PUBLIC DOCUMENTS OF MAINE

1912

BEING THE

ANNUAL REPORTS

OF THE VARIOUS

DEPARTMENTS AND INSTITUTIONS

For the Year 1911

VOLUME I

AUGUSTA
WALLACE S. LADD PRINTING COMPANY
1912

TWENTY-SEVENTH ANNUAL REPORT

OF THE

Maine Agricultural Experiment Station

ORONO, MAINE

1911

STATE OF MAINE.
1912.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

Organization January to June, 1911.

THE STATION COUNCIL.

PRESIDENT ROBERT J. ALEY,	*President*
DIRECTOR CHARLES D. WOODS,	*Secretary*
JOHN A. ROBERTS, Norway,	*Committee of Board of Trustees*
CHARLES L. JONES, Corinna,	
SAMUEL W. GOULD, Skowhegan,	
JOHN P. BUCKLEY, Stroudwater,	*Commissioner of Agriculture*
EUGENE H. LIBBY, Auburn	*State Grange*
RINALDO L. CUMMINGS, West Paris,	*State Pomological Society*
RUTILLUS ALDEN, Winthrop,	*State Dairymen's Association*

AND THE HEADS AND ASSOCIATES OF STATION DEPARTMENTS.

THE STATION STAFF.

ADMINISTRATION	CHARLES D. WOODS, Sc. D.,	*Director*
	BLANCHE F. POOLER,	*Stenographer*
	RALPH K. JONES, B. S.,	*Librarian*
	CHARLES J. DUNN,	*Treasurer*
	GRACE M. COLBURN,	*Bookkeeper*
BIOLOGY	RAYMOND PEARL, PH. D.,	*Biologist*
	EUGENE P. HUMBERT, PH. D.,	*Associate*
	MAYNIE R. CURTIS, A. M.,	*Assistant*
	WALTER ANDERSON,	*Poultryman*
	LOTTIE E. McPHETERS,	*Computer*
CHEMISTRY	JAMES M. BARTLETT, M. S.,	*Chemist*
	HERMAN H. HANSON, M. S.,	*Associate*
	ALBERT G. DURGIN, M. S.,	*Assistant*
	ALFRED K. BURKE, B. S.,	*Assistant*
	HARRY C. ALEXANDER,	*Laboratory Assistant*
ENTOMOLOGY	OSKAR A. JOHANNSEN, PH. D.,	*Entomologist*
	EDITH M. PATCH, M. S.,	*Associate*
	ALICE W. AVERILL,	*Laboratory Assistant*
HORTICULTURE	WALTER W. BONNS, B. S.,	*Associate Horticulturist*
PLANT PATHOLOGY	WARNER J. MORSE, M. S.,	*Pathologist*
	CHARLES E. LEWIS, PH. D.,	*Associate*
	JOHN SUMMERS,	*Laboratory Assistant*

HIGHMOOR FARM, WELLINGTON SINCLAIR,	*Superintendent*
ROYDEN L. HAMMOND,	*Seed Analyst and Photographer*
HENRY A. MILLETT,	*Meteorological Observer and Janitor*

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

Organization July to December, 1911.

THE STATION COUNCIL.

PRESIDENT ROBERT J. ALEY,	*President*
DIRECTOR CHARLES D. WOODS,	*Secretary*
CHARLES L. JONES, Corinna,	*Committee of Board of Trustees*
SAMUEL W. GOULD, Skowhegan,	
OSCAR R. WISH, Portland,	
JOHN P. BUCKLEY, Stroudwater,	*Commissioner of Agriculture*
EUGENE H. LIBBY, Auburn,	*State Grange*
ROBERT H. GARDINER, Gardiner,	*State Pomological Society*
RUTILLUS ALDEN, Winthrop	*State Dairymen's Association*

AND THE HEADS AND ASSOCIATES OF STATION DEPARTMENTS.

THE STATION STAFF.

ADMINISTRATION	CHARLES D. WOODS, Sc. D.,	*Director*
	BLANCHE F. POOLER,	*Clerk and Stenographer*
	GEM M. COOMBS,	*Stenographer*
BIOLOGY	RAYMOND PEARL, PH. D.,	*Biologist*
	EUGENE P. HUMBERT, PH. D.,	*Associate*
	MAYNIE R. CURTIS, A. M.,	*Assistant*
	WALTER ANDERSON,	*Poultryman*
	LOTTIE E. McPHETERS,	*Computer*
CHEMISTRY	JAMES M. BARTLETT, M. S.,	*Chemist*
	HERMAN H. HANSON, M. S.,	*Associate*
	ALBERT G. DURGIN, M. S.,	*Assistant*
	ALFRED K. BURKE, 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*
HORTICULTURE	WALTER W. BONNS, B. S.,	*Associate Horticulturist*
PLANT PATHOLOGY	WARNER J. MORSE, M. S.,	*Pathologist*
	CHARLES E. LEWIS, PH. D.,	*Associate*
	VERNON FOLSOM,	*Laboratory Assistant*
HIGHMOOR FARM,	WELLINGTON SINCLAIR,	*Superintendent*
ROYDEN L. HAMMOND,		*Seed Analyst and Photographer*
ELMER R. TOBEY, B. S.,		*Inspector*
ALBERT VERRILL, B. S.,		*Inspector*
EDGAR WHITE,		*Inspector*
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 advantages of rotative cropping as pursued under a varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and water; the chemical composition of manures, natural and artificial, with experiments designed to test their comparative effects on crops of different kinds; the adaptation and value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and cheese; and such other researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective states or territories."

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

INVESTIGATIONS.

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

INSPECTIONS.

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

OFFICES AND LABORATORIES.

The 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.

HIGHMOOR FARM.

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

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

THE AIM OF THE STATION.

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

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

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

CORRESPONDENCE.

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

Agricultural Experiment Station,
Orono, Maine.

Publications.

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

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

BULLETINS ISSUED IN 1911.

No. 187. Insect Notes for 1910. 24 pages, 36 illustrations.
No. 188. Field Experiments. 8 pages.
No. 189. Orchard Spraying Experiments. 48 pages, 23 illustrations.
No. 190. Two Species of Macrosiphum. 12 pages, 14 illustrations.
No. 191. Method for Determining Weight of Parts of Eggs. 20 pages, 3 illustrations.
No. 192. Breeding for Egg Production. 64 pages, 9 illustrations.
No. 193. Poultry Notes. 24 pages, 8 illustrations.

No. 194. Control of Blackleg Disease of the Potato. 28 pages, 1 illustration.
No. 195. Insect Notes. 20 pages, 5 illustrations.
No. 196. Fungus Gnats. Part III. 80 pages, 148 illustrations.
No. 197. Finances and Index, 12 pages.

OFFICIAL INSPECTIONS ISSUED IN 1911.

No. 29. Fertilizer Inspection. 36 pages.
No. 30. Oysters, Pork Sausage, Clams, Imitation Beer. 8 pages.
No. 31. Feeding Stuff Inspection. 20 pages.
No. 32. Changes in Inspection Laws. 12 pages.
No. 33. Fertilizer Inspection. 32 pages.
No. 34. Spices, Prepared Mustard, Honey and Gluten Flour. 16 pages.
No. 35. Food Sanitation. 12 pages.

MISCELLANEOUS PUBLICATIONS ISSUED IN 1911.

No. 398. Poultry Diseases and Their Treatment. 216 pages.
No. 399. Maine Apple Diseases. 1 page.
No. 400. Papers from Plant Pathological Laboratory. 1 page.
No. 401. Four Insect Pests. 24 pages.
No. 402. Suggestions for Woodlot Owners in Maine. 28 pages.
No. 403. Notice of No. 402. 1 page.
No. 404. Seed Test Register. 1 page.
No. 405. List of Publications in 1910. 1 page.
No. 406. The Typhoid Fly and Its Allies. 8 pages.
No. 407. Flea Beetles and Early Blight of Potatoes. 4 pages.
No. 408. Plant Lice of the Apple in Maine. 12 pages.
No. 409. Cut Worms in Maine. 4 pages.
No. 410. Notice Relative to Publications. 1 page.
No. 411. Notice Relative to Publications. 1 page.
No. 412. Note Regarding Variation in the Single Combs of Fowls. 8 pages.
No. 413. Notice of Poultry Diseases and Their Treatment. 1 page.
No. 414. Notice of Poultry Diseases and Their Treatment. 1 page.
No. 415. Available Bulletins and Reports of the Station. 4 pages.
No. 416. Packing Food under the Maine Pure Food and Drug Law. 4 pages.
No. 417. Notice of Four Insect Pests. 1 page.
No. 418. Laws Regulating the Sale of Agricultural Seeds, Feeding Stuffs, Fertilizers, Drugs, Foods, Fungicides and Insecticides. 12 pages.
No. 419. Directions for Taking Samples of Fertilizers. 2 pages.
No. 420. Requirements Under the Law Regulating the Sale of Agricultural Seeds. 2 pages.
No. 421. Requirements Under the Law Regulating the Sale of Commercial Feeding Stuffs. 8 pages.

No. 422. Requirements Under the Law Regulating the Sale of Commercial Fertilizers. 4 pages.
No. 423. Requirements Under the Law Regulating the Sale of Fungicides and Insecticides. 4 pages.
No. 424. Requirements Under the Law Regulating the Sale of Drugs. 4 pages.
No. 425. Requirements Under the Law Regulating the Sale of Foods. 22 pages.
No. 426. Free Aanalyses of Feeding Stuffs. 2 pages.
No. 427. Manufacturer's Certificate, Feeding Stuffs Inspection. 1 page.
No. 428. Manufacturer's Certificate, Fertilizer Inspection. 1 page.
No. 429. Manufacturer's Certificate, Fungicides and Insecticides Inspection. 1 page.
No. 430. Certificate of Registration. 1 page.
No. 431. Orchard Spraying Experiments. 1 page.
No. 432. Experiments at Highmoor Farm, 1911. 6 pages and map.
No. 435. Proper Growing and Handling of Potato Seed Stock. 16 pages.
No. 436. Notice of Potato Seed Stock. 1 page.
No. 437. On the Accuracy of Trap Nest Records. 10 pages.
No. 438. Breeding Poultry for Egg Production. 1 page.
No. 439. Poultry Notes. 1 page.
No. 440. Breeding Poultry for Egg Production. 1 page.
No. 441. Poultry Notes. 1 page.
No. 442. Control of the Blackleg Disease of the Potato. 1 page.
No. 443. Station Publications. 1 page.

BIOLOGY PUBLICATIONS 1911.

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

No. 24. Biometric Ideas and Methods in Biology: Their Significance and Limitations. By Raymond Pearl. Scientia (Bologna), Vol. X, 5th year (1911), XIX-3, pp. 101-119. (A French translation of this paper was also issued).

No. 25. Inheritance of Fecundity in the Domestic Fowl. By Raymond Pearl. Amer. Nat., Vol. XLV, pp. 321-345. (This paper is reprinted as Part IV of No. 32 below).

No. 26. The Mendelian Inheritance of Certain Chemical Characters in Maize. By R. Pearl and J. M. Bartlett. Zeitschr. f. Abst. u. Vererb. Lehre, Bd. VI, pp. 1-28.

No. 27. An Accurate Method for Determining the Weight of the Parts of the Eggs of Birds. By Maynie R. Curtis. Me. Agr. Exp. Stat. Ann. Rpt. for 1911, pp. 93-112.

No. 28. Biometric Arguments Regarding the Genotype Concept. By Raymond Pearl. Amer. Nat. Vol. XLV, pp. 561-566.

No. 29. The Personal Equation in Breeding Experiments Involving Certain Characters of Maize. By Raymond Pearl. Biol. Bul., Vol. XXI, pp. 339-366.

No. 30. On the Accuracy of Trap-nest Records. By Raymond Pearl. Me. Agr. Exp. Stat. Ann. Rept. for 1911, pp. 186-193.

No. 31. A Note on Certain Biometrical Computations. By Raymond Pearl and Lottie E. McPheters. Amer. Nat. Vol. XLV pp. 756-760.

No. 32. Breeding Poultry for Egg Production. By Raymond Pearl. Me. Agr. Expt. Stat. Ann. Rept. for 1911, pp. 113-176.

Papers published but not in the numbered series:

a. Poultry Diseases and Their Treatment. Compiled by R. Pearl, F. M. Surface and M. R. Curtis. Me. Agr. Expt. Stat. Circular 398, pp. 1-216.

b. A Note Regarding Variation in the Single Combs of Fowls. By R. Pearl. Mendel Jour. Vol. I, pp. 189-195.

c. Some Recent Studies on Variation and Correlation in Agriculture Plants. By R. Pearl. Amer. Nat. Vol. XLV, pp. 415-425.

d. Opportunities for Corn Breeding in Maine. By R. Pearl. Ann. Rept. Me. Seed Imp. Assoc. for 1910, pp. 146-152.

e. Poultry Notes—1910. By R. Pearl. Me. Agr. Expt. Stat. Bul. 193. pp. 177-200.

ENTOMOLOGICAL PUBLICATIONS.

No. 45. Paedogenesis in Tanytarsus. O. A. Johannsen, Science XXXII, 768.

No. 46. Insect Notes for 1910. O. A. Johannsen, Me. Agr. Exp. Sta., Bul. 187, pp. 1-24.

No. 47. Two species of Macrosiphum. Edith M. Patch, Me. Agr. Exp. Sta. Bul. 190, pp. 81-92.

No. 48. Insect Notes of 1911. O. A. Johannsen and Edith M. Patch, Me. Agr. Exp. Sta. Bul. 195. pp. 229-243.

No. 49. Pemphigus tessellata on Alder and Maple. Edith M. Patch, Me. Agr. Exp. Sta. Bul. 195, pp. 244-248.

No. 50. Fungus Gnats, Part III. O. A. Johannsen, Me. Agr. Exp. Sta. Bul. 196. pp. —

CHANGES IN STATION STAFF.

March 1 Dr. Frank M. Surface resigned as Associate Biologist to accept a research position in the Kentucky Agricultural Experiment Station. From March 1 to December 31 Dr. Eugene P. Humbert was Associate Biologist at which date he resigned to go to the New Mexico College of Agriculture and experiment Station.

Gem M. Coombs began work as stenographer in May.

June 1 Henry A. Millett resigned as Assistant and was succeeded by Charles C. Inman, and in September John Summers resigned as Assistant and was succeeded by Vernon Folsom.

BULLETIN NO. 187

INSECT NOTES FOR 1910.*

O. A. JOHANNSEN.

Following the custom of former years, notes of a miscellaneous character comprising new observations, new locality references, etc. of insects taken by us or sent in during the season are given here. Compilations and remedial measures are both avoided, and the statements are often the mere transferral of notes from the Station records. Insect notes of more popular character are given in more detail in other bulletins and circulars issued by the Station. The lot numbers quoted are references to our Station records, inserted for our own convenience. The parts on the *Aphididæ* and *Psyllidæ* were written by Miss Edith M. Patch, to whom the new species must be credited.

LEPIDOPTERA.

As usual by far the largest number of species concerning which complaints are made and also sent to the Station for identification this year, belong to this order. Those most frequently sent in were *Anisota rubicunda, Diacrisia virginica, Hyphantria cunea, Euproctis chrysorrhœa,* and *Tmetocera ocellana.* The following species are noted here primarily for the locality or food plant records.

Apatela americana. Mountain ash. Seal Harbor. Sept.

Balsa malana. Apple. Orono. May.

Noctua clandestina. Hollyhock, strawberries. E. Sumner. May.

Cucullia convexipennis. Cult. aster. Orono. Sept.

Rhodophora florida. Evening primrose. Orono. July.

Pheosia dimidiata. Balm of Gilead. Orono. July.

Euproctis chrysorrhoea. Strawberries. Bath. June.

Paleacrita vernata. Apple. Orono. May.

---

*Papers from the Maine Agricultural Experiment Station: Entomology No. 46.

Alsophila pometaria. Apple. Monmouth and Orono. May.
Epicnaptera americana. Apple. Orono. July.
Eurycyttarus confederata. (Fig. 2.) Cambridge. June.
Plodia interpunctella. Packed raisins. Portland, Orono.
Coleophora fletcherella. Apple. Orono, Monmouth. April.
Bucculatrix canadensisella. Birch, alder. Many localities.
Bucculatrix pomifoliella. Apple. East Corinth.
Tischeria malifoliella. Apple. Monmouth. June.

