04	
11103	Portland, E. C. Dyer............	25	24.1	24.1	none	18.92	
11104	Portland, Gribbin Bros..........	25	15.5	15.1	2.45	15.43	Probably soaked in fresh water.
11086	Portland, R. D. Hamilton Co...	25	14.8	13.8	6.68	15.18	Probably soaked in fresh water.
11119	Portland, Munjoy Fish Market...	25	14.4	14.4	none	14.33	Probably soaked in fresh water.
11106	Portland, Geo. C. Shaw Co......	33	14.9	14.0	6.04	16.38	Probably soaked in fresh water.
11117	Portland, Geo. C. Shaw Co......	33	16.7	14.3	14.32	13.75	Adulterated. Interstate shipment. Case reported to Federal authorities.
11201	Rockland, Simmons, White Co...	-	76.0	-	1.87	21.79	
11207	Rockland, Simmons, White Co...	-	45.9	-	1.30	22.66	

(471-4-13)

University of Maine.

MAINE
AGRICULTURAL EXPERIMENT STATION,
ORONO, MAINE.
CHAS. D. WOODS, Director.

Methods of Poultry Management at the Maine Agricultural Experiment Station.

(Revised to February, 1913.)

RAYMOND PEARL.

[This publication is mailed free to residents of Maine. To others the price is twenty cents a copy.]

CONTENTS.

METHODS OF POULTRY MANAGEMENT AT THE MAINE AGRICULTURAL EXPERIMENT STATION.

INTRODUCTION.

Many years' practical experience in raising and keeping poultry and investigations in poultry breeding at the Maine Experiment Station have resulted in the accumulation of a considerable fund of information on poultry management. It is the purpose of the following pages to outline this experience for the benefit of poultry kepers and thereby to help them to discriminate between some of the wrong theories which have underlain much of the common practice of the past and the better theories which underlie other and newer methods that are now yielding more satisfactory results. It may be that these methods are no better than those practiced by others, but the attempt is made to state concisely the methods which have been or are now being successfully employed at the Station.

POULTRY HYGIENE AND SANITATION.

Second in importance only to high constitutional vigor and health in the stock is attention to the basic rules of hygiene and sanitation in the management of poultry. This section gives an account of the general principles involved in the methods of dealing with these matters practised at the Maine Agricultural Experiment Station. Attention to the rules and principles here set forth will go a great ways towards preventing the occurrence of disease. This does not mean that if these rules are *not* followed disease and destruction will forthwith result. Everyone knows of plenty of instances of more or less successful poultry keeping under the most unsanitary and unhygienic of conditions. So similarly human beings are able when forced to do so to live under unhygienic conditions. But every civilized country in the world believes that the most economical insurance against the steady loss of national wealth which the prevalence of disease involves is the enforcement of sanitary regulations throughout its domain. In poultry keeping many may be successful for a time in managing their birds in defiance of the laws of sanitation and hygiene; a *very few* may be successful in this practice for a long time, but in the long run the vast majority will find that thorough, careful, and intelligent attention to these laws will be one of the best guarantees of *permanent* success that they can find.

Poultry hygiene and sanitation will be considered here under seven main heads, as follows: 1. Housing. 2. Feeding. 3. The Land. 4. Exercise. 5. External Parasites. 6. Disposal of the Dead. 7. Isolation of Sickness. What is said under all of these heads is intended to apply (unless a specific statement to the contrary is made) both to adult birds and to chicks. No discussion of the hygiene of incubation, or of the relative merits of artificially and naturally hatched chickens will be undertaken here, because there are special subjects falling outside the field of general poultry hygiene.

I. POULTRY HOUSE HYGIENE AND SANITATION.

A. Cleanliness.—The thing of paramount importance in the hygienic housing of poultry is *cleanliness*. By this is meant not merely plain, ordinary cleaning up, in the housewife sense, but also bacteriological cleaning up; that is, *disinfection*. All buildings or structures of whatever kind in which poultry are housed during any part of their lives should be subjected to a most thorough and searching cleaning and disinfection once every year. This cleaning up should naturally come for each different structure (i. e., laying, colony or brooder house, individual brooder, incubator, etc.) at a time which just precedes the putting of new stock into this structure.

A very thorough method of cleaning a poultry house: Not every poultryman knows how to clean a poultry house thoroughly. The first thing to do is to remove all the litter and loose dirt which can be shovelled out. Then give the house—floor, walls and ceiling—a thorough sweeping and shovel out the accumulated debris. Then play a garden hose, with the maximum water pressure which can be obtained, upon floor, roosting boards, walls and ceiling, until all the dirt which washes down easily is disposed of. Then take a heavy hoe or roost board scraper and proceed to scrape the floor and roosting boards *clean* of the trampled and caked manure and dirt, Then shovel out what has been accumulated and get the hose into action once more and wash the whole place down again thoroughly and follow this with another scraping. With a stiff bristled broom thoroughly scrub walls, floors, nest boxes, roost boards, etc. Then after another rinsing down and cleaning out of accumulated dirt, let the house dry out for a day or two. Then make a searching inspection to see if any dirt can be discovered. If so apply the appropriate treatment as outlined above. If. however, everything *appears* to be clean, the time has come to make it *really* clean by *disinfection.* To do this it is necessary to spray, or thoroughly wash with a scrub brush wet in the solution used, all parts of the house with a good disinfectant *at least twice,* allowing time between for drying. For this purpose 3 per cent cresol solution or 5 per cent formalin is recommended. The chief thing is to use an effective disinfectant and plenty of it, and apply it at least twice. A discussion of disinfectants immediately follows. To complete the cleaning of the house, after the second spraying of disinfectant is dry it is the practise at this Station to apply a liquid lice killer (made by putting 1 part crude carbolic acid or cresol with 3 parts kerosene) liberally to nests and roosts and nearby walls. After all this is done the house will be *clean.* In houses cleaned annually in this way the first step is taken towards hygienic poultry keeping.

The same principles which have been here brought out should be applied in cleaning brooders, brooder houses, and other things on the plant with which the birds come in contact.

What has been said has reference primarily to the annual or semi-annual cleaning. It should not be understood by this that no cleaning is to be done at any other time. On the contrary the rule should be to keep the poultry house *clean* at all times, never allowing filth of any kind to accumulate and using plenty of disinfectant.

Disinfection.—In the matter of disinfection there are several options open to the poultryman. He may make his own disinfectant, or he may purchase proprietary compounds, or he may buy a plain disinfectant like formaldehyde, or carbolic acid.

The Maine Agricultural Experiment Station has tried various disinfectants with a view to finding the most useful, when the factors of efficiency, ease of application and low cost, are considered. There is probably no more effective disinfectant than formaldehyde. The only objection to its use is that a man may find it difficult to withstand the fumes long enough to spray and scrub out thoroughly a pen. Formaldehyde is very good where it can be used, and there is no cheaper disinfectant, efficiency considered. The formaldehyde gas method for disinfecting poultry houses has recently been advocated, using the permanganate method of generating. This, however, is indicated only for rooms which can easily be closed up air tight. It costs too much in time and trouble to make any form of "fresh air" poultry house even moderately air tight. The formaldehyde gas method is well adapted to disinfecting and fumigating feed rooms, incubator cellars, brooder houses and all houses which can be readily made air tight. For the benefit of those who wish to use the method for such purposes the following directions are given. This will give a very strong fumigation and disinfection, but such is indicated about poultry establishments.

Formaldehyde Gas Disinfection: First make the room as tight as possible by stopping cracks, key-holes, etc., with pieces of cloth or similar substance. Use a metal or earthern dish for a generator, of sufficient size so that the liquid will not spatter or boil over on the floor, since the permanganate will stain. The temperature of the room should not be below 50° F. and more effective disinfection will be obtained if the temperature is 80° F. or above at the beginning. Sprinkle boiling water on the floor or place a kettle of boiling water in the room to create a moist atmosphere. Spread the permanganate evenly over the bottom of the dish and quickly pour in the formaldehyde (40 per cent strength as purchased). Leave and tightly close the room at once and allow to remain closed for 4-6 hours or longer, then air thoroughly." *Use 23 ounces of per-*

manganate and 3 pints of formaldehyde to each 1000 cubic feet of space.

For general disinfecting purposes about a poultry plant the Station has found one of the cheapest and most effective disinfectants to be compound cresol solution. This is used here for spraying and disinfecting the houses after they are cleaned, disinfecting brooders, brooder houses, incubators, nests and everything else about the plant which can be disinfected with a liquid substance. Any person can easily make this disinfectant. The following revised directions for its manufacture are quoted from Bulletin 179 of the Maine Agricultural Experiment Station.

Cresol Disinfectant.—The active base of cresol soap disinfecting solution is commercial cresol. This is a thick, sirupy fluid varying in color in different lots from a nearly colorless fluid to a dark brown. It does not mix readily with water, and, therefore, in order to make a satisfactory dilute solution, it is necessary first to incorporate the cresol with some substance like soap which will mix with water and will carry the cresol over into the mixture. The commercial cresol as it is obtained, is a corrosive substance, being in this respect not unlike carbolic acid. It should, of course, be handled with great care and the pure cresol should not be allowed to come in contact with the skin. If it does so accidentally the spot should be immediately washed off with plenty of clean water. The price of commercial cresol varies with the drug market.

Measure out 3 1-5 quarts of raw linseed oil in a 4 or 5 gallon stone crock; then weigh out in a dish 1 lb. 6 oz. of commercial lye or "Babbit's potash." Dissolve this lye in as little water as will completely dissolve it. Start with 1-2 pint of water, and if this will not dissolve all the lye, add more water slowly. Let this stand for at least 3 hours until the lye is completely dissolved and the solution is cold; then add the *cold* lye solution very slowly to the linseed oil, stirring constantly. Not less than 5 minutes should be taken for the adding of this solution of lye to the oil. After the lye is added continue the stirring until the mixture is in the condition and has the texture of a smooth homogeneous liquid soap. This ought not to take more than a half hour. Then while the soap is in this liquid state, and before it has a chance to harden add, with constant stirring, 8 1-2 quarts of commercial cresol. The cresol will blend perfectly with the soap solution and make a clear, dark brown fluid. The resulting solution will mix in any proportion with water and yield a clear solution.

Cresol soap is an extremely powerful disinfectant. In the Station poultry plant for general purposes of disinfecting the houses, brooder houses, incubators, nests, and other wood work, it should be used in a 3 per cent solution with water. Two or 3 tablespoons full of the cresol soap to each gallon of water will make a satisfactory solution. This solution may be applied through any kind of spray pump or with a brush. Being a clear watery fluid it can be used in any spray pump without difficulty. For disinfecting brooders or incubators which there is reason to believe have been particularly liable to infection with the germs of white diarrhea or other diseases the cresol may be used in double the strength given above and applied with a scrub brush in addition to the spray.

B. Fresh Air and Light.—Too great stress cannot be laid on the importance of plenty of fresh air in the poultry house if the birds are to keep in good condition. And it must be remembered in this connection that "fresh" air, and cold stagnant air are two very different things. Too many of the types of curtain front and so-called "fresh air" houses now in use are without any provision other than an obliging southerly wind, to insure the circulation or changing of air within the house. Even with an open front house it is wise to provide for a *circulation* of air in such way that direct drafts cannot strike the birds. This applies not only to the housing of adult birds in laying houses, but also to the case of young stock in colony houses on the range. Further a circulation of fresh air under the hover in artificial rearing is greatly to be desired and will have a marked effect on the health and vigor of the chicks.

Not only should the poultry house be such as to furnish plenty of fresh air, but it should also be *light*. The prime importance of sunlight in sanitation is universally recognized by medical authorities. Disease germs cannot stand prolonged exposure to the direct rays of the sun. Sunlight is Nature's great disinfectant. Its importance is no less in poultry than in human sanitation. The following statement made some years ago (1904) by a writer signing himself "M" in Farm Poultry

(Vol. 15) brings home in a few words the importance of having plenty of light in the poultry house.

"Light in the poultry house has been found by the writer a *great help in keeping the house clean and keeping the fowls healthy*. Probably there is no greater assistance to the diseases of poultry than dark and damp houses, and dark houses are frequently damp. In recent years I have had both kinds of experience, those with the hens confined in a large, dry and light house, and with hens confined in a dark house in which a single window looking towards the setting sun furnished the only light. Being forced to use the latter building for an entire winter I found it impossible to get it thoroughly dried out after a rain had rendered the walls damp. By spring some of the fowls that had been confined there began to die of a mysterious disease and a post-mortem examination showed it to be liver disease. Later the roup broke out in the same house and this dread disease continued with the flock for months exacting a heavy toll in laying hens."

C. Avoid Dampness. Of all unfavorable environmental conditions into which poultry may, by bad management, be brought, a damp house is probably the worst. Nothing will diminish the productivity of a flock so quickly and surely as will dampness in the house, and nothing is so certain and speedy an excitant to roup and kindred ills. *The place where poultry are housed must be kept dry if the flock is to be productive and free from disease.*

D. Provide Clean and Dry Litter. Experience has demonstrated that the best way in which to give fowls exercise during the winter months in which, in northern climates at least, they must be housed the greater part if not all of the time, is by providing a deep litter in which the birds scratch for their dry grain ration. For this litter the Experiment Station uses pine planer shavings with a layer of oat straw on top. Whatever the litter it should be changed as often as it gets damp or dirty.

II. HYGIENIC FEEDING.

Along with housing as a prime factor in poultry sanitation goes feeding. This is not the place to enter upon a detailed discussion of the compounding of rations and such topics.

These matters are considered farther on in this circular (see pages 34-54). There are, however, certain basic principles of hygienic feeding which must always be looked after if one is to avoid diseases. These are:

A. Purity. It should be a rule of every poultryman never to feed any material which it not clean and wholesome. Musty and mouldy grain, tainted meat scraps or cut bone, table scraps which have spoiled, and decayed fruits or vegetables should never be fed. If this consideration were always kept in mind many cases of undiagnosed sickness and deaths, and low condition in the stock would be avoided. Keep all utensils in which food is placed *clean*.

B. Avoid Overfeeding. Intensive poultry keeping involves of necessity heavy feeding, but one should constantly be on the lookout to guard against overfeeding, which puts the bird into a state of lowered vitality in which its natural powers of resistance to all forms of infectious and other diseases are reduced. The feeding of high protein concentrates like linseed or cotton seed meal needs to be particularly carefully watched in this respect.

C. Provide Plenty of Green Food. Under natural conditions poultry are free eaters of green grass and other plants. Such green food supplies a definite need in metabolism, the place of which can be taken by no other sort of food material. It is not enough merely to supply *succulence* in the ration. Fowls need a certain amount of succulent food, but they also need *fresh green food.* It is desirable to provide for a succession of green food throughout the year. The succession followed at the Maine Agricultural Experiment Station is as follows:

Beginning in the early fall when the pullets are put in the laying house they are given green corn fodder cut fine in a fodder cutter. Stalks, leaves and ears are cut together in pieces averaging about 1-2 inch in length. The birds eat this chopped corn fodder greedily. It is one of the best green foods for poultry that we have as yet been able to find. Its usefulness is limited only by the season within which it is possible to get it. The feeding of corn fodder is continued until the frost kills the plants.

When the corn can no longer be used cabbage is fed. The supply of this usually lasts through December. In the event of the supply of cabbage failing before it is desirable to start the oat sprouter (see p. 50) the interval is filled out by the use of mangolds. From about January 15 to May 15 green sprouted oats grown as described below (pp. 50-54) form the source of green food. From about May 15 until the corn has grown enough to cut, fresh clover from the range is used. During the summer the growing chicks on the range are given rape (Dwarf Essex) and green corn fodder cut, as described above to supplement the grass of the range, which rather rapidly dries out and becomes worthless as a source of green food under our conditions. The very young chicks in the brooders are given the tops only of green sprouted oats chopped up fine.

D. Provide Fresh and Clean Drinking Water. The most sure and rapid method by which infectious diseases of all kinds are transmitted through a flock of birds is by means of the water pail from which they all drink in common. Furthermore the water itself may come from a contaminated source and be the origin of infection to the flock. Finally it is difficult to devise any satisfactory drinking fountain in which the water is not liable to contamination from litter, manure, etc. All these considerations indicate the advisability of adding to all drinking water which is given to poultry some substance which shall act as a harmless antiseptic. The best of all such substances yet discovered for use with poultry is potassium permanganate. This is a dark reddish-purple crystalline substance which can be bought of any druggist. It ought never to cost more than 20c-30c per pound and a pound will last for a long time. It should be used in the following way: In the bottom of a large mouthed jar, bottle or can, put a layer of potassium permanganate crystals an inch thick. Fill up the receptacle with water. This water will dissolve all of the crystals that it is able to. This will make a stock saturated solution. As this solution is used add more water and more crystals as needed, always aiming to keep a layer of undissolved crystals at the bottom. Keep a dish of stock solution like this alongside the faucet or pump where the water is drawn for the poultry. *Whenever any water is drawn for either chicks or adult fowls at the Maine Agricultural Experiment Station enough of the stock solution is* *added to give the water a rather deep wine color.* This means 1 to 2 teaspoons of the stock solution to 10 quarts of water. At the same time one should clean and disinfect the drinking pails and fountains regularly, just as he would if he were not using potassium permanganate. At the Maine Station plant for some 4 years past no bird has ever had a drink of water from the time it was hatched which did not contain potassium permanganate, except such water as it got from mud puddles and the like.

III. THE LAND.

One of the most important considerations in poultry sanitation is to keep the ground on which the birds are to live, both as chicks and as adults, from becoming foul and contaminated. This is not a very difficult thing to do if one has enough land and practices a definite and systematic crop rotation in which poultry form one element. On the open range where chicks are raised a four year rotation is operated at the Maine Agricultural Experiment Station and serves its purpose well. This system of cropping is as follows: First year, chickens; second year, a hoed crop, such as beets, cabbage, mangolds or corn; third year, seed down to timothy and clover, using oats or barley as a nurse crop; fourth year, chickens again. Other cropping systems to serve the same purpose can easily be devised.

To maintain the runs connected with a permanent poultry house, where adult birds are kept, in a sweet and clean condition is a more difficult problem. About the best that one can do here is to arrange alternate sets of runs so that one set may be used one year and the other set the next, purifying the soil so far as may be by annually plowing and harrowing thoroughly and planting exhaustive crops. Failing the possibility of alternating in this way, disinfection and frequent plowing are the only resources left.

The following excellent advice on this subject is given by the English poultry expert Mr. E. T. Brown (Farm Poultry, Vol. 18, p. 294): "Tainted ground is responsible for many of the diseases from which fowls suffer, and yet it is a question that rarely receives the attention it deserves. The chief danger of tainted soil arises when fowls are kept in confinement, but still we often find that even with those at liberty the land over which they are running is far from pure. So long as the grass can be kept growing strongly and vigorously there is small fear of foul ground, as the growth absorbs the manure; it is when the grass becomes worn away that the chief danger arises. The manure constantly falling upon the same small area, and there being nothing to use it up, the land is bound in a short space of time to become so permeated as to be thoroughly unfit for fowls. The question is very often asked in connection with this subject as to how many fowls a certain sized piece of land will accommodate the whole year through. Occasionally one may see in some of the agricultural or poultry journals this question answered, but as a matter of fact to give any stated number is most misleading. It depends very largely upon the class of soil, as some can carry twice as many birds as others; it depends upon the breed of poultry, some being much more active than others, and thus requiring more space; it depends, too, upon the time of year, because during the spring and summer, when there is an abundance of vegetable growth in the soil, a considerably larger number of birds can be maintained than during the autumn or winter. The number must be varied according to these circumstances, and no hard and fast rule is applicable."

"The results of tainted ground are generally quickly noticeable, as the fowls have a sickly apearance, the feathers lose their brilliant lustre, and the wings begin to droop. Roup, gapes, and other ailments speedily show themselves, causing, if not death itself, considerable loss and unpleasantness. One of the greatest advantages to be derived from portable houses is that they so greatly reduce the risk of tainted ground, as they are being constantly moved from one place to another, thus evenly distributing the manure. When it is remembered that each adult fowl drops nearly a hundred weight of manure in the course of a year, the importance of this question will be immediately realized. It is quite possible, however, provided that suitable precautions are taken, to keep a comparatively small run pure for a long time. If the grass is short it should be occasionally swept, in this manner removing a good deal of the manure. Another important point is to always have around the house a space of gravel, upon which the birds should be fed, and if swept once or twice a week this will have a wonderful effect in preserving the purity of the grass portion. Anyone who has observed poultry will know how fond they are of constantly being near the house, and thus the greater portion of their droppings falls within its immediate vicinity. The shape of the run also has a great bearing upon the length of time it will remain untainted, a long narrow run being much superior to a square one. I have proved by my own experience how true this is, and probably a long and narrow run, containing the same amount of space will remain pure twice as long. It is unnecessary here to go into a full explanation of why this is so, but I may state the fact, which I am confident is quite correct. If the space at one's disposal is very limited it is a good plan to divide it into two equal parts, placing the house in the middle. During one year one-half would be available for the fowls, the other being planted with some quickly growing vegetables, the order being reversed the year following. The vegetable growth has the effect of quickly using up the manure, and in this manner quite a small plot of land can be heavily stocked with poultry for an unlimited number of years."

IV. EXERCISE.

If poultry are to be in good condition, and maintain their normal resistance to disease *they must exercise.* As chicks they will do this on the range. As adults (in climates like that of Maine) the most feasible way to bring this about is to provide litter and make the birds scratch for their feed.

V. EXTERNAL PARASITES.

In hygienic poultry keeping the birds must be kept reasonably free at all times of lice, mites, and all other forms of external parasites. The methods of dealing with this matter in use at this Station are given in detail farther on. It is desired here merely to call attention to the matter as one of the general principles of hygienic poultry management.

VI. DISPOSAL OF DEAD BIRDS.

The poultry plant which does not have some dead birds to dispose of from time to time has yet to be started. Just in connection with the disposal of such dead birds is one of the weakest points in poultry sanitation as too commonly practiced. The number of poultry keepers who throw dead birds on the manure pile or out on a temporary unused field is much too large. This is a short sighted and dangerous procedure. Anyone who continues for a long enough time to dispose of his dead birds in such a way is tolerably sure, sooner or later, to be wiped out of business by an epidemic, with a thoroughness and despatch which will leave him wondering what in the world has happened.

The most sanitary method of disposal of dead bodies is cremation. Wherever it is possible every dead bird should be burned just as soon as may be after death has occurred. In many cases, however, a farmer or poultryman is not so situated as to be able to burn dead animals without too great an expenditure of time or labor. In this event burial is about the only alternative, and here it is wise to dig the grave deep. Otherwise, through the aid of foxes, dogs, skunks, or other creatures, the dead may "rise again" in a literal and most unsanitary manner.

VII. ISOLATION OF SICKNESS.

Whether one expects to treat the bird or to kill it, *every individual that shows signs of sickness should be removed from the general flock.* When the bird has been isolated a decision as to what will be done about the case can be reached at leisure, and in the meantime the flock is not subjected to the danger of infection. This is an important matter with young chickens as well as with adult stock.

THE ESSENTIALS OF POULTRY HYGIENE.

To summarize this discussion of poultry hygiene and sanitation it may be said that the essentials in the hygienic and sanitary management of poultry are

1. Clean Houses.
2. Clean Air.
3. Clean Food.
4. Clean Water.
5. Clean Yards and Clean Range.
6. Clean Incubators and Brooders.
7. Clean Birds, Outside and Inside.

THE SELECTION OF BREEDING STOCK.

At the Maine Agricultural Experiment Station the poultry plant is conducted for purely experimental purposes in connection with the study of the principles of breeding. On that account the considerations which determine the choice of birds to go into the breeding pens are somewhat different to what they would be in a purely commercial plant. It will therefore be advisable to discuss here only those general guiding principles in regard to the selection of breeding stock, which the experience of this Station has demonstrated to be of fundamental importance in building up an economically productive strain of poultry.

Whatever the object of the breeder, whether egg production, table fowl production, or the fancy, the first selection of breeding stock should be for constitutional vigor and vitality. No bird which shows the slightest sign of weakness or lack of vigor should be used as a breeder. The selection for constitutional vigor should begin at a very early age and be continued until the pens are mated. It is a great mistake to leave the whole of the process of selection until just prior to the breeding season. As the chicks are growing on the range the most vigorous ones, those which impress themselves in the eye of the breeder as surpassing their associates in vitality, rate of growth, vigor, etc., should be marked and watched. With later development some of these early selected birds will fail to fulfill the promise of their youth and will then be discarded. Others which were not conspicuously excellent at an early age will develop into unusually good specimens later. They may then be taken into the selected group. Finally as the mating season approaches the breeder should go carefully over this group of birds which have been selected from the beginning of their lives, and pick out the most vigorous of the lot which also carry the other qualities for which he is breeding. The point is to make the selection of breeders a process of continuous picking out the good and culling the poor throughout the entire growth of the birds.

Another point of importance is in relation to the size of the breeding stock. It is a nearly universal experience, if line breeding be practised for any particular character, as for example egg production or feather marking, that unless special attention is paid to this point there will tend to be a progressive deterioration in the average size of the birds. This is particularly liable to happen when one is breeding for egg production. To counteract this tendency special attention must be paid to the size of the breeding stock, making it a rule never to use as a breeder any bird, whatever the other excellencies may be, which does not attain a certain weight standard set by the breeder.

What has been said regarding size is only a special case of the general rule of breeding that always the effort in selecting breeders should be towards all-round excellence. Selection for any one character alone—as for example egg production—with an entire disregard of all other characters of the birds will, in comparatively few generations, defeat its own end. It will be found that the stock has deteriorated quite as much in regard to some important qualities as it may have gained in respect to the character for which selection was made.

While it is not possible here to enter upon an exhaustive discussion of the subject of breeding for egg production a word may be said regarding the results of the Maine Agricultural Experiment Station along this line. From long continued experiments it appears to be conclusively demonstrated that the male bird has a hitherto unsuspected importance in the transmission of high-laying qualities to the progeny. Egg production, in the Barred Plymouth Rock fowl at least, appears to depend upon two separately inherited physiological factors. Either of these factors when present alone in a bird makes it a poor or mediocre layer. If both factors are present together the bird is a high producer. The novel feature of the case lies in the point that the factor upon which high production depends (i. e., which must be present if the bird is to be a high producer) is never transmitted in inheritance from a mother to her daughters, but only to her sons. It behaves, in other words as a sex-linked character. The male bird which possesses this hereditary factor for high production may however transmit it both to his sons and his daughters. It thus appears that the high egg productiveness exhibited by some pullets or hens is always directly inherited from the sire, and not at all *directly* from the dam, though the sire himself may very likely have inherited the quality from his dam. Indeed the male which is hereditarily pure (homozygous) with respect to this high producing factor must receive one half of his endowment from his dam. The practical significance of this matter is that more attention will have to be paid to the male birds in breeding for egg-production than has hitherto been the case. Only males from high-laying dams should be used as breeders and of those only a portion will transmit high producing qualities to any large proportion of the daughters. An important practical step is to toe-mark, or otherwise identify, all pullets so that their *sire* may be known. From their performance the breeder will be able to judge of the ability of the sons of this sire (the brothers of the pullets) to transmit high-producing qualities.*

Raising Chickens by Natural Processes.

While even the small grower of chickens in many cases uses an incubator for hatching, circumstances make it necessary at times to hatch and raise chickens by aid of the mother hen. To persons so situated an outline of the method practiced at the Station before incubators had reached their present development may be helpful. An unused tie-up in a barn was taken for the incubating room and a platform was made along the inner side. The platform was 3 feet above the floor and was 2 1-2 feet wide and 50 feet long. It was divided into fifty little stalls or nests, each 1 foot wide, 2 feet long, and 1 foot high. This left a 6-inch walk along the front of the nests for the hens to light on when flying up from the floor. Each nest had a door made of laths at the front, so as to give ventilation. The door was hinged at the bottom and turned outward. Across the center of each nest a low partition was placed, so that the nesting material would be kept in the back end—the nest proper. For early spring work paper was put in the bottom of the nest, then an inch or two of dry earth, and on that the nest, made of soft hay.

Whenever half a dozen hens became broody they were taken in from the henhouse and put on the nests, each nest having a dummy egg in it; the covers were then shut up, and nearly

*A detailed report of the experiments on the basis of which the above statements are made is published as Bulletin 205 of the Maine Agricultural Experiment Station.

every hen seemed contented. In a day or two 13 eggs were placed under each hen. Every morning the hens were liberated as soon as it was light, when they would come down of their own accord and burrow in the dry dust on the floor, eat, drink, and exercise, and in twelve or fifteen minutes they would nearly all go back to the nests voluntarily. In the afternoons one would occasionally be found off the eggs looking out through the slatted door. If she persisted in coming off she was exchanged for a better sitter. The double nest is necessary, otherwise the discontented hen would have no room to stand up, except on her nest full of eggs, and she would very likely ruin them. There was no danger of this with the double nest, as she would step off the nest, go to the door and try to get out.

The advantages of a closed room in which to confine the sitters are many, as the hens are easily controlled and do not need watching as they do when selecting nests for themselves, or when sitting in the same room with laying hens. A room 12 feet square could be arranged so as easily to accommodate 50 sitters.

The most satisfactory arrangement used at the Maine Station for the accommodation of the hen with her brood of young chicks consisted of a closed coop about 30 inches square, with a hinged roof and a movable floor in two parts, which would be lifted out each day for cleaning. This little coop had a wire-covered yard attached to it on the south side. The yard was 4 by 5 feet in size and 1 1-2 feet high. Its frame was of 1-inch by 3-inch strips and was fastened securely to the coop.

The wire on the sides was of 1-inch mesh, but on top 2-inch mesh was sufficient. Such a coop is easily kept clean, and the coop and yard can be set over upon clean grass by one person.

The small run will be sufficient for the first few weeks, but soon the chicks need greater range, and then the fence at the farther end of the run can be lifted up 3 or 4 inches and they can pass in and out at will, while the mother will be secure at home and they will know where to find her when they get cold or damp or need brooding. Such a coop accommodates 15 to 20 chicks until they no longer require brooding, after which several flocks should be combined in one and put in a portable house on a grassy range.

Whenever the hen is allowed to hatch or to mother chicks, much care must be exercised to prevent lice from getting a foothold and ruining the birds. The free and frequent use of the lice powder described farther on (p. 71), working it through the feathers to the skin, is one of the best methods for destroying the pests. Grease or oil is effective when applied to the heads and under the wings of young chicks, but care must be taken not to get too much on them, especially during damp weather. The feeding of chicks raised in coops with their mothers does not vary much from the feeding of those raised in brooders as described below.

Raising Chickens by Artificial Processes.