Hyphantria cunea (Fall Web-worm).

Of all insects submitted to us for identification the web-worm was most frequently sent in, and in this region at least its work was the most conspicuous. Many different kinds of trees and shrubs were affected, the apple being particularly subject to injury. Fig. 1 illustrates one of several apples which were taken from a web-worm nest. The caterpillars had peeled the apples.

Heterocampa guttivitta (Saddled prominent).

After 3 seasons of very severe infestations these insects have suddenly disappeared. We have seen no specimens nor have any been sent in. In response to letters sent to people living in districts most severely infested in former years we learn that no insects of this species have been observed.

Bucculatrix canadensisella (Birch leaf Bucculatrix) as a leaf miner.

This insect was reported and the larva described in Insect Notes for 1909. This year the adults were abundant in June upon the birch leaves. Though some cocoons were found upon the trunks and branches, most of them were seen upon dried leaves, sticks and grass underneath the trees and among rubbish in fence corners. Some flat, translucent objects, resembling the eggs of the codling moth, though of course much smaller, were seen on the under side of the leaves, which may have been the eggs of the Bucculatrix. Early in August no larvæ had yet been observed externally upon the leaves, but many leaf miner trails, each with a minute larva within, were seen. Several leaves containing miners were carefully examined to be sure that there were no larvæ upon the surface, and placed in a cage.

After a few days all the larvæ had left the mines and were feeding on the surface. Examination proved them to be the larvæ of *B. canadensisella.* Thus it is seen that this species passes the first 2 months of its existence as a leaf miner in the same manner as the Apple Bucculatrix.

The young larva is rendered quite conspicuous by the prominence of the black ganglia of the ventral nerve cord, visible even when within the leaf mine. The full grown larva has 3 pairs of claws on each of the intermediate abdominal prolegs, but in the earlier stage there is but one pair. The nerve ganglia become less noticeable as the larva increases in size.

Fortunately for the birches, the larvæ do not reach their greatest development until late in August, so that there can be but little permanent injury done to the tree. In the region about Orono, *Betula populifolia* and *papyrifera* as well as the cultivated *B. alba* show the greatest amount of injury, while *B. lenta* and *lutea* are less severely treated. The alder (*Alnus incana*) when near a birch tree may also be attacked, though the injury to the leaf is not so great.

DIPTERA.

From among a number of observations upon the biology of various species of Diptera and reserved for publication elsewhere, the following have been selected as being of general interest. As in former years, *Rhagoletis pomonella* (Apple maggot) heads the list of the more injurious Diptera of Maine.

Parthenogenesis and Pædogenesis in Tanytarsus.

Notes on the pædogenetic reproduction of *Tanytarsus dissimilis* have already been published in Science (Nov. 25, '10). To the observations made there may be added that although many adults were reared this year no males were among them. One female, accidentally held captive by its wings in its own pupal skin, was observed to lay eggs. These eggs were transferred into distilled water, but unfortunately immediately disintegrated. Later more eggs were obtained which had been laid by newly emerging females. The eggs in each string, about 60 in number, are arranged side by side, but lie somewhat obliquely in a single row, surrounded by gelatine. Each egg is elongate oval in outline, flattened on one side. About 2 days after deposition the larvæ emerge through a longitudinal slit. The nearly transparent larvæ, within a few hours begin the construction of their cases or tubes. As the insects were confined in glasses with tight fitting covers, and no males have been bred this year, we have demonstrated here a case of parthenogenetic reproduction.

Simulium and pellagra.

The two species *S. hirtipes* and *venustum,* so common in various parts of the northeastern states, were abundant during the spring and summer in this vicinity. To those who have camped in the woods or mountains where *Simulium* is abundant, the bite of this short-bodied, hump-backed little fly is only too well known. The females only are blood-thirsty. They are a veritable scourge to the hunters and fishermen in Maine. Recently some German veterinarians have shown that they are the cause of a serious disease in cattle. More recently still Dr. L. W. Sambon of England makes the claim that *S. reptans* is the transmitter of the disease *Pellagra* prevalent in the south of Europe, which in the last 2 or 3 years has excited physicians in the southern states. Sambon states that the disease follows water courses and only persons much in the open are attacked. These facts are peculiarly significant and here is the clue by which a link may be added to the chain of circumstantial evidence to establish the guilt or innocence of the gnat. The insect breeds only in water which is shallow but at the same time swift. If the larva be transferred to still water it will die in a very few hours, but it may live for several days in a situation kept moist by trickling water. The larvæ are found on rocks and debris, particularly in little brooks. and the adult flies are never found at a great distance from such localities, rarely entering houses. If Sambon is correct in his view we must assume that a person afflicted with pellagra has been in the open in the vicinity of a brook or stream where *Simulium* abounds, at a comparatively recent period prior to his infection.

Simulium reptans, the species which is accused of carrying the infection in Europe, has been thus far only recorded from Greenland on the western hemisphere. This, however, in itself would be no bar to the acceptance of the theory, since we know that in the case of malaria several species of *Anopheles* are concerned in the transmission of the disease.

Another theory is the one recently advanced by Alessandrini in his paper, "Pellagra due to Filaria in drinking water from shallow wells," in Policlinico (June 26, 1910). He claims that the sea shore and mountainous regions are exempt, and that the disease ceases to spread where artesian wells are substituted for shallow wells and surface drinking water. As *Simulium* is particularly common in the vicinity of small streams in mountainous regions, and cannot breed in quiet surface water or shallow wells, the views of this investigator are decidedly opposed to those of Sambon.

Though laboratory methods are necessary to finally establish the fact whether or not this little gnat is concerned in transmitting pellagra, the peculiarities in its breeding habits give the physician living in regions where the disease is prevalent a basis upon which to work.

Psila rosæ (Carrot rust fly) on parsnips.

This insect has occasionally been reported from Canada and also from Maine and New York as injurious to carrots and celery. This spring some parsnips which had been in the ground over winter, were pulled, and found to bear the characteristic "rust spots" of the carrot rust fly. The pupal skins were found in the ground, not adhering to the roots. The larvæ form cavities, especially in the upper third of the root, the cavities not exceeding ½ inch in depth. As a number of larvæ were found it appears that part at least hibernated in this state. Adults emerged the first 2 weeks in May. Many parsnip roots exposed for sale in the markets in this vicinity at this time were found to be similarly affected.

Eurosta solidaginis.

See *Eurytoma gigantea* under Hymenoptera.

Phorbia fusciceps (Fringed Anthomyiian).

In a market garden in Orono many bean plants were affected by the larvæ of this insect mining in the cotyledons and stems early in June. Though at first the plants seemed severely injured, after the larvæ had pupated most of the plants fully recovered, apparently unaffected by the earlier injury.

Some complaints were also received from farmers in Aroostook County claiming injury to seed potatoes. Specimens submitted were badly decayed and infested with the larvæ of this fly. It is quite possible that the infestation by the fly occurred after decay had set in, as some decayed tubers were found free from larvæ. The flies emerged the latter part of June.

Phorbia (Chortophila) cinerella.

A number of specimens, both male and female, were reared from larvæ associated with *Musca domestica* from horse manure, the flies emerging about September 1. This insect was first described by Fallen and redescribed by Meigen under the name of *pusilla,* under which name it is given by Schiner (II. p. 638). The description by Rondani in Dipt. Ital. Prodromus VI. p. 220 is most characteristic.

Hæmatobia serrata (Horn fly).

This insect has been recorded from Maine in the Report of Maine Agr. Expt. Stat. in 1892 and again in 1896. These pests were very abundant this year during August, upon the University herd.

Musca domestica (Typhoid fly).

Many specimens were reared from nearly fresh, non-fermenting horse manure. The eggs were deposited about Aug. 20, the flies emerging September 8-10. Associated with this species were the larvæ of *Sphærocera subsultans, Borborus geniculatus,* and *Phorbia cinerella.*

Phormia regina.

The larvæ of this widespread species were found early in July, in decaying water melon rind. Adults emerged July 29-30. In the key on p. 342 of Williston's manual (3d Ed.) the last line reads, "Mesonotum flattened behind transverse suture." This does not apply to *Phormia regina.* See also Townsend's statement in last paragraph on page 123, Smithsonian Miscellaneous Collections, Vol. 51, and Thompson's note, last paragraph on page 213, Psyche, Vol. XVII.

COLEOPTERA.

Beetle injuries most frequently noticed this season were those caused by *Saperda candida* (Round-headed apple-tree borer), *Conotrachelus nenuphar* (Plum Curculio) on the apple, and *Pissodes strobi* killing the terminal shoots of young pine. Other injurious species are those noted below.

Amphicoma vulpina.

Mr. John C. Parlin of Norridgewock sent in some specimens of this species with the statement that he had seen large numbers of them clinging to oat heads and flying over the field near Buckfield, Maine. He writes further, " * * * the owner of the farm told me that in June he found in a corn field adjoining the grass field a great number of brownish grubs which they called 'little grubs' to distinguish them from the 'white grub.' * * * He said they were about the diameter of a lead pencil, shorter than the white grub. Of course he does not know that these grubs were the larvae of *Amphicoma* but when he found the beetles so abundant just off that end of the corn field he connected them in thought even before I spoke of them. He said there were thousands of the beetles in the field." Mr. Parlin states in a later communication that the corn field was an old run out June grass field the year before. He also had seen the beetles in great numbers in the vicinity of Norridgewock flying over a newly mown field.

Callidium antennatum (Black horned Callidium).

The larva of this species was noted by Harris, and later by Packard, living in the trunks of pines and junipers. It was again noted in Bulletin 148 (Me. Agr. Sta.) numerous specimens having been found at Athens in the attic of a new house, the inference being that they emerged from the pine timber. Specimens were also found in Orono resting on cedar trunks. This year some specimens were sent in August 10 from East Holden, Maine. Lots 18 and 1294.

Saperda obliqua (Alder borer) infesting birch.

A number of specimens of this species were found in Orono in the small branches (½ to 1 inch in diameter) of the European white weeping birch *(Betula alba)*. At the time of pupation, the latter part of June, the branches containing grown larvae and pupae were broken off by the wind, the break occurring near the cell containing the insect. The larvae are white in color. Adults were obtained about 2 weeks later. Lot 1229.

Otiorhynchus sulcatus (Black vine weevil).

This species has been recorded by Professor Forbes, Mr. Swartz, and also by Doctor Fletcher of Canada upon corn, ferns, and the cyclamen. In March of this year Mr. Wm. Miller of Bar Harbor sent in specimens for identification which were said to be nibbling the flowers while the larvae were doing much damage to the roots of cyclamen. As the species works by night some difficulty was experienced in catching the culprits. Lot 852.

HYMENOPTERA.

Lophyrus abietis (Fir Sawfly)

This year there have been no complaints made to the Experiment Station concerning this insect which for several seasons has been so injurious to the firs in some parts of the State.

Emphytus canadensis (Violet sawfly).

Some larvae answering Dr. Dyar's description of the above mentioned species were found July 2 in Orono, feeding upon pansies. This insect has been reported from several northern states and from Canada. In Bul. 27, n. s., U. S. Dept. Agri., Div. Ent. p. 26, is given a full account of this pest. Lot 1236.

Aulax glechomae and *Torymus flavicoxa*.

Spherical galls were very common this summer upon plants of *Nepeta hederacea* (Ground Ivy) which grow abundantly along the roadsides near the University campus. The galls (Fig. 4) which are usually green, though sometimes tinged with red and yellow, were full grown by the end of July and by the middle of September had become dry. They do not appear to differ from Connold's figure in "British Vegetable Galls." The gall maker is an *Aulax* in the sense of Kieffer *(Genera Insectorum)* and answers Cameron's description of *A. glechomae* in his "British Phytophagous Hymenoptera," excepting that the abdomen is uniformly dark brown and shining. Some plants with galls upon them were transplanted to the Insectory in June. In September, when examined, each gall was found to contain a single mature, fully developed *Aulax;* while all galls gathered from plants growing in the open at this time were found to contain larvae of Hymenopterous parasites. Galls gathered in the fall of 1909 and kept over winter produced only parasites *(Torymus flavicoxa,* lot 767) which emerged in June.

Eurytoma gigantea.

Is this species a true gall maker or is it parasitic upon the larvae of *Eurosta solidaginis?* The galls in which they are found cannot be distinguished externally from those inhabited by the Trypetid excepting possibly by their slightly smaller size. The cavity within the gall, however, is irregular in shape, discolored and darkened, and filled with frass, differing in this respect from the cell of the dipteron which is clean and oval in shape. Larvae of various sizes of the Hymenopteron were found in the smaller galls collected March 29, while only pupae of the Trypetid were present in the larger galls. In August galls were again gathered and examined. Each contained a half grown *Eurytoma* larva and in none was there evidence of it having been inhabited by the Trypetid. The fact that the frass seems to be of plant tissue, that the gall cell is irregular in shape, and that half grown larvae are found, all lead one to believe that this species is not parasitic.

HETEROPTERA.

Blissus leucopterus (Chinch bug).

Complaints have been made that some insects, spoken of as "ground fleas" kill the grass in large patches on the lawns in Bar Harbor and in Bangor. An examination showed that the injury was due to the nymphs of the Chinch bug which were present in large numbers. Some years ago this trouble was more wide spread. The details of these former occurrences and the remedies suggested will be found in the Reports of the Maine Station for 1892 and 1894 and also in Bulletin 91 (1903). Lot 1276.

HOMOPTERA.

Gossyparia spuria (Elm bark louse).

Badly infested twigs of the American Elm were sent in from Castine, Maine. Several trees upon the University campus at Orono are also affected. Lot No. 1298.

Phenococcus sp.

Some specimens of what may be *P. dearnessi* with the description of which they agree, were sent in from Wiscasset, Maine, in June. The white downy secretions make this insect a conspicuous object. They were found under the bark of an apple tree. Lot No. 1244.

Eulecanium canadense.

This species was abundant on the branches of an elm tree in Bridgton, Maine, June 9, 1910. Lot No. 1207.

Chionaspis lintneri.

One tree of *Betula populifolia,* was found in Orono in August badly infested with this scale. Lot No. 1300.

PSYLLIDAE.

EDITH M. PATCH.

So little attention has been paid the psyllids in New England that a group of 6 species taken in Maine during the summer of 1910 has been of interest to the collectors. Two of these, at least, *Psylla pyricola* and *P. striata,* from the character of the host plants are of real economic importance, the one being at times a serious pest of the pear and the other when abundant being injurious to the new growth on shade birches. Besides these 6 species, a blackberry psyllid is sometimes abundant in Maine but we have at present no material to work up for this.

For the study of structural characters, the admirable paper by Mr. H. B. Stough* has been of great aid and the species here briefly recorded were worked over with reference to that publication. For the Comstock-Needham terminology of psyllid

*1910, H. B. Stough. The Hackberry Psylla. Pachypsylla Celtidismammae Riley. A study in Comparative Morphology. The Kansas University Science Bulletin, Vol. 5, No. 9.

wing veins (Fig. 18) the reader is referred to "Die Fossilen Insekten"** and to "Homologies of Wing Veins"*** for the interpretation of *Sc* and *R*.

Psylla pyricola.

Apparently the first record of an infestation of the common pear tree psyllid in Maine was given by a correspondent in Camden, Maine, September 10. The pear leaves submitted were badly discolored both by the psyllid work and the attendant honey dew fungus. Nymphs, pupae and adult psyllids were abundant at this date.

Psylla floccosa.

The downy psyllid of the alder was very abundant upon the new growth of *Alnus incana* (L.) Moench, this spring. This species was described in The Canadian Entomologist Vol. 41, pp. 301-303. For the sake of comparison with the two new species of this genus which follow a few characters of *floccosa* are here given.

Head. The head is broader than the prothorax, and of practically the same type as that of *galeaformis*. The epicranial plates are distinctly separated by a median suture and the 3 ocelli are arranged as in *galeaformis*. Like the 2 other representatives of this genus here described the antennae are normally 10-jointed and a single distal circular sensorium is borne upon joints IV, VI, VIII and IX. The terminal spine-like setae are nearly equal in length. Slender setae are present, but not numerous, on joints III-X inclusive. The antenna is about 2.5 mm. long and filiform and the tip extends nearly to the genital segment of the abdomen. Fig. 8 gives the head in cephalic aspect.

Wings. Fig. 5. The wings are colorless but in form and venation they are exceedingly similar to *galeaformis*, and the stigma though indicated is very narrow and pale. The wing is about 4.2 mm. long.

Genitalia. Male. The supra-genital plate is somewhat cylin-

**1906-1908. A. Handlirsch. Die Fossilen Insekten und die Phylogenie of Rezenten Formen.

***1909. Edith M. Patch. Homologies of the Wing Veins of the Aphididae, Psyllidae, Aleurodidae and Coccidae. Annals of the Entomological Society of America, Vol. 2, No. 2.

drical and without lateral processes. At the geniculation the copulatory organ is enlarged and knob-shaped. From a lateral aspect the forceps widen out near the tip. The tip on the inner surface has 2 blunt processes not claw-like as in *galeaformis,* and the inner setae at the tip are much more numerous than in *galeaformis.* Fig. 7 will give an idea of some of these characters.

Female. The lateral aspect of the genital segment (Fig. 6) shows the following characters for the female. The dorsal line of the supra-genital plate is nearly straight to near the tip where the end of the plate is abruptly and conspicuously turned up. The setae of this plate are scattered but long, and they are not present at the tip. Numerous setulae, small and blunt, give the plate a pebbly appearance when viewed through a 1-6 in. objective. Circum-anal wax glands are present. The subgenital plate has a pointed end and the surface is very sparingly supplied with setae the length of those upon the supra-genital plate. The ovipositor and the very broad sting-palpi extend beyond the upper and lower plates. Fig. 6.

Psylla galeaformis n. sp.

Specimens of this species have been taken from the leaves of the Alder, *Alnus incana,* July 26, 1905; August 17, 1905, and September 1, 1910. In head and wing characters it is so much like *floccosa* that they might easily be taken for the same species. These 2 alder species can, however, be definitely separated on the characters of the genitalia as will be seen from the accompanying descriptions and figures. The frontal cones of *galeaformis* are relatively shorter and blunter than in *floccosa* and the wings are yellow which distinguishes them from the hyaline, colorless wings of *floccosa.*

The general body color of a well colored specimen is pale yellowish brown beneath and dark brown dorsally. Head reddish orange dorsally, rest pale yellowish brown. Thorax with lobes reddish amber marked with white curved lines, the lobe of the metathorax being redder than the others. Legs are pale yellowish brown. The fore-wings are transparent and a pale golden brown in color with veins brown except at base, where they are greenish. Abdomen with about 7 dark brown transverse heavy bands, between the first and second of which is a deep rich red band. The genital segment is dark brown.

Head. The head is broader than the prothorax. The cephalic aspect (Fig. 13) presents 2 sub-quadrate epicranial plates, the dorsal margin of which gives a decided concave curve. A distinct median suture separates the plates. All 3 ocelli are visible in this view of the head. The front ocellus, situated at the ventral end of the median epicranial suture, is just at the median dorsal angle of the frontal lobes. The frontal cones are large, triangular processes, their combined bases extending the full breadth of the head ventrad the compound eyes, and in length the cones are nearly equal to the length of the epicranial plates from the same aspect. The distal tip of the cone is directed ventrad. The setae of the cones are longest and most numerous near the tips. The antennal sockets are about on a line with the front ocellus. The antennae are about ·2.75 mm. long, reaching if extended backward far along on the abdomen. The antenna is 10-jointed. III is longer than any other joint, IV to VIII are subequal, IX and X combined are about equal to VIII. Joints IV, VI, VIII and IX each bear a single distal circular sensorium. There are a very few scattered slender setae on the antenna and X is armed with two stout terminal spine-like setae not quite equal in length.

Wings. In form and venation the wings of *galeaformis* are typical of the genus Psylla. The stigma is distinctly indicated but narrow, appearing like a mere widening of the costal margin. Fig. 9 gives a more adequate idea of the venation than a description. The wing length is about 4.1 mm.

Genitalia. Female. The genital segment is long and tapering, from the lateral aspect. The supra-genital plate has a slight concave curve in dorsal outline, the tip is rounded and somewhat hood-shaped and is bristling with long setae. Setae of the same sort are present but less numerous along the dorsal line of the supra-genital plate back from the tip and along the lateral surface are small but stout spine-like setulae which are visible through a 1-6 in. objective. The subgenital falls far short of the supra-genital plate in length. The tip is pointed and splinter-like. Along the ventral surface are long setae and on the lateral surface are short, stout spine-like setulae, both setae and setulae being practically the same as those of the upper plate. The ovipositor slightly exceeds the supra-genital plate in length. The sting-palpi are narrow, compared with those of *Psylla floccosa*. Fig. 12 represents this segment.

Male. The genital segment (fig. 10) is of the same general type as that of *floccosa* and it would be difficult to separate these two species on that segment without a dissected mount. A reliable character is found, however, in the forceps of the subgenital plate. When viewed from the caudal aspect each arm of the forceps is seen to be tipped with two acute claw-like projections in contrast with the blunt forceps of *floccosa*. The terminal inner setae of the forceps are not so numerous as in *floccosa*. Fig. 11.

The color notes are taken from the living specimen, and the structural details from balsam mounts. Cotypes collected from *Alnus incana* (L) Moench. July-September, at Orono, Maine. (Lot 1326 Sub. 3.)

Psylla striata n. sp.

The tips of birch shoots were very commonly covered by inconspicuous woolly masses in the new growth during the spring of 1910. Concealed in this protective covering were psyllid nymphs. Late in June the mature forms appeared. The freshly molted specimens had greenish thorax and abdomen and yellow wings. Among the older well colored individuals the females had 3 distinct, abruptly marked color divisions, the head and thorax being amber yellow, the abdomen vivid green to the cephalic edge of the genital segment which was dark yellowish brown. The wings were amber in tone and darker than the head and thorax. In the male the head and thorax were pale amber yellow, the wings a darker yellow and the abdomen pale green. The eyes of both male and female were dove gray.

Head. The head is broader than the prothorax. The cephalic aspect (Fig. 16) presents the following characters. The 2 epicranial plates taken together are heart-shaped, the dorsal line being a concave curve and the line from the posterior ocelli to the front ocellus being a convex curve. A distinct median suture separates these plates. The frontal lobes are prominent but are relatively shorter than in *floccosa and galeaformis* and are more rounded. They are supplied with setae. The antennae are relatively shorter than in *floccosa* and *galcaformis*. They are 10-jointed. III is the longest joint. IV to VIII are subequal. IX and X together are about equal to VIII. A single distal circular sensorium is borne by each of segments IV, VI, VIII and IX. The 2 terminal stout spine-like setae of X are unequal in length, one being about ¾ the length of the other. The antennal length is about 1.55 mm.

Wings. In form and venation the wings of *striata* (fig. 14) are the same general type as those of *floccosa* and *galeaformis* except that in the *striata* wing the stigma is relatively much wider and more strongly indicated. The wing length is about 2.65 mm.

Genitalia. Male. The supra-genital plate is somewhat conical with the anal opening at the distal tip a little flared. This plate is about evenly and thickly supplied with setae. The forceps of the subgenital plate are also thickly setous, the setae becoming shorter and more spine-like at the tip. The tip of each branch of the forceps is armed with 2 strongly chitinized claws. Fig. 15 gives a very good idea of these structures.

Female. From the lateral aspect, well shown in Fig. 17, the genital segment of the female shows the following characters. The supra-genital plate is fusiform at the end. This fusiform portion is without long setae and the margin is striated. A few scattered setae are present along the dorsal line and numerous stray blunt, very short setulae thickly stud the lateral surface of the plate. A well defined circular area of circum-anal wax glands is present at the cephalic portion of the plate. The subgenital plate is broader than in *galcaformis* and *floccosa* and the tip is gently curved up. There are a few setae present chiefly along the ventral line and the lateral surface of the plate is thickly set with strong setulae similar to but longer than those of the upper plate. The lower plate is considerably shorter than the upper. A little cephalad the tip of the lower plate the ovipositor takes a sudden bend dorsad and the tip of the ovipositor touches the supragenital plate, but does not extend to the end of the plate.

The color notes are from living material and the structural details are from balsam mounts.

Cotypes collected from *Betula*, June, at Orono, Maine. (Lot 1228)

Aphalara veazici n. sp.

A green bodied psyllid with amber yellow wings was collected in great numbers in the vicinity of Orono. The vegetation swept by the collecting net was *Solidago* and *Myrica asplenifolia* L. (sweet fern) in one locality and grass, *Solidago* and other growth in a second locality. The nymphs were not found and the host plant is as yet unknown. The species was most abundant in late June and early July, though a few specimens were taken in the same localities July 27.

Head. The head is broader than the prothorax and nearly twice as broad as long when viewed from the dorsal aspect. The cephalic aspect of the head (Fig. 19) shows 2 approximate but separated quadrate *epicranial plates (ep)*. These are raised and very distinct. At the latero-caudal angles of these plates are situated the posterior ocelli. In a triangular enlargement of the suture between the 2 epicranial plates at their mediocephalic angles is situated the front ocellus *(fo)*. The ventral aspect of the head (fig. 20) shows the *frontal cones (fc)*, ovoid in outline placed one on each side the *frons (fr)*. The frons is also rather ovoid and about the size of the frontal cones. The distal end of the frons projects caudad. The antennal sockets are about on a line with the front ocellus and are situated in an angle caudad the frontal cones and mesad the compound eyes. The antenna, if extended backward, would reach a little caudad the base of the first pair of wings, their length being about 0.8 mm. There are 10 joints. III is longer than any other. IV to VIII are subequal, each being about half the length of III. IX and X are shorter and broader than the preceding joints. X with two stout terminal diverging spines, one of which is slightly longer than the other. Joints IV to VIII inclusive each bear a single distal, laterally placed, circular sensorium fringed with delicate hairs. These resemble somewhat the terminal sensorium of the fifth and sixth antennal joints of the aphids. The antenna is not setose.

Wings. The wings are amber yellow in tone and are with or without pale brown flecks which when present give the distal portion of the wings a mottled appearance. The variation in the flecking of the wings is perhaps due to differences in the age of the individuals, as psyllids are uniformly paler when young than the more highly colored individuals. The distal end of the wing is rounded and the veins are stout. There is no stigma, R1 striking the margin at a point a little nearer to the base of the wing than to the distal end of Rs. The cephalic branch of R touches very nearly the extreme tip of the wing. The wing length is about 1.85 mm. Fig. 18 gives a typical wing of this species.

Genitalia. In the male the abdomen is abruptly constricted just cephalad the genitalia. The *supra-genital plate (sa)* is a fleshy upright structure attached to the dorso-cephalic portion of the subgenital plate. It ends distally in a membranous ring which is the anus*(a)*. Extending caudad from the lateral areas of the supra-genital plate are two *lateral processes (lp)* of this plate. In a lateral aspect these plates are triangular in form, the cephalic portion being attached to the upright portion of the supra-genital plate. The distal portion of these lateral processes touch the lateral surface of the forceps when the forceps are directed cephalad. The supra-genital plate is armed with short spine-like setae which are visible through a 1-6 in. objective. Those near the region of the anus are longest and stoutest.

The arms of the forceps *(f)* at the caudal extremity of the sub-genital plate *(sg)* are from the lateral aspect largest at the distal end which is blunt and somewhat rounded. Each arm (Fig. 24) is supplied on the inner surface near the tip with a large strong claw-like process. The forceps when examined through a 1-6 in. objective are seen to be sparsely supplied with setae. At the base of each arm on the cephalic surface is a strong spine-like seta. Figs. 21, 22 and 24 represent these parts.

The genital segment of the female is somewhat wedge shaped and is less than the combined length of the 3 preceding ventral segments. The supra-genital plate *(sa)* is gently up-curved at the distal tip. The dorsal portion is supplied with long setae plainly visible through a 2-3 inch objective. Its lateral surface is thickly beset with very short, stout setulae visible through a 1-6 inch objective. Near the base of this plate at the dorsal median line is a region of circum-anal wax glands. These were difficult to locate in the ordinary dissected balsam mount. The subgenital plate *(sg)* is not so long as the upper plate, being about the length of the 2 preceding ventral segments. Its surface is sparingly supplied with small setae, larger however than the setulae of the supra-genital plate.

The brown highly chitinized pointed tip of the ovipositor extends about to the tip of the supra-anal plate *(sa)*. Fig. 23 gives a good lateral aspect of this segment.

The color notes are from live specimens and the structural notes are from balsam.

Cotypes collected in June and July at Orono and Veazie, Maine. (Lots 1232 and 1326 Sub. 1).

Trioza obtusa n. sp.

This species was bred from nymphs developing on *Amelanchier canadensis* (L.) Medic, the winged forms appearing July 6, 1910, and later. A male of the same species taken from *Amelanchier* is in our collection with the date August 1, 1906. In general coloration this species varies from pale green bodied freshly molted individuals with colorless hyaline wings, to older deeply colored individuals with bodies of ochre yellow and wings very dark and smoky. The mesonotum is roundly pointed cephalad and more elevated than pronotum.

Head. The frontal cones are not vertical but are distinctly visible from above. They are widely diverging, the mesal line being convex and the lateral line concave. The tip is rather acute. A dorso-cephalic aspect of the head (Fig. 29) shows 2 quadrate epicranial plates with a median suture between them. All 3 ocelli are visible in this aspect. The antennae are short and 10-jointed. IX, X and distal VIII are darker and somewhat broader than the preceding joints. IV, VI, VIII and IX each bears a distal circular sensorium. Two very unequal setal spurs terminate X, the shorter one being about half the length of the longer and thicker. The antennal length is about 0.85 mm.

Wings. Fig. 25 sufficiently represents the form and venation of the fore wing. They are sometimes very dark and 3 characteristic black dashes are present at the wing margin, one between the cubital branches, one between the branches of media and one between media and cubitus. The wing is roundly pointed at the apex between the branches of media. The venation is a good *Trioza* type, the main vein branching into R, M, and Cu at practically the same point. There is no stigma. The wing length is about 2.63 mm.

Genitalia. Female. The genital segment ends in an obtuse point. Fig. 26 represents a slightly dorso-lateral view. The supragenital plate has no long setae at the tip but some very small setulae. A circum-anal area of wax-glands is present at the cephalic portion of this plate. The deep hollow subgenital plate is pointed at the apex. There are numerous stout setae scattered over the surface but none at the distal tip.

Male. The abdomen of the male is strongly constricted just cephalad the genital segment. The supragenital plate consists of an erect portion ending in a circular opening,—the anus. Extending nearly from the base but not quite to the tips of this portion are two broad lateral processes. These processes are concave on the dorsal line and bluntly rounded at the tip. They are very thickly set with setae. A row of very long, strong lash-like setae fringe the concave line of these processes and are thickest at the tip. The forceps of the subgenital plate are strong structured enlarged and blunt at the end, and considerably constricted about midway their length. Fig. 27 shows this segment.

The nymphs of this species were found in all stages upon the leaves of *Amelanchier canadensis*. They were collected by Mr. William C. Woods, July 6 to July 27, 1910. They fed upon the ventral surface of the leaves where their presence was readily detected on account of the beautiful white floss-like wax filaments that curled softly up from the margin of their bodies. These wax filaments are secreted by wax glands which extend in a single marginal row in the earlier stages but which in the later instars occur both on the margin and for a considerable distance mesad on the dorsal surface of the body. A crescent shaped area of wax glands surrounds the anus in all the nymphal stages.

Nymph. First instar. Fig. 30. The marginal wax tubes are cylindrical and are arranged 8 on each side of the head cephalad the eye, one on each thoracic segment at the caudal angle, and about 12 along each side of the abdomen.

Second instar. Fig. 31. The marginal wax tubes are cylindrical and are arranged 10-13 on each lobe of the head cephalad the eye; a single prothoracic waxtube situated caudad the eye, 7 along the mesothorax, 3-4 on the metathorax, and about 18 along each side of the abdomen.