Incubators have been much improved and there are several kinds on the market that will hatch about as many chicks from a given lot of eggs as can be done by selected broody hens. Furthermore, in the experience of this Station, with proper management during and subsequent to incubation the chicks so produced are *fully* the equal in constitutional vigor, average duration of life, and productivity, of hen-hatched chicks. The best present day incubators require little care, maintain an even temperature arising from the development of the embryoes going on in the eggs. In some machines the moisture supply is automatic and adapted to the requirements; in others it has to be supplied, and skill is necessary in determining the quantity needed. The economy of the incubator is very great. A 360-egg machine will do the work of nearly 30 broody hens, and can be kept at work continually if desired. For more than 10 years past all chicks in the Maine Experiment Station's poultry plant have been hatched in incubators. There has yet to appear any reason for going back to the old system of hatching with hens.

THE INCUBATOR.

There are many makes of incubators on the market, some of which will give satisfactory results. The Maine Station has not tested many makes of incubators, and very likely some of the makes not tested would prove as satisfactory as those used.*

Whatever make of incubator is used, pains should be taken to become thoroughly acquainted with the machine before the eggs are put into it. It is advisable for a person not familiar with the use of an incubator to run the machine empty for several days before filling it. After the eggs are put in, changes and adjustments should be made with the greatest care for fear of extreme results. By the use of an incubator it is possible to determine exactly the time when the chickens shall be hatched. With the strain of Barred Plymouth Rocks bred by the Maine station it was formerly necessary to hatch the chickens in March in order to have them ready for November laying. By better methods of feeding, breeding, and treatment, it is now possible to delay the hatching until April and the first of May and have the pullets in good laying condition the last of October and early in November. Chickens hatched in March under the present method of breeding and feeding would in many cases begin laying in August.

THE INCUBATOR ROOM.

It is important that the incubator room be so situated that it can be kept at a fairly constant temperature. On this account an underground room is usually selected. For many years the well-lighted cellar under the wing of the farmhouse was used by the Maine Station. A cold or badly ventilated cellar would, however, be poorly adapted for incubators. Ventilation is very important, and where several incubators are in use artificial ventilation must be provided, in order that the machines may be furnished with clean, fresh air at all times.

In 1905 the Maine Station erected an incubator house which practically consists of a well-made, light, airy cellar with a house for the poultry man above it. The incubator room, which occupies the entire cellar, is 30 feet square. The room is 7 feet

*A discussion of the different types of incubators and the methods of managing them to get the best results is given in Farmers' Bulletin 236, "Incubation and Incubators," which may be obtained free on application to the Secretary of Agriculture, Washington, D. C. The directions furnished by the manufacturers of the different incubators should be strictly adhered to by the beginner.

high in the clear, 5 feet of which is below the level of the outside ground. It is lighted by six 3-light windows, carrying glass 10 inches by 16 inches. The cement walls are finished smooth and the cement floor is slightly inclined toward the southeast corner where the intake of the drain is located. This enables the free use of water from hose in cleaning the room preparatory to starting the incubators. Two chimneys extend to the basement floor and contain ventilating flues that have no opening into the rooms above. Entrance to the room is through a covered outside cellar stairway leading into a shed at the rear of the building. The room now contains thirteen 360-egg machines.

In the directions which accompany certain of the incubators which have been used at the Station it is stated that an artificial source of moisture is not needed in operating these incubators except in very arid parts of the country. It is said that in other places the normal moisture of the atmosphere is sufficient to insure the necessary moisture in the incubator. The experience of the Station indicates that except possibly in a rather wet season this is not the case. It has been found here that in an ordinary season if no artificial moisture is supplied to the incubators there is too great an evaporation from the eggs. It is demonstrable that many eggs fail to hatch because of this dryness of the air in the incubator. It is not desirable here to enter into a detailed discussion regarding experiments on this point. It suffices to state the fact that in the Station's experience better hatches have been obtained when moisture beyond that normal in the atmosphere is supplied during incubation. The most satisfactory way to supply this extra moisture in machines where sand trays are not an integral part, has been found to be by sprinkling the eggs with warm water twice a day. The water is warmed to a temperature of from 104°-108° Fahr. The sprinkling may be done either with a small hand sprayer or by simply shaking the water on with the hand or a whisk broom. This is done in connection with the regular manipulation of the eggs (cooling and turning) during incubation. The application of moisture is begun as soon as the eggs go into the machine and is continued until the 18th day. Since adopting this procedure a very considerable reduction in the mortality of chicks in the shell has been effected.

BROODER HOUSES.

Some years ago there was erected at this Station a long continuous brooder house, containing 10 brooders and with capacity for 600 to 1000 chicks. This house burned during the first season of its use, and has never been replaced.

A permanent brooder house would be indispensable for the raising of winter chickens, and a house piped for hot water has some advantages. The advantages are especially great when raising chickens if April or May proves to be cold or wet, for then the small houses are apt to be cold outside of the brooders. In ordinary seasons, even in Maine, little or no difficulty is experienced in raising chicks hatched in April and May in the small houses. The expenditure would be greater for the piped house, for the reason that colony houses still must be provided in which the chicks may be sheltered after they leave the brooder house.

Since the burning of the house just described, the Maine Station has used small portable brooder houses (see fig. 1). The small brooder houses built on runners are readily moved about, and for the work with spring-hatched chickens are preferred to the large permanent brooder house. Several styles and sizes have been used, but the following meets the needs of the Station better than any other that has been tried. The houses are built on two 16-foot pieces of 4 by 6 inch timbers, which serve as runners. The ends of the timbers, which project beyond the house, are chamfered on the underside to facilitate moving. The houses are 12 feet long; some of them are 6 feet and others 7 feet wide; 7 feet is the better width. They are 6 feet high in front and 4 feet high at the back. The frame is of 2 by 3 inch lumber; the floor is double boarded, and the building is boarded and covered with a good quality of heavy roofing paper. Formerly shingles were used for the outside covering, but paper is preferred and is now used exclusively. This kind of covering for the wall is not so likely to be injured in moving as shingles. A door 2 feet wide is in the center of the front and a 6-light window, hinged at the top, is on each side of it. Two brooders are placed in each of these houses and 50 to 60 chicks are put with each brooder. A low partition separates the flocks while they are young. The houses are large

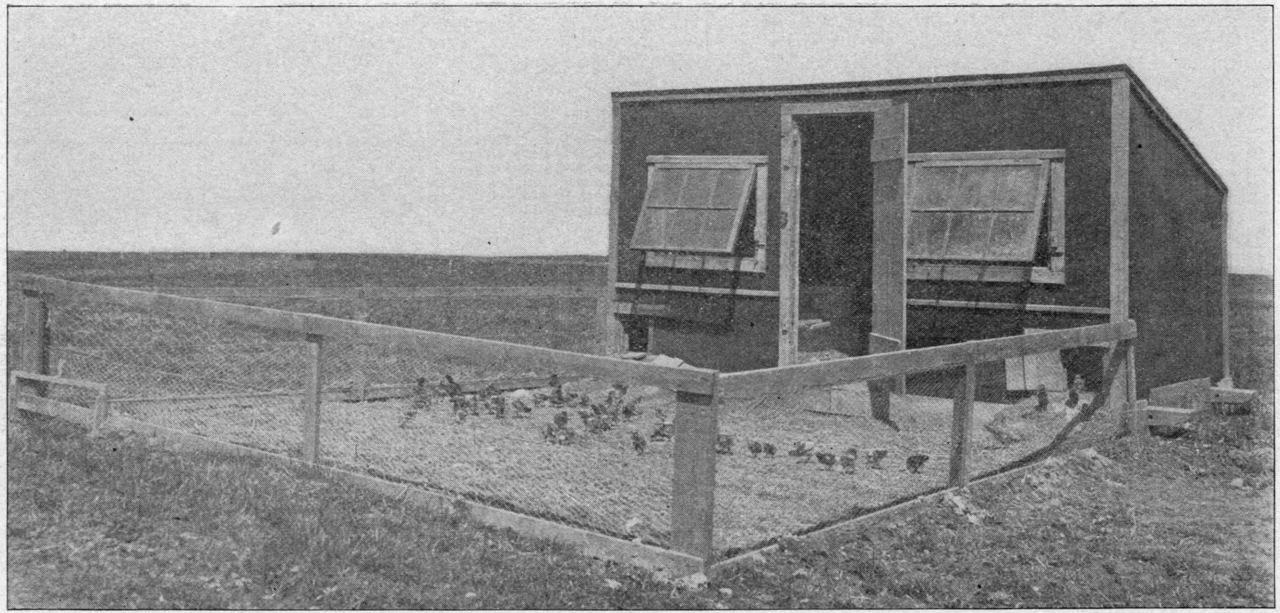


FIG. 1.—Portable brooder house and temporary yard.

enough so that a person can go in and do the work comfortably, and each one accommodates 100 chicks until the cockerels are large enough to be removed. One of these houses is shown in figure 1.

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

A FRESH AIR BROODER.

For a number of years prior to 1910 the Maine Station used in rearing chickens a commercial, hot air, brooder. These brooders never gave entire satisfaction. During the period in which they were used the mortality during the first three weeks in the brooder was too large, and remained so even after all factors other than the brooder had so far as possible been corrected.

After careful consideration of the matter it appeared that there were three fundamental defects in brooders of the type used. These are: (1) In order to get a sufficiently high temterature underneath the hover in the sort of weather which prevails in this locality during the latter part of March and first part of April it is necessary to turn the lamp so high that the floor of the brooder gets much too hot. In other words, if brooders of this type are forced at all there is too much "bottom heat." (2) Brooders of this kind have no provision for taking the lamp fumes and vitiated air out of the building in

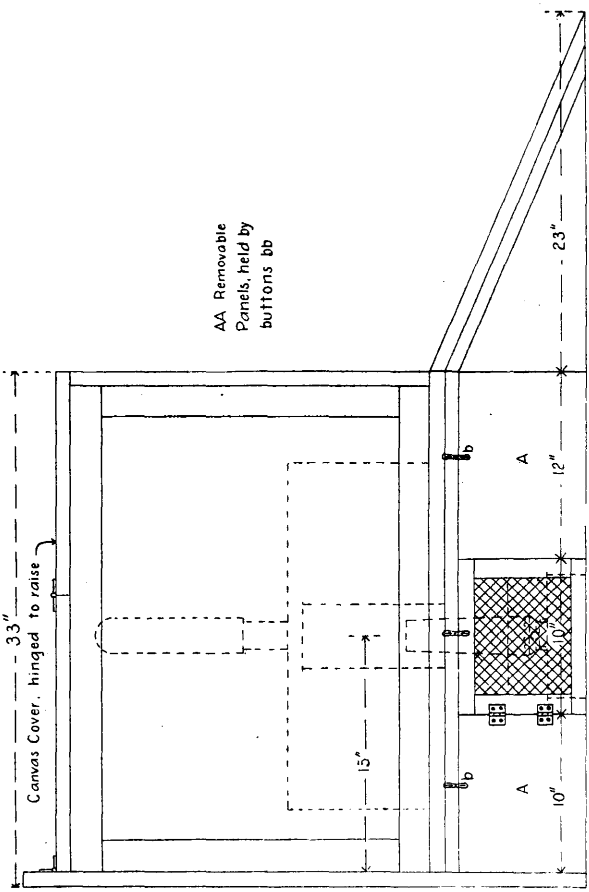


FIG. 2. End elevation of brooder. Note sloping run to floor, hinged cover, removable side panel *AA* on base of brooder. In the center of this is a small door made of 1-4 in. mesh galvanized wire. Through this door the lamp is withdrawn for filling and cleaning. The panel *AA* is removed from the brooder is dismantled, and the whole superstructure is then packed away under the base. See text for further explanation.

which the brooder is operated. This becomes a very serious matter when, as is the case at this Station, two of these brooders are operated in a small colony house, with a floor area of only 6 or 7 feet by 12 feet. In the cold weather of April it is necessary to shut these houses at night in order to maintain anything like the proper temperature underneath the hovers. When the door of such a house with two of these brooders operating in it is opened in the morning the air is plainly very bad. Not only does it contain all the lamp fumes, but it also has a peculiarly dry, burned-out smell. (3) When these brooders are operated in small colony houses, and the same houses are used for growing the chickens on the range throughout the summer, a considerable labor expense and a good deal of wear and tear on the brooders themselves is involved in

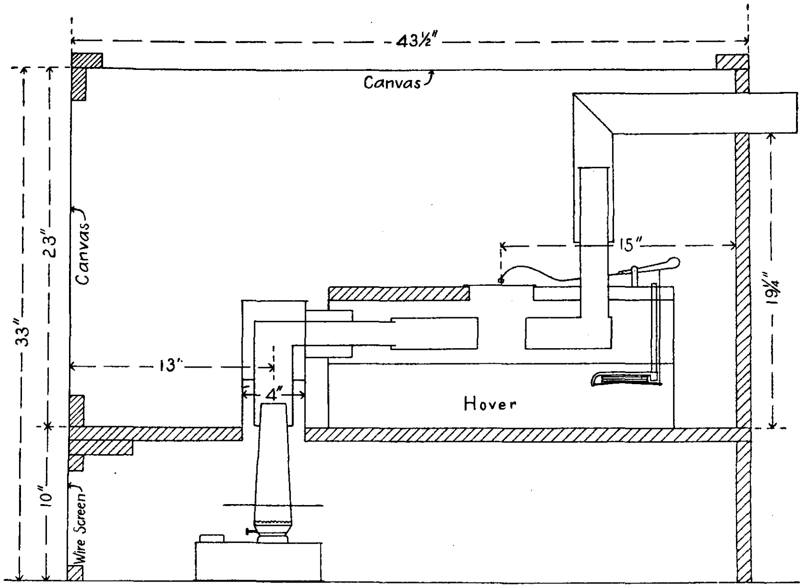


FIG. 3. Section through middle of brooder. Note cloth cover and side, large space between floor of brooder and floor of house, in which the lamp is placed while the brooder is in operation, and which serves as a storage place for the whole upper part of the brooder when the latter is not in use.

moving them about. After the chicks have reached a size when it is no longer necessary for them to have a hover the brooders must be moved out and stored somewhere until the houses are cleaned out in the fall. Then the brooders have to be moved back in again in preparation for the next year's hatching season. All this involves a good deal of labor. Every poultryman knows, or ought to know, that one of the primary factors in determining financial success or failure in the poultry business is the labor cost. Any plan which attains a real saving of labor, without involving any disadvantages in other ways, is to be welcomed. Certainly the operation of brooders which

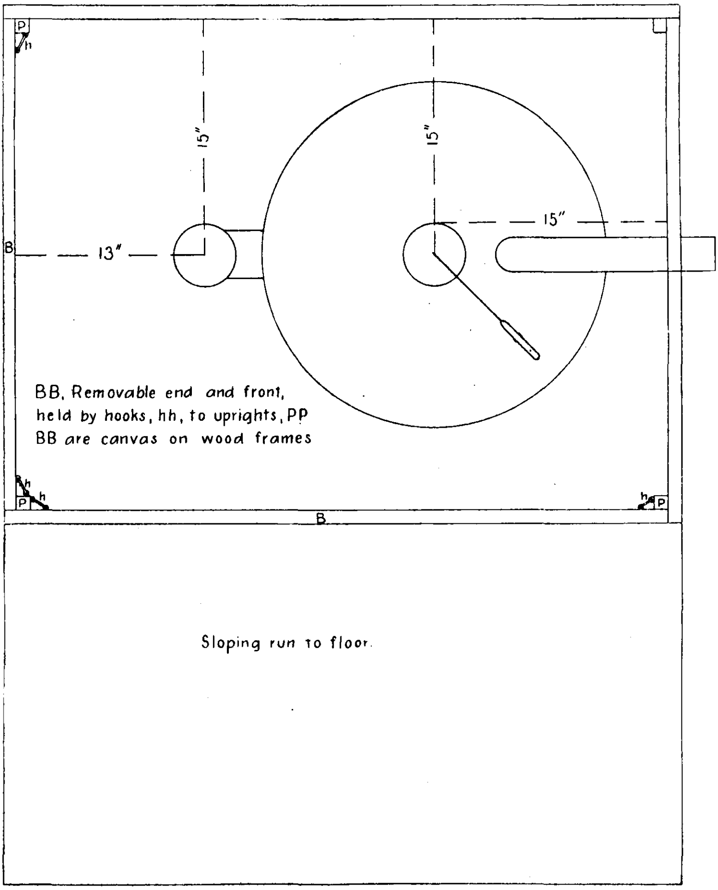


FIG. 4. Floor plan of brooder. For further explanation see text.

have to be handled about so much every season constitutes a labor leak, which on a large plant operating 50 to 100 brooders is considerable in amount.

In view of these considerations it was decided in the hatching season of 1909 to begin some experiments looking toward an improvement in the brooders used for rearing the chickens at this Station. At first some different types of commercial brooders were tested. The results, however, were not satisfactory. Before the hatching season of 1910 it was decided to try on an experimental scale a brooder devised to overcome the objections mentioned above to brooders of the type formerly used. The results obtained were strikingly favorable to

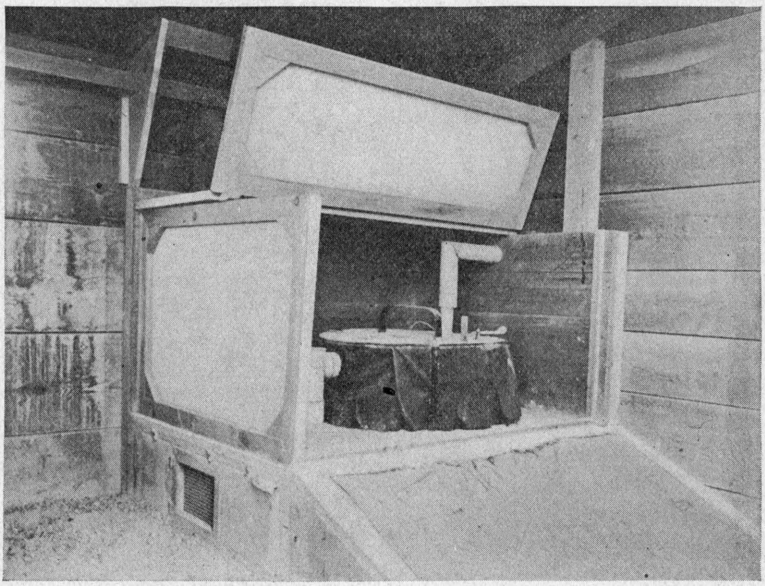


FIG. 5. Showing brooder installed and ready for operation.

the new brooders. In this bulletin is given a detailed description of this brooder, together with working plans so that any poultryman can construct one for his own use if he cares to do so.

The advantages which have been found to accrue from the use of this brooder at the Maine Station fall into two general categories. The first of these is that it is possible to rear in this brooder a larger number of chickens in proportion to the number originally put in than in any other brooder with which the Station has had any experience. That is, the mortality rate of chicks raised in this brooder, is relatively low, particularly as compared with brooders of the old type. Furthermore not only do the chicks live better in this new brooder but also, according to our experience, those which do live grow better and are thriftier than those raised in the other type of brooder. The second advantage lies in the great saving of labor which is effected by the use of the new brooder. The fact that the brooder never has to be taken away from the house where it is operated means a decided economy.

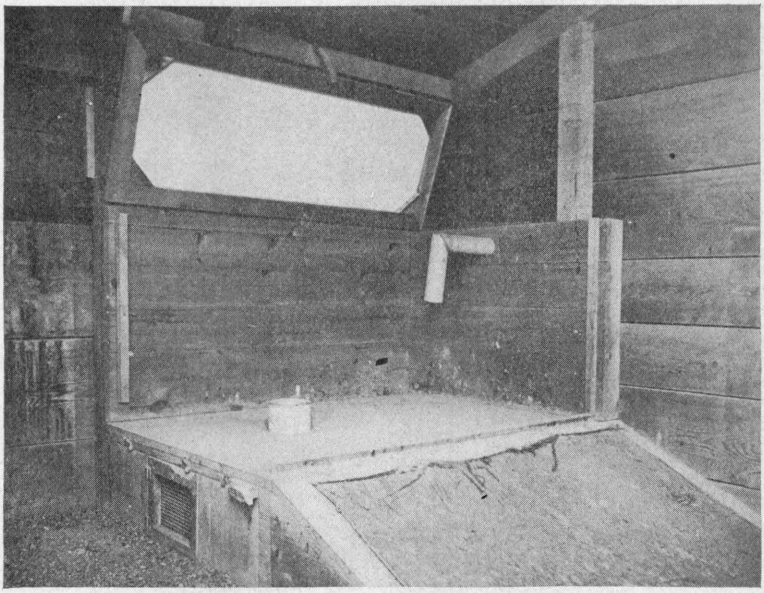


FIG. 6. Showing brooder dismantled and parts stored in base.

CONSTRUCTION OF BROODER.

In planning this brooder the primary point aimed at was to make it a "fresh air" and a "pure air" brooder. With this idea in mind it was thought advisable to make the wall of the brooder in some degree permeable to air. To meet this requirement the walls and cover of the brooder are made of cloth. Essentially the brooder is a cloth box containing a hover, of the type in which the lamp fumes are conducted outside of the building by an exhaust pipe.

These brooders are built as a constituent part of the houses which they occupy. Two brooders are placed in each colony house, one in each of the back corners of the building. In this way one end wall and the back wall of the building form two of the sides of each brooder. The remaining side and cover are made of cloth tacked on light wooden frames as shown in the working drawings.

The floor of the brooder stands 10 inches above the floor of the house. From the front of the brooder a sloping walk extends down to the house floor, reaching in width clear across the whole front of the brooder. The cloth front and side of the brooder are not permanently fixed in position but are removable panels, which are held together and to the frame work by hooks and eyes (see fig 4). The cover is hinged in the middle in such a way that it can be either half opened or entirely opened and folded back out of the way. In consequence of this arrangement it is possible to regulate with great nicety the amount of air which shall be admitted to the brooder. Either the front or the side panel may be tilted out as much as desired at the base thus admitting air there. Furthermore by partly opening a panel and the cover it is possible to insure that there shall be a circulation of air through the brooder at all times.

The hover used in this brooder is the Universal Hover, made by the Prairie State Incubator Co., Homer City, Pa. It is, however, modified in certain particulars for present use. In the first place the arrangement is such that the lamp is inside the house underneath the brooder rather than in a box outside the house, as in the usual arrangement of this hover. The lamp in this brooder is in the house directly under the hover. The reason for this modification is that in this climate, where one is likely to have bad weather during the early part of the hatching and rearing season, with heavy winds, snow, and rain, it is much easier and more satisfactory to take care of the lamp inside the house than from a small box outside the house. Another modification is that in the hovers which are installed in these brooders an especially heavy insulation is put on top of the drum to reduce the loss of heat by radiation in extremely cold weather early in the spring.

One of the essential points about the brooder is its compactness in storage, and the fact that all the parts may be stored in the base of the brooder itself. In this way the labor expense of carrying back and forth parts from a storage house each year is avoided. To bring about this result the size of the base is so calculated that all the parts of the brooder may be enclosed in it. The way in which this is done is apparent from an examination of fig. 2. It will be seen that the end of the brooder base, (marked *AA* in the diagram) is removable, being held in place by buttons *bb*. When the end of the brooding season is reached and there is no further use for the brooder that year, the side and front end panel of the brooder are removed, the canvas cover folded back and tacked to the wall of the building and the hover dismantled. All of the parts are then shoved under the brooder floor and the panel *AA* put back in place again. The floor of the brooder is removable so that it, and the floor underneath, may be cleaned and disinfected. By removing its legs the hover may be stored in the brooder base along with the other parts, or if one does not desire to do this the hover may be suspended close up to the roof of the building. In that position it will be impossible for the birds to roost on it. Of course, all movable parts should be taken from the hover before it is hung up in this way. These parts may be stored in the brooder base. After the chickens are out of the house in the fall the parts of the brooder are taken out, thoroughly cleaned and disinfected, and then the whole is reassembled and made ready for the hatching season of the next year.

Detailed working drawings of the brooder are given herewith. Fig. 2 shows the end elevation of the brooder; fig. 3 shows a section through the middle of the brooder; fig. 4 shows a floor plan; fig. 5 shows the brooder in operation; and fig. 6 shows its appearance when dismantled and with the parts stored in the base, while the large chickens are using the house. All dimensions are given on these drawings and from them it should be possible for anyone to construct the brooder for himself.

As material any sort of planed lumber may be used. Probably pine will be found satisfactory and economical in most cases. Spruce or hemlock may be used to build the base, if one desires. For the cover and removable sides almost any sort of cloth may be used. Here we have employed the lightest weight canvas (duck) that could be obtained locally. Burlap may be used, or even unbleached cotton cloth in localities where the outside temperature is not too low.

TREATMENT OF YOUNG CHICKS.

In the work of the Maine Station all of the birds are hatched in incubators, and in pedigree wire baskets* since all are pedigreed. They are not disturbed on the 21st day of incubation, but on the morning of the 22nd day the chicks are removed from the baskets and leg-banded. Each chick is then returned to the basket from which it came and put back in the incubator. There they are left until they are from 48 to 72 hours old. The reason for keeping the chicks isolated in this way for so long a time is to prevent their eating each others droppings. It has been shown by Rettger and Stoneburn† that one of the most important chick scourges, bacillary white diarrhea, is (a) transmitted through the egg, and (b) can only infect non-infected birds during the first 48 hours of their life.

After this time the chicks are carried in warm covered baskets to the brooders, and 50 or 60 are put under each hover, where the temperature is between 95° and 100° F. The temperature is not allowed to fall below 95° F. during the first week, or 90° F. during the second week; then it is gradually reduced according to the temperature outside, care being taken not to drive the chicks out by too much heat, or cause them to crowd together under the hover because they are cold. They should flatten out separately when young, and a little later lie with their heads just at the edge of the fringe of the hover. They should never be allowed to huddle outside of the brooder. They huddle because they are cold, and they should be put under the hover to get warm, until they learn to go there of their own accord. Neither should they be allowed to stay under the hover too much, but in the daytime should be forced out into the cooler air where they gain strength. They ought not to be allowed to get more than a foot from the hover during the first two days; then a little farther away each day, and down on the house floor about the fourth or fifth day, if the

* See Bulletin 159, Maine Agricultural Experiment Station.

† Storrs Agr. Expt. Stat. Bulletin 60.

weather is not too cold. They must not get cold enough to huddle or cry, but must come out from under the hover frequently.

The floor of the brooder is cleaned every day and kept well sprinkled with alfalfa meal. So far as we are aware sand may be used for this purpose, but it has never been tried at this Station. The floor of the house is covered with clover leaves or with hay chaff from the feeding floor in the cattle barns.

Feeds and Feeding.

FEEDING YOUNG CHICKENS.

The best method of feeding young chicks is at present a matter of some uncertainty, and it is doubtful if there ever will be general agreement as to the one best method. One condition, however, appears to be imperative, and that is that the young things be not allowed to overeat. A number of different methods of feeding young chickens have been used at the Station in the past. The most useful of these methods follow.

Method 1.—Infertile eggs are boiled for half an hour and then ground in an ordinary meat chopper, shells included, and mixed with about six times their bulk of rolled oats, by rubbing both together. This mixture is the feed for two or three days, until the chicks have learned how to eat. It is fed with chick grit, on the brooder floor, on the short cut clover or chaff.

About the third day the chicks are fed a mixture of hard, fine-broken grains, as soon as they can see to eat in the morning. The mixture now used has the following composition:

	Parts by weight.
Cracked wheat	15
Pinhead oats (granulated oat meal)	10
Fine screened cracked corn	15
Fine cracked peas	3
Broken rice	2
Chick grit	5
Fine charcoal (chick size)	2

It is fed on the litter, care being taken to limit the quantity, so they shall be hungry at 9 o'clock a. m.

Several of the prepared, dry, commercial chick feeds may be substituted for the broken grains. They are satisfactory when made of good, clean, broken grains and seeds, but they contain no secret properties that make them more desirable than the home-mixed broken grains mentioned above. Their use is simply a matter of convenience. When only a few chicks are raised, it is generally more convenient, and probably not more expensive, to buy the prepared feed, but when many are raised it is less expensive to use the home-mixed feeds.

Sharp grit, fine charcoal, and clean water are always before the chicks. At 9 o'clock the rolled oats and egg mixture is fed in tin plates with low rims. After they have had the feed before them five minutes the dishes are removed and they have nothing to lunch on. At 12.30 o'clock the hard-grain mixture is fed again, as in the morning, and at 4.30 or 5 o'clock they are fed all they will eat in half an hour of the rolled oats and egg mixture.

When they are about 3 weeks old the rolled oats and egg mixture is gradually displaced by a mixture having the following composition:

	Parts by weight.
Wheat bran (clean)	2
Corn meal	4
"Daisy flour" (or other low grade flour)	2
Linseed meal	1
Screened beef scrap	2

This mixture is moistened with water just enough so that it is not sticky, but will crumble when a handful is squeezed and then released. The birds are developed far enough by this time so that the tin plates are discarded for light troughs with low sides. Young chicks like the moist mash better than that not moistened, and will eat more of it in a short time. There is no danger from the free use of the properly made mash twice a day, and since it is already ground the young birds can eat and digest more of it than when the feed is all coarse. This is a very important fact, and should be taken advantage of at the time when the young chicks are most susceptible to rapid growth, but the development must be moderate during the first few weeks. The digestive organs must be kept in normal condition by the partial use of hard feed, and the gizzard must not be deprived of its legitimate work and allowed to become weak by disuse.

By the time the chicks are 5 or 6 weeks old the small broken grains are discontinued and the two litter feeds are wholly of screened cracked corn and whole wheat. Only good clean wheat that is not sour or musty should be used.

When young chicks are fed as described, the results have always been satisfactory if the chicks have not been given too much of the scratch feed and if the dishes of ground material have been removed immediately after the meal was completed. The objections to this system of feeding are the extra labor involved in preparing the eggs, mixing the feed with water, and removing the troughs at the proper time.

Method 2.—This is like Method 1, except that fine beef scrap is used instead of boiled eggs and the mash is not moistened.

Early in the morning the chicks are given the hard feed on the floor litter as described in Method 1. At 9 o'clock they are fed a mixture having the following composition:

	Parts by weight.
Rolled oats	2
Wheat bran	2
Corn meal	2
Linseed meal	½
Screened beef scrap	1

This is given in the plates or troughs, and the dishes are removed after ten minutes' use.

At 12.30 the hard grains are fed again, and at 4.30 or 5 the dry-meal mixture is given to them for half an hour or left until their bedtime. The meal being dry, the chicks can not eat it as readily as they can the egg and rolled oats or the moistened mash. For that reason it is left for them to feed upon longer than when moistened with the egg and water, but is never left before them more than ten minutes at the 9-o'clock feeding time. The aim is to give them enough at each of the four meals so that their desire for food may be satisfied at the time, but to make sure that they have nothing left to lunch upon. It is desired to have their crops empty of feed before feeding them again. When treated in this way they will have sharp appetites when the feeder appears, and come racing out from the brooder to meet him. If they have been overfed at the previous meal, and have lunched when they saw fit, they do not care for the feeder's coming. If overfed a few times the creatures become debilitated and worthless.

What has been said so far is with reference to chicks that are hatched out in early spring, at a season of the year when it is impossible under the climatic conditions in Maine for them to get out of doors for work.

Method 3.—This is like Method 2, except that the first mash for the young chicks has the following composition:

	Parts by weight.
Wheat bran	4
Corn meal	3½
Linseed meal	½
Screened beef scrap	2
Alfalfa meal	1

This mixture is scalded and then dry rolled oats are mixed with it in the proportion of 2 parts rolled oats to 6 parts of the mixture. The reason for mixing in this way is that it has been found by experience that if rolled oats are mixed with the other materials of the mash before scalding there is a tendency for the mash to be soggy after it is wet. Mixing in the way here outlined has been found to improve the mash greatly.

This mash and the dry grains are fed as in Method 2 until the chicks are about 3 weeks old. From 3 weeks on to 6 or 8 weeks the composition of the mash is as follows:

	Parts by weight.
Wheat bran	2
Corn meal	3
Linseed meal	½
Daisy flour (or other low-grade flour)	1
Beef scrap	1

Method 4.—When warm weather comes and the later-hatched chicks are able to get out on the ground they find much to amuse them, and they work hard and are able to eat and digest more feed. Under these conditions the dry-meal mixture described in Method 2 is kept constantly before them in troughs, with good results. With two feeds a day of the broken grains in the litter

they have hard feed enough to insure health and they can safely peck away at the dry-meal mixture—a mouthful or two at a time—when they seem to happen to think of it, and thrive. This method has been considerably used in feeding April and May hatched chicks. Many times the results from it have been good. At other times, when the weather was dark and raw out of doors and the little things were held inside, they would hang around the troughs and overeat. They would grow rapidly for a few days, then commence to go lame, eat little, and seek the warm hover never to recover.

Method 5.—This consists in feeding the cracked corn, cracked wheat, pin-head oats, and millet seed in the litter four times a day, and keeping a trough of fine beef scrap within reach all the time. Sometimes commercial chick feeds have been used instead of the cracked corn, wheat, oats, and millet. By this system the losses of birds have been small when the feeding has not been so liberal as to clog the appetite. Much care is necessary in adjusting the quantity of feed to the needs of the birds.

Other methods of feeding young chicks have been tried and the results watched. Method 1 has been used for several years and no other has been found that gives better growth or less losses of birds. The only objection to it is the labor required in preparing the feed. In the work of the Station Method 3 is now preferred and used. The losses of chicks are small by either of the methods. The labor in Method 2 is considerably less than is required in Method 1. Where either Methods 1, 2, or 3 are used the liability of injury to the chicks is much less than when Methods 4 or 5 are followed.

There are no mysteries connected with the raising of the young chickens. Every chick that is well hatched out by the twenty-first day of incubation should live, and will do so as a rule if kept dry, at reasonable temperatures, and not allowed to overeat.

The most careful work of the poultryman during the whole year is required in getting the chicks through the first three weeks of their lives successfully. If they are vigorous up to the fourth week, there is little liability of injuring them thereafter by any system of feeding, if it is only generous enough and they have their liberty.

FEEDING CHICKS ON THE RANGE.

By the middle of June the chickens that were hatched in April are being fed on cracked corn, wheat, and the mash. At about that time the portable houses containing the chickens are drawn from their winter locations out to an open hayfield where the crop has been harvested and the grass is short and green. If not too much worn, the same field may be used a second season for chickens, but this is not recommended. A new, clean piece of turf land should be used each year. At least two acres should be allowed for each 1000 chickens, if the land can be had. It is possible, as has been demonstrated repeatedly, to grow good sound vigorous stock on smaller areas. But to do this is much more difficult and trying work than with larger areas.

When the chickens are moved to the range, the sexes are separated. The methods of feeding the cockerels and pullets differ, and there has been a gradual change in the methods of feeding. Each method has given good results. The changes have been introduced to save labor. After the chickens were moved to the range they were fed in the morning and evening with a moistened mixture of corn meal, middlings, and wheat bran, to which one-tenth as much beef scrap was added. The other two feeds were of wheat and cracked corn.

In 1904 a change was made in the manner of feeding 1,400 female chickens by omitting the moist mash and keeping in separate slatted troughs cracked corn, wheat, beef scrap, cracked bone, oyster shell, and grit where they could help themselves whenever they desired to do so. Grit, bone, oyster shell, and clean water were always supplied. There were no regular hours for feeding, but care was taken that the troughs were never empty.

In 1905 another trough containing a dry mash consisting of 1 part wheat bran, 2 parts corn meal, 1 part middlings, and 1 part beef scrap was used in addition to those containing the grains. The results were satisfactory. The labor of feeding was far less than that required by any other method tried. The birds did not hang around the troughs and overeat, but helped themselves, a little at a time, and ranged off, hunting or playing, and coming back again to the food supply at the troughs when so inclined. There was no rushing or crowding about the attendant, as is usual at feeding time where large numbers are kept together. While the birds liked the beef scrap, they did not overeat of it. During the range season, from June to the close of October, the birds ate just about 1 pound of the scrap to 10 pounds of the cracked corn and wheat. This is practically the proportion eaten when the moist mash was used.

THE FEEDING TROUGH.

The difficulty of keeping the feed clean and dry during continued exposure is nearly overcome by using troughs with

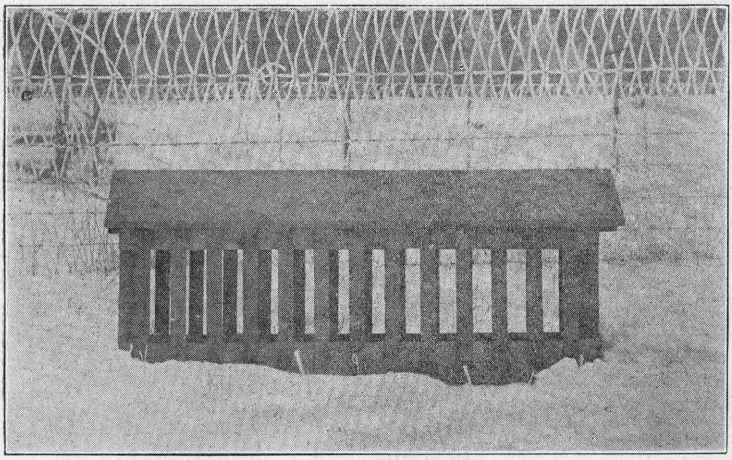


FIG 7. Chicken feeding trough, accessible from both sides, with cover on.

slatted sides and broad, detachable roofs (figs. 7 and 8). The troughs are from 6 to 10 feet long, with the sides 5 inches high. The lath slats are 2 inches apart, and the troughs are 16 inches high from floor to roof. The roofs project about 2 inches at the sides and effectually keep out the rain except when high winds prevail.

The roof is very easily removed by lifting one end and sliding it endwise on the opposite gable end on which it rests, as shown in figure 8. The trough can then be filled and the roof drawn back into place without lifting it. This arrangement is economical of feed, keeping it in good condition and avoiding waste. When dry mash is used there may be considerable waste by the finer parts being blown away, and on this account the dry-mash should be put in a sheltered place out of the reach of wind.

FEEDING THE COCKERELS FOR MARKET.

At the Maine Station many of the cockerels are to be used for breeding purposes, and they are fed in flocks of about 100 on the range in about the same way as the pullets. The dry-feed method is now used for them as satisfactorily as for the pullets.

A very large proportion of the cockerels raised in New Eng-

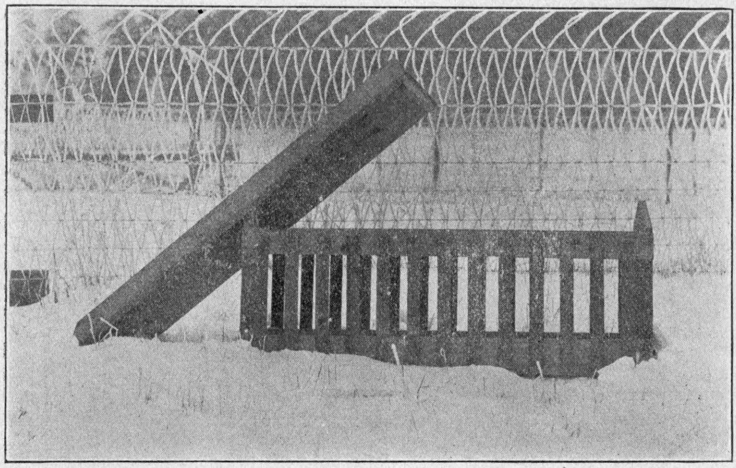


FIG. 8. Chicken feeding trough with cover removed.

land are sent to the market alive, without being fattened. Quite extended experiments at the Maine Station with many birds in different years indicate very clearly that keeping the cockerels for a few weeks with special feeding will add materially to the selling price. Not infrequently this will make the difference between loss from the low price obtained for slow-selling unfattened birds and the profit from comparatively quick-selling specially fed birds at a much higher price. The higher price is due partly to the increased weight and partly to the superior quality of the well-covered soft-fleshed chickens. As the bulletins containing the results of these feeding experiments with cockerels are out of print, the following brief summary of the results obtained is given:

The number of pounds of grain required to produce 1 pound of gain in fattening cockerels was ascertained in experiments comparing (1) the effect of housing, (2) the effect of age, and (3) the effect of skim milk. The grain mixture used in these series of experiments was the same, consisting of 100 pounds of corn meal, 100 pounds of wheat middlings, and 40 pounds of meat meal. This was fed as a porridge thick enough to drop but not to run from a spoon.

The French and English fatteners who make a specialty of the business, fattening thousands of chickens each year, confine the chickens in small coops. The coops used at the Maine Station gave a floor space of 16 by 23 inches, in each of which 4 chickens were placed. The coops were constructed of laths with closed-end partitions of boards. The floors, sides, and tops were of laths placed three-quarters of an inch apart. By simply moving the pens thus constructed the floors were kept clean. V-shaped troughs with 3-inch sides were placed in front and about 2 inches above the level of the floors of the coops. Cockerels thus fed were compared with others kept in small houses 9 by 11 feet in size, with an attached yard 20 feet square. The yard was entirely free from anything that would serve as green feed. Twenty birds were put in each of these houses. As a result of experiments with fattening 286 birds it was found that on the average 7.9 pounds of grain were required to produce 1 pound of gain in the case of birds fed in the coops, and 5.9 pounds in the case of those fed in the small houses and yards.

An experiment with 150 birds when they were 4 months old showed that they required 4.9 pounds of grain to produce 1 pound of gain, while birds from the same stock, when they were 6 months old, required 7.4 pounds of grain to produce 1 pound of gain.

An experiment with 68 birds showed that when the porridge was wet with skim milk only 4.3 pounds of grain were required to produce 1 pound of gain, against 5.3 pounds when the porridge was wet with water. Eight pounds of skim milk was used with each pound of grain.

These experiments warrant the following conclusions: (1) As great gains are made just as cheaply and more easily when the chickens are put into small houses and yards as when they are fed in small lots in lattice coops just large enough to hold them. (2) Four weeks is about the limit of profitable feeding, both individually and in flocks. (3) Chickens gain faster while young. Birds that are from 150 to 175 days old have uniformly given comparatively small gains. (4) The practice of successful poultrymen selling chickens at the earliest marketable age is well founded. The spring chicken sold at Thanksgiving time is an expensive product.

The experiments clearly indicate that it is profitable to fatten chickens in cheaply constructed sheds or in large coops with small runs for about four weeks and then send them to market dressed. In quality the well-covered, soft-fleshed chickens are so much superior to the same birds not specially prepared that the former will be sought for at a higher price. The dairy farmer is particularly well prepared to carry on this work, as he has the skim milk which these experiments show to be of so great importance in obtaining cheap rapid growth and superior quality of flesh.

FEEDING THE LAYING PULLETS.

The feed of all adult birds, whether pullets or not, consists of two essential parts: (a) the whole or cracked grains scattered in the litter, and (b) the mixture of dry ground grains which has come to be generally known as a dry mash. These two component parts of the ration and the methods of feeding them will be considered separately. In addition to the grains and dry mash, oyster shell, dry cracked bone, grit, and charcoal are kept in slatted troughs, and are accessible at all times. Plenty of clean water is furnished. About 5 pounds of clover hay cut into 1-2-inch lengths is fed daily to each 100 birds in the breeding pens during the breeding season. When the wheat, oats, and cracked corn are given, the birds are always ready and anxious for them, and they scratch in the litter for the very last kernel before going to the trough where an abundance of feed is in store.

It is very evident that the hens like the broken and whole grains better than the mixture of the fine, dry materials; yet they by no means dislike the latter, for they help themselves to it, a mouthful or two at a time, whenever they seem to need it, and never go to bed with empty crops, so far as noted. They apparently do not like it well enough to gorge themselves with it, and sit down, loaf, get overfat, and lay soft-shelled eggs, as is so commonly the case with Plymouth Rocks when they are given warm morning mashes in troughs.

Some of the advantages of this method of feeding are that the mash is put in the hoppers at any convenient time, only guarding against an exhaustion of the supply, and the entire avoidance of the mobbing that always occurs at trough feeding when that is made a meal of the day, whether it be at morning or evening. There are no tailings to be gathered up or wasted, as is common when a full meal of mash is given at night. The labor is very much less, enabling a person to care for more birds than when the regular evening meal is given.

Taking first the dry grains, the following may be said in regard to the method in which they are fed: Early in the morning for each 100 hens 4 quarts of whole or cracked corn is scattered on the litter, which is 6 to 8 inches deep on the floor. This is not mixed into the litter, for the straw is dry and light, and enough of the grain is hidden so the birds commence scratching for it almost immediately. At 10 o'clock they are fed in the same way 2 quarts of wheat and 2 quarts of oats. This is all of the regular feeding that is done.

When corn is used freely and made a prominent factor in the ration it has been thought best to have the kernels broken, so that in hunting and scratching for the small pieces the birds might get the exercise needed to keep themselves in health and vigor. It was reasoned that even a small quantity of whole corn could be readily seen and picked up from the straw litter with little exertion, and that the vices of luxury and idleness would follow. In order to test this view an experiment was carried out at the Station in the winter of 1906-7 in which whole corn was substituted for cracked corn in the ration of 500 laying pullets. A control lot of 500 received cracked corn. All other conditions affecting the two lots were kept as nearly identical as possible. The result of the experiment was that there was no appreciable difference in regard to either egg production, health, or general well-being between the two flocks of birds.

The litter which the Station now uses for its houses in preference to all others which have been tried, consists of a mixture of dry pine shavings and straw. The shavings can be obtained in this part of the country from box mills in bales, which are sold at a price of from 5 to 10 cents per bale. These shavings are spread on the floor of the pen to a depth of some 5 to 7 inches. From 6 to 8 bales will cover the floor of a pen which accommodates from 100 to 125 birds. On top of these shavings is spread a thin layer of straw. Straw which has not been baled is preferred because it is less liable to be broken and will consequently wear longer in the pen. This combination of straw and shavings gives excellent satisfaction as a litter. The straw serves the purpose of protecting the shavings so that they last a longer time than would otherwise be the case before they are finally worked up into a mass of fine material which packs down and becomes damp. The shavings became damp much less quickly than does a litter of straw alone. This is because they are finer, and the birds can keep them worked over much more thoroughly. This constantly exposes and dries out new portions of the mass of litter. Using this combination of shavings and straw it is not usually found necessary to change the litter in the pens oftener than once in three months.

It is in regard to the dry mash portion of the ration in which the changes already referred to have been made. The dry mash which was *formerly used* at the Station had the following composition:

	Pounds.
Wheat bran	200
Corn meal	100
Daisy flour (or other low-grade flour)	100
Gluten meal or brewers' grains	100
Linseed meal	100
Beef scrap	100

The experience of the Station with this mash extending as it has over a number of years has indicated that it was somewhat too rich. The relatively large amount of such concentrated feeds as linseed meal and gluten meal seemed to make too rich a ration for the well-being of the fowls. During the years when this mash was fed more or less difficulty was always experienced with liver troubles in the birds. Birds died with all the symptoms that would be expected to come from indigestion arising from feeding too rich food.

In planning the new dry mash ration consideration was given to the physiological conditions under which the birds developed and under which they were placed in the laying houses. It is evident that the bringing of the birds in from the range upon which they have grown from little chickens, into the laying houses, is apt to be a very violent and abrupt transition. It has seemed in studying the birds in the fall of the year that this change was an important time in the life of the bird, and that the results during the subsequent winter with reference to egg production depended much upon the way the transition from range conditions to the laying house was made. It seemed advisable both on general grounds and from observation of the birds themselves to make this change as gradual as possible. With this idea in mind the pullets have been brought into the houses from the range much earlier during the past few years than was the custom before. It is the custom at the present time to bring in the pullets from the range as soon as possible after the first of September.

When the pullets are brought in as early as this it is not, of course, advisable to shut them up entirely in the houses at once. On the contrary, the work is planned in such a way that there is always a freshly seeded yard full of green grass for the birds to run in after they are brought into the house until cold weather sets in in the fall. In other words, the birds are brought from free range into a condition of restricted range, but with better pasturage on the restricted than on free range. The yards are freshly seeded and have not been trampled down or burned and dried out by the sun, as is the grass on the open range from which the birds are taken. In this way the attempt is made to have the transition from open range conditions to house conditions as gradual as possible. After about two months, or occasionally even a little longer of restricted range, the birds are finally shut up in the curtain front house for the winter season.

Further in accordance with this idea of gradual change it is thought wise not to put the pullets which are brought in from the free range conditions abruptly on to the heavy, forced-laying mash which it seems to be necessary for them to have during the winter months if they are to do their best in the way of egg production. It has been said that a hen will not lay her best unless she is on full feeding. This is quite true, but it is probably equally true that a great deal of harm can be done to a pullet in regard to her future egg production by abruptly bringing her from free range conditions into restricted yards or to entire confinement in the house and putting her on a heavy, rich laying mash like the one which was formerly fed at this Station. On the contrary, it seems reasonable to bring the birds more gradually on to this rich ration. It is in accordance with this idea that the dry mash feed which is now used at the Station has been planned. The formulas and method of feeding this new dry mash are given below. It will be noted that the mash is made richer in successive months. These formulas are planned on the assumption that the pullets will be brought into the winter laying quarters sometime during the month of September.

Composition of Dry Mash Fed to Laying Pullets.

First month in laying house (September):—

Bran	300 lbs.
Corn meal	100 lbs.
Daisy flour (or other low-grade flour)	100 lbs.
Meat scrap	100 lbs.

Second month in laying house (October):—

Bran	200 lbs.
Corn meal	100 lbs.
Daisy flour, or other low-grade flour	100 lbs.
Gluten meal	100 lbs.
Meat scrap	100 lbs.

Third month in the laying house (November):—

The mash has the same composition as that of the second month given above *with the addition of 50 pounds of linseed meal.*

Fourth month in the laying house:—

The mash has the same composition as that of the second month given above.

Fifth month in the laying house:—

The mash has the same composition as that of the third month as given above.

From this time on 50 pounds of linseed meal are put into the mash as given for the second month above every alternate month. That is to say, one month linseed meal is fed and the next month it is not.

This dry mash made as described above is kept before the birds all the time in open hoppers of the type described farther on.

The advantages which it is believed have resulted from this method of feeding the laying pullets are two fold: first, in the good effect on the vitality of the birds, and, second, in its effect on the evenness of egg production during the winter months. It is a fact well known to poultrymen that if pullets are too rapidly forced for egg production in the early fall there is a marked tendency for them to moult during the winter at just the time when they should be doing their best work in egg production. Since adopting the method of feeding the pullets described above, not only have the birds been much freer of digestive troubles and diseases involving the liver, but also there has been no moulting in the early winter after a short spurt of egg production in the fall months. On the contrary the egg production on this plan begins in September and October and gradually and steadily increases through the winter months. During the past two years while this method of feeding has been used, there has been hardly a pullet in winter moult, whereas on the old system of feeding such birds were common every year.

FEEDING THE HENS, COCKERELS AND COCKS KEPT OVER THE WINTER FOR BREEDING PURPOSES.

Observations made in connection with the work of this Station, as well as a study of the literature which exists upon the subject, have led to the opinion that in order to get the best results in respect to the fertility and hatching quality of eggs it is not desirable to feed birds which are to be used as breeders the heavy laying ration which is used to force egg production during the winter months in pullets. The feeding of such rich food has a tendency, it is believed, to reduce or impair the fertility and hatching quality of the eggs. Therefore, a plan of feeding birds kept to be used as breeders has been devised with the idea of getting over this difficulty so far as possible. This method of feeding is used for old hens, cockerels and cock birds which are kept from one season to another for breeding. The aim is to keep these birds on as light a ration as is consistent with the maintenance of good condition until just before the beginning of the breeding season when they are to be used and then to put them on a more stimulating and richer ration. The scratch food given to this breeding stock is the same as that given to the pullets, namely, corn for the first morning feed and a mixture of wheat and oats for the second feed of the day, both scattered in the litter. If, however, there is any tendency for the yearling hens kept as breeders to get unduly fat during the winter corn is not fed as a litter grain. The hens, under such circumstances, are simply given the mixture of wheat and oats at both feedings.

The dry mash used for these birds kept as breeders has the following composition:—

Bran	400 lbs.
Corn meal	50 lbs.
Daisy flour, or other low-grade flour	50 lbs.
Meat scrap	100 lbs.

Birds kept over from one season to another are managed in the following way. The birds completing their pullet year which are to be kept as breeders are continued on the usual pullet ration until after they have finished their moult in the early fall, usually in September or early October with the birds here. Immediately after the moult is over and the hens are well feathered out they are put on the dry mash ration given above. They are fed in the way described until the beginning of their second breeding season. At this Station the breeding pens are usually mated up about the first of February. During the breeding season all birds, both hens and pullets are fed the following mash:

Wheat bran	200 lbs.
Corn meal	100 lbs.
Daisy flour	100 lbs.
Gluten feed	100 lbs.

It will be noted that this contains no meat scrap or other animal food. The experience of the Station indicates that by reducing animal food to a minimum or dropping it altogether it is possible to improve markedly the hatching qualities of the eggs. Besides the dry mash the breeders are fed wheat, corn and oats in the same way as the laying pullets. Further they are given an abundance of green food, always including green sprouted oats.

THE PREPARATION OF GREEN SPROUTED OATS.

Green sprouted oats have been very widely exploited in recent years as a green food for poultry. There are some so-called "poultry" systems on the market which really consist of very little else than the use of this food. The first experiments with this material at the Maine Agricultural Experiment Station were not satisfactory. It was found difficult to get the oats to make a sufficiently quick growth. Experience here has indicated that in order to make a satisfactory green food the oats must be grown very quickly. In order to get quick growth it is necessary to have three things:—first, warmth; second, plenty of moisture; and third, sunlight. After a number of experiments to get the right combination of these three factors the plan to be described was finally worked out and has proved very satisfactory.

There is in connection with the poultry plant a hot water heating system which has a 3-inch out-go pipe. This out-go pipe as it leaves the heater passes along the rear wall of a small room which was formerly used as a grain storage room. To provide a place in which to sprout oats the back part of this room was partitioned off as a closet inclosing the 3-inch hot water pipe. The partition wall which forms the front of this closet consists of glass doors, made from regular storm window sash, hinged so as to swing open as an ordinary door does. These glass doors face towards the south side of the building which has a window directly in front of the doors. Throughout the day the closet gets plenty of light. The dimensions of this sprouting closet are as follows:—

Length	9 ft. 3 inches
Depth	2 ft. 6 inches
Height	6 ft.

The place of shelves in this closet is taken by large, square green-house flats made of 7-8-inch stuff. These flats have the following dimensions:—

Length	2 ft. 5 inches	(inside)
Breadth	2 ft. 5 inches	(inside)
Depth	2 inches	(inside)

The length of the closet is such as just to accommodate three tiers of these flats, which slide on supports so that they can be moved in or out or turned around to suit the convenience of the operator, and the needs of the sprouting grain. These flats set 15 inches apart (i. e., vertically). There can be accommodated four rows of flats, three in a row, in the closet at one time. A number of holes are bored in the bottom of each one of the flats in order to drain off the surface moisture which comes with the wetting of the oats.

The arrangement of the sprouting closet and the flats is shown in Figs. 9 and 10.

The advantage of the closet arrangement described is that it enables one to control the three necessary factors of heat, moisture and light, quite completely. In this closet it is easily possible to maintain a temperature which does not run at any time below 70 degrees. The closet being perfectly tight it is possible to saturate the air with moisture quite easily and virtually convert the whole space into a great moist chamber. With this arrangement one is able to grow oats from 4 to 6 inches high in one week's time. The only difficulty with which one has to contend is the matter of mould. There is always a tendency for the oats to mould in the sprouting process. The only way in which it has been found possible to control this mould is by thoroughly cleaning the flats after each time when they are used. After a flat has been emptied it is thoroughly scrubbed with a 50 per cent. solution of formalin (that is, equal parts of commercial formalin and water). Enough formalin is used to soak

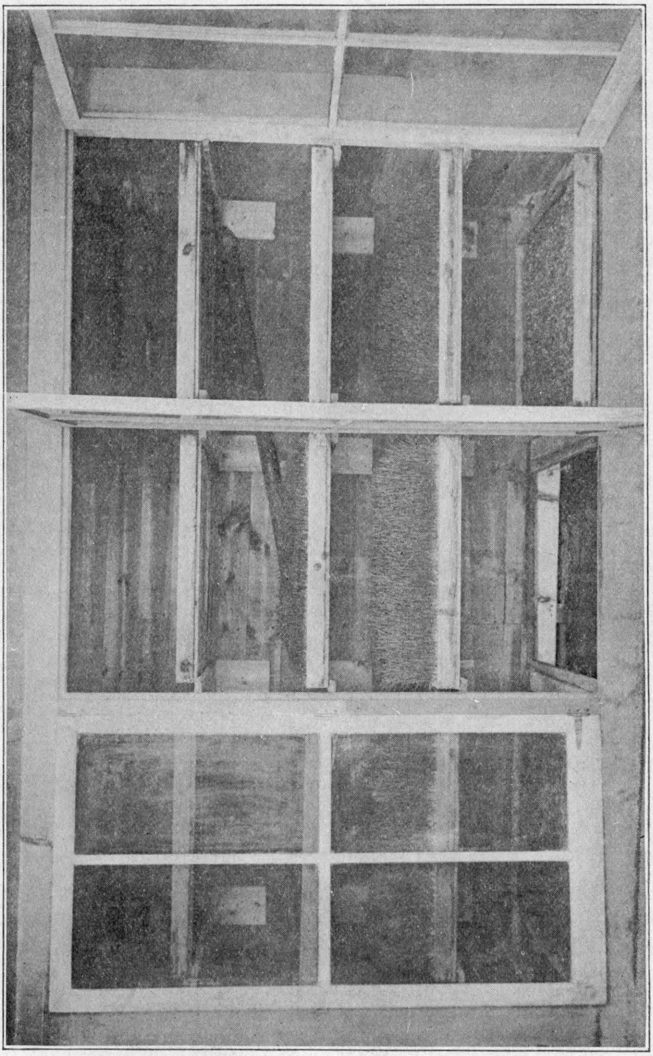
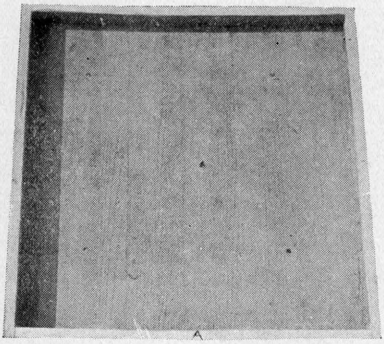
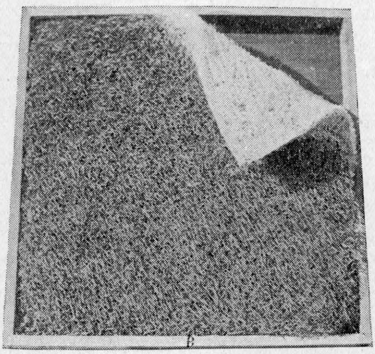


FIG 9. Green Food Grower.

the flat well. With this precaution, and if the oats are further made to grow rapidly, the mould does not give any trouble whatever.



A



B

FIG. 10. A, empty flat. B, oats started to sprout.

The actual method of sprouting the oats is as follows: Clean and sound oats are soaked in water over night in a pail. The next morning flats are filled to the depth of about two inches, and put into the sprouting closet. At the beginning freshly filled flats are placed near the top of the closet so as to get the maximum amount of heat, and in that way get the sprouts started at once. During the first few days, until the sprouts have become from a half to three-quarters of an inch long, the oats are thoroughly stirred and raked over at least two or three times during the day. This stirring insures an even distribution of moisture throughout the mass of oats in the flat. After the sprouts become sufficiently long so that the oats form a matted mass it is not desirable to stir them, or to disturb them in any way. Stirring at that time will break off and injure the sprouts and the green portion above the mass will not grow so well. The matter of prime importance in growing the oats successfully has been found to be sufficient moisture. The tendency at first is to use too little moisture. The oats should be kept quite wet. The aim here is to keep condensed moisture standing on the glass doors which form the front of the closet at all times. In order to do this it is found necessary to wet the oats three times a day. This is done with an ordinary greenhouse sprinkling can, with very little expenditure of time or labor. As the oats grow the flats are moved to different positions in the closet. The taller the green material gets the nearer the flats are moved towards the floor, because the growing grain then needs less heat. This procedure leaves the desirable places in the closet for the grain just beginning to sprout where high temperature is needed.

The oats are fed when they are from 4 to 6 inches in height. They are fed at the rate of a piece of the matted oats and attached green stalks about 6 to 8 inches square for each 100 birds per day. In feeding, this 6 to 8-inch square piece is broken into smaller pieces and scattered over the pen, so to ensure that all the birds shall have an opportunity to get some. Fed at the rate indicated, this material has never caused any bowel trouble among the birds.

It should be clearly understood that the purpose for which green sprouted oats are fed is their tonic and stimulative influence on the digestive organs. They are not fed for the food value of the oats themselves. If one wishes merely to feed oats they can be most economically fed not sprouted. The point of sprouting is to furnish fresh, succulent, *green* food during the winter months.

Housing The Hens.

When work in poultry management was first undertaken at the University of Maine, the hens were kept in small colonies in accord with what was at that time believed to be the best practice. Houses 10 feet square were erected with the idea of accommodating about 15 birds each. Although the houses were well warmed they were apt to be damp and lined with white frost in very cold weather, when the windows had to be kept shut to protect the birds from cold at night. Another disadvantage of this kind of house is its small size. A person can not care for hens in such small pens without getting them into a condition of unrest for fear of being cornered in such a small room. The question of extra labor in caring for hens in these small colonies scattered over quite a large area is an important factor in a commercial plant. When the Maine Station began experiments in 1897 a warmed house 150 feet long by 16 feet wide was erected. This house was burned the next spring, but was replaced by another of the same kind. This warmed house, while constructed after the most approved model of the time, was never a satisfactory house for laying hens. For some years it was used only for the keeping of surplus stock and for carrying cockerels over the winter. Finally it was abandoned entirely in favor of curtain-front houses to be described below.