Third instar. Fig. 32. The marginal wax tubes are not quite uniform in size. They are arranged 14 on each lobe of the head cephalad the eye, a single one on the prothorax just caudad the eye, 15-16 on the wing pad of the mesothorax, 4-5 on the wing pad of the metathorax and about 30 along each side of the abdomen.

Fourth instar. Pupa. Fig. 33. The marginal wax tubes are vasiform and vary in size. Upon the head the wax tubes are thickly situated over an area nearly the breadth of the eye. There is one prothoracic marginal wax tube just caudad the eye. The marginal wax tubes of the mesothoracic wing pad number about 60 while others are present extending mesad, and the marginal tubes of the metathoracic wing pad number 10-12. On the abdomen are about 60 marginal tubes and a thick triangular area of dorsal tubes extending cephalad.

The thorax and abdomen of the pupa are pale green with pale yellowish brown broad transverse bands. The head is of a pale yellowish brown tint, with dark eyes. The antennae hardly reach the wing pads which are creamy white. Entire body with a stiff but delicate white fringe of long wax filaments in an unbroken and perfectly regular row.

Cotypes collected on *Amelanchier canadensis* (L.) Medic, in July at Orono, Maine. (Lot 1238).

APHIDIDAE.

EDITH M. PATCH.

Mindarus abietinus Koch.

(*Schizoneura pinicola* Thomas).

On July 12, 1909, the tips of white spruce, *Picea canadensis* (Mill.), and balsam fir, *Abies balsamea* (L.) Mill., in the vicinity of Orono were noticed to be very generally and very seriously affected. No cause for the trouble could at that date be found. In the growth of mixed young balsam fir and white spruce the new shoots of the fir were entirely killed, having withered after making a growth of about one-fourth inch. The spruce tips were much ruffled and in many cases also dead and it was surmised that the same cause might be responsible for the trouble of both these conifers. (Lot 759. Lot 760).

It was not until May 25, 1910, however, that the explanation of this fir and white spruce trouble was chanced upon. At this date the new growth of both these conifers on the Maine Campus was noticed to be badly ruffled and upon examination found to be thickly packed with *Mindarus abietinus.* Only apterous viviparous forms were present, those on the fir being mature and already producing, while those collected on the spruce molted on the night of May 25 and were producing by the 27th. The tender new growth was the only part of the tree infested, the aphids feeding upon the shoots and the needles becoming curled, roughened, and uneven from the disturbance. The infestation was so severe that these trees could not be touched without a heavy shower of honey dew ensuing and the branches were wet with the sticky globules.

In the vicinity of Orono these aphids were so very generally attacked by Syrphus maggots that by the first of June scarcely a *Mindarus* could be found, and in their stead hungry syrphids were vainly seeking for food. Practically the whole infestation in this locality was therefore wiped out about two weeks before the usual time* for the development of the winged forms and their migration from white spruce and fir.

The 1910 growth of both white spruce and fir retained their ruffled appearance during the season and many of the twig tips died. Typical work of *Mindarus* was received July 8, 1910, from Caribou, Maine, from the owner of a fine spruce hedge who reported that it had made excellent growth for about 12 years but that this present season the tips of nearly all the upper branches were dying.

The work of this insect is illustrated by Figs. 34-36, these photographs being taken July 11 of spruce and fir twigs which were thickly infested late in May.

Specimens of *Mindarus abietinus* upon *Abies balsamea* were sent from Highspire, Pa., on May 25, with the comment that they were present in 4 different localities. These were winged which would indicate that the migrants develop some 3 or 4 weeks earlier in that region than in Maine.

The summer generations of *M. abietinus* have not been found in Maine. Of special interest in this connection is the record by Doctor Felt (25th Report) of the abundance of *pinicola* Thomas

*Me. Agr. Expt. Sta. Bulletin 182, p. 244.

upon the roots of white pine seedlings, and the fall migration thence. (Aphid Nos. 21-10, 22-10, 53-10, 54-10).

RECENT LITERATURE ON MINDARUS ABIETINUS KOCH.

Felt, E. P. Schizoneura pinicola Thomas. 25th Report of the State Entomologist (1909) 1910. pp. 80-81.

Nüsslin, O. Zur Biologie der Gattung Mindarus Koch. Biologischen Centralblatt. Bd. XXX, Nr. 12 and 13. 15. Juni und 1, Juli 1910.

Patch, Edith M. Me. Agric. Expt. Sta. Bul. No. 182, pp. 242-245. 1910.

Tullgren, Albert. Aphidologische Studien I. Uppsala 1909. pp. 59-61.

Aphis sedi Kalt.

The Garden Orpine, or Live-for-ever, *Sedum purpureum* Tausch., along the Orono roadsides was observed to be badly deformed in June, the stem terminating in a rosette of abnormally small leaves (Fig. 3). The aphid concerned with this deformation corresponded to *Aphis sedi* Kalt as presented both by Koch and Buckton and there seems no reason to consider it a different species. This species has not previously been recorded for America. (Aphid 24-10).

Eucallipterus tiliae (Linn.)

From September 5 to 29 collections of *E. tiliae* were made from the ventral surface of leaves of the basswood. *Tilia americana* L. at Orono. During this month, apterous viviparous, alate viviparous, apterous oviparous females and alate males were taken. (Aphid 110-10).

Pemphigus rhois (Fitch).

Sumacs in Bangor, Me., were rendered particularly ornamental this fall by virtue of great numbers of the large beautiful galls of *P. rhois* on the leaves. The aphids in one gall were counted on October 2, and 141 apterous viviparous forms, 1150 winged viviparous forms besides numerous nymphs and pupae were present in a single gall. (Aphid 145-10).

Hyalopterus arundinis (Fab.)

An especially heavy infestation of *H. arundinis* occurred on a variety of large green plum trees at Orono this season. Later in July the leaves on the ventral surface were so thickly packed that there was "beak room only" for the aphids present, the rest of their bodies being pressed out from the leaf and supported by one another. No tendency of leaf curl was manifested, the leaves remaining perfectly flat. (Aphid 79-10).

Tetraneura graminis (colophoidea).

Through a misprint on page 208 of Bulletin 181 of this Station the name of this insect appeared written as a trinomial. *Colophoidea* should have been enclosed in braces as it here appears.

Chermes cooleyi in New England.

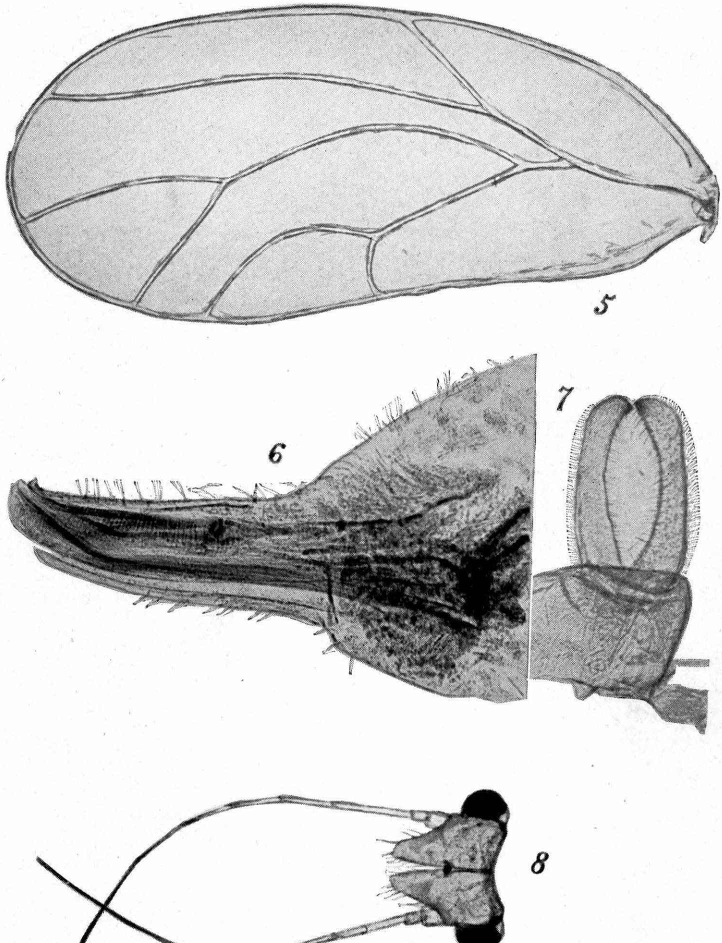
Typical large, well-formed galls of *Chermes cooleyi* Gillette were received from Manchester, Mass., in September 1910, where they were taken on Colorado Blue Spruce. As this tree is not generally grown in the east the infestation is of especial interest. In *Chermes of Colorado Conifers,* Proceedings of the Academy of Natural Sciences of Philadelphia, 1907, Professor Gillette states that in Colorado this species migrates to red fir, *(Pseudotsuga mucronata)* and that he finds the galls most numerous in parks or lawns where the blue spruce and red fir are clustered together. This fact in the life history is significant for its possible economic bearing. In plans for landscape gardening in the east which include the Colorado Blue Spruce, it would seem wise not to plant the red fir or closely allied varieties on the same or neighboring estates.

THYSANURA.

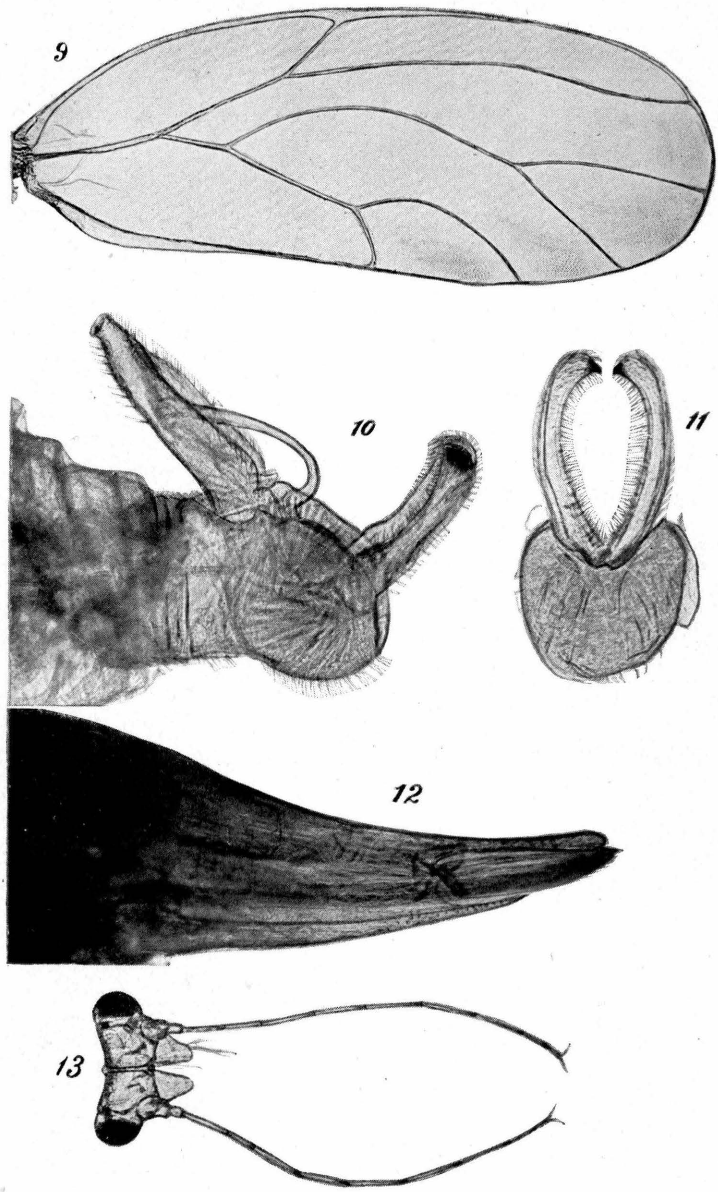
Smynthurus albamaculata (Garden flea).

A correspondent from Newport Farm, Maine, sent in specimens of this insect with the statement: " * * * they eat up everything in sight. I am also sending you a sample of their work on peas and onions. As for small seedlings such as beets, carrots, and spinach, they eat them as soon as they break ground." Accounts of the habits together with the description of this species were published in the Report of the Maine Agricultural Experiment Station for 1896, pp. 124-126. See also notes in Bulletins No. 123, p. 220, and No. 134, p. 225. Lot No. 1152.

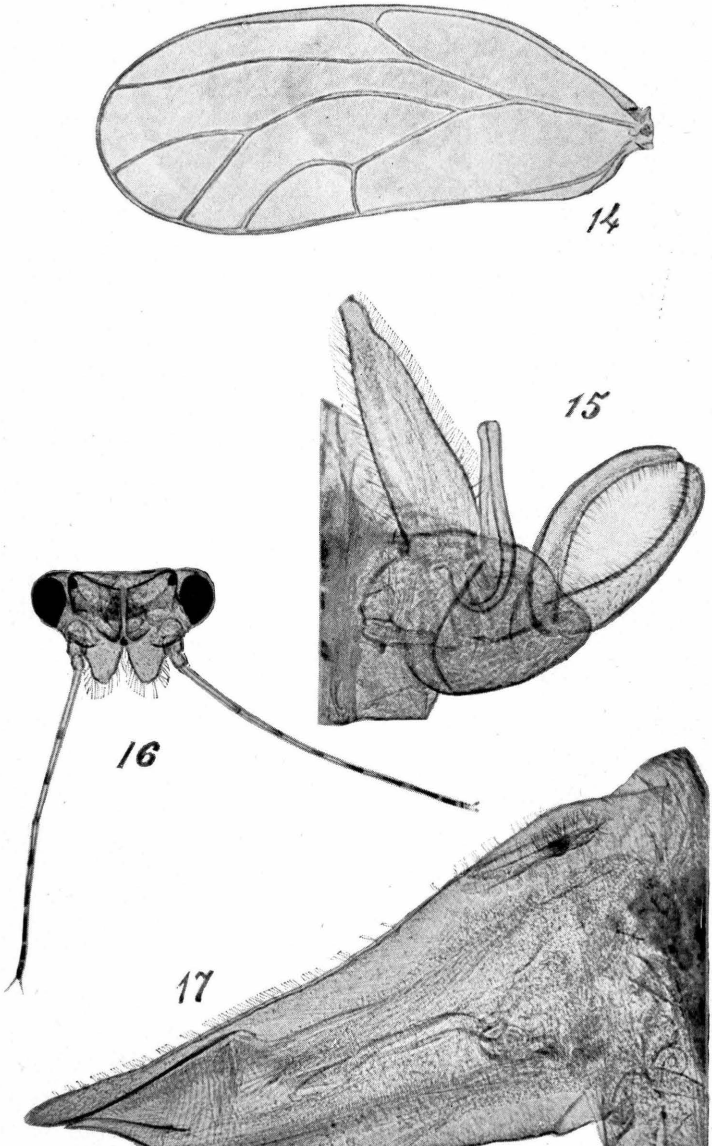
1, Webworm injury. 2, Bag worm (Eurycyttarus confederata). 3, Work of Aphis sedi on Live-for-ever. 4, Gall of Aulax glechomae on Ground Ivy.