THE ROOSTING-CLOSET HOUSE.

Fourteen years ago one of the 10-foot square houses described above was taken for a nucleus and an addition made, so that the reconstructed house was 10 feet wide and 25 feet long. The inside end of the old house was taken out, so that there is one room with a floor space of 250 square feet. The walls are about 5 1-2 feet high in the clear inside of the building. The whole of the front wall is not filled in, but a space 3 feet wide and 15 feet long is left just under the plate. This space had a frame covered with white drilling, hinged at the top on the inside, so that it could be let down and buttoned during driving storms and winter nights, but hung up out of the way at all other times. The cloth of the outer curtain was oiled with hot linseed oil. The roost platform extended the whole length of the back of the room. It was 3 feet 4 inches wide and 3 feet above the floor. The back wall and up the roof for 4 feet was lined and the space filled and packed hard with fine hay. The packing also extended part way across the ends of the room.

Two roosts were used, but they did not take the whole length of the platform, a space of 4 feet at one end being reserved for a crate where broody hens could be confined until the desire for sitting was overcome. The space, from the front edge of the platform up to the roof was covered by frame curtains of drilling, similar to the one on the front wall, except that it was not oiled. They were hinged at the top edge and kept turned out of the way during the daytime, but from the commencement of cold weather until spring they were closed down every night after the hens went to roost. The hens were shut in this close roosting closet and kept there during the night, and were released as early in the morning as they could see to scratch for grain which was sprinkled in the 8-inch deep straw on the floor.

This building was used through five winters with 50 hens in it. The birds laid as well as the others in the large warmed house; their combs were red and their plumage bright, and they gave every evidence of perfect health and vigor. While they were on the roosts they were warm. They came down to their breakfasts and spent the day in the open air. Such treatment gives vigor and snap to the human being, and it seems to work equally well with the hen.

This house was given the name of the "pioneer" house.

THE ABANDONMENT OF THE ROOSTING CLOSET.

When the curtain-front house was first devised it was thought essential to provide such a roosting closet as described above to conserve the body heat of the birds during the cold nights when the temperature might go well below zero. Experience has shown, however, that this was a mistake. Actual test shows that the roosting closet is of no advantage, even in such a severe climate as that of Orono. On the contrary the birds certainly thrive better without the roost curtain than with it. It has been a general observation among users of the curtain front type of house that when the roost curtains are used the birds are particularly susceptible to colds. It is not hard to understand why this should be so. The air in a roosting closet when it is opened in the morning is plainly bad. The fact that it is warm in no way offsets physiologically the evils of its lack of oxygen and excess of carbon dioxide, ammoniacal vapors and other exhalations from the bodies of the birds.

For some time past it has been felt that the roosting closet was at least unnecessary, if not in fact a positive evil. Consequently the time of beginning to close the roost curtain in the fall has been each year longer delayed. Finally in the fall of 1910 it was decided not to use these curtains at all during the winter. Consequently they were taken out of the houses, or spiked to the roof as the case might be. The winter of 1910-11 was a severe one. On several occasions the temperature dropped to 30 degrees below zero. Yet during this winter the mortality was exceptionally low and the egg production exceptionally high. The roost curtain will not again be used at this Station.

CURTAIN-FRONT HOUSES.

The result of the use of the "pioneer" house indicated that this was essentially a correct system of treating and housing hens, and it was decided to build several houses on the same plan and join them together under one roof as one house.

A curtain-front house 12 feet wide by 150 feet long, known as house No. 2, was erected in 1903. The back wall is 5 feet 6 inches high from floor to top of plate inside, and the front wall is 6 feet 8 inches high. The roof is of unequal span, the ridge being 4 feet in from the front wall; and the height of the ridge above the floor is 9 feet. The sills are 4 by 6 inches in size and rest on a rough stone wall laid on the surface of the ground. A central sill gives support to the floor. The floor timbers are 2 by 8 inches in size and are placed 2 feet apart; the floor is of two thicknesses of hemlock boards. All the rest of the frame is of 2 by 4 inch stuff. The building is boarded, papered, and shingled on roof and walls. The rear wall and 4 feet of the lower part of the rear roof are ceiled on the inside of the studding and plates, and the space between inner and outer walls is packed very hard with dry sawdust. In order to make the sawdust packing continuous between the wall and roof, the wall ceiling is carried up to within 6 inches of the plate; then follows up inclining pieces of studding to the rafters, the short pieces of studding being nailed to the studs and rafters. By this arrangement there are no slack places around the plate to admit cold air. The end walls are packed in the same way. The house is divided by close-board partitions into seven 20-foot sections;* one 10-foot section is reserved at the lower end for a feed-storage room.

Each of the 20-foot sections has two 12-light outside windows screwed to the front, and the space between the windows (which is 8 feet long) for a distance of 3 feet down from the plate is covered during rough winter storms and cold nights by a light frame covered with 10-ounce duck, oiled and closely tacked on. This door, or curtain, is hinged at the top and swings in and up to the roof when open.

In the front of each section is a door 2 feet 6 inches wide. The roost platform is at the back of each room and extends the whole 20 feet. The platform is 3 feet 6 inches wide and 3 feet above the floor. The roosts are of 2 by 3 inch stuff placed on edge and are 10 inches above the platform. The back one is 11 inches out from the wall, and the space between the two roosts is 16 inches, leaving 15 inches between the front roost and the front of the platform.

Six trap nests are placed at each end of each room. They are put near the front so that the light may be good for reading and recording the numbers on the leg bands of the birds. Several shelves are put on the walls 18 inches above the floor for shell, grit, bone, etc. The doors which open from one room to another throughout the building are frames covered with 10-ounce duck, so as to make them light, and are hung with double-action spring hinges. The advantages of having all doors push from the person passing through are very great; otherwise they would hinder the passage of the attendant with his baskets and pails. Strips of old rubber belting are nailed around the studs which the doors rub against as they swing to, so as just to catch and hold them from being opened by the wind. Tight board partitions are used between the pens instead of wire, so as to prevent drafts. An outside platform 4 feet wide extends along the entire front of the building.

*The house is now used as a breeding house, and temporary partitions divide each of the 20-foot pens into two 10-foot pens.

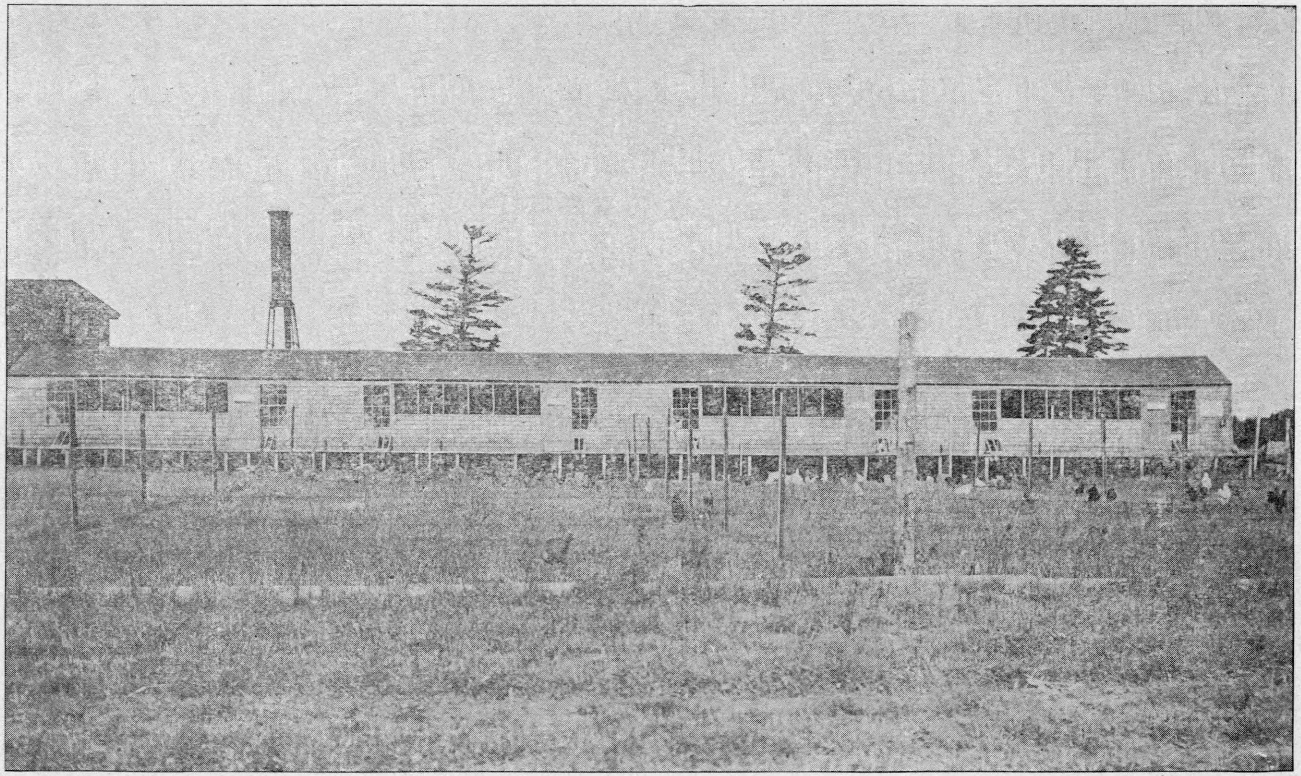


FIG. 11. Curtain-front poultry house No. 3.

This house accommodates 350 hens—50 in each 20-foot section—is well made of good material, and should prove to be durable. A rougher building, with plain instead of trap nests, and with the roof and walls covered with some of the prepared materials instead of shingles, could be built for less money, and would probably furnish as comfortable quarters for the birds.

Curtain front house No. 3 was constructed in 1904. It is 16 ft. wide by 120 ft. long and is of the same style as No. 2 except that it is wider. There are four pens in the building, each 16 ft. wide by 30 ft. long. The pens are arranged to hold from 125 to 150 hens each, depending on the exigences of the experimental work. One hundred and fifty birds per pen do very well in these pens. Unless there is special reason for it, it is usually preferred to put but 125 birds in each pen. The interior of one pen in this house is shown in Fig. 12.

The economy in cost of the wider house over the narrower one like No. 2 described above, when space is considered, is evident. The front and back walls in the narrower house cost about as much per linear foot as those in the wide house and the greatly increased floor space is increased by building in a strip of floor and roof running lengthwise of the building. The walls, doors, and windows remain the same as in the narrow house, except that the front wall is made a little higher. Three six inch square sills run lengthwise of the house. The outer ones rest on rough stone walls high enough from the ground for dogs to go under the building to look after rats and skunks that may be inclined to make their homes there. The stone walls rest on the surface of the ground. The middle longitudinal 5 in. x 6 in. timber rests on cedar posts. The floor timbers are 2 by 6 inch in size and rest wholly on the top of the sills. All wall studs rest on the sills. The front ones are 8 ft. long and the back ones 7 ft. 3 in. long. The two sides of the roof are unequal in width, the ridge being 5 ft. and 4 in. from the front wall. The height of the ridge from the sill to the extreme top is 11 ft. and 2 in. All studding is 2 by 4 in. in size and the rafters are 2 by 5 in. The building is boarded by 1 in. boards and is papered and shingled with good cedar shingles on walls and roof. The floor is two thicknesses of hemlock boards which break joints in the laying and have building paper between.

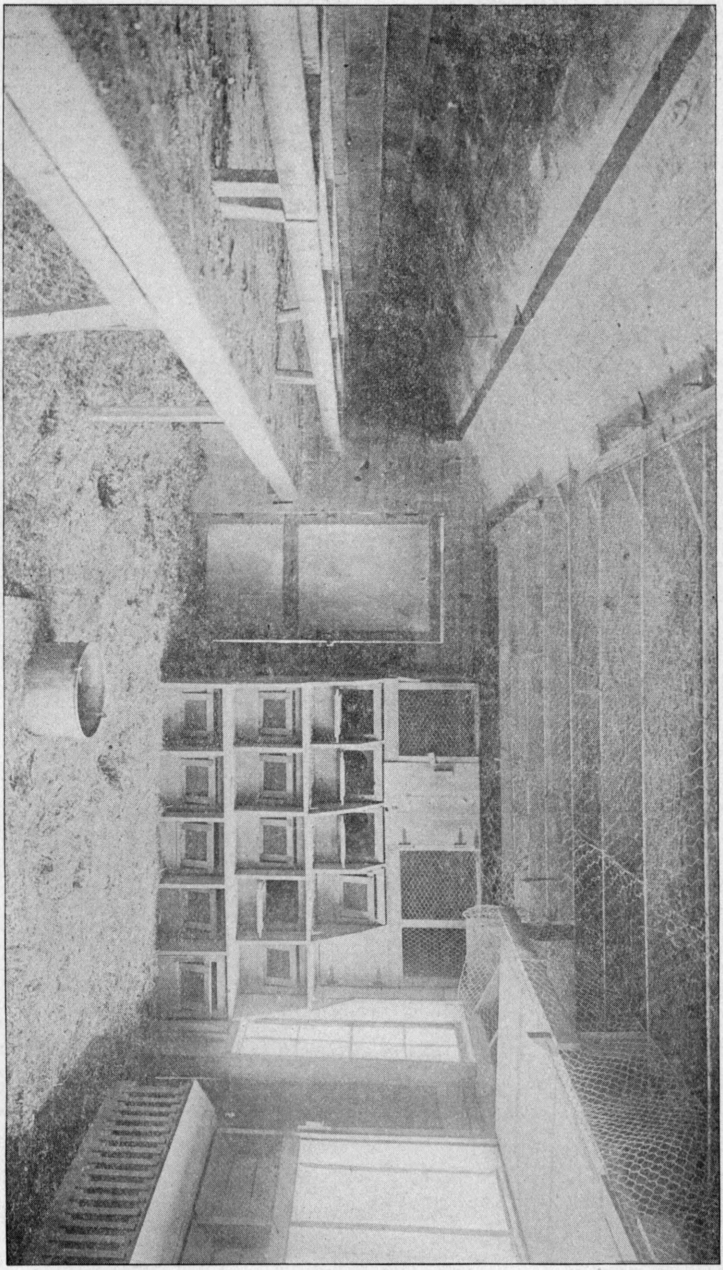


FIG. 12. Interior of curtain front poultry house No. 3.

The building is divided by tight board partitions into four sections, each being 30 ft. long. All of the sections are alike in construction and arrangement. The front side of each section has two storm windows of 12 lights of 10 by 12 in. glass. These windows are screwed on upright and as high up as possible on the front, so that the top of the window just clears the eaves. The opening in the front which is closed by a cloth curtain is 14 ft. and 6 in. long and 3 ft. high. Between one end of this curtain opening and the window is placed a door for the attendants to pass through into the pen. A small door is placed under each of the windows on the front side of the house with a runway through which the birds may pass under the front walk into the yard. A single door in the center of the back wall under the droppings board allows the birds to pass out into the back yard when necessary. A light frame covered with 10 ounce white duck is hinged to the top of the front opening and covers it when closed down. This curtain is easily turned up into the room, where it is caught and held by swinging hooks until released.

The roost platform is made tight and extends along the whole length of the room against the back wall. It is 4 ft. 6 in. wide and 3 ft. above the floor, being high enough for a person to get under comfortably when necessary to handle or catch the birds. There are 3 roosts framed together in two 15 ft. sections. The tops of the roosts are 8 1-2 in. above the platform and hinged to the back wall so that they may be turned up out of the way when the platform is being cleaned. The back roost is 7 in. from the wall and the spaces between the next two are 16 in. They are made of 2 by 3 in. spruce lumber on edge with the upper corner rounded off.

In every pen there is a door placed 5 in. out from edge of the roost platform. Fifteen trapnests are placed in three tiers against the partition in each end of the room. The trapnests are described in a subsequent section of this bulletin.

Troughs similar to those described on page 40 are used for feeding mash, shell, bone, grit, and charcoal.

There is a walk outside of the building which extends along its entire front. It is 4 ft. and 8 in. wide and made of 2 in. planks and is on the level of the floor of the building.

Detailed working drawings and specifications for one section or unit of this curtain front house follow. From these data anyone can figure what the cost of building one of these houses of any desired length at the prices of building material in his locality.

Material needed for one unit of curtain front house:

LUMBER.

(Spruce is specified simply because that is the material actually used in the building described. Any other equally strong lumber may be used. Amounts are given in board feet unless otherwise specified.)

The following estimates do not allow for waste in cutting:

9 cedar posts, 6 feet long, 6-inch butts.
270 feet 2 by 4 inch spruce for studs, door, window, and coop frames.
550 feet 2 by 6 inch plank for floor joists, outside walk, etc.
370 feet 6 by 6 inch spruce for sills.
40 feet 4 by 4 inch spruce for corner studs and wall stringers.
70 feet 2 by 3 inch spruce for roosts, etc.
235 feet 2 by 5 inch spruce for rafters.
115 feet 1 by 7 inch spruce for rafter braces.
33 feet 1 by 9 inch spruce for doors.
10½ feet 1 by 6 inch spruce for door braces.
3200 feet boards for outside, floor, nests, etc.
20 linear feet 2 in. x 2 in. planed to 1 3-4 in. x 1 3-4 in.
12 linear feet 2 in. by 3-4 in. spruce.
65 board feet 1 in. spruce for feed and grit trough.
35 linear feet spruce for curtain frames.
20 laths.
12,000 shingles.
11 feet boards, spruce, for roost frames.

HARDWARE.

4 pr. heavy 6 inch T hinges with screws.
4 pr. light 3 inch T hinges with screws.
2 pr. 3 by 3 inch butts with screws.
60 pr. 2 by 2 inch butts with screws.
40 lbs. 3 penny shingle nails.
100 lbs. 8 penny common nails.
35 lbs. 10 penny common nails.
15 lbs. 20 penny common nails.
2 lbs. 3 penny common nails.
1 lb. 3 inch staples.
2 thumb latches complete with screws.

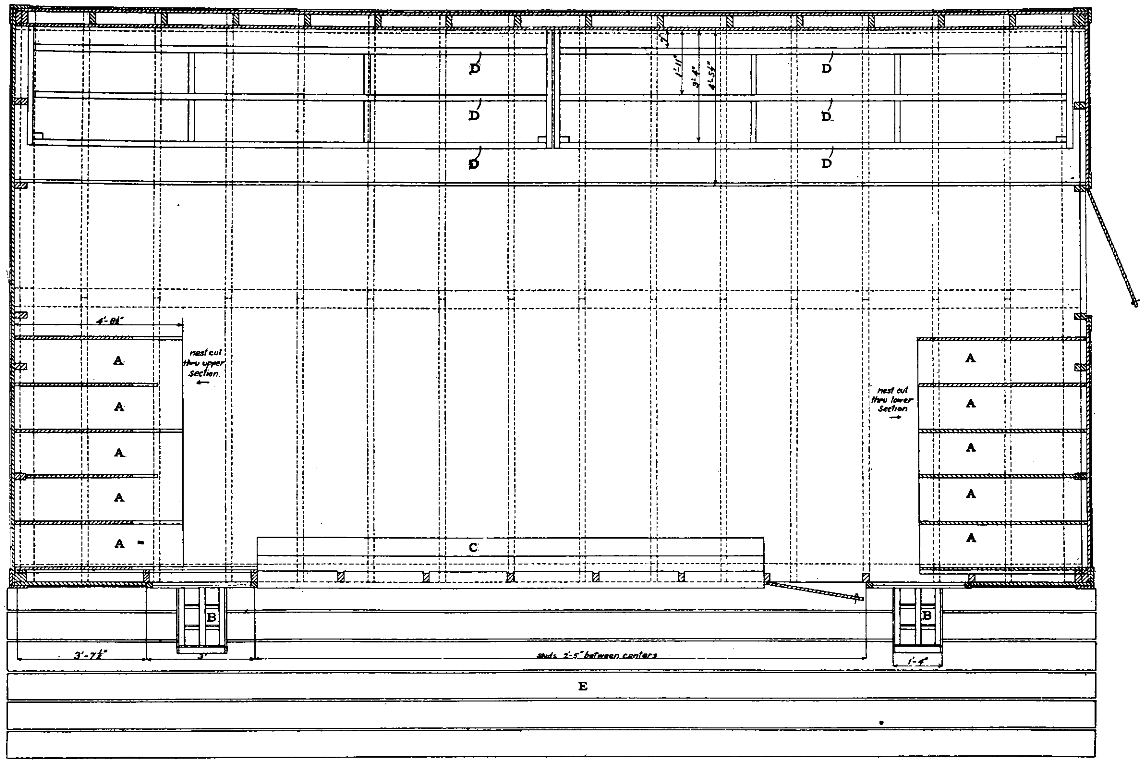


FIG. 13. Floor plan of one unit of No. 3 curtain front poultry house. In this and the following four figures the significance of the letters is as follows: A.—trap nests. B.—runways to yards. C.—dry mash trough. D.—roosts. E.—walk. F.—front opening. G.—coop for broody hen. H.—spike to hang green food on. I.—grit trough. J.—curtain front.

MISCELLANEOUS.

2 storm windows, 12 lights 10 by 12 inch.
6 squares building paper.
10 feet 42 inch poultry netting.
14½ feet 42 inch 10-ounce duck.

ADVANTAGES OF CURTAIN FRONT HOUSES.

The "Pioneer House" was in use for 5 years with 60 pullets in it each year. No. 2 house has been in use 9 years and the No. 3 house 8 years. No. 2 and No. 3 houses have proven entirely satisfactory, especially No. 3. This is the type of house described in the present bulletin which the Station after 8 years experience feels warranted in recommending. Some years ago the experiment was tried of building a house on the same general plan as that of No. 3 but making it 20 ft. wide instead of 16 ft. wide with the pens 20 ft. long. This house was given a trial for a number of years on a private plant in Orono, but from all that can be learned the house was never so satisfactory as the 16 ft. house at the Station, and has finally been abandoned.

Maine is subject to long spells of severe cold weather, with the temperature considerably below zero at night, and about zero during the day, and with a good deal of high wind. During such rough weather the bedding on the floor has kept comparatively dry. The yields of eggs during severe weather and immediately following it are rarely below those immediately preceding it. It should be borne in mind that had the weather been mild all that time the hens probably would have increased in production rather than remained stationary. They are doubtless affected by the severe weather, but not seriously, as they uniformily begin to increase in production very soon after the weather becomes normal for midwinter.

These curtain front houses have all proved eminently satisfactory. The egg yields per bird have been better in these houses than in warmed ones. The purpose of having rooms and flocks of different sizes was to compare the welfare and egg yields of the birds under the different conditions.

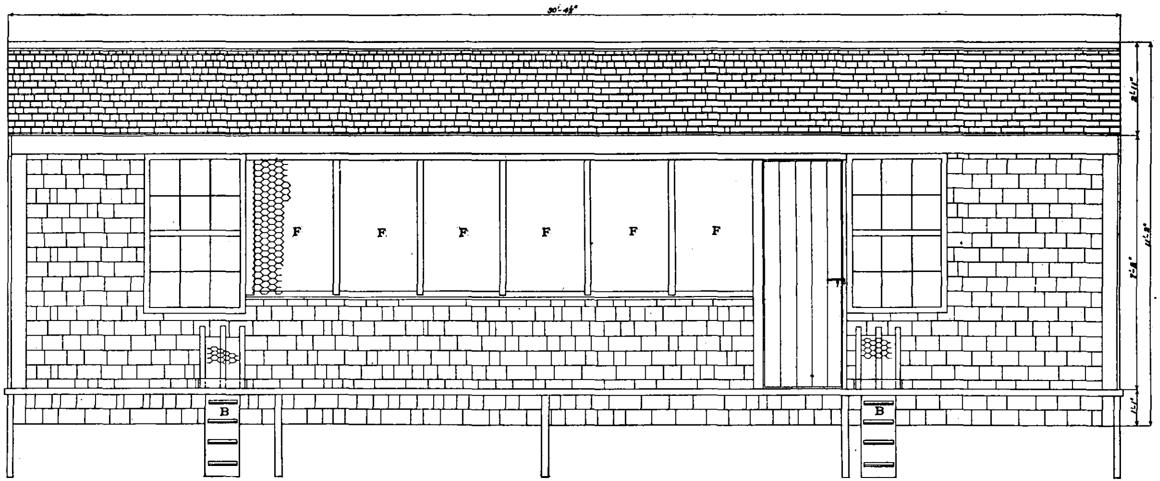


FIG. 14. Front elevation of one unit of No. 3 curtain front poultryhouse. Letters as in Fig. 13.

The Yards.

The yards to most poultry houses are at the south, or on the sheltered sides of the buildings, to afford protection during the late fall and early spring, when cold winds are common. The warmed house had yards on both north and south sides, with convenient gates. This is a highly desirable arrangement since it permits the alternate use of the two sets of runs. In this way trouble from soil contamination may be avoided. The south yards were used until the cold winds were over in spring, when the hens were allowed to go to the north yards, which were well set in grass sod. The birds are kept shut in the curtain front house until the weather is suitable and the ground dried out in the spring. The necessity for getting them out of the open-front house, where they are really subject to most of the out-of-door conditions during the daytime, is not so great as when they are confined in closed houses with walls and glass windows. The clear, open fronts of the curtain-front houses allow teams to pass close to the open doors of the pens for cleaning out worn material and delivering new bedding, and also allow attendants to enter and leave all pens from the outside walk and reach the feed room without passing through intervening pens.

Lice.

One of the most difficult and trying problems which the poultry keeper has to meet is that of keeping his poultry houses and stock reasonably free from lice, mites and other external parasites. There are many proprietary preparations on the market designed to accomplish this end in one way or another. Most of these preparations are, in proportion to their efficiency, very expensive. Many of them have been tried at the Maine Experiment Station. The Station has finally, however, come to follow the procedure outlined in this circular to the exclusion of all others, and with results which are extremely satisfactory. Indeed, it may be said that vermin on the poultry or in the houses no longer cause any appreciable annoyance in the work of the Station plant.

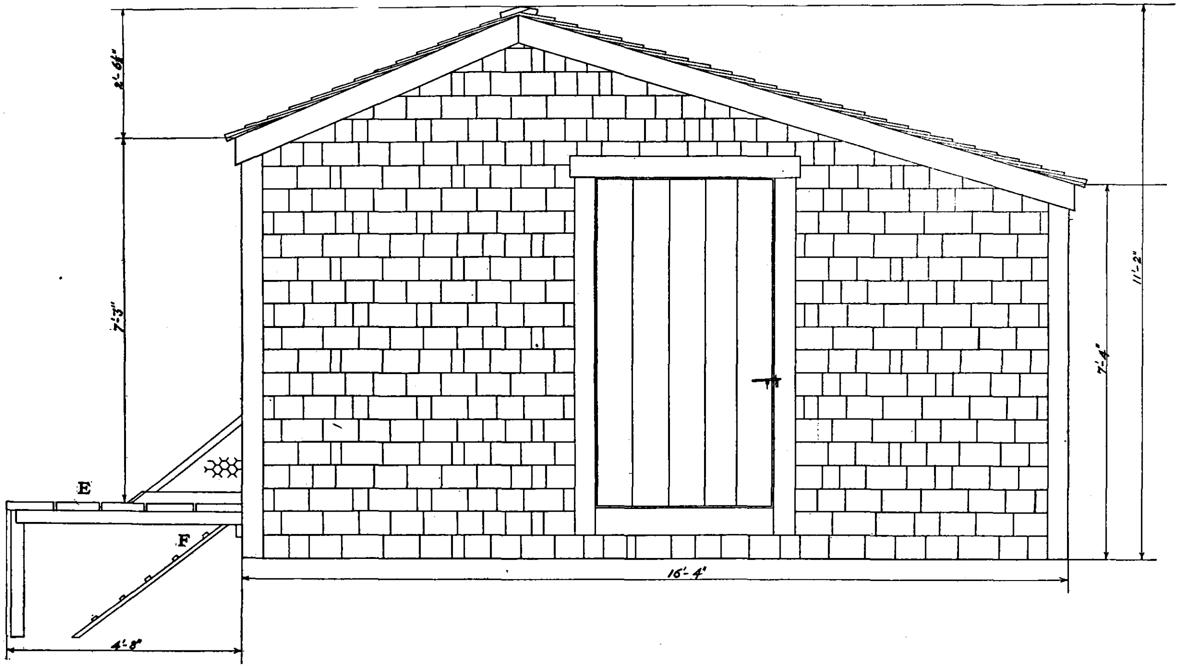


FIG. 15. End elevation of No. 3 curtain front poultry house. Letters as in Fig. 13.

The routine method which the Station uses in handling its stock with reference to the lice problem is as follows:—

All hatching and rearing of chickens is done in incubators and brooders. The growing chickens are never allowed to come into any contact whatever with old hens. Therefore, when the pullets are ready to go into the laying houses in the fall they are free from lice. Sometime in the late summer, usually in August or early in September, the laying houses are given a thorough cleaning. They are first scraped, scoured and washed out with water thrown on the walls and floor with as much pressure as possible from a hose. They are then given two thorough sprayings, with an interval of several days intervening, with a solution of cresol such as is described on page 7. Then the roosting boards, nests, floors and walls to a height of about 5 feet are thoroughly sprayed with the lice paint (kerosene oil and crude carbolic acid). Finally, any yearling, or older birds, whether male or female, which are to be kept over for next year's work are given two or three successive dustings, at intervals of several days to a week between each application, with the lice powder described below, before they are put into the cleaned houses.

As a result of these methods the Station's poultry plant is at all times of the year practically free from lice.

In keeping a poultry plant reasonably free from lice there are two points of attack: One, the birds themselves; the other, the houses, nest boxes, roosting boards, etc. For the birds themselves experience has shown that the best way to get rid of the lice is by the use of a dusting powder to be worked into the feathers. In using any kind of lice powder on poultry it should always be remembered that a single application of powder is not sufficient. When there are lice present on a bird there are always unhatched eggs of lice ("nits") present too. The proper procedure is to follow up a first application of powder with a second at an interval of 4 days to a week. If the birds are badly infested at the beginning it may be necessary to make still a third application. To clean the cracks and crevices of the woodwork of houses and nests of lice and vermin a liquid spray or paint is probably the most desirable form of application.