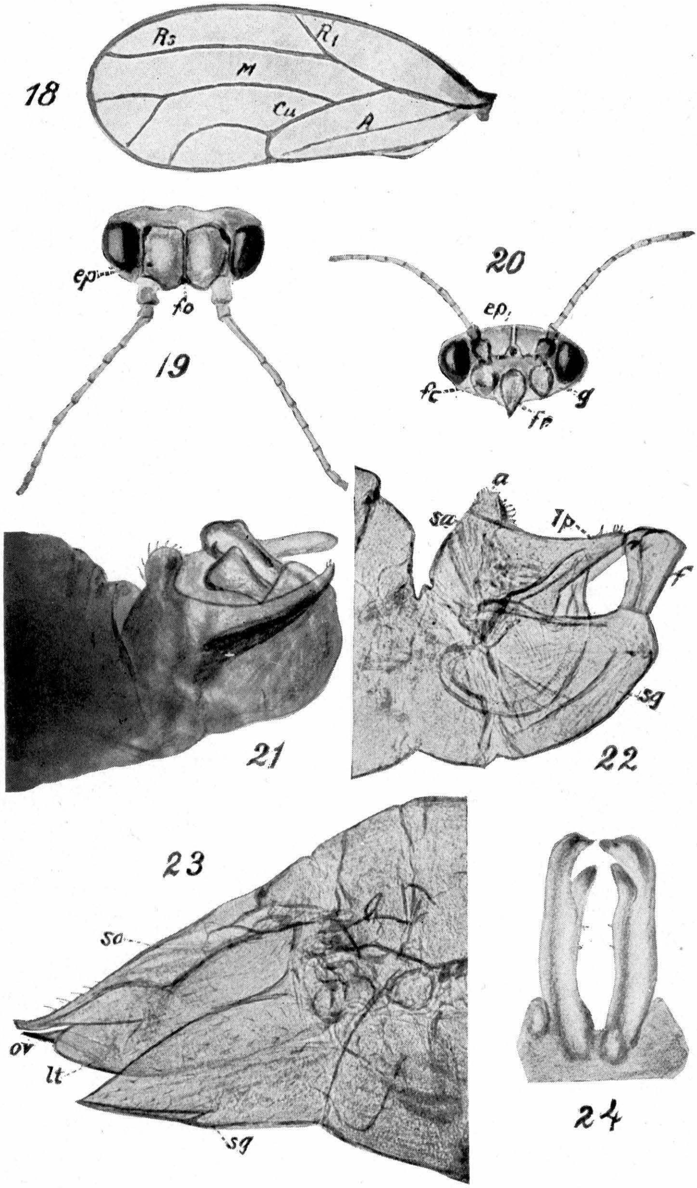
Psylla floccosa. 5, Fore Wing. 6, Caudal segment of female; lateral aspect. Note that the supra genital plate has an abrupt upward turn at apex. 7, Forceps of male; caudal aspect. Note blunt tips. Compare with fig. 11. 8, Head, cephalic aspect.



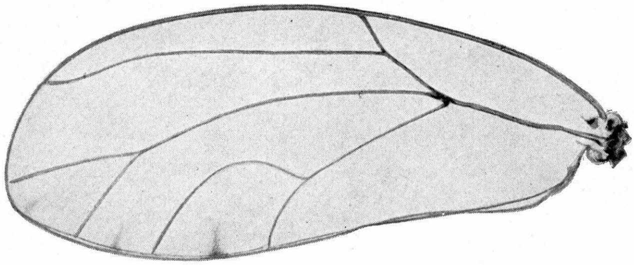
Psylla galeaformis. 9, Fore wing. 10, Caudal segments of male; lateral aspect. 11, Forceps of male; caudal aspect. 12, Caudal segment of female; lateral aspect. 13, Head, cephalic aspect.



Psylla striata. 14, Fore wing. 15, Caudal segment of male; caudo-lateral aspect. 16, Head; cephalic aspect. 17, Caudal segment of female; lateral aspect.

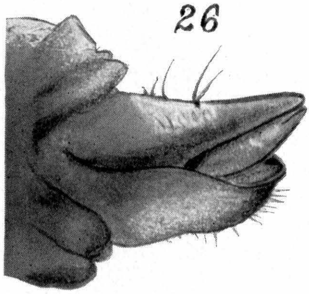


Alphalara veaziei. 18, Fore wing. 19, Head, cephalic aspect. 20, Head; ventral aspect. 21, Caudal segment of male; dorso-lateral aspect, forceps retracted. 22, do.; lateral aspect. 23, Caudal segment of female; lateral aspect. 24, Forceps of male; cephalic aspect.

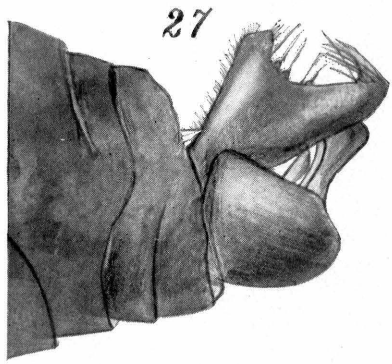


25

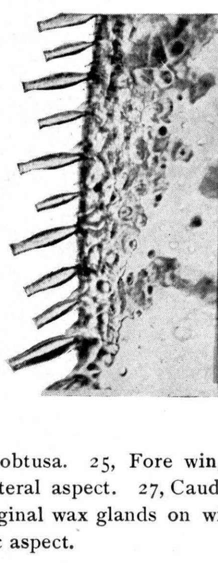
26

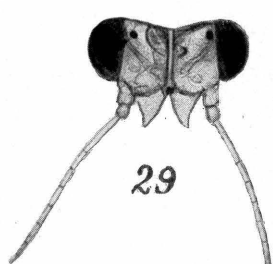


27



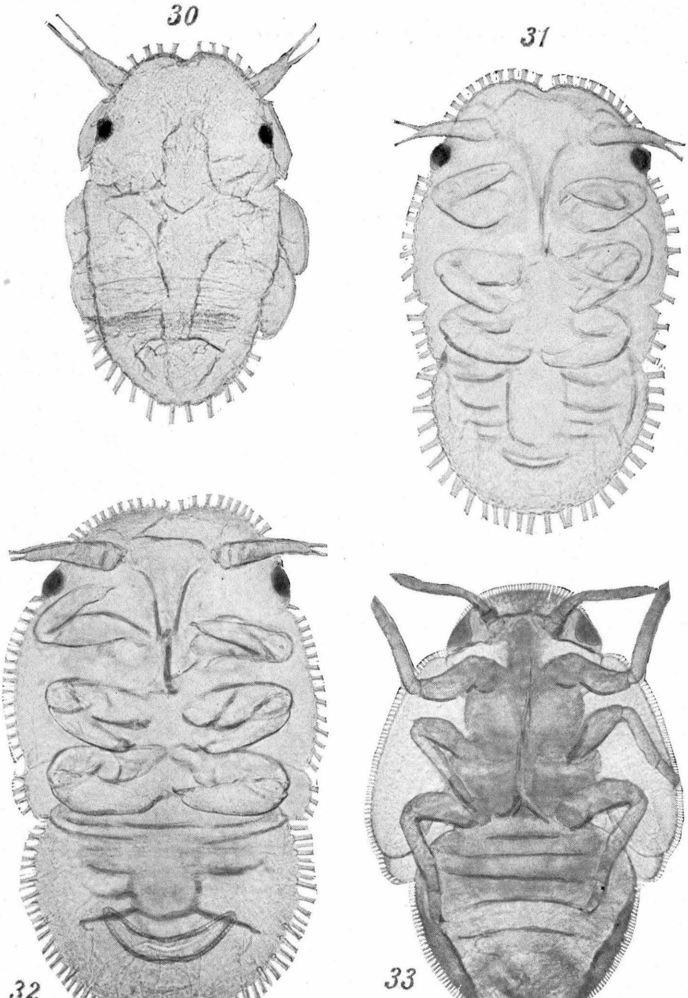
28





29

Trioza obtusa. 25, Fore wing. 26, Caudal segment of female; dorso-lateral aspect. 27, Caudal segment of male; lateral aspect. 28, Marginal wax glands on wing pad of pupa. 29, Head; dorso-cephalic aspect.



Trioza obtusa. 30, First instar. 31, Second instar. 32, Third instar. 33, Pupa.

Work of Mindarus abietinus. 34, On Spruce (Picea canadensis).
35, 36, On Balsam Fir (Abies balsamea).

BULLETIN NO. 188*

FIELD EXPERIMENTS.

REPORTED BY CHARLES D. WOODS.

VARIETY TEST OF OATS, 1910.

According to the Yearbook of the U. S. Department of Agriculture the oat crop in the State of Maine for 1909 amounted to 4,558,000 bushels. The value of this crop on December 1, 1909, is given as $2,661,000. Only two other crops, (potatoes and hay) exceeded oats in the total amount of wealth produced in the State. Nevertheless it is clear that the majority of the farmers in the State devote but little attention to oats as a grain crop. It is seldom that one finds a farmer who plants more than a few acres and these are often cut green and used for hay. Yet the ease with which the oat crop can be seeded, its resistance to late frosts, its adaptability to our climate and soil conditions and the high price which the grain brings in the eastern market, recommend it as a profitable crop. More attention to cultural methods and to seed selection are practically certain to yield greatly increased returns with this crop.

On account of the importance of this crop to the farmers of the State, the Experiment Station has long desired to undertake some experiments relating to better methods of culture than those usually practiced and better seed. The acquisition of Highmoor Farm for experimental purposes made it possible to start some of this work in 1910.

Many of the poor yields of oats are due to poor seed. For this reason it is proposed to undertake some breeding or seed improvement work with oats. The aim of this work will be to obtain varieties which are better adapted to our conditions and which will yield a greater number of bushels per acre.

---

* Experiments on top dressing mowing land and the effect of differcut methods of culture of potatoes were begun in 1910. These will be reported when completed.

As a preliminary to definite breeding operations it is necessary to determine some of the varieties which are best suited to Maine conditions. Accordingly during the past season a number of varieties have been tested. Thirty-one plots were planted, each containing one-tenth of an acre. Twenty-five different varieties were used. In the case of the Kherson, Regenerated Swedish Select and Banner oats two or more plots were planted with the same variety. In these cases, however, each plot represented seed from a different source (cf. Table p. 27). The land selected for the test was to all appearances very uniform. It was a light sandy loam soil sloping gradually towards the east. The land had been summer fallowed the year before to kill out the witch grass. It was disked twice in the spring before the oats were sown. This gave an excellent seed bed. The grain was put in with a disk grain drill and sown at the rate of 2 bushels (by measure) per acre. Commercial fertilizer carrying 3.3 per cent of nitrogen, 10 per cent available phosphoric acid and 7 per cent potash was applied at the rate of 300 pounds per acre. The field was rolled after the grain was sown. Notes were taken on each plot during the growing season. The grain from each plot was cut and threshed separately.

Before planting the seed oats were given the formaldehyde treatment for smut. As a consequence the entire field was free from smut, except for one small patch in one of the plots, where some untreated seed was planted by hand to fill out. Here smut appeared. It is impossible to give accurate figures regarding the matter but the annual loss to the State from oat smut must be large. This loss is entirely preventable. One needs only to treat the oats with a weak solution of formaldehyde before planting. Full directions for carrying out this treatment have been published by the Station as a circular bearing the title "Oat Smut and Its Prevention." A copy of this will be sent to any resident of Maine upon application to the Director of the Station. The treatment is simple and easy of application, and costs almost nothing. One pint of commercial formaldehyde should cost not to exceed 20 cents anywhere in the State, and it will treat 50 bushels of seed.

Table Showing Varieties of Oats, Sources of Seed and Yields Per Plot and Per Acre.

Plot number.	VARIETY NAME.	PURCHASED FROM	Pounds of straw from 1-10 acre.	Pounds of grain from 1-10 acre.	Calculated bushels per acre.	Color of grain.	REMARKS.
1	Danish Island	W. A. Burpee, Philadelphia, Pa.	235.25	149.25	46.6	White.	Late in maturing.
2	Burpee's Welcome	W. A. Burpee, Philadelphia, Pa.	231.75	181.25	56.6	White.	
3	White Tartar King	W. A. Burpee, Philadelphia, Pa.	260.75	185.25	57.9	White.	Closed head.
4	Tartar King	J. Levasseur, Tessierville, Quebec	297.50	215.50	67.3	White.	
5	Black Tartarian	Iowa Seed Co., Des Moines, Iowa	263.50	211.50	66.1	Black.	Closed head.
6	Kherson (Univ. No. 1)	Griswold Seed Co., Lincoln, Nebr.	250.25	222.25	69.4	Yellow.	Early.
7	Kherson	Iowa Seed Co., Des Moines, Iowa	234.00	203.50	63.6	Yellow.	Early.
8	Irish Victor	Iowa Seed Co., Des Moines, Iowa	312.00*	225.50	70.5	White.	
9	Early Champion	Iowa Seed Co., Des Moines, Iowa	264.50	211.50	66.1	White.	Early.
10	Prosperity	Iowa Seed Co., Des Moines, Iowa	287.50	209.50	65.5	White.	
11	Silver Mine	Iowa Seed Co., Des Moines, Iowa	278 00	227.00	71.0	White.	
12	Lincoln	Iowa Seed Co., Des Moines, Iowa	299.00	224.00	70.0	White.	
13	Regenerated Swedish Select	Garton-Cooper Co., Chicago, Ill.	284.25	230.75	72.1	White.	
14	Regenerated Swedish Select	Griswold Seed Co., Lincoln, Nebr.	279.50	222.50	69.5	White.	
15	Regenerated Swedish Select	L. L. Olds Co., Madison, Wis.	280 00	234.50	73.3	White.	
16	Swedish Select	L. L. Olds Co., Madison, Wis.	245.25	209.75	65.5	White.	
17	President	Garton-Cooper Co., Chicago, Ill.	261.75	218.25	68.2	White.	
18	Senator	Garton-Cooper Co., Chicago, Ill.	248.75	171.25	53.5	White.	Closed head.
19	Victor	Garton-Cooper Co., Chicago, Ill.	261.50	190.50	59.5	Black.	
20	Old Island Black	E. E. Arsenault, Urbinville, P. E. I.	244.50	178.00	55.6	Black.	Weak straw.
21	White Egyptian	T. J. Wigginton, Bridgetown, P. E. I.	289.75	181.25	56.6	White.	Closed head.
22	Newmarket	C. R. Gies, Hidelberg, Ontario	254.00	213.50	66.7	White.	
23	Imported Scotch Oats	H. L. Goltz, Bardsville, Ontario	243.00	192.00	60.0	Yellow.	Early.
24	Early Blossom	D. Innes, Tobique River, N. B.	286.25	178.75	55.8	White.	Closed head.
25	Unnamed White, Maine grown	Geo. B. Haskell Co., Lewiston, Me.	222.25	193.25	60.4	White.	Mixed varieties.
26	Banner	W. H. Pawsen, Cooldale, Alberta	248.50	226.50	70.8	White.	
27	Banner	Geo. Boyce, Meridale, Ontario	254.50	208.00	65.0	White.	
28	Banner	W. M. Black, Creelman, Saskatchewan	253.50	221.50	69.2	White.	
29	Banner	W. E. Palmer, Scotch Lake, N. B.	245.25	206.75	64.6	White.	
30	Ligowo	D. Carmicheel, West Lorne, Ont.	277.50	212.50	66.4	White.	
31	Unnamed White, Maine grown	Prof. G. H. Hamlin, Orono, Me.	242.75	210.25	65.7	Mixed.	Mixed, early and late.
	Averages		262.48	205.35	64.2		

* Straw a little damp when weighed.

The table on the preceding page gives for each plot the name of the variety, the source of the seed, the number of pounds of straw obtained from each, the number of pounds of grain and the calculated yield per acre. Data relating to color of the grain and the time of maturity are also given. The weights of the grain and straw were obtained at the time of threshing and before the grain had been recleaned. The number of bushels per acre are calculated on the basis of 32 pounds to the bushel. The seed for Plot Nos. 4, 20, 21, 22, 23, 24, 26, 27, 28, 29 and 31 was purchased from members of the Canadian Seed Growers Association.

SUMMARY.

From this table the following points are to be noted:

1. The average yield over the whole piece was at the rate of 64.2 bushels to the acre. This can only be regarded as very satisfactory when it is remembered that for the State as a whole the average yield of oats per acre in 1909 (Yearbook U. S. Dept. Agr.) was but 37.0 bushels. In the same year the state showing the highest average yield per acre was Montana with 51.3 bushels. The high yield obtained in the experiments here reported shows what it is possible to do under average Maine conditions with proper attention to quality of seed and cultural conditions.

2. The highest yielding variety in the test was Regenerated Swedish Select, with an average of 3 plots at the rate of 71.6 bushels to the acre. The highest yielding single plot was No. 15, the Regenerated Swedish Select plot planted with seed from Wisconsin. There was, however, no significant difference between this plot and No. 13 planted with Garton-Cooper seed.

3. The plot yielding at the lowest rate was No. 1, the Danish Island oats, with 46.6 bushels to the acre. This was an end plot, and probably does not represent the relative worth of this variety. Taking the yield as it stands, however, it is nearly 10 bushels (exactly 9.6) *more* to the acre than the general average for the State in 1909.

4. The Kherson oats, which are so popular in certain parts of the West, yielded very well in this test, somewhat contrary to expectation. They are a small oat but with a relatively low percentage of hull, which enhances the feeding value.

5. The Senator oats (Plot No. 18) made a very rank growth in the field, and were to the casual observer before threshing the best in the test. The straw was heavy, the leaves broad, and the grains very large and plump. Because of the large percentage of hull, however, this variety proved upon threshing to be next to the lowest in rate of yield of all those in the test.

6. From the table it appears that but one plot (No. 1) yielded at a rate lower than 50 bushels per acre. Six plots out of the 31 (Nos. 8, 11, 12, 13, 15 and 26) yielded at the rate of 70 or more bushels to the acre.

7. It is of some interest to examine the yields of the 4 plats of Banner oats, because the seed from which they were planted represents such a wide geographical range. It was thought at the outstart that the New Brunswick seed (Plat 29) would be likely to give a better yield than seed of the same variety from the far west. The climatic conditions in New Brunswick are very similar to those obtaining in Maine. As a matter of fact, however, the two plats planted from seed from the Canadian Northwest (No. 26, Cooldale, Alberta, and No. 28, Creelman, Saskatchewan) each produced at the rate of about 5 bushels more per acre than plot No. 29 from New Brunswick seed.

It is to be understood that these statements are simply based upon the experience in 1910. They are not offered as definite conclusions regarding the relative merits of the varieties concerned. To reach such conclusions it is necessary to conduct such variety tests over a period of years. It is expected that these experiments with oats will be continued in 1911.

High Riidge vs. Modified Ridge Culture for Potato Growing in Aroostook County.

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

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

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

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

EXPERIMENT IN 1907.

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

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

Yield of Merchantable Potatoes Per Acre. 1907.

Plot 1 Full ridge.	Plot 2 Modified ridge.	Plot 3 Full ridge.	Plot 4 Modified ridge.	Plot 5 Full ridge.	Plot 6 Modified ridge.
366 bushels	231 bushels	297 bushels	308 bushels	312 bushels	355 bushels

Average for full ridge culture .... 325 bushels.
Average for modified ridge culture, plots 4 and 6 .... 333 bushels.

EXPERIMENT IN 1908.

For the modified culture experiment this year 90 rows, nearly three acres, were planted on new land on the northwest part of Mr. John Watson's farm in Houlton. The plan of planting in a solid piece instead of in strips as in 1907 was adopted for convenience in cultivating early in the season when it is desirable to run the weeder and smoothing harrow crosswise to keep down the weeds.

While July was rather dry for the high ridge culture, the potatoes did not appear to suffer much from the drought. Abundant rains early in August insured the crop. The yields were as follows:

Yield Merchantable Potatoes 1908.

Full ridge check plot*	314	bushels.
Modified ridge, 3 acres	902	"
Full ridge check plot	268	"
Average for check plots	291	"
Average modified cultûre plots	301	"

EXPERIMENT IN 1909.

This year about three acres were selected for the experiment of fairly uniform land which was in grass the preceding year. Other than part of the field carried a good deal of witch grass it proved to be a good piece for the purpose. Two acres of the middle section of the piece were taken for the low ridge culture and a half acre on each side were planted to check plots and given the high ridge culture.

The spring proved to be cold and wet and the field was not planted until May 31. The whole season had abundant rainfall even too abundant for the high ridge culture during the season. Because of the continued cold and wet the potatoes did not break through the ground until June 18. The potatoes were so late planted and so slow to come up that the vines were still very green and tender when the first frost came early in September. On this account the yields were very materially reduced. They were as follows:

Yield of Merchantable Potatoes 1909.

Full ridge per acre, average two plots	204	bushels.
Modified ridge, per acre	216	"

The average for the three years was

Low ridge culture	273	bushels per acre.
Modified ridge culture	283	bushels per acre.

In these three years there were, therefore, practically nothing to choose between the two methods so far as the yield was concerned in Aroostook County.

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

BULLETIN No. 189

ORCHARD SPRAYING PROBLEMS AND EXPERIMENTS: A REVIEW OF, AND A CONTRIBUTION TO PREVIOUS DATA.

W. W. BONNS.

The spraying of economic plants for the control of insect and fungous enemies has markedly increased within the past decade. This is largely due to the work of experiment stations in demonstrating the effectiveness of the operation and the profit attending it. Great improvements in spray machinery and materials have helped much towards the adoption of spraying as an annual farm operation, and especially is this true of the fruit growing industry. The progressive orchardist today recognizes the necessity of timely, thorough and intelligent application of insecticides and fungicides in order to sell his fruit in the best and most profitable markets.

SPRAY INJURY.

The increase of spraying operations has, however, been accompanied by serious problems for the solution of which the grower turns to the experimenter. The use of bordeaux mixture, for many years the standard orchard spray, and even today recognized as the best all-round fungicide known, has been accompanied by injury to fruit and foliage.

Complaints of such injury have been increasing with each season and are not confined to any section of the country. The severity of the injury varies in degree and in different seasons. It has long been known that bordeaux mixture cannot be used with safety on the peach and Japanese plum when the tree is in leaf, although Cordley and Cate report the use of 5-6-50 and 3-6-50 formulae on peach foliage without injurious results.*

---

* Cordley, A. B. and Cate, C. C. "Spraying for Peach Fruit Spot." Oregon Agric. Expt. Sta. Bulletin 106 (1909), p. 11.

On the apple and pear the injuries have manifested themselves in two ways,—burning and spotting of the leaves and russeting or "corking" of the fruit.

The leaves so affected show dead brown spots, similar in general appearance to some leaf spots produced by fungi and especially to those of the fungus causing black rot and canker of pomaceous fruits (*Sphaeropsis malorum,* Pk.). These spray injury spots are generally circular or roundish, though often irregular. Frequently the areas are large, as if a number of smaller ones had coalesced. Occasionally the margins of the leaves show the characteristic dark brown or blackened dead tissues (Fig. 47).

Such foliage injury is very frequently followed later in the season by yellowing and premature leaf fall. This occurs early or late according to the severity of the injury; in some seasons it is absent. That this phenomenon is the direct result of using bordeaux mixture or other sprays has not been fully proved, but the frequency with which it accompanies spray injury tends to establish a correlation between them.*

On the fruit the injury is first seen as small, dark, fly-speck like spots. These are not to be confused with infections of the scab fungus (*Venturia Pomi* (Fr.) Wint.) or with the fly speck fungus (*Leptothyrium Pomi* (Mont. and Fr.) Sacc.). The former are regular, smaller,—about one millimeter diameter,—and not sunken. The final appearance of the fruit is well known to nearly all orchardists with experience in spraying. The skin is washed or splashed with a rusty or russet colored coating which materially detracts from its appearance. In very mild cases of injury fruit of a naturally good color may, it is said, practically overcome a slight russeting as the season develops. Such instances have been reported in this State this year. In more severe cases the apple has been stunted in growth and has suffered malformation, while the russeted sur-

---

* Mr. F. C. Stewart also reports spotting and yellowing of leaves following the use of an arsenical without bordeaux. "Two Unusual Troubles of Apple Foliage." New York Agric. Exp. Sta. (Geneva). Bulletin 220, Part II, p. 226.

Woodworth and Colby also ascribe leaf yellowing and early leaf fall to injury from Paris green. California Agric. Expt. Sta. Bulletin 126, p. 11. (1899).

face may be greatly roughened, corrugated, or show pustule or teat-like formations. In very severe cases the skin may crack and exhibit V-shaped clefts in the flesh of the fruit (Fig. 50).

BORDEAUX Injury; Literature and Comment.

The toxic action of copper compounds on plants has been a fertile field of investigation for botanists and plant pathologists at home and abroad, but the most recent important contributions to the literature of bordeaux injury are those of Prof. U. P. Hedrick, New York,* Prof. C. S. Crandall, Illinois,** and Dr. B. H. A. Groth, New Jersey.***

Hedrick's extended investigations and experiments developed the following points:

Spray injury is prevalent in all sections of the world where bordeaux mixture is used.

Excess of lime is not a preventitive, nor improperly made bordeaux the sole cause of injury.

Injury increases proportionally with the amount of copper sulphate used.

Wet weather following applications is a favorable condition for the production of injury.

Yellowing and leaf fall are dependent upon the amount of injury.

Different species vary in susceptibility to injury; the peach, apricot and Japanese plum being most readily affected, the common plum, quince and apple showing more resistance.

Varieties within the above groups vary in susceptibility to injury.†

Somewhat similar injuries occur on trees not sprayed with bordeaux, and are ascribed to factors of frost, fungi, arsenicals and the lens or "burning glass" action of drops of water on the fruit in intense sunlight.

---

* Hedrick, U. P. "Bordeaux Injury". New York Agric. Expt. Sta. (Geneva), Bulletin 287 (1907).

** Crandall, C. S. "Bordeaux Mixture". Illinois Agric. Expt. Sta. Bulletin 135 (1909).

*** Groth, B. H. A. "Contribution to the Study of Bordeaux Injury on Peaches." New Jersey Agric. Expt. Sta. Bulletin 232 (1910).

† NOTE.—Attention is called to Hedrick's classification of apple varieties in relation to their susceptibility to spray injury which is given on pp. 346-349, of Bulletin 185 of the Maine Station.

Changes in the chemical nature of bordeaux are produced by weather conditions and by atmospheric moisture in particular.

The injurious action of bordeaux is ascribed to the solvent action of the cell sap and of meteoric waters following spraying, upon the copper hydroxide of the mixture. The copper thus left in solution is the toxic agent.

No great importance is attached by Hedrick to the nature of the lime (air slaked or freshly slaked), used in making the mixture as a factor in producing injury.

Crandall, after a series of carefully controlled experiments covering a number of seasons, arrived at the following conclusions:

Air slaked lime in bordeaux gives more injurious results than when freshly slaked lime is used.

Equal and full dilution of the two ingredients gives least injury.

Excess of lime is advantageous only as a subsequent spray and not as an addition to the bordeaux.

Properly prepared bordeaux gives injury under unfavorable weather conditions; rain and dew are important assisting factors.

Small amounts of copper become soluble soon after the application of bordeaux, and this solvent action increases more rapidly with meteoric waters than with water artificially applied.

The physical condition of the leaves bears a relation to the amount of injury. Lesions produced by insects and fungi render foliage more susceptible to injury.

Recurrent leaf yellowing epidemics have no direct relation to weather conditions, and evidence of bordeaux as the sole cause of yellowing is not established. Copper sulphate solutions, however, when injected directly into trees produce yellowing, the degree of injury depending on the strength of the solution.

Groth's work was confined to the peach after some preliminary work which included the apple and the plum. His experiments, conducted both in the field and under control conditions under glass, led him to a theory of spray injury involving, among the chemical and meteorological factors previously recognized, a physiological one. He finds:

Bordeaux injury is independent of the density of the application.

Copper is the toxic agent.

Apples are more resistant to injury than peaches.

The factors necessary to the production of injury appear to be water on the leaves, high atmospheric humidity, shade and an excess of plant respiration over carbon dioxide assimilation.

His theory is, that under proper conditions of minimum light intensity, the carbon dioxide of respiration exceeds that of assimilation and escapes through the stomata where, dissolving in water on the leaves, it brings the copper of the bordeaux mixture into solution. Such solvent copper enters the leaves by diffusion through the stomata and causes death of the cells.

The solvent action of plant secretions upon bordeaux mixture mentioned by Hedrick as a possible causative agent in bordeaux injury of the apple is doubtless offered on the strength of analogous experiments of Schander* with bordeaux in its relation to Fuchsia and Oenothera and also with Phaseolus multiflorus.

This work is cited by both Hedrick and Crandall. Schander ascribes all bordeaux injury to the action of secretory organs upon the copper hydroxide. Crandall, in commenting on this, points to the fact that no proof of the solvent action of secretory organs upon bordeaux has been demonstrated in the case of the apple. The possibilities, as Crandall notes, are in favor of a combination of many of the factors heretofore regarded as solvents of the copper in the mixture; the physiological factor recently submitted by Groth appears to be a vital one in arranging experiments where the conditions of control shall be well assured.

Leaf injury has in all cases, so far as known, been ascribed to the entrance of copper in solution into the leaf tissues. How this toxic agent comes in contact with the tissues finally destroyed is a question regarding which there is a difference of opinion. One theory of imbibition and osmosis held by a group of prominent foreign investigators is opposed to the chemotactic theory of others.**

Crandall has rightly emphasized the necessity of isolating and determining, if possible, the group of factors now held responsible for injury under the general heading of atmospheric

*Schander, R. "Ueber die Physiologische Wirkung der Kupfervitriolkalkbrühe." Landwirtschaftliche Jahrbücher 33, pp. 517-584. (1904.)

**For a detailed account of these theories and the experiments on which they are based, see Crandall (*loc. cit.* pp. 228-232).

conditions, and Groth's experiments have been along this line. In addition, as Crandall again points out, the physical condition of the leaves as related to injury demands experiments to determine this point.

Clark* considers that the amount of injury done to a species is dependent upon the following conditions:

The specific susceptibility of the protoplasm of the plant to the toxic action of copper.

The solvent properties of the cell sap on the copper hydroxide.

The permeability of the epidermis or cuticle to the cell contents under favorable exosmotic conditions.

Weather conditions following spraying which provide conditions for exosmosis of a portion of the cell contents.

Obviously, if these are the necessary conditions, there is another important physiological factor to be considered. This is the nature of the cell content of the leaves, which will regulate the degree of permeability. Such cell contents will depend largely upon the conditions that affect the metabolism of the leaf. Nothing makes this appear more evident than the striking differences in the amount of injury produced under identical conditions on trees of varying degrees of thriftiness.

Choice of Insecticides.

The use of insecticides has not to date given rise to such serious problems. Insoluble arsenicals have been the common agents employed, usually combined with the fungicide solution. Paris green was the form of arsenic originally used and is still adhered to by some. Although effective, it has been very largely superseded by arsenate of lead which combines equal efficiency with increased adhesiveness and greater safety to foliage.

The tendency of arsenate of lead to undergo chemical change when combined with the fungicide, and the nature of such change when it does occur, are questions now before station chemists. Of late arsenite of lime has been recommended by

*Clark, J. F. "On the Toxic Properties of Some Copper Compounds with Special Reference to Bordeaux Mixture." Botanical Gazette 33: pp. 26-48. (1902.)

Prof. J. P. Stewart* as a cheaper and chemically more stable form of arsenic to use. Stewart's data indicate a slower rate of decomposition of this material in combination with lime-sulphur solutions than either Paris green or arsenate of lead. Its adhesive properties appear to be less than the latter's. No field experiments are cited to support the recommendation. Experiments of the season just past have shown that arsenite of lime is less desirable than arsenate of lead.†

Whatever the differences of opinion regarding the actual method of injury, the fact accepted by all investigators in this field is that copper is the injurious element in bordeaux mixture. Recognizing this fact, an effort has been made in recent years to eliminate the copper containing solutions in spraying plants of proved susceptibility despite their recognized high fungicidal efficiency, and to find a satisfactory substitute.

Sulphur and Sulphur Compounds as Fungicides.

In this effort attention has chiefly been turned to solutions of sulphur in chemical combination.

Pure sulphur in powdered form has long had a place among fungicides. Flowers of sulphur has been used for the control of powdery mildew of the grape (*Uncinula necator* (Schw.) Burr.) and is effective in greenhouses against rose mildew (*Sphaerothea pannosa* (Wallr.) Lév.). A lime-sulphur paste is also mentioned by Duggar‡ as a means of control of this greenhouse fungus.

"Curiously enough, however, as early as 1833, before the general use of fungicides, Dr. Wm. Kenrick§ recommended for mildew on grapes a mixture of sulphur (1½ pints), quicklime (a piece the size of the fist) and boiling water (2 gallons). This mixture, after cooling, was diluted with cold water and

*Stewart, J. P. "Concentrated Lime-Sulphur. Its Properties, Preparation and Use." Annual Rept. Pa. State College (1908-1909) Part II, pp. 292-293.