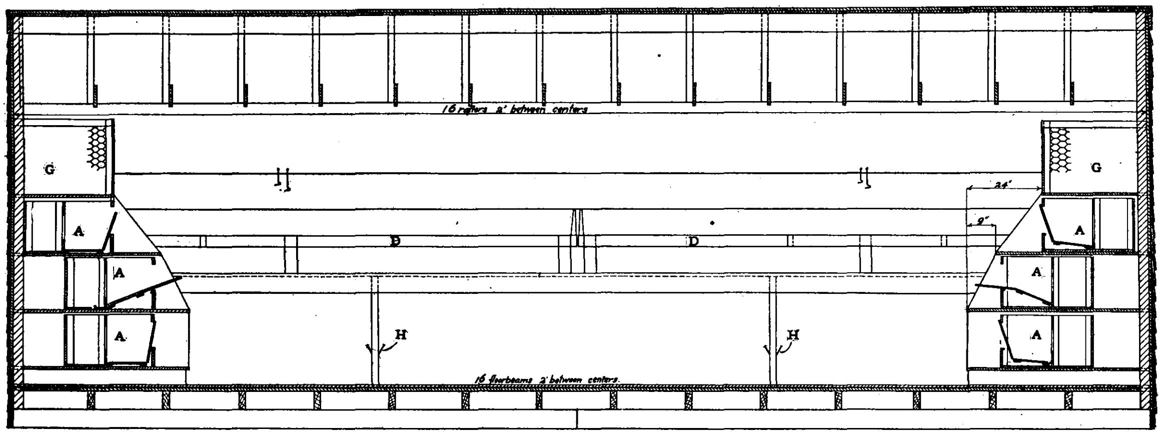


FIG. 16. Longitudinal section of one unit of No. 3 curtain front poul try house. Letters as in Fig. 13.

The most efficient lice powder known to the writer is that invented by Mr. R. C. Lawry, formerly of the Poultry Department of Cornell University. This powder is made by incorporating the liquid mixture of

3 parts of gasoline
1 part of crude carbolic acid

in sufficient plaster of paris to take up all the moisture.

Twe difficulties have arisen regarding the practical utility of the powder as above described. In the first place a great many druggists appear to have a deep-seated and ineradicable prejudice against furnishing their customers *crude* carbolic acid at any price. Reports have reached the Station of druggists making such utterly preposterous and absurd claims as that carbolic acid is a highly explosive substance, which they do not dare to handle! In the second place difficulty has arisen over the fact that there are in the drug trade three grades of crude carbolic acid. Two of these are very much weaker than the other and are quite useless for making the lice powder. The three grades are listed as follows by a reputable chemical house. These are retail prices.

Acid Carbolic, *Crude,*		per gallon 25c.
Acid Carbolic, *Crude*	50-60 per cent.,	per gallon 40c.
Acid Carbolic, *Crude*	90-95 per cent.,	per gallon 50c.

To get the proper results *only the 90-95 per cent. should be used for making lice powder.* The weaker acids are ineffective.

Owing to the difficulty in getting the strong crude carbolic acid locally in this State at reasonable prices, the Station has experimented to see whether some other more readily obtainable substance could not be substituted for it. It has been found that *cresol* gives as good results as the highest grade crude carbolic.

The directions for making the powder are, therefore, modified as follows:

Take *3 parts of gasoline, and*
1 part of crude carbolic acid, 90-95 per cent. strength, or, if the 90-95 per cent. strength crude carbolic acid cannot be obtained take
3 parts of gasoline and
1 part of cresol.

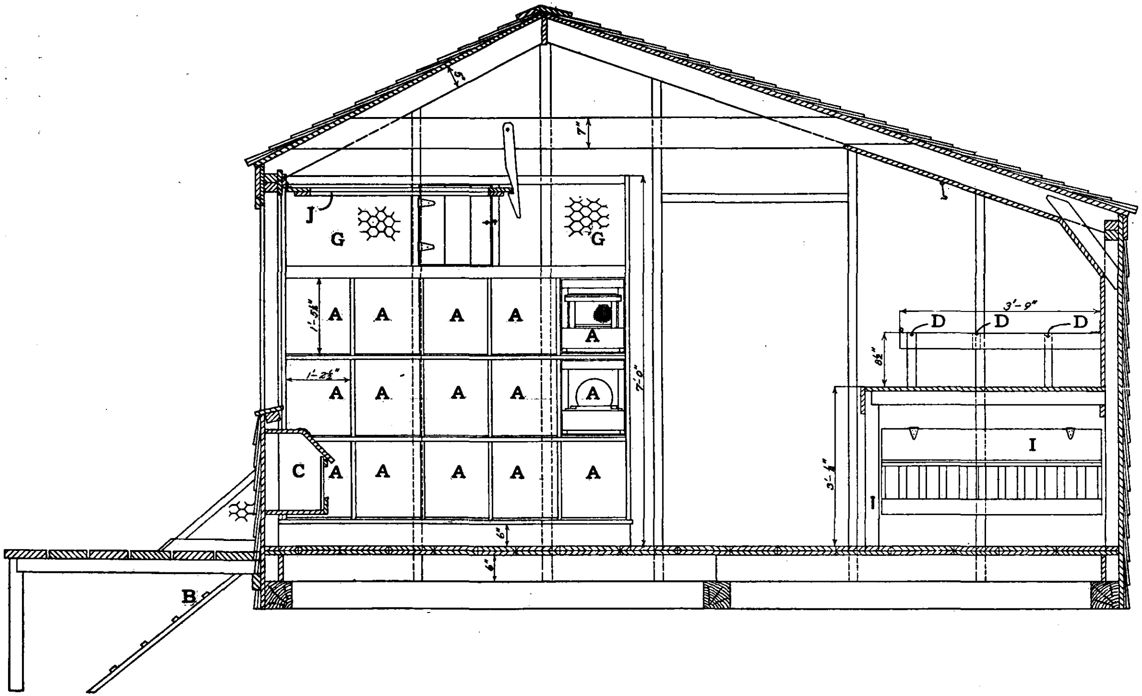


FIG. 17. Cross section of one unit of No. 3 curtain front poultrv house. Letters as in Fig. 13.

Mix these together and add gradually with thorough stirring, enough plaster of paris to take up all the moisture. As a general rule it will take about 4 quarts of plaster of paris to 1 quart of the liquid. The exact amount, however, must be determined by the condition of the powder in each case. The liquid and dry plaster should be thoroughly mixed and stirred so that the liquid will be uniformly distributed through the mass of plaster. When enough plaster has been added the resulting mixture should be a dry, pinkish brown powder having a fairly strong carbolic odor and a rather less pronounced gasoline odor. The powder may be passed repeatedly through a sieve to aid in the mixing.

Do not use more plaster in mixing than is necessary to blot up the liquid. This powder is to be worked into the feathers of the birds affected with vermin. The bulk of the application should be in the fluff around the vent and on the ventral side of the body and in the fluff under the wings. Its efficiency, which is greater than that of any other lice powder known to the writer, can be very easily demonstrated by anyone to his own satisfaction. Take a bird that is covered with lice and apply the powder in the manner just described. After a lapse of about a minute, shake the bird, loosening its feathers with the fingers at the same time, over a clean piece of paper. Dead and dying lice will drop on the paper in great numbers. Anyone who will try this experiment will have no further doubt of the wonderful efficiency and value of this powder.

For a spray or paint to be applied to roosting boards, nest boxes or walls and floor of the hen houses the following preparation is used:—*3 parts of kerosene and 1 part crude carbolic acid, 90-95 per cent. strength.* This is stirred up when used and may be applied with any of the hand spray pumps or with a brush.

If 90-95 per cent. crude carbolic acid cannot be obtained cresol may be substituted for it in this paint.

Trap Nests.

In all the experimental work with laying hens at the Maine Agricultural Experiment Station use is made of trap nests. In 1908 a new type of trap nest was devised which has proved extremely satisfactory. The features in which this nest is superior to the type formerly used at the Station are (1) certainty and precision of operation; (2) greater simplicity of construction, with less tendency to get out of order and work badly; (3) saving of labor in resetting the nest after use.

The nest is a box-like structure, without front, end, or cover, 28 inches long, 13 inches wide, and 16 inches deep, inside measure. A division board with a circular opening 7 1-2 inches in diameter is placed across the box 12 inches from the rear end and 15 inches from the front end. Instead of having the partition between the two parts of the nest made with a circular hole, it is possible to have simply a straight board partition extending up 6 inches from the bottom, as shown in figure 18. The rear section is the nest proper.

The front portion of the nest has no fixed bottom. Instead there is a movable bottom or treadle which is hinged at the back end (fig. 18). To this treadle is hinged the door of the nest. The treadle is made of 1-2-inch pine stuff, with 1 1-2-inch hardwood cleats at each end (figs. 19 and 20) to hold the screws which fasten the hinges. It is 12 inches wide and 12 1-4 inches long. Across its upper face just behind the hinges holding the door is nailed a pine strip 4 inches wide, beveled on both sides, as shown in figures 19 and 20. The door of the nest is not made solid, but is an open frame (figs. 18 and 20), to the inner side of which is fastened (with staples) a rectangular piece of 1-8-inch mesh galvanized screening (dimensions 8 by 9 inches). The sides of the door are strips of 3-4-inch beech stuff 12 inches long and 1 1-2 inches wide, halved at the ends to join to the top and bottom of the door. The top of the door is a strip of hard wood 13 inches long and 1 1-2 inches wide, halved in 2 3-4 inches from each end. The projecting ends of this top strip serve as stops for the door when it closes (fig. 18). The bottom of the door is a hard-wood strip 10 1-4 inches by 4 inches. The side strips are fitted into the ends of this bottom strip in such way as to project slightly (about 1-32 inch) above the front surface of that strip, for a reason which will be apparent.

When the nest is open the door extends horizontally in front, as shown in figure 19. In this position the side strips of the door rest on a strip of beech 1 1-2 inches wide, beveled on the inner corner, which extends across the front of the nest. This beech strip is nailed to the top of a board 4 inches wide, which forms the front of the nest box proper. To the bottom of this is nailed a strip 2 inches wide, into which are set two 4-inch spikes from which the heads have been cut (compare fig. 19). The treadle rests on these spikes when the nest is closed. The hinges used in fastening the treadle and door are narrow 3-inch galvanized butts with brass pins, made to work very easily. It is necessary to use hinges which will not rust.

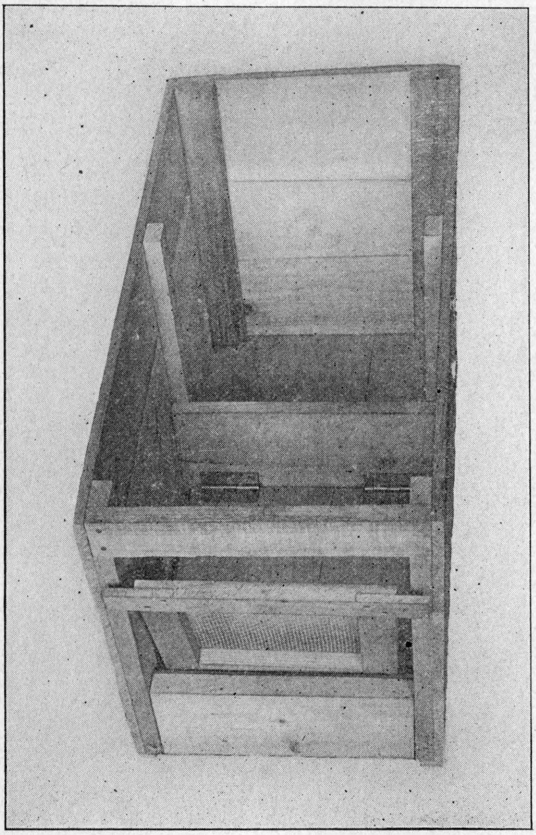


FIG. 18. Trap nest closed. View from above.

The manner in which the nest operates will be cleared from an examination of figures 19 and 20, which show a sample nest with one side removed to show the inside. A hen about to lay steps up on the door and walks in toward the dark back of the nest. When she passes the point where the door is hinged to the treadle her weight on the treadle causes it to drop. This at the same time pulls the door up behind her, as shown in figure 20. It is then impossible for the hen to get out of the nest till the attendant lifts door and treadle and resets it. It will be seen that the nest is extremely simple. It has no locks or triggers to get out of order. Yet by proper balancing of door and treadle it can be so delicately adjusted that a weight of less than half a pound on the treadle will spring the trap. All bearing surfaces are made of beech because of the well-known property of this

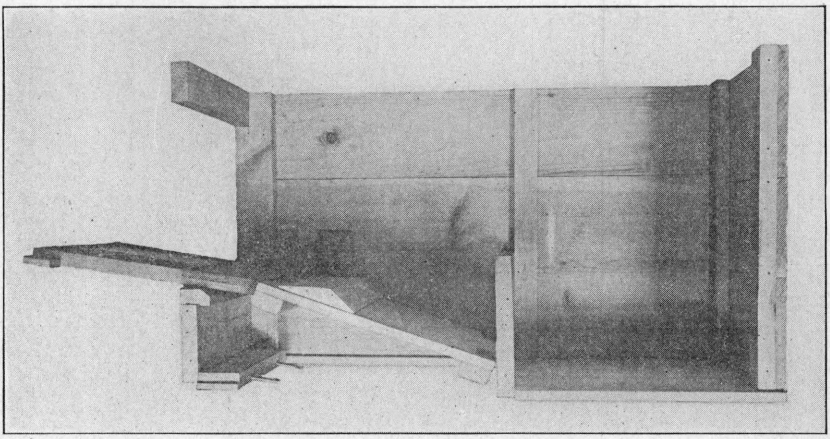


FIG. 19. Trap nest open. One side removed to show method of operation.

wood to take on a highly polished surface with wear. The nests in use at the Maine Station have the doors of hard wood, in order to get greater durability. Where trap nests are constantly in use, flimsy construction is not economical in the long run. For temporary use the nest door could be constructed of soft wood.

The trap nests are not made with covers because they are used in tiers and slide in and out like drawers. They can be carried away for cleaning when necessary. Four nests in a pen accommodate 20 hens by the attendant going through the pens once an hour, or a little oftener, during that part of the day when the hens are busiest. Earlier and later in the day his visits are not so frequent. The hens must all have leg bands in order to identify them; a number of different kinds are on the market. The double box with the nest in the rear is necessary. When a hen has laid an egg and desires to leave the nest, she steps out

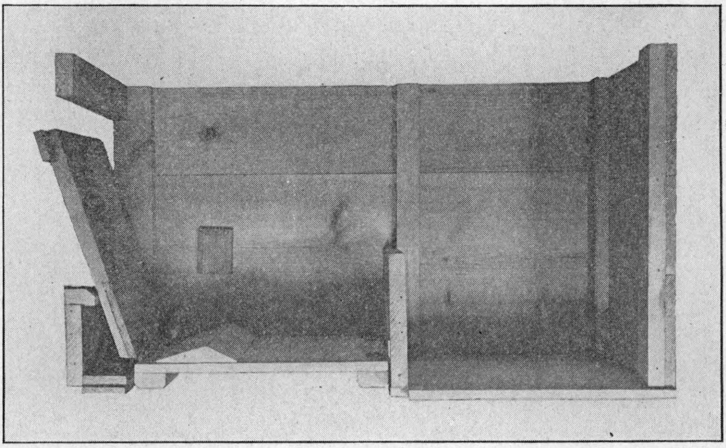


FIG. 20. Trap nest closed. One side removed to show method of operation.

into the front space and remains there until she is released. With only one section she would be likely to crush her egg by stepping upon it, and thus learn the pernicious habit of egg eating.

To remove a hen, the nest is pulled part way out, and as it has no cover she is readily caught, the number on her leg band is noted and the proper entry made on the record sheet. After having been taken off a few times the hens do not object to being handled, most of them remaining quiet, apparently expecting to be picked up.

Before commencing the use of trap nests it was thought that some hens might be irritated by the trapping operation and object to the noise incident to it, but such does not seem to be the case. Trap nests have been used at the Maine Station for Leghorns, Brahmas, Wyandottes, and Plymouth Rocks and a number of other breeds.

The amount of time required in caring for the trap nests can only be estimated, since the attendant's time is divided with other duties. The time varies from one day to another and with the number of nests in use. By noting the total time used each day in caring for the nests when the hens were laying most heavily, it has been estimated that one active person devoting his entire time to trap nests could take care of 400 to 500 nests used by 2,000 to 2,500 hens. When commencing the year's work he would need assistance in banding the birds, but after that was done he could care for the nests without assistance until midsummer, when the egg yield would probably be diminished and a part of his time could be spared for other duties.

485-10-13

MAINE
AGRICULTURAL EXPERIMENT STATION,
ORONO, MAINE.
CHAS. D. WOODS, Director.

SPECIAL REPORT

OF THE

Maine Agricultural Experiment Station

FOR THE

COMMISSIONER OF AGRICULTURE

For the Year 1912

Reprint from the report of the Commissioner of Agriculture for 1912

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

THE STATION STAFF.

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	BLANCHE F. POOLER,	*Clerk and Stenographer*
	GEM M. COOMBS,	*Stenographer*
BIOLOGY	RAYMOND PEARL, PH. D.,	*Biologist*
	MAYNIE R. CURTIS, A. M.,	*Assistant*
	CLARENCE W. BARBER, B. S.,	*Assistant*
	WALTER ANDERSON,	*Poultryman*
	ESTELLA MORRISON,	*Computer*
CHEMISTRY	JAMES M. BARTLETT, M. S.,	*Chemist*
	HERMAN H. HANSON, M. S.,	*Associate*
	ALBERT VERRILL, B. S.,	*Assistant*
	EDWARD E. SAWYER, B. S.	*Assistant*
	HELEN W. AVERILL, B. S.,	*Assistant*
	HARRY C. ALEXANDER,	*Laboratory Assistant*
ENTOMOLOGY	OSKAR A. JOHANNSEN, PH. D.,	*Entomologist*
	EDITH M. PATCH, PH. D.,	*Associate*
	ALICE W. AVERILL,	*Laboratory Assistant*
PLANT PATHOLOGY	WARNER J. MORSE, PH. D.,	*Pathologist*
	CHARLES E. LEWIS, PH. D.,	*Associate*
	VERNON FOLSOM,	*Laboratory Assistant*
HIGHMOOR FARM	WELLINGTON SINCLAIR,	*Superintendent*
	GEORGE A. YEATON,	*Orchardist*
	ROYDEN L. HAMMOND,	*Seed Analyst and Photographer*
	ELMER R. TOBEY, B. S.,	*Inspector*
	EDGAR WHITE,	*Inspector*
	CHARLES S. INMAN,	*Assistant*

THE WORK OF THE MAINE AGRICULTURAL EXPERIMENT STATION IN 1912.

Director Chas. D. Woods.

Introductory to this brief outline of the work of the Maine Agricultural Experiment Station for the year 1912 a few paragraphs covering the purpose for which the Station was established, the limits of the field of its operations and a brief history of its more than a quarter of a century of work seem essential.

Historical Sketch.

The Legislature of 1885 enacted a law establishing the Maine Fertilizer Control and Agricultural Experiment Station. The purpose of the Station as defined in Section 1 of the act was as follows: "That for the purpose of protection from frauds in commercial fertilizers, and from adulterations in foods, feeds and seeds, and for the purpose of promoting agriculture by scientific investigation and experiment, The Maine Fertilizer Control and Agricultural Experiment Station is hereby established in connection with the State College of Agriculture and Mechanic Arts." The act was approved by the Governor March 3, 1885, and early in April the Station was organized with a director, who was also chemist, an assistant chemist, and an assistant in field and feeding experiments.

It depended for its quarters upon the hospitality of the Maine State College. A chemical laboratory for the Station was partitioned off from the College laboratory and supplied with apparatus. Part of the dairy room of the College was fitted up with apparatus for use in experiments involving the handling of milk. A part of the new barn just erected by the College was turned over to the Experiment Station for feeding experiments and was fitted up with stalls, scales, etc. Field experiments were started by laying off about three acres of land into blocks, and box experiments for growing plants were also begun.

While the principal object of the establishment of this Station was the maintenance of a fertilizer control, in the first months of existence lines of investigation were entered upon, many of which have been continuously followed by this Station.

The Maine Fertilizer Control and Agricultural Experiment Station existed about two and a half years and issued twenty-six bulletins and three reports, the former being published only in the leading papers of the State and the latter as a part of the report of the Maine Board of Agriculture. Upon the passage by Congress of what is known as the Hatch Act, establishing agricultural experiment stations in every state, the Legislature of 1887 repealed the law of March 3, 1885, by an act which took effect October 1, 1887. It was expected at the time this act was passed, that by October 1 a station would be in operation under the provisions of the national law. This did not prove to be the case owing to the failure of Congress to appropriate money, and had not the College assumed the risk of advancing the funds to pay the expenses of the Station, work would have ceased on the date in which the old Station law stood repealed. As it was, the work was continued until January, 1888, when the Station force disbanded to await the action of Congress. It was not until after the passage of the deficiency bill early in February, 1888, that the funds became available for the payment of the expenses of the year 1887-1888. Prior to this, the Maine Legislature of 1887 had accepted the provisions of the Hatch Act on the part of the State, and at the meeting of the College Trustees in June, 1887, the present Station was organized as a department of the College by the election of a director and two other members of the staff of officers.

At a meeting of the Trustees, held February 16, 1888, a general plan for carrying out the provisions of the Hatch Act involving the expenditure of $15,000 per annum, was presented to the Board of Trustees and was accepted by them, and the development and management of the Station under this plan was placed in charge of a Station Council, made up of the President of the College, the Director of the Station, the heads of the various departments of the Station, three members of the Trustees and a representative from each of the state agricultural organizations.

The Station Council meets once a year. At this meeting, the Director and other members of the Station staff outline the work which has been undertaken in the past year and make recommendations for the following year. Such of these as commend themselves to the Station Council as well as suggestions from that body are approved and the Director is instructed to carry them out in detail. The appointment of members of the staff is made by the Trustees, and the recommendations of the Council are subject to their approval.

The Director is the executive officer of the Station and passes upon all matters of business. The members of the staff have charge of the lines of work which naturally come under their departments.

Income of the Station.

For the year which ended June 30, 1912, the income of the Station in round figures was:—Hatch Fund, \$15,000; Adams Fund, \$15,000; U. S. Department of Agriculture for poultry investigations, \$1,000; State printing, \$5,000; Inspections, \$1,700; Sales, \$8,800. All of the receipts and expenditures are audited by the State Auditor and those from the Federal Government by the Office of Experiment Stations of the U. S. Department of Agriculture.

Relation of the Station to the University of Maine.

The Station is by act of legislature a department of the University of Maine and in the organization of the University is co-ordinate with the different colleges. The function of the colleges is to teach. It is by the Act of Congress establishing the Station, "The object and duty of said experiment stations to conduct original researches or verify experiments .... bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective States or Territories." None of the funds received by the Station can lawfully be used for teaching, for demonstration, for exhibition purposes or for any purpose whatever outside of research into agricultural problems, and carrying out the provisions of the laws regulating commerce of which the Director is the executor.

Organization of the Station.

While the work for which the Experiment Station was primarily established is that of investigation it has been found much more convenient for the State, because of the Station laboratory facilities, to make the Director of the Station the executive officer of the laws regulating the sale of agricultural seeds, commercial feeding stuffs, commercial fertilizers, drugs, foods, fungicides and insecticides, as well as calibrating the creamery glassware used in the State. It is necessary to have the work of investigation and that of inspection distinctly organized in order that the funds for these two distinct purposes may be lawfully expended. From necessity the Director and the office force must divide their time between these two divisions of Station work. But outside of this there is no overlapping of the duties of the staff. Those who are engaged upon the work of investigation devote their whole time to the carrying out of the various scientific projects that bear upon the solving of the problems that confront Maine Agriculture. The remainder of the staff devote their whole time to the work of inspection.

Dissemination of Information.

It is not the function of the Station to disseminate general agriculture or other information. That is for the College through its extension department. It is, however, the distinct duty of the Station to publish the results of its investigations. Although the correspondence that bears upon general agriculture is referred so far as practicable to the correspondence department of the University the Station receives and answers many thousand letters each year.

The Station publishes: (a) Bulletins which contain the results of investigation; (b) Official Inspections which give the results of the work of inspection; (c) Miscellaneous publications; and (d) a series of publicity letters that are issued Fridays of each week and sent to a limited number of papers to be released for publication on the following Wednesday. The bulletins, the official inspection and the chief miscellaneous publications are bound together at the close of the year and make up the Annual Report of the Station. During 1912 there were issued 11 bulletins containing about 475 pages; 10 Official Inspections containing about 200 pages; 20 miscellaneous publications and 52 Publicity Letters.

The following are the principal publications although there were numerous circulars not here listed as well as more pretentious papers that were printed in scientific periodicals, both American and foreign.

List of Principal Publications in 1912.

Work of Investigation (Bulletins)

198 Orchard Spraying Experiments
199 Orchard Notes
200 Fungus Gnats Part IV
201 Sweet Spirit of Nitrous Ether
202 Aphid Pests of Maine, Psyllid Notes
203 Elm Leaf Curl and Woolly Apple Aphid
204 Triplet Calves
205 Inheritance of Fecundity in Poultry
206 Histology of Oviduct of Hen
207 Insect Notes for 1912
208 Meteorology, Finances and Index

Work of Inspection (Official Inspections)

36 Seed Inspection
37 Carbonated Beverages. Ice Cream
38 Feeding Stuff Inspection
39 Miscellaneous Foods
40 Sundry Drugs
41 Jams, Sausage, Vanilla
42 Fertilizer Inspection
43 Clams, Oysters, Scallops
44 Creameries
45 Soda Water, Ice Cream, and Cream

All publications are distributed free to residents of Maine. The demand for the Station bulletins outside of the State has made such inroads upon the printing fund that a price is put upon them to non-residents with the exception of exchanges, scientific investigators and libraries.

Equipment of the Station.

The Station is well equipped in laboratories and apparatus, particularly in the lines of chemistry, entomology, horticulture, pomology, plant pathology and poultry investigations. Its poultry plant is probably the most complete for the purposes of investigation of that of any Experiment Station in the country. While the Station carries on some coöperative work such as orcharding, and field experiments with farmers in different parts of the State, most of the work is conducted in its own laboratories and poultry plant at Orono, and upon Highmoor Farm, situated in the town of Monmouth.

Its offices and laboratories are chiefly located in Holmes Hall (named in honor of Dr. Ezekiel Holmes, the first Secretary of the Board of Agriculture) on the University of Maine campus, Orono. It is a two story brick building, 81 x 48 feet. On the ground floor are five large chemical laboratories used for the analysis of foods, feeding stuffs, drugs, fertilizers, fungicides and insecticides; the laboratories of the plant pathologists; and two of the biological laboratories. The general office and mailing room, the Director's office, the laboratory for seed testing and photography, the entomological laboratories and the library, are on the second floor. In the basement there is a chemical laboratory; rooms for the grinding and preparation of samples; culture and preparation rooms used by the plant pathologists and rooms for the storage of chemicals and glassware. The large attic is also used for the storage of samples and supplies. The building is connected with the steam heating plant of the University; is supplied with gas and electricity; and is thoroughly equipped with apparatus for the work of agricultural investigation. The library consists of about 3000 volumes, chiefly agricultural and biological journals and publications of the various experiment stations. Holmes Hall is situated near the University Library and card catalogues of books in the University Library that are likely to be used by the Station workers are also in the Station Library.

The poultry plant is also situated on the University of Maine campus and includes two long houses built on the curtain front plan. It is possible in these houses to carry over the winter from 800 to 1000 laying hens. One of these long poultry houses is used for pedigree breeding work during the breeding season in the spring. In this house it is possible to carry from 200 to 300 breeding hens in such condition that the exact pedigrees of their offspring may be recorded. The entire portion of the poultry plant devoted to laying hens is equipped with an improved form of trap nest which makes it possible to obtain exact records of the egg production of each individual bird. Besides these two laying houses the poultry plant has a house 35 x 16 feet which is divided into three compartments used for hospital purposes in connection with the experimental work of the department and for special physiological investigations with poultry. The incubator house and brooder houses include ample facilities for the annual hatching and rearing of about 4000 pedigreed chickens during the breeding season from April 1 to June 1. There is also a well equipped laboratory on the poultry range that is chiefly used and especially equipped for physiological work. It includes three rooms arranged in a linear series. The outer one of these rooms is devoted to general laboratory purposes and the conducting of post-mortem examinations on poultry. The two inner rooms are devoted to experimental physiological work. The first of these rooms is the sterilizing room and is equipped with the usual instruments and facilities for the sterilization of instruments, etc., including steam and hot air sterilizers. The last room in the series in this laboratory is the experimenting room. The rooms are so constructed as to be practically dust proof, and the walls and ceilings are entirely covered with white enamel which makes it possible to thoroughly sterilize the rooms.

HIGHMOOR FARM.

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

The farm consists of 225 acres, about 200 of which are in orchards, fields and pastures. There are in the neighborhood of

3000 apple trees upon the place which have been set from 15 to 25 years. The fields that are not in orchards are well adapted to experiments with corn, potatoes, and similar general farm crops. The house is two story with a large wing, and contains about 15 rooms, well arranged for the Experiment Station offices and for the home of the farm superintendent. The barn is large, affording storage for hay and grain. The basements of the building afford a moderate amount of storage for apples, potatoes and roots.

Although the farm is used as a laboratory by the different departments of the Station and some of the work in progress upon the farm is described in other parts of this report it may be of interest to briefly note the more important investigations that were carried on upon the farm during the growing season for 1912.

Field Experiments Highmoor Farm.

Rotation Experiment.

The object of this experiment is to ascertain the differences in yields and in the exhaustive effects of corn and potatoes in relation to land treated with chemical fertilizers and with organic manure. The whole field was planted to potatoes on chemical fertilizer in 1911. It is to be seeded to grass with oats in 1913.

Plot 5 A. One acre Irish Cobbler potatoes (planted 3½ inches deep), with 1700 pounds of 4-8-7 chemical fertilizer.

Plot 5 B. One acre sweet corn (planted 18 inches in the row), with 1700 pounds 4-8-7 chemical fertilizer.

Plot 5 C. One acre sweet corn (planted 18 inches in the row), with 600 pounds 4-8-6 chemical fertilizer plus 8 cords manure.

Plot 5 D. One acre Irish Cobbler potatoes (planted 3½ inches deep), with 600 pounds of 4-8-7 chemical fertilizer plus 8 cords manure.

Cyanamide Fertilizer Experiment.

This is in continuation of an experiment started in 1911 to test the efficiency of a chemically prepared nitrogen supplying fertilizer, known as cyanamide, with the other forms of nitrogen fertilizers now in common use.

Three plots of one acre each, planted to Irish Cobbler potatoes, 3½ inches deep, treated uniformly in respect to phosphoric acid and potash. Nitrogen fertilizers as follows:—

Plot 15 A. 190 pounds nitrate of soda plus 425 pounds dried blood per acre.

Plot 15 B. 385 pounds cyanamide plus 190 pounds nitrate of soda per acre.

Plot 15 C. 580 pounds cyanamide per acre.

POTATO CULTURAL EXPERIMENT.

This is a continuation of the experiment started in 1910, comparing the results of planting at different depths with different cultural methods. Three plots of land are planted to Irish Cobbler potatoes, treated with 1700 pounds of 4-8-7 chemical fertilizer (1000 pounds in the hill, 700 pounds worked in) per acre.