†Mr. L. Caesar of the Ontario Agricultural College reports severe injury in some cases this past season from the use of arsenite of lime. In general the results were markedly inferior to those obtained with lead arsenate.

‡Duggar, B. M. "Fungous Diseases of Plants" (1909), p. 90.

§The New American Orchardist (1833), p. 328.

allowed to settle. The clear liquid was then drawn off and diluted to make a barrel full before using. In 1885 Wm. Saunders* also recommended for pear blight a self-boiled lime and sulphur wash consisting of 8 pounds sulphur and one-half bushel of lime with boiling water, the mixture to be applied as a whitewash with brushes, and for mildews he advised applications of the clear sulphur liquid drawn off from this wash and greatly diluted."** This was the forerunner of Mr. W. M. Scott's now well known "self boiled" lime sulphur preparations.

In spraying peach trees in the Pacific Coast States with boiled lime sulphur solutions for the control of the San José scale it was found that this insecticide also served in some way as a fungicide, in that a winter application acted successfully as a preventative of peach leaf curl (*Exoascus deformans* (Berk.) Fuckel) the following spring. Possibly it was this fact that furnished a hint of the availability of lime-sulphur solutions for other fungous parasites.

Experiments at the New York (Geneva) Station in 1902† developed the fact that lime-sulphur applied in early spring for the control of San José scale had an apparent fungicidal effect in controlling apple scab. (*Venturia Pomi* (Fr.) Wint.) Later work at this station also took into account the fungicidal value of the early lime-sulphur application as a substitute for the first bordeaux-arsenical spraying.‡ As this application was made before foliage developed it gave no indication of the value of the sulphur solutions for summer use. Summer spraying at a strength sufficient to control San José scale on Japan plums was injurious to the trees.

Experiments in making a lime-sulphur wash without boiling were reported without data as to trials.§

---

*Report of the U. S. Commissioner of Agriculture, 1885, pp. 43-44.

**Scott, W. M. "Self Boiled Lime Sulphur Mixture as a Promising Fungicide." U. S. D. A., Bureau of Plant Industry Circular 1, (1908).

†Lowe, V. H. and Parrott, P. J., "San José Scale Investigations IV. Part 1." N. Y. Agric. Expt. Sta. Bul. 228 (1902), pp. 405-407.

‡Parrott, P. J., Beach, S. A. and Woodworth, H. O. "The Lime-Sulphur-Soda Wash for Orchard Treatment." N. Y. Agric. Expt. Sta., Bull. 247, (1904).

Parrott, P. J., Beach, S. A. and Sirrine, F. A. "Sulphur Washes for Orchard Treatment." N. Y. Agric. Expt. Sta. Bull. 262, (1905).

§Lowe, V. H. and Parrott, P. J. *loc. cit.* Part III.

PREVIOUS EXPERIMENTS WITH LIME-SULPHUR AS SUMMER SPRAYS.

Two forms of lime-sulphur sprays have been employed as fungicides since 1907—the self-cooked or so-called "self-boiled" preparation devised and first used by Mr. W. M. Scott of the Bureau of Plant Industry, U. S. D. A., and the boiled solution first tried as a summer spray by Prof. A. B. Cordley of the Oregon Experiment Station.* The results obtained have proved an incentive to further work along these lines by the Federal Department of Agriculture and station workers in several states where the fruit growing industry is of considerable importance.

Scott's work in 1907** carried on in Arkansas and Missouri, was a comparison of his self-boiled with the cooked lime-sulphur and with bordeaux in the control of bitter rot (*Glomerella rufomaculans* (Berk.) Spauld. and von Schrenk), apple blotch (*Phyllosticta solitaria,* E. & E.), peach brown rot (*Sclerotinia fructigena* (Pers.) Schroet.) and peach scab (*Cladosporium carpophilum,* Thüm). The self-boiled mixture was of the 15-10-50 formula.† Both cold and hot water were used in the making. The 5-3-50 formula was boiled for 45 minutes. Weather conditions were favorable for spraying, and 3 applications were made.

Results: Bitter rot, a serious trouble in southern apple regions, was successfully controlled by self-boiled lime-sulphur, as indicated in the following table.

* NOTE.—The commercial lime-sulphur preparations do not differ in nature to any extent from the properly prepared home-boiled concentrated solution.

**Scott, W. M. *loc. cit.*

†NOTE.—In referring to the composition of lime-sulphur solutions in this bulletin, the first amount represents pounds of lime, the second pounds of sulphur, and the last gallons of water. For the dilutions of concentrates the first figure represents concentrate in gallons, the second water. For bordeaux mixture, copper sulphate in pounds is given first, lime in pounds next, and water in gallons last.

Table 1.

	Per cent Sound Fruit.	
	Ben Davis.	Givens.
Lime-sulphur self-boiled	90.96 to 92.72	96.90 to 99.02
Bordeaux	91.65 to 96.40	89.12 to 99.80
Unsprayed	9.50 to 19.08	37.79 to 60.66

Apple blotch on Ben Davis trees was satisfactorily controlled with the self-boiled spray without leaf injury. The boiled 5-3-50 solution gave considerable leaf scorch and some defoliation, but no injury followed the use of the self-boiled spray.

Apple leaf-spot was held in check and peach brown rot and peach scab were both well controlled by the self-boiled solution. No data were taken on the control of apple leaf spot (*Sphaeropsis malorum,* Pk.), but observations showed no infections after applications were begun. No experiments in controlling apple scab were made at this time. Concentrated lime-sulphur at 1-25 did no injury to apples, but no effective strength was found that was not harmful to peach trees.

Cordley* was the first to record the favorable results of using a concentrated boiled lime-sulphur. His first work was with a stock solution of home preparation showing a specific gravity of 1.27 (Beaumé 31°) and an analysis of 2.38 pounds of sulphur per gallon. This was used on apple, peach, pear, plum, prune, quince, grape, potato and celery. The results indicated that a dilution of 1-15 could be safely used on all of these plants except the peach. His experiment on Yellow Newtown apples for scab control yielded the following results.

Table 2.

	Per cent. Clean.	Per cent. Slightly Scabby.	Per cent. Badly Scabbed.	Per cent. Spray Injury.
Unsprayed	19.9	28.7	51.3	0
Bordeaux, 3 applications.	49.1	35.4	15.5	31.9
Lime sulphur 3 applications	79.3	15.3	5.3	0

* Cordley, A. B. "Lime-Sulphur Spray to Prevent Apple Scab." Better Fruit. Sept. 1908, p. 26.

A very great superiority of lime-sulphur over bordeaux in scab control is here shown on this one variety for that particular season. It is more valuable as an indication of lime-sulphur efficiency *per se* than as an index of its superiority over bordeaux as a fungicide.

In 1908, using both kinds of lime-sulphur sprays and bordeaux on the same block of trees, these results were obtained.

Table 3.

	Per cent. Clean.	Per cent. Slightly Scabby.	Per cent. Badly Scabbed.	Per cent. Spray Injury.
Unsprayed...	15.1	17.1	67.1	0
Self-boiled Lime-sulphur 2 applications	50.0	16.5	33.3	0
Bordeaux 3-3-50, 2 applications	55.9	8.0	35.9	52.1
Boiled Lime-sulphur 2 applications	69.6	18.8	11.3	0

Here again we find a greater efficiency in scab control of boiled lime-sulphur over bordeaux.

Especially noteworthy is the high per cent of spray injury to fruit sprayed with bordeaux, and its entire absence on both lime-sulphur plots. This immunity was not shared by the foliage. The same dilution used without any bad effects in 1907 seriously injured the leaves in 1908. Cordley accounts for this by the difference in climatic conditions in these seasons. He would endow a greater resistance to injury to the foliage produced under the favorable conditions for growth that existed in 1907. In 1908 a greater precipitation and lower temperatures produced, according to his explanation, "a growth which was less vigorous, less hardy, more edematious and more susceptible to spray injury."**

In 1907 and 1908 Cordley and Cate*** tested bordeaux and concentrated lime-sulphur (home-boiled) on peaches for the control of peach fruit spot. Bordeaux of 5-6-50 and 3-6-50

* Cordley, A. B. "Lime-Sulphur Spray Preventive of Apple Scab." Better Fruit, April, 1909, pp. 33-35.

**Cordley, *loc. cit.* p. 35.

***Cordley, A. B. and Cate, C. C. *loc. cit.*

strengths were used, and lime-sulphur (Beaumé 20°) at dilutions of 1-10, 1-18, 1-20, and 1-20 in successive applications. Bordeaux caused no injury in either season. In 1908 the 1-18 lime-sulphur of the second application resulted in very slight injury; the third at 1-20 inflicted noticeable damage. The fourth spraying at the same dilution had no further bad effect.

In point of efficiency Bordeaux was pronounced slightly better on the basis of actual figures, with a difference in its favor so small as to leave open the question of its superiority.

In 1908 Mr. W. J. Morse* of this station attempted the control of apple scab with the self-boiled mixture of Scott's formula prepared with hot and with cold water, and bordeaux mixture, 3-3-50, making 3 applications. Several varieties failing to set fruit, the data were confined to 4 Fameuse trees in each plot. Scab-free fruit was as follows:

Table 4.

Treatment.	Bordeaux 3-3-50.	Self-boiled Hot Water.	Self-boiled Cold Water.	Unsprayed.
Per cent. clean fruit......	50	33	16	1

No definite conclusions were drawn. Observations pointed to the prevalence of the disease in that season, as indicated also by the high per cent of scabby fruit. The increased strength of lime-sulphur prepared with hot water is indicated in its greater control compared with the cold water preparation.

Scott's experiments in 1908** were made in Georgia, Arkansas, Nebraska and Illinois and in New Hampshire in cooperation with the state experiment station. Results showed self-boiled 10-10-50 and bordeaux 2-4-50 to be equally effective in controlling cherry leaf spot (*Cylindrosporium padi,* Karst.) on Montmorency. Self-boiled 6-6-50 and commercial concentrates at 1-40 gave slightly less control. Attempts to determine the relative effectiveness of the sulphur sprays and bordeaux for apple scab on Winesap in Arkansas had to be abandoned early

* Morse, W. J. "Notes on Plant Diseases, 1908, Maine Agric. Expt. Sta. Bull. 164, (1909).

**Scott, W. M. "Lime-Sulphur Mixtures for the Summer Spraying of Orchards". U. S. D. A. Bureau Plant Industry, Circular 27, (1909).

in the season, but estimates pointed to bordeaux, commercial lime-sulphur and self-boiled mixture as effective in the order named. In Nebraska the efficiency of commercial lime-sulphur for scab on the Winesap variety equalled 3-3-50 and 4-4-50 bordeaux. Dilutions of 1-25 produced slight leaf injury. Self-boiled mixture caused no damage, was less adhesive and less effective, preventing only the early infections. Bordeaux caused fruit russeting but no leaf injury.

The experiments of Prof. Brooks* at New Hampshire, co-operating with the Bureau of Plant Industry, embraced, in addition to the home-prepared, commercial lime-sulphurs and bordeaux mixture, commercial bordeaux and a so-called unboiled lime-sulphur mixture; in preparing the latter the lime was slaked and diluted to half the final volume, and the sulphur added to the remaining 25 gallons. These were then united to form a purely mechanical mixture of 50 gallons. Trees used were McIntosh. Results were as follows.

Table 5.

	Times Sprayed.	Per cent. Badly Scabbed.	Per cent. Slightly Scabbed.	Per cent. Clean.
Self-boiled L. S. 15-10-50..	5	2.9	45.0	52.1
Lime and Sulphur Mixture, 9-6-50.........	5	10.2	57.8	32.0
Boiled L. S. 2-1-50........	5	3.8	42.6	53.6
Commercial L. S. 1-24....	5	0.9	9.4	89.7
Commercial L. S. 1-49....	5	1.3	16.5	82.2
Bordeaux 3-3-50..........	5	1.2	18.2	80.6
Commercial bordeaux....	5	1.7	24.5	73.8
Self-Boiled L. S. 15-10-50..	4	9.5	55.8	34.7
Lime and Sulphur Mixture, 9-6-50.......	4	7.1	46.4	46.5
Bordeaux 3-3-50.....	4	1.2	9.4	89.4
Bordeaux 4-4-50..........	4	2.7	5.6	91.7
Unsprayed...............		21.9	45.2	32.9

The percentages here again indicate an efficiency of the self-boiled lime-sulphur considerably lower than the commercial or

* Brooks, Chas. N. H. Expt. Sta. 19th and 20th Reports (1908). Report of Dept. of Botany, pp. 385-389.

home-made concentrates. Bordeaux was most effective and commercial sulphur sprays were superior to the home made. The mechanical lime-sulphur mixture was highly inefficient.

No injury was effected by the sulphur sprays. "In fact while there was occasionally an apple on the bordeaux plots whose appearance had been damaged by spray, the apples on the lime-sulphur plots were smoother and apparently more waxy and more highly colored than on the check plots."*

Prof. R. K. Beattie** of the Washington State station in a comparative test of bordeaux and lime-sulphur on Jonathan and Ben Davis trees obtained the following data. The proportions of lime-sulphur indicated were obtained by diluting commercial concentrates to the desired strengths.

Table 6.

Spray.	Per cent. Clean Fruit.
Lime-sulphur ½-1-4	95
Lime-sulphur ½-1-5	93
Lime-sulphur ½-1-6	88
Lime-sulphur 1st and 2nd applications	89
Lime-sulphur 2nd and 3rd applications	94
Lime-sulphur all three applications	92
Lime-sulphur all sprayings	91
Bordeaux with vermorel nozzle	52
Bordeaux with bordeaux nozzle	40
Bordeaux made with milk of lime	48
Bordeaux made with lime water	39
Bordeaux all trees	44
Unsprayed	37

The last application, made just after the petals fell, was on a rainy day. No injury to fruit or foliage occurred with the lime-sulphur sprays, but fruit russeting resulted from bordeaux; such fruit was classed as unmarketable and was not included in the above table.

* Brooks, C. *loc. cit.*

** Beattie, R. K. "Lime-Sulphur Wash for Apple Scab." Western Fruit Grower. Jan. 1909, pp. 6-7.

At the Delaware station Prof. C. A. McCue* in 1908 sprayed several varieties of peaches with commercial and both home-made sulphur sprays, sulphur water and benzoate bordeaux. He did not consider his results the basis for definite conclusions, and merely pointed out the promising possibilities of the lime-sulphur sprays as fungicides for the peach. Benzoate bordeaux and sulphur water he declares unsafe, as well as undiluted lime-sulphur, irrespective of its time of boiling. Although controlling brown rot with the self-boiled spray, he could not obtain peaches free from a heavy coating of lime.

The season of 1909 witnessed an extension of experimental work along the lines in question. At the Michigan station Taft and Wilken** compared commercial and home-made concentrates on apples, pears, cherries and plums. At 1-25 the proprietary sprays caused foliage injury and had to be reduced to 1-40. Home-made concentrate of 12-15-50 formula reduced to one-fifth of that strength for summer use did practically no damage to foliage.

At Cornell University, Wallace's work was concerned with the control of peach leaf curl† and apple scab. One form of a commercial lime-sulphur solution was employed.

On peaches strengths of 1-9, 1-12, 1-15 and 1-20 were used. The per cent effectiveness was arrived at by choosing limbs with the eyes closed and counting the leaves thereon. Results are given in the following tables.‡

Table 7.

JACKSONVILLE ORCHARD, EAST SIDE, SPRAYED APRIL 9, 1909.

Treatment.	Number of Trees.	Limbs Selected.	Number of Diseased Leaves.	Per cent. of Diseased Leaves.
Unsprayed...............	4	14	660	58.9
Niagara Lime-sulphur 1-9	6	22	18	0.9

* McCue, C. A. "Spraying for Brown Rot of the Peach, 1908". Delaware Agric. Expt. Sta. Bull. 85, (1909).

** Taft, L. R. and Wilken, F. A. Mich. Agric. Expt. Sta. Special Bull. 48, (1909).

† Wallace, E. "First Report Niagara Sprayer Co. Fellowship on Peach Leaf Curl and Its Control." Cornell University 1909. See also Bull. 276 (1909) N. Y. (Cornell) Expt. Sta. by E. Wallace and H. H. Whetzel, which gives additional data obtained by practical growers.