Plot 19 A. Planted 2 inches deep. To be highly ridged.

Plot 19 B. Planted 5 inches deep. To receive level culture.

Plot 19 C. Planted 3½ inches deep. To have a low ridge.

"MINERAL FERTILIZER" EXPERIMENT.

A comparative test of the New Mineral Fertilizer with barnyard manure and with complete chemical fertilizer, on corn and potatoes was made in 1911. It was planned to repeat it in 1912. The results of 1911 seem to be conclusive that this material is of no value on this land. The experiment is cancelled.

TOP DRESSING ON GRASS.

The third year of an experiment comparing acid phosphate and Thomas slag as a source of phosphoric acid. Plots 16 A and 16 C each receive 112 pounds of muriate of potash and 100 pounds of nitrate of soda. Plot 16 A has in addition 600 pounds of high grade soluble acid phosphate. Plot 16 C has 600 pounds of Thomas phosphate powder. Plot 16 B received no top dressing of any kind.

EXPERIMENTS WITH THE APPLE.

EXPERIMENTAL NURSERY.

About an acre has been reserved for growing of young apple trees to be used later in experimental plots. There are two thousand one-year-old French Crab seedlings for budding or grafting, and about one thousand grafts of Tolman Sweet cions, root grafted on French Crab, for experimental work.

FERTILIZER EXPERIMENT ON APPLE TREES.

Thirty-two Baldwin trees have been divided into three sections. Ten at each end have been treated with 4-8-7 chemical fertilizer at the rate of 1000 pounds per acre plus nitrate of soda at the rate of 100 pounds per acre. The 12 trees in the middle of the row have received the 4-8-7 chemical fertilizer at the rate of 1000 pounds per acre.

The Baldwin orchard has also been divided into two parts for a fertilizer test. Rows 1 to 26 inclusive (beginning at the north end of the orchard) have received the 4-8-7 fertilizer at the rate of 1000 pounds per acre plus nitrate of soda at the rate of 100 pounds per acre. The remainder of the orchard has received the 4-8-7 formula at the rate of 1000 pounds per acre.

An experiment to compare the effect of fertilizer over a series of years is begun this year. The orchard has been cultivated and fertilized for three years and has been brought into good condition. All the lots will be cultivated and everything (other than apples) that grows upon the land will be plowed in each spring.

9 A. Rows 1 to 4 will receive no fertilizer.

9 B. Rows 5 to 8 will receive annually 500 pounds per acre of a 5-8-7 commercial fertilizer.

9 C. Rows 9 to 12 will receive annually 1000 pounds per acre of a 5-8-7 commercial fertilizer.

It is planned to begin in 1913 a similar experiment with more mature trees which will also be carried through a series of years.

For the past three years this plot has been used for testing swine and sheep in orchard management. A few missing trees have been replaced. This year the plot is treated with 1000 pounds commercial fertilizer (4-8-7 goods) and is kept in clean cultivation in order that the trees may be in good vigor when the fertilizer experiment is begun.

Plant Breeding Experiments.

Sweet Corn.

Experiments with sweet corn were begun at Farmington in 1907. An experiment is being started this year to test the effect on yield and quantity of crossing two highly bred, closely related strains of white sweet corn, in each of which earliness is a fixed characteristic.

Yellow Field (Dent) Corn.

Preliminary experiments with dent corn were conducted at Farmington 3 years ago. This work has since been continued at Highmoor. Plots No. 17, 18 and 18a are planted with a variety of corn originally obtained from Mr. Hiram Cornforth of Waterville. During the past three years the corn has been selected on the ear-to-row system, until finally some highly desirable types have been bred. These are being tested this year in the plots here noted (17, 18, 18a) on a larger scale. A further ear-to-row test is also being carried on on these plots.

Orchard Spraying Experiment.

This is a continuation of last year's work, and is a test of the home made concentrated lime-sulphur spray as a fungicide used at different strengths, with arsenate of lead as the insecticide. Tests of arsenate of lead as a fungicide are also included. One plot of trees is treated with bordeaux mixture for comparison. No trees have this year been left unsprayed for insects, as the desirability of spraying has been fully established.

There are 25 rows in the experiment. The first six trees in each row are treated as follows:

Rows 1 to 3, inclusive, arsenate of lead at the rate of 4 pounds to 50 gallons of water.

Rows 4 to 9, inclusive, home made concentrated lime-sulphur solution, used one-fifth stronger than the strength recommended by the latest dilution tables, with 2 pounds arsenate of lead to 50 gallons of water.

Rows 10 to 15, inclusive, the same lime-sulphur solution used at the dilution recommended, according to its density, plus 2 pounds arsenate of lead to 50 gallons of water.

Rows 16 to 21, inclusive, the same lime-sulphur solution used at a dilution of one-fourth weaker than the strength recommended by the latest dilution tables, plus 2 pounds arsenate of lead to 50 gallons of water.

Rows 22 and 23, arsenate of lead, at the rate of 2 pounds to 50 gallons of water.

Rows 24 and 25, bordeaux mixture of the 3-3-50 formula, plus 2 pounds aresnate of lead to 50 gallons of water.

Orchard Management Experiments.

In 1910 and 1911 two plots were pastured with hogs and sheep in a comparison with the cultivated plots. The results showed so decisively that cultivation is essential on the soil of Highmoor Farm for growing the apple that they are discontinued.

12. Rows 19 to 25, inclusive, beginning with the seventh tree in each row, have been left in grass, to compare with the cultivated and pastured plots.

13 A. Rows 26 to 30, inclusive, throughout their entire length, have been dressed with barnyard manure at the rate of 6 cords per acre, to compare this means of fertilizing with the three preceding plots and with 13 B.

13 B. Rows 31 to 35, inclusive, have been treated with the complete 4-8-7 chemical fertilizer at the rate of 1000 pounds per acre.

All of the plots included have been pruned and sprayed; all excepting 12 are cultivated, and all excepting 13 A have been fertilized with 4-8-7 chemical fertilizer at the rate of 1000 pounds per acre.

These orchard management experiments are to be continued in order to obtain data covering long periods of time.

Oat Selection Experiments.

This year the seed from the individual oat plants, selected from last year's plots because of their excellence in one or more qualities, is planted on the head-row system. 25 grains from each of 225 selected lines are planted in short rows in the oat-breeding garden No. 1. The visitor should note the many different types to be found among these pedigree oat rows. Next year the best of these rows will be used for further propagation. The effect of individual plant selection within a pedigree line is being tested in this oat-garden.

Beans.

This plot contains the continuation of an experiment in breeding yellow-eyed beans, of both the old-fashioned and improved varieties. One bean was planted to a hill. Strains embodying desirable characters are being propagated on a larger scale. Variety tests of unselected seed of standard varieties are also being conducted in connection with the pedigree work.

Variety Test of Oats.

The object of this variety test is two-fold. First, to demonstrate the great differences in the yield and other characters of the different varieties. Second, to serve as a check and basis of comparison in a series of breeding experiments with oats. The variety tests this year are a continuation of those of last year.

There are 22 varieties under test this year. Of these 8 are new (i. e., have never before been tested at Highmoor) and 14 have been in these tests in previous years. Each plot is 1-10 acre in size, and there are 44 of them. Each of the 22 varieties has two-tenth acre plots assigned to it. One of these duplicates is on 4A, and the other is on 4B. The plants are seeded (with a grain drill) at the rate of two bushels to the acre.

The following table shows the names of the varieties and the sources of seed used:

Plot Nos.	Variety Name.	Source of Seed.
167, 168	American Clydesdale	1911 Plot 43
169, 170	Danish Island	1911 " 44
171, 172	Kherson	1911 " 45
173, 174	Irish Victor	1911 " 46
175, 176	Early Champion	1911 " 47
177, 178	Prosperity	1911 " 48
179, 180	Silver Mine	1911 " 49
181, 182	Lincoln	1911 " 50
183, 184	Swedish Select	1911 " 51
185, 186	President	1911 " 52
187, 188	Senator	1911 " 53
189, 190	Victor	1911 " 54
191, 192	Imported Scotch	1911 " 55
193, 194	Banner	1911 " 56
195, 196	White Plume	L. L. Olds Seed Company, Madison, Wis.
197, 198	Rebred 60 Day	L. L. Olds Seed Company, Madison, Wis.
199, 200	Early Pearl	R. L. Copeland, Brewer, Maine.
201, 202	Daubeney	C. R. Gies, St. Jacobs, Ont.
203, 204	Gold Rain	Experimental Farm, Charlottetown, P. E. I.
205, 206	Siberian	Wm. Lewis, Dunsford, Ont.
207, 208	Minnesota, No. 26	Garton-Cooper Co., Chicago, Ill.
209, 210	Abundance	James Ferguson, Dalmeny, Ont.

Pure Line or Pedigree Oats.

In 1910 about 500 of the best single oat plants to be found in the plots of that year were selected. In 1911 the 200 best individuals out of these 500 were planted in rows in the oat garden. This year there have been selected for further propagation the 83 best rows of last year's planting. The seed from each of these rows will be separately planted in two plots, each of which will be just 1-2000 of an acre in area. These "two-thousandth" acre plots will be found in 4B. Each plot represents a "pure line," all the plants on it being descended from a *single head* grown in 1910. Some of these pure lines give great promise of being exceptionally fine oats.

Work of Inspection.

The inspections entrusted to the Maine Agricultural Experiment Station include agricultural seeds, apple packing, commercial feeding stuffs, commercial fertilizers, creamery glass ware, drugs, foods, fungicides, and insecticides. In the course of the year this work leads the deputies to visit practically every town of importance in the State at least once and many of them several times.

The work of inspection comprises much more than the actual collection of the samples. The deputy has constantly to be on the watch for goods which are not registered in the case of fertilizers, feeding stuffs, fungicides and insecticides; labels and tags have to be constantly examined in order to see that the statements thereon are apparently in accord with truth. Weighings are often made in order to see that the net weight actually contained in the package does not fall below the guaranteed weight; and there must be constant watch for old, shop-worn and damaged goods.

The fertilizer inspection must of necessity be carried on almost entirely during the early spring months just before that commodity is used by the farmers. While a large amount of fertilizer comes into the State during the fall and winter and is stored in large warehouses, more and more is being shipped into the State by rail and directly to the points of consumption so that the collection of samples of the various brands becomes more and more difficult and involves a larger expenditure of time and money each year.

The feeding stuffs inspection comes naturally during the fall and winter months when commercial feeding stuffs are most in use. This work also increases year by year as the consumption of commercial cattle feeds increases. The importance of this inspection becomes more and more apparent as the number of compounded feeding stuffs on sale increases. The tendency to use waste and inferior materials, screenings, chaff, oat clippings, hulls, cob meal, and other low grade materials, is ever increasing and the importance of having such compounds marked plainly so that the consumer may know exactly what he is getting is, of course, apparent.

The inspection of agricultural seeds also comes during the spring months just before the seed is placed in the ground. A comparatively few samples of seeds are actually analyzed because the seed analyst himself does the actual work of inspection and no samples are taken unless the appearance of the goods indicates that the guarantees accompanying it may be too high, or for some other reason there is cause for suspicion.

The insecticides and fungicides inspected include all classes of materials which are used to destroy, repel, or mitigate in any way insect and fungus pests. The requirements of the insecticide and fungicide law are more recent than the other inspection laws of the State, but the importance of the work is already evident.

The inspection of foods and drugs goes on constantly throughout the year, and the number of samples collected does not represent in the least either the importance of the work or the scope of the ground covered by the deputies.

The importance of manufacturing, storing and dispensing food materials under sanitary conditions is just being realized by the public. Just how much disease is spread because flies carry with them and deposit upon exposed foods the germs of dangerous diseases, or the dust of the streets containing dangerous disease germs is scattered upon food materials, or the spray from human mouths contaminate food products, can never be ascertained. That diseases are spread by these means, however, is indisputable. In like manner it can never be ascertained of just what value various inspection laws are to the commonwealth, but by comparing the reports of many other states with our own we can feel certain that at the present time the old statement that Maine is the dumping ground for inferior materials can no longer hold true. The character of the various materials offered for sale in the State, which come under the requirements of the various inspection laws, is constantly improving.

The actual work of inspection in the field is accomplished by means of several deputies. The collection of samples of fertilizers, feeding stuffs and seeds is done, as noted above, at certain short definite periods of the year and is usually done by special deputies who search for these particular materials only. The remainder of the inspection work is at the present time done principally by local inspectors appointed to look after some limited locality in which they reside.

By this means the larger towns and cities are at present being constantly inspected and the sanitary conditions of food displays are being constantly improved.

The prosecution feature of the enforcement of these laws is a disagreeable duty. For the most part Maine dealers are and desire to be law abiding. As it is the object of the law to protect the public in the future rather than to impose penalties for the past, cases are only prosecuted as a last resort. It has been found necessary to bring about 125 prosecutions during the year.

CHEMISTRY.

The work of this department, as for the past four years, has been confined almost entirely to inspections and is briefly considered under the following heads: Fertilizer Inspection, Feeding Stuffs Inspection, Food and Drug Inspection, Fungicide and Insecticide Inspection, Paint and Oil Inspection.

FERTILIZER INSPECTION.

About 450 samples of fertilizers and chemicals were analyzed in connection with the fertilizer inspection work. Considerably more work was done this year than usual in determining the quality of the nitrogen in mixed goods by the method adopted by the New England State Stations and New York and New Jersey Stations. This additional work on nitrogen increases the time required to analyze a fertilizer about one-third, but in view of the importance and desirability of having this information the directors of the several stations felt warranted in incurrng this additional expense.

FEEDING STUFFS INSPECTION.

In connection with the feeding stuffs inspection work about 1300 samples of feeds have been examined the past year. The larger part of them were only tested for protein, but owing to a change in the law requiring a guaranty of fiber as well as protein and fat, one complete analysis of each brand of feed sold in the State was made. A large number of the samples examined for nitrogen were sent in by dealers who wished to know if the goods were up to standard before offering them for sale. The official samples, or those taken by the regular Station inspector, were the ones on which complete analyses were made. Complete analyses also were made on 55 samples of oats for the Department of Biology in connection with oat breeding experiments.

FOOD AND DRUG INSPECTION.

In connection with this inspection about 800 samples of foods and drugs have been examined. The work in this line covers a very great variety of materials and varies to some extent with the season. During the summer considerable time is given to examinations of ice creams on the market. During the early fall when preservatives are most likely to be used, oysters and clams were collected in the open markets and tested. It is pleasing to note that not a single instance of a preservative being used was found and only a few instances in the case of oysters was an undue amount of water found to be present—a very great improvement over the condition in which these goods were found a few years ago. A notable improvement has also been noticed in the vinegars and molasses. Canned goods and drugs are examined at any and all times of the year whenever occasion calls for such examination.

FUNGICIDES AND INSECTICIDES.

Owing to the passage of a fungicide and insecticide law the Maine Agricultural Experiment Station collected and turned into the laboratory for analysis 75 different insecticides and fungicides. These have nearly all been examined and the results will soon be reported in a bulletin.

PAINTS AND OILS.

With a view of learning something about the character of the paint and oil materials on the market, about 60 different kinds of materials were bought and examined. These comprise some dry pigments, pigments ground in oil, and several kinds of mixed paints. Also several oils and driers were tested. The results of this work will soon be published and will be of considerable interest to people who use paint.

BIOLOGY.

The Department of Biology is chiefly engaged in the study of plant and animal breeding. The final goal of this work is to find out how the common farm crops and live stock may be improved in quality and productivity by breeding. On the animal side the experimental work is largely with poultry, while on the plant side corn, oats and beans have been the crops chiefly studied.

WORK WITH POULTRY.

During nearly the whole existence of the Maine Agricultural Experiment Station it has carried on work with poultry along one line or another. Two phases of the poultry work of this Station have attracted wide attention, namely its experiments in breeding for increased egg production, on the one hand, and in poultry management on the other hand. In recent years an increasing amount of attention has been paid to the former line of work. This is warranted by the great practical importance to agriculture of the subject of breeding for performance in general. Not only will a working out of the fundamental principles upon which successful breeding for egg production depends be useful and valuable to the poultryman, but also to the breeder of any kind of live stock who is seeking to improve utility qualities. Poultry probably furnishes more favorable material for working out the laws of inheritance and breeding than any other of the domestic animals.

Breeding for Egg Production.

The work in breeding for increased egg production is now drawing to a close. During the past year the essential features of the mechanism by which egg production is inherited have been finally worked out. These final results have been published during the present year in Bulletin 205, thus completing an investigation which has engaged the attention of the Station for over 14 years.

The essential facts which have been brought out in this study are the following:

1. The record of egg production of a hen, taken by and of itself alone, gives no definite, reliable indication from which the probable egg production of her daughters may be predicted. Furthermore mass selection on the basis of the fecundity records of females alone, even though long continued and stringent in character,. failed completely to produce any steady change in type in the direction of selection.

2. Egg production must be inherited, however, since (a) there are widely distinct and permanent (under ordinary breeding) differences in respect of degree of fecundity between different standard breeds of fowls commonly kept by poultrymen,

and (b) a study of pedigree records of poultry at once discovers pedigree lines (in some measure inbred of course) in each of which a definite, particular degree of fecundity constantly reappears generation after generation, the 'line' thus 'breeding true' in this particular.

3. A careful experimental analysis of the inheritance of fecundity in both pure bred and cross-bred fowls has demonstrated the following unexpected and practically important facts, viz.:

High egg productiveness may be inherited by daughters from their sire, independent of the dam. This is proved by the numerous cases presented in the detailed evidence where the same proportion of daughters of high fecundity are produced by the same sire, whether he is mated with dams of low or of high fecundity.

High productiveness is not inherited by daughters from their dam. This is proved by a number of distinct and independent lines of evidence, of which the most important are: (a) continued selection of highly fecund dams does not alter in any way the mean egg production of the daughters; (b) the proportion of highly fecund daughters is the same whether the dam is of high or of low fecundity, provided both are mated to the same male; (c) the daughters of a fecund dam may show either high fecundity or low fecundity, depending upon their sire; (d) the proportion of daughters of *low* fecundity is the same whether the dam is of high or of low fecundity provided both are mated to the same male.

A low degree of fecundity may be inherited by the daughters from either sire or dam or both.

These results receive their best interpretation through the application of Mendel's law of inheritance. A detailed discussion of the matter will be found in Bulletin 205. They make possible a definite system of breeding for high production, in which success is assured if the guiding principles are carefully followed. The most notable practical feature of the work is to demonstrate the very great importance of the male bird in breeding for increased production. The goal of the practical breeder must be to get a strain of birds in which the males carry the hereditary factor for high productiveness in pure form.

How Many Eggs Can a Hen Lay?

In connection with the studies on breeding for egg production an anatomical study has been made of the potentialities of hens in regard to production. The eggs which a hen can by any possibility lay are limited by the number she carries in her body in the ovary or egg cluster. How many of these primitive eggs does an ordinary hen have? The following table shows the results of some counts which have been made in this department of the primitive egg *visible to the naked eye,* in various individuals.

Bird No.	BREED.	Total Number of Eggs Laid in Life.	Actual Winter Production.	Total Visible Primitive Eggs on the Ovary.
8021	Barred Ply. Rock	10	3	1,228
8017	Barred Ply. Rock	10	0	1,666
8030	Barred Ply. Rock	7	0	914
8005	Barred Ply. Rock	17	5	1,174
1367	Barred Ply. Rock	34	3	2,306
8018	Barred Ply. Rock	16	0	1,194
8009	Barred Ply. Rock	15	0	2,101
8010	Barred Ply. Rock	19	5	1,576
425	Barred Ply. Rock	23	0	1,521
3546	White Leghorn	198	54	2,452
2067	White Leghorn	197	32	3,605
3453	White Leghorn	10	0	1,701
3833	White Leghorn	2	0	2,145
52	Cornish Ind. Game	52	13	1,550
71	F1 Cross	124	106	2,000
	Guinea hen	–	–	765
	Guinea hen	–	–	586

It is evident that the potentialities in respect to production far outrun the actually realized laying. Laying is a physiological matter rather than an anatomical. All hens, whether good or poor layers, have a vast lot more eggs available for laying than they ever actually lay.

The Function of the Comb and Wattles of Poultry.

Curiosity is often expressed by the poultry man as to the practical utility to the bird, or to himself as a poultryman, of the comb and wattles of fowls. The following brief discussion of the subject was prepared for the purpose of answering such inquiries.

The comb and wattles of poultry are what are known to the biologist as secondary sexual characters. According to Darwin's theory of sexual selection the original purpose and function of these structures was to make the male conspicuous and attractive to the female. It is supposed on this theory that those males which had the largest comb and wattles would be most attractive to the females and would, therefore, stand a better chance of mating and perpetuating themselves in the offspring. Like many other secondary sexual characters the comb and wattles while present in both sexes are very much better developed in one sex than in the other. It is doubtful whether the sexual selection theory really accounts for the presence of large comb and wattles in the male. It is more in line with modern biological opinion to suppose that these organs are merely one representative of the surplus of growth energy and physiological vigor which characterizes the male as compared with the female. It is doubtful, in other words, whether they have any selective value.

It is quite certain that neither the combs nor wattles serve any useful physiological function. That is to say, a bird from which these structures has been removed is quite as healthy and lives as long and is fully as able to perform all its vital functions as a bird which possesses them. They are in some degree, however, and in a manner which is not yet fully understood, connected or correlated with the primary sexual organs (that is, the testes in the male and ovary in the female). Further proof of this has recently been furnished by the work of an English biologist who shows that throughout the life of a hen every period of laying is preceded by an enlargement of the comb. This enlargement is due to an actual growth of tissue in the comb substance. The enlargement in many cases is not marked and can only be detected by very accurate measurements.

The fact that the comb and wattles diminish in size and become pale in color during periods of physiological depression such as molt or in various diseases finds its physiological explanation in the considerations which have been advanced above. These organs being in the nature of non-essential excrescences or ornaments, with a very considerable blood supply when the bird is in health and vigor, it stands to reason that when that vigor is diminished for one reason or another, the supply of blood and nutriment to the tissues of these organs will be diminished in order that it may be diverted to other more vital parts. The reduction of the comb in size and color during periods of depression is physiologically comparable with the fact that a person when ill is usually pale. This means that the supply of blood to the skin is smaller than in condition of full health and vigor.

A large comb does not necessarily indicate strong constitution. In the first place it must be recognized that comb size in part depends upon the breed. The most vigorous specimens of some breeds have by nature and inheritance relatively small combs as compared with other birds. While it is practically always true that a bird with a comb relatively small in proportion to the size normal for its breed is a weak and worthless bird, the converse is not always true. That is to say, some weak, poor specimens will have large combs. The size and condition of the comb should be taken as only one indication along with a whole series of others in judging the constitutional vigor of a bird. Simply selecting large-combed birds regardless of everything else would not result in a strong vigorous strain.

Poultry Management.

At all times efforts are being made to improve the methods of management of poultry on the Station plant. During the past year a new concrete shed for the storage and proper conservation of poultry manure has been built on the plant. A full description of this with directions for the care and use of this valuable fertilizing material will be issued as a bulletin during the coming year.

Green Food for Poultry.

During recent years an increasing amount of attention has been paid by poultrymen everywhere to the furnishing of green food to their fowls during the winter months, when it is imposible in northern parts of the country, at least, for the birds to get fresh succulent pasturage out of doors. It has been the universal experience that an addition of green succulent food to the ration of laying hens tends to keep them in better physical condition and helps towards a better egg production, with consequently increased profits to the poultryman. On the poultry plant of the Maine Agricultural Experiment Station considerable attention has been given to this matter of supplying green and succulent food to poultry, and as a result of experience extending now over a number of years a very satisfactory scheme of supplying this necessary part of the ration has been worked out.

It is, of course, obvious that if it is to be satisfactory not only must the green food given to poultry be of the proper kind to give good results in egg production, but also it must be something which can be produced and handled at small cost. Furthermore a factor which is frequently lost sight of here is that fowls need something besides succulence in their so-called "green food." There is a distinction between a succulent fodder and a "green food" in the strict sense. One can supply succulence in the form of root crops like mangolds or other similar crops. A careful examination of the situaton, however, indicates that probably the fundamental need of the fowls is not for succulence as such, but rather for the tonic effect which is produced by green plants. The green color of plants is due to the presence of cholorophyll, a chemical compound which is very rich in iron. In feeding fowls for high egg production it is necessary that they be given a ration rich in protein. Only birds of very strong constitution and with thoroughly sound digestive systems can continuously handle for a long period the heavy laying rations carrying meat scrap and oil meal, which are now so widely used by poultrymen, with successful results for egg production. On these heavy rations there is always a tendency for the bird's liver first to become impaired in function and ultimately to become enlarged and diseased. As the matter has been studied at the Maine Agricultural Experiment Station it would appear that one of the chief, if not indeed the most important functions of green food in the ration is to counteract this tendency of the digestive system, and especially the liver, to break down under the strain of assimilating heavy laying rations over a long period of time. It would appear that the green food given to poultry acts primarily as a mild tonic rather than as a food in the proper sense. There is very little of this tonic effect produced from succulent non-green foods like mangolds. For this dependence must be placed primarily upon cholorophyll bearing plants.

The practical problem then becomes to find a satisfactory and economical system whereby a supply of green food may be kept at hand for the birds at all seasons of the year when wanted. The following system of rotation in the green stuff supply has been in use for several years on the poultry plant of the Maine Agricultural Experiment Station with entirely satisfactory results. It should be said that, owng to the small area of ground available for the poultry work at the Station in relation to the number of birds it is necessary to carry, green food must be added to the ration practically throughout the year, not only for the adult fowls in the laying houses, but also for the chicks growing on the range. The number of birds reared is so great in proportion to the area which can be devoted to them that the natural pasturage is very quickly exhausted.

Beginning with the time in the fall of the year when the pullets are put into the laying house they are given green corn fodder chopped fine in a feed cutter. This is fed stalks, leaves and ears (if there are any) all together. The pieces are cut from a quarter to a half inch in length by the feed cutter used. This green corn fodder is one of the most satisfactory sources of green food for poultry which the Maine Agricultural Experiment Station has ever been able to discover. The birds eat it ravenously and in large quantities. It may be safely fed in larger amounts than any other green food yet tried. After the corn has been killed by frost so as no longer to be available the birds are given cabbage and mangolds fed with the tops on. These plants serve until well into the winter (December or January).. Then the oat sprouter is started and green sprouted oats serve as the chief source of green food until well on into the spring (April or May). The green oats are supplemented with mangolds or with clover hay cut in short lengths with the feed cutter and steamed. In case clover hay is not available cut alfalfa is sometimes substituted for this. As soon as possible in the spring fresh green clover is cut from the range and fed to the birds in the houses. To the young chicks in the brooders, however, the best source of green food which has yet been found is green sprouted oats. To these little chicks only the tops are fed and these are cut fine. In the regular crop rotation system carried out on the range green corn, Dwarf Essex rape, mangolds and cabbages are planted each spring.

The green corn, Dwarf Essex rape and the thinnings from the mangolds are used during the summer to feed both the adult birds in the houses and the growing chickens on the range after the natural pasturage has become exhausted. Dwarf Essex rape is an excellent source of green food for poultry but it must be fed with great caution to birds which are laying, because if eaten in any considerable amounts it may color the yolks of the eggs green with disastrous results in the market.

Following such a system as is outlined above it is possible to have throughout the year a continuance of green fodder well calculated to keep the birds in the best of physical condition and at the maximum of productivity.

Natural Enemies of Poultry.

One of the difficulties that the poultryman has to contend with is the continued loss of chicks, and sometimes even of nearly or quite full grown birds, as a consequence of the depredations of natural enemies. It is safe to say that the magnitude of the loss from these sources is not anything like fully realized by anyone who has not kept an accurate account of all his birds. In the experimental breeding work with poultry at the Maine Agricultural Experiment Station it is necessary to keep account of every single bird on the plant. It has, therefore, on this account been possible to check up and form an adequate estimate of the losses due to the creatures that prey upon poultry. A good deal of attention has been devoted to the problem of how these losses may be cut down and the results of this experience may be of benefit to other poultry keepers in this State.

In the experience of the Maine Agricultural Experiment Station the most destructive natural enemy of poultry, in the long run, has been found to be the crow. The depredations of hawks are more spectacular perhaps but on the whole far less destructive. A hawk will only visit a poultry yard occasionally, and especially if he is shot at once or twice will be very wary about approaching it again. On the contrary the crow is a steady and persistent robber. He will continue his depredations just as long as it is physically possible for him to do so. While there may be some doubt as to whether crows are beneficial or harmful as regards other phases of agriculture, there can be no question that, so far as the poultryman is concerned, the only good crow is a dead one. For a number of years the crows killed and either carried away, or left behind partly eaten, a large number of chicks on the Maine Agricultural Experiment Station poultry plant. The losses were not by any means confined to the small chicks, but half grown birds, nearly if not quite equal in weight to the crow itself, were killed and partly eaten and left behind on the range. In a single year the crows destroyed something over 500 chicks. One after another all the devices which had been suggested by others or could be devised by those in charge of the poultry work, were tried in order to stop these ravages. Various sorts of scarecrows were put up but with no effect whatever. Dead crows were hung up on stakes about the yard as solemn warnings to their fellows, but instead of operating as warnings they appeared rather to serve as "invitations to the dance." Decoying the birds in various ways, so that they might be shot, was tried but with very slight success, and no substantial effect on the steady losses. Poisoning, which is reported to have been used with success in other places, has never been tried on the Maine Agricultural Experiment Station plant and it is very doubtful whether it is ever justifiable, save under very exceptionable circumstances. The point is that it is difficult to manage a poisoning campaign in such way as to insure that the crows and only the crows will get the poison. There are so many useful and valuable animals about the farm, which might very easily get the poison before the crows did, with resulting losses greater than those caused by the crows, that it would seem wise to resort to poisoning only when it can be done under well controlled conditions.

The plan which has finally been adopted on the Maine Agricultural Experiment Station poultry plant for dealing with crows is one which is perfectly safe and sure in its operation. It consists simply in running strands of binder twine about two feet apart over the whole of the poultry range occupied by the young birds. These strings are left in place until the chicks attain such size that they are able to take care of themselves. These strings are run over the tops of the brooder houses and on supports made by running cross strands 20 to 30 feet apart of either wire or of five or six strands of binder twine twisted together. These cross strands are held up where necessary by posts. The whole network of strings thus formed is put at such height that the attendants in working about the yard will not hit them when standing upright. The area covered in with strings in this way on the Station poultry plant is usually about 3 acres per year. The expense of covering this area is from $15 to $20 for twine. The labor of putting it up is comparatively small. It forms a perfect and complete protection against both crows and hawks.

Next in importance to the predaceous birds as poultry enemies stand the rats and the foxes. In times past foxes have destroyed many chickens from the Station's poultry plant. Of late years, however, none has been lost. The protection is afforded by a fox proof fence surrounding the whole plant. Rats may become a very pest. They live under the brooder houses and take the young chicks. Various methods have been tried at the Station, but no wholly satisfactory way of dealing with rats has yet been found. Trial has been made of one of the most widely advertised of the bacterial rat destroyers, which when fed to rats is supposed to induce a disease which kills them all. No effect whatever was observed to follow the use of this preparation. The rats ate freely of grain which had been moistened with it and if any disease developed as a consequence it has not yet manifested itself, and the trial was made some three years ago. Digging the rats out of their holes and shooting them is on the whole about as effectual a method of dealing with them as the Station has yet found. Several good cats on the place also aid materially in fighting this pest. If someone will discover an effective, non-poisonous rat repellant or destroyer he will confer a great boon on all mankind, and especially on the poultryman.

Work with Dairy Cattle.

Proposed Plan for a Comprehensive Investigation of the Inheritance of Milk Production in Dairy Cattle, with Special Reference to Breeding for Improved Production.

There has never been carried through anywhere in the world any systematic or comprehensive scientific investigation of the laws of the inheritance of the function of milk production in dairy cattle. Whatever progress has been made up to this time in breeding for this quality has been built largely on an empirical basis. There is no body of well-grounded scientific principles to guide a person at the present time in building up a high producing dairy herd or improving what he already has in such a way that the improvement shall be definite and permanent. The need for investigation which shall lead to the accumulation of knowledge of the principles referred to has been keenly felt for sometime past by the dairymen in the State. The dairy industry in Maine is just now in a critical condition. The increased prices of feed without anything like a corresponding increase in the price of milk and other dairy products has materially reduced the profits of the business. For several years past the Maine Dairymen's Association has had a Committee empowered to discover ways and means if possible whereby the Maine Agricultural Experiment Station might undertake a comprehensive investigation along the lines indicated. Furthermore, this matter has been taken up by the Experiment Station Council and efforts have been made by that body to secure funds for this purpose. It is felt that the experience which the Station has gained in its long continued experiments on breeding for increased egg production in poultry would be of very material advantage in undertaking work on the problem of breeding for dairy production. The amount of work, however, under way at the Station uses up all the funds which it has available and it is therefore not possible to embark on any new project of this kind until additional funds are provided from some source.

A plan of coöperation between the Agricultural College and the Experiment Station has been worked out, whereby the barns and herd of the College will be available for this investigation. It is hoped that during the year the necessary funds will be provided and the Station can then undertake this important line of work.

Triplet Calves.

A tendency towards increased fecundity in any domestic animal, provided it is not associated with loss of other valuable qualities, is a thing much to be desired. During the past year a bulletin (No. 204) has been published, dealing with the subject of multiple gestation in cattle in general, and describing a case of triplet calves in detail.

The triplets were the progeny of a grade Guernsey cow that produced 14 calves in her first eight pregnancies, bearing triplets twice, twins twice, and single young four times. This cow undoubtedly inherited and transmitted a tendency to high fecundity.

The triplets described consisted of two females and one male. The latter was sexually normal in every particular, and was used in service, getting normal offspring. The females never came in heat and probably were freemartins.

In color and pattern inheritance the triplets exhibited the following peculiarities: The male was typically a Guernsey, resembling closely his dam. The females were of quite different color and pattern, resembling more closely their sire, a grade Hereford. A possible Mendelian interpretation of these facts is discussed in the bulletin.

Work with Plants.

Beans.

During the year the experiments looking towards the improvement of the old-fashioned yellow-eye bean were continued. Owing to the unfavorable season, however, but little progress was made. A committee of the Station Council and Maine Seed Improvement Association have been actively engaged in the question of bean grading and standardization. Considerable progress has been made, and it is possible now to go forward with the breeding work with a definite standard as to types and quality in yellow eye beans, which will be in accord with the demands of the market.

Variety Tests of Oats.

In 1912 the oat variety tests were continued at Highmoor. It was a very unfavorable season but the yields considerably exceeded those of the year before.

The yields in 1912 are shown in the following table.

Oat Variety Test

1912.

Name of Variety.	Yield in Bushels Per Acre.
Reg. Swed. Select	-
Reg. Swed. Select	56.5
Silver Mine	52.9
Banner	62.6
Irish Victor	61.6
Lincoln	68.3
Kherson	52.6
President	56.5
Early Champion	50.4
Prosperity	67.4
Imported Scotch	62.2
Victor	56.9
Senator	53.5
Danish Island	57.7
Clydesdale	54.5
Early Pearl	64.2
White Plume	44.1
Rebred 60-Day	47.5
Gold Rain	53.8
Abundance	47.9
Minnesota, No. 26	52.7
Siberian	50.0
Daubeney	43.3

These tests have been running for three years now. The ten best yielding varieties with their average yields for the three years, in bushels per acre, are given in the following table. These tables should be of value to the Maine farmer in deciding what variety of oats to grow.

The Best Yielding Varieties of Oats on the Basis of Average of Three Successive Years Test.

NAME OF VARIETY.	Average Yield for Three Years in Bushels per Acre.
Irish Victor	62.6
Lincoln	62.0
Prosperity	61.9
Imported Scotch	61.5
Banner	59.7
Silver Mine	59.3
President	58.0
Victor (a black oat)	57.0
Kherson (an early oat)	56.6
Regenerated Swedish Select	56.5

The breeding work with oats has consisted of the study of individual pedigree strains to find what are most promising. Several strains which appear to be very valuable will be propagated on an extensive scale in 1913. Some of these new sorts have yielded in trials on small plots at rates of 100 bushels or more to the acre. Seed from some of the best of these will probably be available for distribution in 1914.

Corn.

Work with sweet corn and with field corn (yellow dent) is being continued. The field corn of the Cornforth strain has been now bred up to the point where it appears to be a highly desirable sort for the Maine farmer.

An experiment was tried this year to determine the exact stage of development at which sweet corn should be picked for seed, in order to give the best results.

This year a more extended test was given a new sort of white sweet corn, with fine kernels and large amount of stover, which has been bred by the Station. It promises to be superior to any corn now grown in the State for canned purposes.

ENTOMOLOGY.

The year of 1912 has been in some ways of unusual entomological interest. The ravages of the spruce bud moth, the abundance of a new spruce leaf miner and the occurrence of other spruce insects have turned much of the attention toward the conifers, both native and those introduced for ornamental purposes. The increase of the Gypsy moth area and the continued spread of the brown-tail moth have given the emphasis of one more year's experience with these two pests of paramount importance. The season has been so favorable to the development of scale insects that even those species ordinarily little noticed have been conspicuous in many parts of the State. Fortunately correlated with the abundance of injurious species the insects of 1912 have included beneficial species in great numbers. The syrphus maggots and other predaceous insects, for instance, have practically exterminated many species of plant-lice over large areas, and parasites have been actively engaged in their natural warfare against injurious caterpillars and other insects.

Dr. O. A. Johannsen has completed this year a study begun ten or fifteen years ago of the Fungus Gnats of North America and this Station has published this work in four parts, the last of which contains those gnats of most economic importance, dealing with a group which attacks apples and corn as well as potatoes and other root crops.

As a basis for studies of New England Psyllids, or "Jumping plant-lice," a series of systematic studies was undertaken and the results of this preliminary work have been published this summer. The "Jumping plant-lice" are sucking insects which injure plants in much the same way as the aphids. This family of insects has heretofore received such meager attention in this country that it has not been possible to recognize some of the commonest species in the United States from the published accounts and many have been known merely as manuscript species. It is proposed to continue this work until we are much better acquainted with the Maine Psyllidae than at present.

Aphid Investigations.

It is a fact familiar to students of this family of insects that certain aphids live for a few generations (usually wingless) upon one food plant and then produce a winged generation that migrates to an entirely different species of plant for the summer, where it establishes a series of summer generations and by fall produces a second migrant generation that flies back to the original food plant. It is here the true sexes occur and that the winter egg is deposited,—stages absolutely essential to the continuation of the species.

Such a dual personality of certain aphid species is a condition which, before it is detected, betrays the economic entomologist into many futile combative attempts; but on the other hand the same duality may reveal, when once discovered, the most vulnerable point of attack. It is not necessary to go out of our own State for illustrations. The discovery that *Chermes abieticolens,* Thomas 1879, which makes cone-like galls on black and red spruce is the same species as *Chermes pinifoliae* Fitch 1858,* which lays eggs on new growth white pine for progeny that render the pine shoots weakened and unthrifty, gives the landscape gardener his clue. If he treasures the beauty of a group of white pines he would do well to exclude red and black spruces from the vicinity, or conversely if he wishes to grow black spruces with normal branches it is an indiscretion to place them near white pines. Again, when once it was ascertained that the common Alder Blight, *Pemphigus tessellatus* Fitch 1851, was masquerading on the maple (*Acer saccharium* L.—*dasycarpum* Ehrh. and cultivated varieties) as *Pemphigus acerifolii* Riley 1879† the owner of ornamental cut leaved maples had a theretofore unsuspected means of protecting their foliage by the control of the pest on its alternate food plant, the alder, which in many circumstances is an easy point of control.

It is with no slight interest that we have ascertained that the woolly aphid of the apple is such a migratory species with two distinct types of food plants;—the elm, or "original food plant," on which the true sexes occur in the fall and deposit the over-wintering egg, and on which it lives in the curled leaves in the spring; and the apple to which it migrates from the elm-leaf-curl and where it establishes itself as a bark feeder during the summer. This species, in addition, produces in the fall a generation that passes the winter at the roots of the apple, a

* Bulletin 173 Maine Agricultural Experiment Station.

† Entomological News, 1908, p. 484; Journal of Economic Entomology 1909, Vol. II, p. 35; Bulletin No. 195 Me. Agr. Exp. Sta., Feb. 13, 1912.

circumstance which has led to the assumption that the apple alone was concerned in the life cycle of this pest, and the elm-leaf curl which shelters the wolf in sheep's clothing has been previously unsuspected of other danger than that which threatened the elm itself, which except in the case of young trees is not usually great. But the discovery of the annual migration of a fresh infestation from the elm to the apple and the knowledge that the elm generations are an essential portion of the life cycle of the woolly aphid of the apple put a new significance upon the economic status of the elm curl.

There is probably no more interesting line of insect investigation than working out the full life cycle of the migratory aphids and such projects find sufficient economic justification in the fact that there are possibilities of control of certain species of plant lice or aphids by such methods as rotation of crops or the destruction of weeds which serve to maintain a species of aphids dangerous to neighboring crops; or the selection by the landscape gardener of ornamental shrubs and trees which are not susceptible to attacks of aphids common on native vegetation. In some cases circumventing the aphid by means of a knowledge of its food habits and migrations would be simpler and more effective than the direct methods of spraying which need to be repeated each year of attack.

Plant Pathology.

As was pointed out in the 1911 report the department of plant pathology of this Station is equipped for making and does make studies of diseases of the various economic plants of the State. In the past, however, the work has been largely confined to the diseases of the potato and the apple on account of the importance of these crops and on account of the fact that, as a rule, success or failure in potato and apple growing is to a great extent dependent upon proper and efficent disease control.

With regards efficiency in disease control, the commonest methods of spraying potatoes illustrates a case in point. Spraying potatoes for late blight is probably more widely practiced and better done in Maine, as a rule, than in any other part of the United States, but there is still much chance for improvement. Much of the spraying is far from being efficient. Field studies made in comparison with the results obtained from the Station's experimental work in potato spraying have shown that the bordeaux mixture used on many farms was improperly made and not applied at the proper time. Almost without exception potato spraying as practiced by the average potato grower lacked in thoroughness. Usually only one spray nozzle is used for each row of potatoes, applying but 50 gallons of spray per acre. With the rows 32 inches apart and the plants 12 inches apart in the row this means that one pint of liquid must cover 41 plants, or over 100 square feet of surface when the plants cover the ground.

There is much need for demonstration work in various parts of the State to show the farmers what has been done and what can be done in the way of efficient disease control, when the proper methods are used and properly applied. In fact there is probably as much immediate need for this sort of practical work as there is for research upon plant disease problems, although the latter should be of greater permanent value. However, no matter how great the need for demonstration work along the lines mentioned, the Station is not allowed to use the funds available for plant disease studies to carry on work of this nature, except to test under field conditions the conclusions drawn from laboratory studies. The funds available are from the National Government and it is expressly stipulated that they shall be used for original research and experimentation.

IDENTIFICATION OF PLANT DISEASES.

One of the important lines of pathological work now being carried on at the Station is the study of the prevalence and distribution of the different diseases of economic plants within the State. This work is being done in coöperation with the Bureau of Plant Industry of the United States Department of Agriculture, and the Station pathologist is supplied with printed shipping tags which will carry packages of diseased plants without prepayment of postage, and which can be furnished to those who will send specimens. This is an important line of work and its success depends upon the coöperation of the farmers of the State. An increasing number are sending in such specimens each year and it will greatly increase the efficiency of the work if a still greater number will avail themselves of the opportunity. In return for the specimens the Station will endeavor to determine the nature of the disease and advise methods of control if such are known. Such specimens often suggest needed lines of investigation and as the practice of sending them in for identification becomes increasingly common it will become increasingly difficult for a new and dangerous plant disease to establsh itself within the borders of the State.

PREVALENCE OF PLANT DISEASES IN 1912 WITH SUGGESTIONS FOR THEIR CONTROL.

Diseases of orchard trees and fruits. Apple scab, while always of the greatest economic importance in Maine, was particularly severe the past season. This was due to the very favorable climatic conditions during the early part of the growing season, namely an abundance of rainy, cloudy weather. Not only was the fruit crop badly damaged by this disease but the foliage suffered severely in many instances with certain varieties, and in one case specimens were received from a young orchard where the twigs were killed back by the fungus. Wherever spraying was properly done and at the right time the disease was largely controlled. In some cases pink rot of the fruit was very destructive in storage on apples affected by scab.

Black rot is probably next to apple scab in importance as the same fungus causes the leaf spot and canker, as well as the decay of the fruit. About the same amount of damage was recorded from this fungus in 1912 as usual, although a few cases were recorded where the owners reported that the canker was quite destructive and increasing. For the treatment of this and other apple diseases the reader is referred to Bulletin 185 of this Station or pages 380 to 440 of the Report of the Commissioner of Agrculture for 1910.

Crown gall appears to be becoming increasingly common upon the nursery stock shipped into the State, judging from the specimens received. Trees so affected should not be set and nursery men supplying them should be refused patronage. Numerous specimens of various other diseases of the apple were received but those mentioned are of the greatest importance.

Three very common diseases of the stone fruits as usual did much damage within the State last season, and many specimens of them were received. These are the brown rot, black knot and plum pockets.

More specimens of brown rot of the plum were received last season than for several years. The disease also attacks the cherry and the apple in this State, and is one of the most destructive diseases of the peach farther South. Last season it was reported from Bar Harbor as doing considerable damage where the English custom of growing peaches under glass is carried on commercially. In 1911 a very severe outbreak of brown rot was reported from a cherry orchard where not only were the young fruits destroyed but young branches and twigs were killed back by the fungus. Plum fruits are attacked by brown rot about the beginning of the ripening period. The diseased portions turn brownish, forming soft spots which rapidly grow in size till the whole fruit is infested. The fungus then breaks through the surface in the form of small grayish tufts or nodules which are masses of summer spores which scatter and infect healthy fruits. The decayed fruits dry up and form mummies which hang on the trees, or fall to the ground. In either case these mummies are the most important means of carrying the disease over winter and serve as the source of the new infections of the following seasons, when the young twigs, flowers and young fruit may be attacked.

The mummied fruits should be destroyed in the fall, and the trees sprayed with a 5-5-50 bordeaux mixture early in the spring before the leaves appear. After the leaves appear the trees should be sprayed with lime-sulphur the same as is used on apple trees. See Bulletin 185 mentioned above.

Black knot is too common to need description. It is especially common in Maine on wild cherries, particularly the chokecherry, which is one of the sources of the spread of the disease to cultivated plums and cherries and these plants should be rooted out and destroyed wherever found. The knots on the cultivated cherries and plums should be pruned out and burned as fast as they appear. The trees should be sprayed in the same way as described for brown rot.

Plum pockets, judging from observation and from the number of specimens sent in, appears to be a widely distributed and destructive disease of the plum in Maine. In some years, as in 1912, it does much more damage than in others. Cherries are also affected with a similar malady. In this disease the fruit early in the season becomes enlarged to several times the natural size. No stone is formed and the entire fruit is converted into a large, thin-walled, bladder-like structure, at first yellowish but later becoming gray as a coat of spores forms on the surface. The disease does not seem to spread with great ease but the fungus may live over winter in the twigs so that a tree once infected may continue to produce a crop of plum pockets each year instead of normal fruit.

The treatment consists of pruning back severely all affected twigs as fast as the diseased fruits appear on them and spraying the trees heavily with a 5-5-50 bordeaux mixture just before the leaf buds open in the spring.

DISEASES OF FIELD AND GARDEN CROPS.

While many plant disease specimens of this nature have been received and examined during the past season, bean anthracnose, onion mildew and the various potato diseases are by far of the greatest importance.

Bean anthracnose or "pod spot," more commonly known as "rust" by Maine farmers was very destructive last season, some fields being entirely ruined by its attacks. The term "rust" as applied to this disease is a misnomer. Moreover there exists in Maine a true rust of beans, but this produces small brown or black pustules on the leaves, particularly on some varieties of pole beans. These are most conspicuous in late summer. The bean anthracnose is much more destructive, and attacks both the leaf petioles and the pods. On the former it produces brown streaks, finally girdling the leaf stems and causing defoliation. On the latter the appearance is well known to every bean grower. The attacked pods are covered with what are first small brownish or discolored areas, which later enlarge forming rusty-colored pits or ulcers. The fungus frequently grows through the pods into the seed beans beneath, and beans so infected carry the fungus over winter.

To avoid bean anthracnose, rotation of crops is advised, and perfectly clean seed obtained from fields where the disease has not appeared, if possible, should be used. Some varieties are more resistant to the disease than others. Varying results have been obtained from spraying with bordeaux mixture but this is advised as a precautionary measure.

Onion mildew is an important and destructive disease of onions. It is mentioned here particularly because a case reported from Hallowell in the summer of 1912 was the first record of its occurrence in Maine since the department of plant pathology was established at the Station. It appears in late June or July. The fungus which causes it belongs to the same general class as that to which the fungus causing the late blight of the potato belongs. The disease is characterized by a sudden wilting and death of the foliage and rapid spread of the malady where large fields of onions are being grown. In the early stages the attacked portions of the leaves have a furry appearance with a slight violet tinge. Later these become mouldy, pale, streaked or blotched, collapsed and broken.

For treatment, spraying with bordeaux mixture, particularly a modified form having an addition of a sticky substance composed of fish oil, resin and potash, has been found to be very effective.

With regards potato diseases, particularly late blight, the season of 1912 gave very unexpected results. From past experience any prolonged period of rainy weather after the plants have reached the blossoming stage is, in this State, practically certain to result in widespread and destructive epidemics of late blight on all but the most thoroughly sprayed potato fields. The summer of 1912 was probably the first exception to this rule that New England has experienced in many years. While the potato growing season was abnormally wet and late blight of the foliage and the associated decay of the tubers appeared, no real severe cases of this disease were reported to the Station or observed by the pathologists.

There is one possible explanation for this failure of the disease to appear in epidemic form. The fungus is carried over winter in the seed tubers and spreads from these to the young plants in the spring. At this time of the year it is propagated very slowly, does no apparent damage, and consequently is never seen by the average observer. In this region it never breaks out in epidemic form till after the plants attain considerable size and the weather conditions are favorable. The fungus causing the disease is very sensitive to high temperature. Exposure for any considerable period of time to a temperature of 90% to 95% F. or over kills it while continuous and prolonged exposure to a temperature above 86% or 87% F. will accomplish the same results.

The month of July in both 1911 and 1912 was characterized by a period of about 10 days, at the beginning, of the most severe and continuous hot weather recorded in Maine in many years. Not only were high temperatures recorded but the days were very bright and sunny and the nights abnormally warm. During this period young apples on the exposed portions of the trees were partially cooked on one side as a result of the extreme brightness and heat of the sunlight. It seems quite possible that the air and soil temperature were so high that the late blight fungus was in many instances practically killed out during this period. Moreover it came at a time when the fungus was probably no longer alive in the seed tubers but existed in a vegetative stage in the young stems and leaves above or at least very close to the surface of the soil, if below the ground at all.

The hot period of July 1911 was followed by a fairly dry season and there resulted the most healthy crop of potatoes, so far as late blight was concerned, that Maine has produced in years. Consequently the seed tubers used in 1912 contained very little of this disease. The only dry period of the growing season of 1912 was the month of June. This was followed by the hot period of July, already referred to, and apparently furnished the final causes which nearly eliminated late blight from the State this year.

Early blight normally does little damage in wet seasons, but some cases were observed this season where, associated with flea beetles it caused considerable damage. Blackleg and scab caused about the usual amount of losses. The wet weather was quite favorable to the development of the former. Very favorable reports were received from those who used the formaldehyde seed-treatment for these diseases.

DISEASES OF CEREALS AND FORAGE CROPS.

The Station pathologists have made some quite extensive field observations upon the distribution of oat diseases in the State during the past summer. An apparently new leaf blight disease of oats has been found which seems to be very generally distributed throughout Maine. Not enough is known about it as yet to suggest methods of treatment or prevention. It is apparent, however, that it does considerable damage and that a large number of varieties are quite susceptible to it, although some are probably more resistant than others.

Oat smut was found to be much more common and destructive in the State than was at first supposed. In some cases 10% to 25% of the crop was destroyed in this way. This is, perhaps, the most conspicuous illustration of the need for demonstration work in plant pathology. A perfectly successful, cheap and effective method of seed disinfection is known, and it can be carried out by any man of average intelligence. To do this the oats to be treated are spread out on a canvas or clean barn floor and are sprinkled with a solution of one pint of formaldehyde to 40 or 50 gallons of water at the rate of a gallon per bushel, and then shoveled over to insure thorough wetting of each seed. Cover with a blanket or canvas for at least four hours, but not longer, and then spread out to dry.

One of the serious obstacles to growing alfalfa in Maine appears to be the alfalfa leaf-spot. Many specimens of this are received and practically all fields examined show bad attacks of the disease. No practical method of controlling it has been developed, but frequent cutting is said to help. Even though alfalfa is a valuable forage crop it may be wiser to turn attention to the more hardy red clover, which reaches its highest perfection of development in Maine. However a new disease of red clover was found in Maine last season. This is an anthracnose and is apparently similar to one described in Tennessee for the first time a few years ago. How wide-spread and destructive it is has not been determined but some sections of the State were found to be free from it.

DISEASES OF SHADE TREES.

Each year a considerable number of specimens of diseased sugar maple leaves are received the last of June and on through July. Almost invariably these are the result of late frosts, or result from the effects of strong drying winds, associated with bright sunlight, following a period of moist, cloudy weather when the young leaves have been growing rapidly and consequently are very tender

Much complaint is received from a leaf-spot of the horse-chestnut. The disease is so common and destructive that it is strongly advised that other species not susceptible to disease be used when planting shade trees.

Another quite destructive disease of shade trees in Maine is the elm leaf-spot, caused by *Gnomonia Ulmea* (Sacc.) Thum. Shade trees are frequently badly defoliated by attacks of this fungus and many complaints were received regarding such instances during the past summer. Doubtless spraying would be beneficial in the case of this disease as well as the horse-chestnut leaf-spot. However it would doubtless be impractical except where the matter of expense would be no consideration or in those municipalities where special equipment has been purchased to fight gipsy and brown-tail moths or other insect pests.

ORCHARD SPRAYING EXPERIMENTS IN 1912.

When Highmoor Farm came under the management of the Maine Agricultural Experiment Station the pathologist planned a series of experiments, particularly designed to test the effect of lime-sulphur and other sprays in controlling apple scab upon those varieties of apples like the Ben Davis and Baldwin which are quite susceptible to bordeaux injury. Bordeaux mixture is a most effective agent in controlling apple scab but on the varieties mentioned, and certain others, it frequently produces, especially in wet seasons, much damage to both foliage and fruit. So long as a horticulturist was stationed at the farm during the summer months he could best conduct these experiments, therefore they were transferred to his department. This work has again come under the control of the pathological department.

The apple spraying experiments of the past season were the third of the series. A brief résumé of the results of the two preceding years was included in this report for 1911. Weather conditions for 1911 were such that very little scab developed, therefore the experiments for that year were duplicated for 1912 with much more satisfactory results. On account of the more severe outbreak of scab these results regarding certain features of the experiments were quite clear cut and conclusive.

The most important lesson to be drawn from the work of the present year is with regard to the value of the application of the spray made first at the time the flower buds are showing pink. It is not recommended to omit the later sprayings, but where they were made last season and the first spraying omitted the work was probably done at a loss. Where all three applications were made almost perfect results were obtained. In other words last season *the application of the spray made just as the blossoms were showing pink was several times more effective than the other two taken together.*

Lime-sulphur applied at the proper time effectually controlled scab and was very free from leaf injury and produced only a small amount of russeted fruit. Bordeaux mixture, under like conditions controlled scab better than did lime-sulphur but upon the very susceptible Ben Davis produced so much russeting of the fruit that this more than off-set the beneficial effects.

Four pounds of arsenate of lead to fifty gallons of water plainly was of considerable fungicidal value. In fact the results were fully as good as on adjoining plots where two pounds of lead arsenate to fifty gallons of lime-sulphur were used. The heavy application of lead arsenate did result in considerable leaf injury, however. Arsenate of zinc and dry arsenate of lead were used with entire success with regards effect on foliage and fruit, and controlled insect pests, including codling moth, as effectually as did the ordinary lead arsenate paste.

POTATO SCAB.

The work on potato scab is being continued. Recently specimens of a new form of scab called "powdery scab" have been received from an adjoining County of Canada. This like the blackleg and potato canker or wart disease were probably imported to Canada from Europe. Specimens of scabby potatoes are being secured from as many localities in Maine as possible and these are being studied to learn if there is more than one form of the disease in this State. This is only a part of the very extended study that is being made of this disease and the organism causing it.

Some very interesting results have been obtained from feeding scabby potato tubers to the horse and the cow. It was found that the germs of the scab organism could pass through the digestive tract of both these animals and still be able to cause the disease if their manure is used for fertilizing a potato field. However it was concluded that as a rule there is little danger from feeding cows an ordinary amount of scabby potatoes provided none of the uneaten tubers were allowed to get into the manure. Uncooked potato peelings or potato refuse should not be thrown on the manure pile.

STUDIES UPON THE POTATO BLACKLEG ORGANISMS.

Last year's report stated that a practical method of the control of blackleg had been worked out and found to be quite successful. Since that time the more technical studies of the organisms associated with the disease have been completed and will soon be published as one of the research papers from this laboratory. It is sufficient to say in the present instance that only one type of organism was found associated with the disease in this State so that the remedial measures which succeeded in one case should be effective in all.

FUSARIUM DISEASES OF PLANTS.

There are a rather large number of plant diseases caused by species of the genus Fusarium. More than 300 species have been described for this genus and many of the descriptions have been very incomplete so that in many cases it has been impossible to determine from the written descriptions whether a form which was being studied had been described or not. As a result of this, it has happened in some cases that the same species has been described under two or more different names. This has led to much confusion. This is especially true in the case of forms which cause disease in plants. In some cases the occurrence of a form on a certain host plant has led to its being described as a new species, whereas the same form had already been described on another host under a different name. In such cases where one species can cause disease in two or more hosts it is of great importance to know that it is the same fungus which causes the diseases because that knowledge determines largely whether one of the plants can be used to follow the other in a rotation or whether two or more such host plants can be grown near together. It will be seen that a knowledge of the effect of such a species on its hosts may become of great practical value.

On account of the lack of knowledge in regard to diseases of plants which are caused by species of this genus in Maine, studies have been made of Fusarium forms which have been found in connection with diseased conditions in a number of plants which are of economic importance. This work was begun in 1908 when 3 species of Fusarium were isolated from decaying apples and it was found by inoculation experiments that each of these was capable of causing decay of apple fruit. Since no species of Fusarium had been reported as a cause of apple decay in America it was decided to study these forms carefully for comparison with a species which had been described in Europe as a cause of apple decay. One of the Maine forms has been found to agree closely with this fungus. Fusarium forms have been isolated from apples a number of times since but in each case the characters of the fungus have agreed with those of one or the other of the forms isolated in 1908.

In connection with the study of one of the forms from apple it was found that a very similar fungus has been described in other places as the cause of a bud-rot of carnation. The apple fungus was tested by making inoculations of carnation buds and was found to cause the rot. Since that time a fungus similar to, if not identical with, the carnation bud-rot fungus has been isolated from diseased parts of the following plants: Potato, sunflower, sweet corn, and the culms of five grasses which had been injured by the grass thrips. All of these fungi have been grown under the same conditions as the apple fungus for comparison and all have been tested by means of inoculations on carnation buds. As a result of this work it has been found that the same fungus may cause disease in a number of plants which are not closely related. The practical bearing of such work is seen when the chance of infection of one host by the spores produced on another is considered. For example the effect of the growth of this fungus on the grasses is probably not of much importance because the primary injury is caused by the grass thrips but the presence of the fungus on the grass may become of importance if the sod is used for potting soil in a greenhouse where carnations are being grown. If grass in an orchard is affected by this fungus, the spores may be carried to apples and thus bring about their decay.

One of the other species from apple has also been isolated from diseased wheat and from potatoes. The fungus from wheat was tested on apple fruit and found to cause as much decay as the fungus isolated from apple. This species also caused the rot of carnation buds when it was used in making inoculations which shows that this fungus also may cause disease in more than one host.

On account of the difficulty in distinguishing one species of Fusarium from others which closely resemble it, it is necessary to grow the forms from different sources under the same conditions for comparison. In order to determine the extent to which each may cause disease it is necessary to carry on inoculations. In this work species of Fusarium have been isolated from the following hosts in addition to those already mentioned: potato, 3 species; corn, 2 species; cucumber, 3 species; squash, 3 species; garden pea, one species; China Aster, one species; tomato, one species. It has been found that two of the species from potato are very similar to two of those from cucumber and that one species from corn agrees quite closely with one from squash. Inoculations have been made in potato, cucumber, tomato and pea.

When the great number of species of Fusarium is considered in connection with the fact that a given species may cause disease in more than one host plant, it becomes apparent that studies in which inoculations and cross inoculations are made, using material from pure cultures of the fungi, not only have value from the scientific standpoint but are also of great practical importance.

[488-11-13]

University of Maine.

MAINE
AGRICULTURAL EXPERIMENT STATION,
ORONO, MAINE.
CHAS. D. WOODS, Director.

SUMMARIES OF STATION WORK NO. 1.*

CHAS. D. WOODS.

APPLE STUDIES.

The work of this Station with the apple covers many years and includes studies upon varieties, cultivation, propagation, cover crops, fertilization, polination, winter injury and other physiological disturbances, fungous and bacterial troubles, insect enemies, protection by spraying, spray injury, and many allied problems. In the limits of this circular only the more important of these studies can be touched upon.

* Since the establishment of the Maine Agricultural Experiment Station in 1888 it has published many thousands of pages reporting its investigations. The Station Council instructed the Director of the Station to prepare and publish from time to time brief summaries of the results obtained. The work will be reported by kind rather than by departments of investigation. The first paper of this series has to do with apple studies.

MAINE SEEDLING APPLES.

Professor Munson came to the Station as horticulturist in 1891. He became greatly interested in the seedling apples that originated in Maine. In the orchard at Orono he had collected specimens of practically all of the Maine seedling apples. The severe winter of 1906-1907 destroyed many of these trees. This led to the publication in the spring of 1907 of bulletin 143 giving the history and description of the more important of the seedling apples that originated in Maine. This is by far the most complete and most accurate description of these varieties extant, and makes a noteworthy contribution to the apple culture history of the State.

In 1902 there was published a catalog and description of the hardiest apples growing in the State, including the Russian varieties brought into the State by this Station and planted at Orono, Houlton and Perham. This importation of Russian varieties failed to give as valuable apples as was hoped, but it stimulated orcharding in the more northern parts of the State and in this way was productive of lasting benefit.

APPLE CULTURE WORK PRIOR TO PURCHASE OF HIGHMOOR FARM.

For ten years culture experiments with the apple were carried out in the orchards of Mr. Charles S. Pope of Manchester. These included a comparison of cultivation with mulching; the necessity for fertilizing trees in virgin soil; the relative merits of stable manure and commercial fertilizers; the effect of special fertilizers; experiments in orchard renovation; top working a Ben Davis orchard; and a four year trial of the Fisher Formula as an orchard fertilizer. In 1908 there was published as Bulletin 155 of this Station a summary of this work. In general it was found that the unfertilized trees made less growth than the fertilized and the uncultivated than the cultivated. The unfertilized trees clearly showed the need on that particular soil, at any rate, the need of fertilizers. No apparent advantage from the use of stable manure over commercial fertilizers was found.

In the potash orchard no special effect from the application of potash or from the different forms of potash applied was found.

In orchard renovation by proper culture, spraying, pruning, and fertilizing it was found wholly practicable to take an old, unprofitable, rapidly degenerating apple orchard and (1) bring that orchard into profitable bearing; (2) To force Baldwin trees to produce fruit each year; (3) to produce profitable crops of fruits by the use of "chemicals" only, in connection with intelligent culture, pruning and spraying. It was further shown (4) that upon the particular soil involved all expenditures for fertilizer, unless these fertilizers contained some nitrogen, was an absolute waste of money; (5) that apparently the excessive use of nitrogen, in the absence of potash and phosphoric acid, was distinctly injurious to the fruit; and (6) that as a corollary to the other points, that the best results are obtained from a complete well balanced fertilizer, rather than from an excess of any one element.

A four year trial with Fisher Formula seemed to justify the following tentative conclusions. (1) The percentage of nitrogen in the Fisher Formula is too high for the best results. (2) On these soils the Fisher Formula is unnecessarily expensive and wasteful of available nitrogen. (3) A fertilizer carrying about 3 per cent of nitrogen, 6 per cent of available phosphoric acid and 8 per cent of potash, with a supply of humus in the form of cover crops or mulch is the most satisfactory for general orchard use for a term of years.

Apple Work at Highmoor Farm.

Highmoor Farm was purchased for the use of the Station in the summer of 1909. The work of the first season was entirely preparatory. From the beginning three lines of apple studies have stood out as the important ones to be undertaken at Highmoor Farm. These are orchard management, investigations upon apple enemies and investigations in apple propagation and growth. Orchard management covers such questions as cultivation, fertilization, pruning, cover crops, thinning of fruit, and protection from injurious insects and fungi. These are practical questions and call for men experienced in the care of orchards and familiar with the grosser field experiments. The apple diseases require the expert skilled in plant pathology. To be of real permanent value these call for more than superficial investigation. Their study demands the expert botanist to discover, classify, and learn the life habits of the low forms of plant life that cause the injuries. He must have knowledge to distinguish between fungi that are accidentally present because of the damaged and diseased tissue and those that cause the injury. He must have that intimate knowledge with plant physiology and histology that makes it possible for him readily and surely to distinguish between normal and abnormal growth, between healthy and pathological tissue. In like manner the studies of the insects, friendly and unfriendly, that are present in the orchard demand the trained entomologist. The work in propagation and growth demands the trained biologist. On the one hand the skill and knowledge requisite to the breeder of plants and on the other that of the biometrician who is trained to measure growth accurately. To meet these demands the apple studies at Highmoor Farm are planned by a committee consisting of the director, the biologist and the plant pathologist.

Results have been already obtained along all these lines. Three bulletins giving the results of the spraying experiments and one on general orchard notes have been published. These results are outlined in another place in this circular.

The work in orchard management at Highmoor Farm has shown that it is practicable by attention to cultivation, pruning, fertilizing and spraying to take a 25 year old orchard that had been systematically neglected for the greater part of its life and bring it into profitable bearing in three years time. The same treatment is making a healthy orchard of a shallow rooted, fire, mice and borer injured, and seemingly hopeless collection of dwarfed Baldwin apple trees. It has been clearly demonstrated that on the soil of Highmoor Farm, at any rate, cultivation of the soil is of prime importance and that mulching is not an adequate substitute. Farm manure is giving no better results than is obtained by use of commercial fertilizers. Fertilizer carrying high percentages of nitrogen have given no better results than a well balanced high grade fertilizer such as usually used in growing potatoes in Maine. The value of "tree surgery" in increasing the vigor and prolonging the life of apple trees has been clearly demonstrated. Whether on the soil of Highmoor Farm fertilizers pay or are even necessary in growing apples is being told with about 400 bearing trees.

Much biological data have already been obtained. These problems with slow-growing plants have been carefullly planned. After the lapse of ten to twenty years it is expected that the data obtained will furnish a mass of material from the study of which results of great practical as well as scientific values, on the growth and propagation of the apple, will be obtained.

Apple Tree Insects.

During the past twenty-five years the Maine Station has published several hundred pages regarding the apple insects of Maine. In 1910 it published a 75 page illustrated circular describing the more common apple tree insects of this State, giving remedies and control measures. Pictures have also been published of practically all the apple insects discussed in the different publications of the Station. Naturally most of this matter has dealt with the descriptions, habits, and methods of control of injurious species. However, the friendly insects of the orchard have not been neglected, and beneficial parasites and predaceous bugs and beetles, which fight more than half the battle for us have been presented with words of commendation to win appreciation and figures to insure recognition.

Space will here permit of only the merest mention of some of the more important apple insects described by this Station.

INSECTS DEVELOPING INSIDE THE FRUIT.

Apple Maggot (*Rhagoletis pomonella.*)

The full life history of the apple maggot was first worked out by this Station, resulting in the recommendations for the destruction of infested fruit in various ways.

Plum Curculio (*Conotrachelus nemuphar.*)

By a careful study of deformed apples in Maine, we ascertained that a very large per cent of the misshapen apples in this State are caused by feeding and oviposition punctures of the plum curculios which develop in the early neglected "dropped" fruit especially in June. Clean culture and the destruction of early fallen fruit is recommended.

Codling Moth (*Carpocapsa pomonella.*)

Although this insect nowhere in the State is so significant a pest as the two just mentioned, it needs to be guarded against and can be by proper spraying as explained elsewhere in this paper.

INSECTS DEVELOPING BY CHEWING LEAVES.

Mottled Fruit Caterpillar (*Crocigrapha normani*).

A caterpillar not before recorded as an orchard pest was discovered by us to feed upon apple,—both leaves and green fruit. Arsenical sprays.

Saddled Prominent Caterpillar (*Heterocampa guttivitta*).

A species never before recorded as an injurious insect stripped many orchards and forest growths of Maine during a few years attack. We worked out the total life cycle of this insect, gave it its popular name, studied its color variations, parasites, and its collapse under bacterial and fungous disease. Arsenical spray sufficient to protect the orchard.

Brown-tail Moth (*Euproctis chrysorrhoea*).

The first scouting to ascertain the limit of infestation by the Brown-tail Moth and the initial educational campaign concerning this insect was undertaken by this Station. There seems to be no limit to the instruction desired in this connection as the people of York County are *still* sending in Brown-tail Moths in different stages for identification.

Besides the foregoing species the following apple caterpillars have been published by this Station with descriptions, habits and effective remedies in each case practical for orchard use:—

Apple-leaf Bucculatrix, *Bucculatrix pomifoliella.*

Apple Leaf-sewer, *Ancylis nubeculana.*

Ash-gray Pinion, *Lithophane antennata.*

Bud Moth, *Tmetocera ocellana.*

Canker Worms: Fall, *Alsophila pometaria;* Spring, *Paleacrita vernata.*

Cecropia, *Samia cecropia.*

Cherry-tree Tortrix, *Archips cerasivorana.*

Cigar Case Bearer, *Coleophora fletcherella.*
Codling Moth. *Carpocapsa pomonella.*
Fall Web-worm, *Hyphantria cunea.*
Gipsy Moth, *Lymantria dispar.*
Io Moth, *Automeris io.*
Lesser Apple-leaf Folder, *Teras minuta.*
Lesser Apple Worm, *Enarmonia prunivora.*
Lime-tree Winter Moth, *Hybernia tillaria.*
Oblique-banded Leaf roller, *Cacaecia rosana.*
Polyphemus, *Telea polyphemus.*
Red-humped Caterpillar, *Oedemasia concinna.*
Sphinx: Apple, *Sphinx gordius;* Blind Eyed, *Paonias excaecatus;* Plum-tree, *Sphinx drupiferarum;* Twin Spotted, *Smerinthus geminatus.*
Tent caterpillar: Forest, *Malacosoma disstria;* Orchard, *Malacosoma americana.*
Tiger: Hickory, *Halisidota caryae;* Spotted, *Halisidota maculata;* Swallow-tail, *Papilio turnus.*
Tussock: Antique, *Notolophus antiqua;* White-marked, *Hemerocampa leucostigma.*
Velleda Lappet, *Tolype velleda.*
Yellow-edge, *Euvanessa antiopa.*
Yellow-necked, *Datana ministra.*

SUCKING INSECTS.

Among the many insects which trouble the pomologist there is perhaps no one group which is more injurious than are the scale insects, plant lice and other sap-sucking bugs. In Maine there are a number of species of scales but owing to their small size, and sombre coloring they are often passed unnoticed. The increasing practice of spraying of orchard trees by our fruit growers will tend to check the spread of species already established and prevent new ones gaining a foothold. As these insects have sucking mouth parts and live upon the juices of the host plants, they must be fought by means of contact sprays, such as tobacco, oil emulsions, whole oil soap, or lime-sulphur. Belonging to these bugs which feed by means of a jointed beak are the following serious orchard pests to which we have given special attention:

Tarnished Plant Bug, *Lygus pratensis.*
Oyster-shell Scale, *Lepidosaphes ulmi.*
San Jose Scale, *Aspidiotus perniciosus.*
European Fruit Scale, *Aspidiotus ostreaeformis.*
Scurfy Scale, *Chionaspis furfura.*
——————, *Phenacoccus dearnessi.*
Fruit Lecanium, *Eulecanium corni.*
——————, *Pulvinaria vitis.*
Aphids: Woolly, *Schizoneura lanigera;* green, *Aphis pomi;* Rosy, *Aphis pyri.*

Woolly Aphid of the Apple (*Schizoneura lanigera*).

This serious pest of apple trees was discovered by us to be a migratory aphid dependent upon the elm for a part of its life cycle, which is passed in deformed leaves of the American elm. This discovery enables apple nurseries to protect their young trees by excluding the elm from their vicinity.

Green Apple Aphid (*Aphis pomi*).

Beside the work of the Plum Cuculio a second common cause of deformed apples in Maine has been ascertained by us to be the green apple aphid. This insect is guilty of much of the pitted fruit, often crippling the total crop of an orchard. Black leaf 40 spray is effective.

BORERS.

Descriptions, habits, figures and standard remedies for the following apple borers of Maine have been published by this Station:
Round-headed Apple-tree Borer, *Saperda candida.*
Flat-headed Apple-tree Borer, *Chrysobothris femorata.*
Shot Borer, *Xyleborus dispar.*

SPRAYING FOR INSECTS THAT EAT THE FOLIAGE.

Almost continuously since 1891 the Station has conducted work looking to the control of insect pests by spraying with arsenical poisons. When this was begun there was very little spraying in the State. The first work compared London Purple with Paris Green, Paris green was tried at different strengths. Later when arsenate of lead was found to work satisfactorily in gypsy moth control it was tried in orchard work.

It was found that by use of arsenical spray before the buds open that the injury from the bud moth was well controlled.

It was found that by spraying only once after the petals fell with an arsenical spray that the codling moth could be fairly well controlled. With three arsenical sprays, one just before the blossoms opened, one after the petals had fallen and another about two weeks later the number of apples damaged by the work of the codling moth is practically reduced to zero.

It was found that the tent caterpillar can be controlled by one arsenical spraying applied as soon as the eggs hatch.

It was found that the forest tent caterpillar can be controlled by one arsenical spraying applied as soon as the eggs hatch.

It was found that the brown-tail moth caterpillar, the red-humped caterpillar, the fall web worm, and the tiger moth caterpillars can be controlled by an August arsenical spray.

It was found that because of the superior adhesive qualities that arsenate of lead has more lasting effect than Paris Green.

It was found that arsenate of lead injures foliage the least of the arsenical compounds.

SPRAYING FOR INSECTS THAT SUCK PLANT JUICES.

The worst of these in Maine are the oyster shell bark scale, the San Jose scale when present and the apple aphids. These insects have been carefully studied and methods for their control worked out in adequate experiments. For the San Jose scale dormant winter sprays of lime sulphur are a sufficient remedy. The oyster shell bark scale can be successfully controlled by strong applications to the limbs they are infesting during the months of the year when the trees are dormant and without foliage. Strong washes that will kill the eggs in which stage this insect winters under the protecting female scale insects can be safely applied at that time without damage to the trees. Strong soap washes, caustic washes and strong lime-sulphur solutions can be safely used in the early spring months before the buds swell. Washes are best applied with a large brush. Strong lime sulphur can be applied with the spray pump. Even more effective is a spring treatment of the young oyster shell bark scale which can be killed in June and early July by spraying with kerosene emulsion, strong tobacco solutions, or other materials of like nature. These are not designed for internal poisons but kill the insects by contact. Hence in their application it is the insects themselves and not the tree or the foliage or fruit that the substance must reach. It requires greater care to apply insecticides for sucking than for eating (chewing) insects. The apple plant louse does large damage in many Maine orchards. Many insecticides have been tried. Kerosene emulsion is effective but unless properly made and applied under favorable conditions it discolors the fruit, and is likely to do serious damage to the foliage. The aim is to get an insecticide that will kill the aphids and leave as little trace of itself on fruit and foliage as possible. Tobacco solutions come the nearest to meeting these requirements of any thing tried.

Studies of Apple Diseases.

The diseases of the apple other than those produced by insects naturally divide themselves into two classes—those which are caused by plant parasites such as fungi and bacteria, and those which are of a non-parasitic nature, that is physiological diseases or those produced by unfavorable conditions of the environment. For convenience a discussion of what this Station has done in the study of the latter class of diseases will be given first.

NON-PARASITIC DISEASES.

Winter Injury. The first observations recorded by this Station on winter injury were made in 1900 and 1901. This was the coldest winter known here for twenty years. The mercury on one occasion went to —36° F., while the mean temperature for December was 12° F. In the preceding season trees on the warm, rich soils failed to mature new growth. Consequently when the severe winter weather followed trees which should be hardy in our climate were either killed or severely checked.

At this time, it was pointed out that an all important requisite of hardiness is that wood should complete its growth early and become well matured before cold weather. Therefore, orchards and fruit plantations generally should not be cultivated after the first of August.

The next severe case of winter injury was reported for the winter 1904-5, although some was noted in 1903-4, and the conditions which prevailed this winter doubtless influenced the amount of injury experienced in the last mentioned season. The early part of the season of 1903 had very little rainfall. This drouth was followed late in the season by excessive rains resulting in a full development of fruit buds and late growth of wood. The trees suffered somewhat, but not severely, the following winter and bore heavy loads of fruit in 1904, hence all things considered they were that year in a more or less exhausted condition at the beginning of the winter. In almost every case coming under the observation of the Station horticulturist the trees which suffered most were those which bore a full crop the season before. In this instance apparently over-bearing was one of the predisposing causes of winter injury. Baldwin and Gravenstein trees were recorded as particularly affected this season.

The winter 1906-7 was probably the most disastrous in the history of Maine orcharding, the number of trees killed or severely injured being far in excess of any previous records. No doubt the short time intervening between this and the last severe winter contributed to the large amount of injury this season, on account of the trees not having fully recovered. However, the winter of 1906-7 was abnormal and the records show that weather conditions were more favorable that season for the production of winter injury than they had been at any other time during the last 44 years. One week in January, 1907, deserves particular mention. The two lowest records of the season, —47° F. and —35° F., were only 7 days apart and midway between them come two days with a maximum temperature of 45° F. and 47° F. respectively. While no doubt the extreme low temperature materially contributed to the amount of injury experienced abrupt changes from thawing to freezing were in all probability more important factors. The conditions following the day cited above, when the temperature reached 47° F. is a good example of this. Between 2 P. M. and sunrise next morning the mercury fell 60 degrees or to —13° F. and this following two days of marked thawing weather. Following this the temperature continued to fall and within 48 hours it had reached —35° F., or next to the lowest record for the winter, which latter occurred one week before.

Weather conditions were so abnormal and so severe this season that even those orchardists who had followed the most approved methods of caring for their orchards did not always escape loss. As a rule those orchards which were well drained, had not been weakened by over-bearing, were least exposed to cold north winds and were so cared for as to promote early maturity, showed the least injury, although there were many apparent exceptions.

The damage resulting from the winter injury of 1906-7 was much augmented by the failure in a large proportion of the cases to properly care for the trees after it took place. In many instances the dead wood was allowed to remain in the trees. This began to decay and the decay spread to the sound parts of the trees, eventually destroying many of them.

In caring for the trees which have suffered from winter injury the following procedure was found to be the most successful. All badly diseased limbs were cut back to healthy tissue as fast as they were discovered and where the bark on large limbs or trunks of trees was partially destroyed the diseased area was removed entirely back to and including some of the healthy bark, so that the margins of the injured area were entirely surrounded by the latter. The wounds thus made and those made by pruning were disinfected by brushing them with a solution of one ounce of copper sulphate dissolved in a gallon of water. They were then painted with pure white lead in boiled linseed oil or covered with grafting wax. This protective layer was constantly renewed as fast as it disappeared until the wound was healed.

Under the conditions of 1906-7 Baldwins and Ben Davis appeared to be much more susceptible to winter killing than any other varieties, although Northern Spy, Greenings and some others suffered more or less severely, according to location, slope, drainage of the orchard, etc. Not even the hardy Russian varieties escaped without considerable injury at Orono where the weather records mentioned above were taken.

Crotch Injury. A peculiar form of injury on apple trees was observed in the summer of 1907. This was later shown to be an undescribed form of winter injury, although in one State a similar appearing trouble has been attributed to the pear blight organism.

Russeting of Fruit. Studies made at this Station continuing for a number of years show that russeting of fruit is due to a variety of causes. None of the various forms of spray used which would control apple scab were entirely free from producing some russeting or spray injury to the fruit, in the case of very tender varieties like the Ben Davis. Some of the proprietary forms of sprays used in experimental work produced severe injury of this nature. Apparently excessive quantities of arsenate of lead will also produce russeting. On the more tender varieties lime-sulphur was found to be superior to bordeaux mixture on account of the greater amount of russeting produced by the latter.

Evidence accumulated during several years leads to the conclusion that in some years there is a considerable amount of russeting of fruit due to the natural causes. The actual factors concerned in this have not been determined, but it is possible that it may be associated with cold, wet weather or late frosts when the apples are small. This russeting sometimes has appeared in the form of bands around the center of the fruit and here there is no doubt about the injury being traced directly to frosts when the apples are small.

ORCHARD DISEASE STUDIES.

Beginning in 1908 this Station has been carrying out an extensive orchard disease survey of Maine. Before this very little was known of the character and distribution of the various apple diseases in this part of the country, and since that time some very important data have been obtained, both from a scientific and from a practical point of view. Several matters upon which very little or no information was available have been made the subject of rather extended investigations.

Among the non-parasitic diseases it has been demonstrated that with certain sprays injury may be produced which cannot be told by its appearance from the leaf-spot caused by the black-rot fungus. Also recent work done at this Station has confirmed the conclusion arrived at by certain earlier investigators that the true Baldwin spot is without doubt a physiological trouble. This should be not confused with a somewhat similar fruit spot of fungus origin sometimes occurring on Baldwins. Investigations made in Maine indicate that the last named disease is much more common in this State on the Bellflowers and similar light skinned varieties, particularly native seedlings, where the spots are a bright carmine with a brownish center and in no way resemble Baldwin spot.

Apple Scab. Since this is probably the most important apple disease in Maine from an economic standpoint, it has received special attention. This has been largely in the line of control measures which are discussed under spraying. Several observations have been made, however, which are in a way contributions to our knowledge of this disease. Perhaps the most important of these is the fact that in this climate scab may sometimes, on certain varieties, live over a winter in diseased branches and become a source of spring infection the following year. Much damage by scab was recorded during the summer of 1912 from injury to the young branches of actively growing trees of susceptible varieties. It was shown conclusively that in many instances the fungus remained alive over winter in these branches and was a source of infection in the spring of 1913. A dormant spray of lime-sulphur proved to be quite effective in controlling spring infection from this source.

Evidence has been obtained which indicates that apple scab may, if conditions are favorable, spread from diseased to healthy fruit in storage. As has been observed in certain other states, pink rot has been found to be very destructive upon apples affected with scab. The fungus causing this decay apparently is not able to attack apples with a sound skin.

Apple Leaf Spot. Much attention has been given to apple leaf-spot. Various fungi have been named as the cause of this disease in different parts of the country, but an extended and detailed investigation has shown conclusively that aside from the similar appearing spots caused by sprays, the black-rot fungus is the sole cause of leaf-spot in Maine.

Apple Decay. For several years a large amount of attention was given to the subject of apple decays, both to determine the nature and distribution of such forms of apple diseases in Maine and to study conditions favorable to their control. More or less of a handicap has been experienced in attempting to work out the practical applications of this phase of the work on account of no opportunities to conduct cold storage experiments. A cold storage plant at Highmoor Farm would allow the taking up and study of very important problems on a commercial scale which now cannot be touched.

The black-rot fungus and the common blue mold have been found responsible for the two most important apple rots of Maine. The former, like the leaf-spot, caused by the same fungus, can be traced directly to cankers on the limbs. Cutting out these cankers, general orchard sanitation, and spraying have all been found to be helpful in holding this disease in check. Much of the loss from blue mold has been found to be the direct result of careless or rough handling, the fungus as a rule gaining entrance through injuries in the skin.

Bitter rot and brown rot have not been found to be of so much economic importance in Maine as in some other parts of the country. The former appears to be quite widely distributed and some cases recently observed suggest that it may do more damage than was first supposed.

Quite a number of other forms of apple decay have been found in Maine, two of them new and only a few of them of much importance. One of the new forms of decay is of special interest in that it appears to be fairly common and the fungi which produce it are capable of attacking several other quite unrelated plants. It is known as the Fusarium decay. At least two different species of Fusarium have been isolated from decaying apple and several other species of this genus have been found to be able to rot apple fruit on inoculation.

Diseases of Wood. Of the wood diseases canker and twig blights are by far the most common and of the former the black-rot canker is of the greatest economic importance in Maine. Up to a short time ago it was felt that the European apple tree canker was not a factor in Maine orcharding. More recent observations indicate that in all probability this is by no means the case. Bitter-rot canker has been observed but has not yet produced any appreciable damage. Blight, which is very severe on certain varieties of trees in the northwest, has not yet been listed among the Maine apple diseases. Only one case has been observed which in any way suggested the presence of this malady. Pears in Maine appear to be particularly free from this disease also.

Crown gall, the dangerous bacterial disease of apples and many other plants, particularly representatives of the same family as the apple, has been found to occur several times on nursery stock imported into this State. So far it has not been found by this Station upon nursery stock grown in the State.

APPLE SPRAYING INVESTIGATIONS.

While spraying is necessary and essential to the control of several apple diseases, the chief object of the use of fungicidal sprays on apple trees in Maine is for the control of apple scab. This fungous disease, while most conspicuous on the fruit, does much damage to the leaves and, as has already been pointed out, may at times seriously injure the young growth on the tips of the branches of susceptible varieties of trees.

The application of any agent which will kill the causal fungus will prevent the spread of the disease. Unfortunately many of the remedies tried in the past while effective in controlling the disease frequently injure the foliage or fruit, or both, with varying degrees of severity, sometimes doing more damage than the disease itself. This Station, in common with many others has given much attention to the development and testing out of various sprays with the hope of finally securing one which would effectually control scab and kindred diseases and still be free from the production of any form of spray injury. The purchase of Highmoor Farm by the State and placing it under the control of this Station has made it possible to do more work in this line in a few years' time than has been accomplished during all the preceding years of the Station's existence. A very satisfactory degree of success has been attained, except with the case of the more susceptible varieties. The problem still remains to find some material which shall be effective and yet be perfectly safe under all conditions.

Bordeaux Mixture. Both copper and sulphur are efficient fungicides, and so far the greatest success has been attained in the use of compounds of one of these elements. In the earlier years most of the work was done with various compounds of copper. Of these, bordeaux mixture proved to be the most satisfactory from all standpoints. It is an exceedingly efficient fungicide and great success was attained by its use on many varieties of apples. Other varieties it injured in varying degrees. At Highmoor Farm on the Ben Davis and Baldwins, while scab was well controlled, leaf injury was so great and russeting of the fruit was so severe that the injurious effects more than offset the good and bordeaux mixture had to be abandoned.

Lime-sulphur. Attention was then turned to various compounds of sulphur. The best results have been secured with what is known as lime-sulphur, a compound prepared from definite quantities of lime, sulphur and water which are boiled for a given time and then diluted to proper strength for application upon the trees. This Station was among the pioneers in the use of lime-sulphur as a means of controlling apple scab, the first experiments being conducted in 1908. These were made with the so-called, self-boiled lime-sulphur, which was later discarded for the more efficient compound mentioned above. It is doubtful if under all conditions lime-sulphur controls apple scab as well as bordeaux mixture does, but on the tenderer trees it is to be preferred. On the less susceptible varieties bordeaux mixture is still recommended. Certain proprietary compounds of sulphur, but differing from the ordinary commercial or home prepared lime-sulphur concentrates, have produced quite severe injury to both fruit and foliage.

Method of Spraying. It has been found that the first foliage spraying application is of prime importance in the control of apple scab and why this is so. Valuable results have been obtained upon the question of the proper dilutions of lime-sulphur to be used. Comparative studies between lime-sulphur, bordeaux mixture and arsenate of lead as a fungicide have given practical results. Arsenate of lead paste has been compared with dry arsenate of lead powder and arsenate of zinc with both.

Large numbers of trials have been made as to the number of sprays necessary and the time of their application. It was found to be undesirable to spray when the fruit was in bloom because of the danger of pollen injury and also of injury to bees which are not only of economic importance as producers of honey but also assist in the pollination of the apple blossoms, thus helping to a better "setting" of fruit. For apple scab it was found that the best control could be obtained by not less than three sprayings with bordeaux mixture or lime-sulphur and sometimes a fourth later spraying is necessary. The first spraying is more effective before the flower buds open and after they are swelled so as to show a trace of pink color. This is spoken of as the "pink spray." The second spraying should be made as soon after the petals drop as possible. In case of only three sprayings the third and last spray is applied about two weeks after the petals fall while the calyx on the young apples is still directed upward.

Directions for spraying. Because of the expense of applying sprays, combination spraying for eating and sucking insects and for fungi is desirable. Much study has been given to these combinations. Those at present recommended by this Station are outlined below and include a dormant spray for insects which should be applied in addition to the ones recommended above. If bordeaux mixture is preferred it is advised to still use the dormant lime-sulphur spray for insects and then follow with three applications of bordeaux mixture as outlined for lime-sulphur under B, C, and D.

Full directions are given in Circular No. 463 on spraying with lime sulphur which will be sent free to any resident of Maine on application.

A. Spray the dormant trees before the buds begin to swell in the spring, with lime-sulphur diluted according to the second column of the table, in Circular 468, winter strength. This is for blister mites, plant lice eggs, oyster shell bark louse and San Jose scale, but it also assists in holding apple scab and other fungous diseases in check.

B. Just as the blossom buds are showing pink spray the entire tree thoroughly with lime-sulphur * diluted for summer strength as indicated in the third column of the table, in Circular 468, and add 2 to 3 pounds of arsenate of lead paste to each 50 gallons of spray when ready for use. This is for apple scab, leaf-spot, rot, bud moth, canker worm, tent caterpillar and forest caterpillar.

C. Repeat B as soon as the blossoms have fallen for the same parasites and for codling moth.

D. Repeat application B again in ten days or two weeks after application C.

E. If the season is very wet and favorable to apple scab, or bitter rot or black rot are present to any extent, later applications of the summer dilutions may be required. In these the arsenate of lead may be omitted unless caterpillars or other leaf eating insects are present.

Add black leaf 40 for aphids in B., C. and D.

Aphid Control. 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. Directions for using both the home made extracts and reliable commercial products such as Black Leaf 40 are given in Circular 483 on Aphids. These sprays are also valuable in combatting the oyster shell scale at the time the young are crawling in the spring. The tobacco extracts can be applied at the same time and with the sprays for chewing insects and for fungi.

August Sprays for Browntail and other Caterpillars. Six species of caterpillars work damage in Maine orchards in August. Each is a serious pest during a season favorable to its development, and all six may be present in abundance the same year. This is not so discouraging as it seems at first thought because one thorough spray of arsenate of lead will ordinarily control all the August caterpillars which chance to be present.

Such a spray would probably be most effective if applied about the middle of August in Maine. The time may vary, however, a week or two according to seasonal variation as to

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* Bordeaux mixture can be used on the varieties not susceptible to bordeaux injury.

temperature or other climatic conditions which have an effect on the development of the caterpillars.

Four pounds of lead arsenate paste to fifty gallons of water can be used at this time with safety on trees with winter fruit. For trees with very early fruit it would probably be better to use not more than two or three pounds. If dry arsenate of lead is used half the above amounts to fifty gallons of water is sufficient.

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. For the past two years the browntail caterpillars have fed late into the fall, many becoming half grown and working about the fruits as well as the leaves. This experience leads us to emphasize the need of an August spray for this pest. 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 other five species to guard against in this way are the red-humped caterpillar, yellow-necked caterpillar, fall web worm, hickory tiger moth and spotted tiger moth.