‡ Adapted from original.

Table 8.

JACKSONVILLE ORCHARD, WEST SIDE, SPRAYED APRIL 12, 1909.

Treatment.	Number of Trees.	Limbs Selected.	Number of Diseased Leaves.	Per cent. of Diseased Leaves.
Unsprayed	4	15	584	34.3
Niagara L. S. 1-12	4	26	106	4.1
Niagara L. S. 1-15	5	22	46	2.3
Niagara L. S. 1-20	5	30	204	6.1

Table 9.

ITHACA ORCHARD, SPRAYED APRIL 7, 1909.

Treatment.	Number of Trees.	Limbs Selected.	Number of Curled Leaves.	Per cent. of Curled Leaves.
Unsprayed	4	28	920	41.3
Niagara Lime-sulphur 1-9	4	27	213	5.9
Niagara Lime-sulphur 1-15	4	35	273	5.3
Bordeaux 3-3-50	5	37	427	8.3

According to this data, increase of control does not show an absolute relation to amount of dilution. Lime-sulphur is somewhat more effective than bordeaux. In the case of this disease, however, this is practically of no importance, since, according to Duggar,* it has been definitely established that for control spraying must be done before the buds open and later sprayings are of little importance when the early one has been made. Hence the question of leaf injury from bordeaux does not enter into this problem. The advantage of using one form of fungicide throughout the year is of course obvious, but the absolute superiority of lime-sulphur over bordeaux in controlling this disease remains to be established.

Wallace's work on the control of apple scab** brings out more points of interest. The same commercial concentrate was used as in the peach experiments with 2 pounds arsenate of lead to

* *Loc. cit.* p. 182.

** Wallace, E. "Second Report Niagara Sprayer Co. Fellowship on Apple Scab." Cornell Univ. 1909.

50 gallons. The variety tested was Rhode Island Greening, with the following results.*

Table 10.

Treatment.	Number of Trees.	Number of Apples Counted.	Per cent. Sound.	Per cent. Russeted.	Per cent. Scabby.
Unsprayed	5	1,663	2.5	29.7	42.3
Lime-sulphur, 1-30 + lead arsenate	5	2,632	52.0	3.7	3.6
Bordeaux mixture + lead arsenate	6	2,332	9.9	82.2	3.0

Wallace also gives a table showing the effect of applications at different times. According to this, one spraying of lime-sulphur after the petals fall was superior to bordeaux used at that time or before the blossoms opened, both as to scab control or freedom from spray injury. Only one tree was used in each division of this experiment and the results must be considered with this fact in view. It is also proper to note that the other experiments involved a small number of trees per plot.

Prof. Bethune** reports the results of commercial lime-sulphur for controlling apple scab and pear scab (*Venturia Pyrina* (Aderh.) Snow apples received 3 applications at the usual times of 1-25, 1-40 and 1-40 respectively. The results gave 99 per cent of unaffected fruit. In one block where the second spraying was omitted 85 per cent was scab free. The first application caused slight tip burn of foliage but no fruit was russeted.

Flemish Beauty pears received 4 successive applications of 1-9, 1-25, 1-40 and 1-40, entirely controlling the fungus. The 1-25 strength caused slight leaf injury; 1-40 did no harm. Spraying with bordeaux proved less effective.

* Adapted from original table.

** Bethune, C. J. S. Rept. Ontario Agric. College and Experimental Farm (1909), pp. 34-35.

Professors Melander and Beattie* as a result of their trials recommended for apple scab boiled lime-sulphur at ½-1-5, without further dilution. This is practically the concentrated stock solution, and is far too strong for eastern conditions according to experiments so far on record. Such strength, however, they report as very effective without causing serious leaf injury.

The experiments of Scott and Ayres† in 1909 consisted of a trial of the 8-8-50 self-boiled wash on peaches on a commercial scale, using it alone or with arsenate of lead, for controlling peach brown rot, scab and curculio. Very large numbers of trees were included in these trials and the results were in all cases markedly successful, the yield of marketable fruit being increased in some cases by one hundred per cent. In another case the yield of marketable fruit was 10 times that from the unsprayed plot. Reports are also made in this connection of the commercially successful use of this spray in peach orchards of from 15,000 to 35,000 trees. Spray injury resulting from its application was so very small in amount as to be considered negligible.

For apple scab in Arkansas, Virginia and Michigan Scott‡ used 4 commercial concentrates of 31° to 33° Beaumé density, both kinds of home-prepared lime-sulphurs and bordeaux. These were tried alone and with arsenicals. The tests were made on 11 varieties in the several regions. The commercial sprays were used at dilutions ranging from 1½-50 to 2½-50, with arsenate of lead 2 pounds-50 or Paris green 6 ounces-50.

The results showed considerable differences, both in respect to foliage and fruit injury and scab control, the variations evidently depending largely upon the atmospheric conditions at spraying time and the varieties treated. Greater injury was obtained with Paris green than with lead arsenate. The commercial solutions used alone were more injurious to foliage than when combined with lead arsenate. 1½-50 appeared to be the maximum strength consistent with safety. Bordeaux was some-

* Melander, A. L. and Beattie, R. K. Wash. Agric. Expt. Sta. Pop. Bull. 28.

† Scott, W. M. and Ayres, T. W. "The Control of Peach Brown-Rot and Scab." U. S. D. A., Bureau Plant Industry Bull. 174 (1910).

‡ Scott, W. M. "The Substitution of Lime-Sulphur Preparations for Bordeaux Mixture in the Treatment of Apple Diseases." U. S. D. A. Bureau of Plant Industry Circ. 54 (1910).

what behind the boiled sprays in per cent efficiency, while the self-boiled mixture ranked last. The latter caused neither leaf nor fruit injury, while Bordeaux produced russeted fruit in some cases. Slight russeting of fruit is also reported where the stronger commercial sprays were used.

Mr. M. B. Waite* has recently reported the results of several new fungicide combinations for the apple. In these iron sulphate or calcium sulphate is combined with standard bordeaux mixture or one of the forms of lime-sulphur solutions. These have been compared with the standard bordeaux, neutral bordeaux, both kinds of lime-sulphur sprays and a combination of the boiled lime-sulphur with bordeaux; all of these used with lead arsenate.

Promising results are given for the first year's work. The noteworthy facts are the fruit russeting of at least one variety (Ben Davis) by all the copper containing fungicides; the apparent reduction of injury by the addition of sulphur compounds to bordeaux and the promising action of a combination of iron sulphate and self-boiled lime-sulphur.

Parrott and Schoene** have recently reported the results of a large number of cooperative experiments conducted in 1910 by practical apple growers in New York with the home-made lime-sulphur concentrates. These results are almost unanimously favorable to the use of the spray as a substitute for bordeaux. Slight leaf injury and fruit russeting are noted, but of a nature entirely negligible in view of the general superiority to bordeaux. But one case of severe injury was experienced. Of the 20 orchardists conducting this experiment on a practical basis 19 purpose using the sulphur sprays the coming season.

Wallace's work during the season just past enlarged considerably on his previous field work.† About 90 plots, embracing 5 varieties of apples, 4 varieties of peaches and 2 varieties of pears were included in the experiments. The sprays used were

* Waite M. B. "Experiments on the Apple with Some New and Little-known Fungicides." U. S. D. A. Bureau Plant Industry Circ. 58, (1910).

** Parrott, P. J. and Schoene, W. J. "Experiments with the Home Made Concentrated Lime-Sulphur Solutions." N. Y. Agric. Expt. Sta. (Geneva). Bull. 330, (1911).

† Wallace, E. "Lime-Sulfur as a Summer Spray." N. Y. Agric. Expt. Sta. (Cornell). Bulletin 289, (1911).

boiled lime-sulphur at several dilutions with and without arsenicals, self-boiled mixture, bordeaux mixture with lead arsenate, and the latter used alone.

The results reviewed as a whole again demonstrated an efficiency of the sulphur sprays equal to bordeaux in fungus control and reduction of injury to foliage and fruit. Some leaf injury was obtained, but serious defoliation occurred in but 2 cases—one when arsenite of lime was used with lime-sulphur, the other when lime-sulphur with lead arsenate was applied to peaches with the carbonic acid gas sprayer.

Russeting was noted on apples, but of a degree no greater or even less than that effected by the weather on unsprayed fruit.

Wallace regards foliage injury from lime-sulphur* as entirely distinct from that produced by bordeaux mixture, because of the differences in chemical constituents. He is also of the opinion that injury from the former is limited to short periods following the application of the spray, and that injuries appearing a considerable time after spraying may be ascribed to the arsenicals used. In other words, in bordeaux as applied the copper is in the insoluble (hydroxide) or harmless form and cannot cause injury until certain changes occur. In lime-sulphur solution on the other hand, the sulphur is applied in the soluble form, which is then many times more caustic than at any time after it has once dried.

Wallace also emphasizes the conditions of the leaf as affected by insects and fungi and the vigor of the trees as important factors related to the degree and amount of injury inflicted. The amount of spray applied, according as this is excessive or moderate, is also regarded as bearing on the amount of injury.

In connection with the above field experiments laboratory studies of the fungicidal properties of lime-sulphur alone and in combination were made.** Spores of peach brown rot, apple scab and apple canker were employed.

The results show that equal concentrations are not equally efficient for different fungi. Arsenate of lead appears to have

---

*Wallace, E. "Spray Injury Induced by Lime-Sulfur Preparations." N. Y. Agric. Expt. Sta. (Cornell), Bull. 288, (1911).

**Wallace, E., Blodgett, F. M. and Hesler, L. R. "Studies on the Fungicidal Value of Lime-Sulfur Preparations." N. Y. Agric. Expt. Sta. (Cornell). Bulletin 290 (1911.)

some fungicidal value, both laboratory and field tests indicating increased efficiency of the sulphur sprays when lead arsenate is added.

The effect of carbonic acid gas, used in a gas sprayer, is worthy of note. With lime-sulphur solutions alone the reaction of the gas was not of a nature to produce injurious results. Such reaction where lime-sulphur was used with lead arsenate did result in injury to peach foliage. The results obtained by Wallace do not warrant him in recommending the use of a gas sprayer in applying these materials when combinel.

The addition of lime to lime-sulphur solutions gave no conclusive results. Laboratory tests indicated increased fungicidal powers by the addition of iron sulphate to the lime-sulphur; the use of the two combined with lead arsenate was less effective than when the iron sulphate was omitted.

Experiments at Highmoor Farm, Maine Agricultural Experiment Station, 1910.

The increasing evidence of spray injury and the results of the preceding season in the orchards at Highmoor Farm made it desirable to test out the lime-sulphur sprays as substitutes for bordeaux mixture in this State.

The experiment aimed at determining the following points:

1. The comparative efficiency of the lime-sulphur sprays and bordeaux mixture as fungicides, especially for apple scab.
2. A comparison of these sprays in regard to possible injury to foliage and fruit on a variety especially susceptible to spray injury—the Ben Davis.
3. The effectiveness of arsenate of lead in combination with lime-sulphur solutions.
4. The relation of possible leaf and fruit injury to the combination of sulphur sprays with lead arsenate.

The experiments as originally planned included a study of arsenic in other forms combined with the sulphur sprays and a trial of the latter without arsenicals. The number and condition of trees available this season for such a study made it necessary to confine it to the points aforementioned. These cover the really important questions in the lime-sulphur problem. It is, after all, of very secondary importance whether or not lime-sulphur as a fungicide may be advantageously substituted in the orchard for bordeaux. The question of paramount importance is the determination of its relation and action in conjunction with a reliable insecticide. From the standpoint of general economy for the grower the only solution of the spraying problem will be a safe and effective insecticide-fungicide combination.

An orchard of 128 Ben Davis trees from 20 to 25 years old, of fairly uniform size and condition, and promising a moderate yield per tree, was divided into 12 plots. Plot 1 contained 9 trees. The remainder consisted of 12 each, excepting Plot 9 which contained 11.* The following table gives data of treatment.

Table 11.

Plot. Treatment.	Manufactured by	Average Density Degrees Beaumé.	Amount used in 50 gals. water.	Amount lead arsenate in 50 gals. water. First Application.	Amount lead arsenate in 50 gals. water. Second and third Applications.
1 Unsprayed ...					
2 Lime-sulphur	Niagara Sprayer Company......	34	1½ gals............	2 lbs.......	3 lbs.
3 Lime-sulphur	Bowker Insecticide Co........	34	1½ gals............	2 lbs.......	3 lbs.
4 Lime-sulphur	Sterling Chemical Co.........	31	1½ gals............	2 lbs.......	3 lbs.
5 Lime-sulphur	Grasselli Chemical Co.........	33	1½ gals............	2 lbs.......	3 lbs.
6 Lime-sulphur	Jas.A.Blanchard Company......	32	1½ gals............	2 lbs.......	3 lbs.
7 "Sulfocide" ..	B. G. Pratt Co...	40	⅓ gal*............	2 lbs.......	3 lbs.
8 Intensified Self Boiled Lime-sulphur.	Home made.....		10 lbs. lime........ 10. lbs. sulphur....	2 lbs.......	3 lbs.
9 Boiled Lime-sulphur.....	Home made.....	31	2½ lbs. lime 5 lbs. sulphur **	2 lbs.......	3 lbs.
10 Bordeaux mixture	Home made.....		4 lbs. copper sulphate. 4 lbs. lime	2 lbs.......	3 lbs.
11 Bordeaux mixture	Home made.....		3 lbs. copper sulphate. 3 lbs. lime	2 lbs.......	3 lbs.
12 Unsprayed ...					

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

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

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

The lime of the boiled concentrated spray was slaked with a thin paste made of the sulphur in hot water, more water being added up to a total volume of 10 gallons. This volume was kept constant while the solution boiled for one hour. After cooling and straining it showed a density indicated in the table and was used at the same dilution as the commercial solutions.

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

Time of Application.

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

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

Weather Conditions During and Following Spraying.

Weather conditions at the time of the first application were most favorable. The days were bright, mild and warm; and remained so for at least a week after spraying.

The second application was interrupted and followed by weather of the kind most favorable for the production of spray injury, according to previous experiences with bordeaux mixture. Showers interrupted and followed the spraying. The temperature and humidity changes were great and sudden. Cold, rainy periods were followed by bright, hot, humid ones. Un-

* It should be noted that the above method of making this mixture is in reality not the "self- boiled" preparation of Scott's recommendation, but an *intensified* modification, whereby more sulphur than Scott advises goes into solution. In making the self-boiled mixture the directions at the end of this bulletin should be followed.

fortunately meteorological apparatus had not been installed at this time and the observations in this regard are of necessity general. Fair weather accompanied and followed the final application.

RESULTS.

Effect on Foliage. No injury to foliage occurred between the first and second applications.

Observations made 2 to 15 days after the second application showed leaf injury on all the sprayed plots except that treated with self-boiled lime-sulphur. This injury appeared as light reddish-brown spots, in many cases greater in area than bordeaux spots, and frequently seen on the marginal portions of the leaf. As the season progressed these dead areas became darker in color and brittle. In many cases the spots were small and round, being comparable in size and shape to those found on bordeaux injured foliage. The number of such areas per leaf was, however, considerably less.

The degree of injury varied but little on the several sulphur plots. Plot 2 was slightly better than Plot 3 in respect to freedom from injury. In the latter division the injury appeared to be confined to the smaller, less developed leaves. Plots 4 and 5 were both slightly superior to 2, and Plot 6 ranked equally with the latter.

Of all the lime-sulphur sprays the home-boiled preparation showed the greatest amount of leaf injury, and this was more apparent after the third application. (Fig. 48.) The actual amount of damage was slight. A fair estimate would be 2 per cent, compared with one-half to one per cent from the commercial sprays. In all cases, however, the injury had no apparent later effect. Foliage and wood growth were unchecked, fruit developed well and the functions of the tree seemed unimpaired. Indeed, as the season progressed, close observation was needed to detect any foliage injury whatever. (Fig. 57.) The leaves remained notably green and vigorous and hung on until long after harvest.

The "Sulfocide" plot showed leaf scorching of the most severe kind shortly after the second application. Leaves were so badly burned that the affected tissues were crisped (Fig. 49). De-

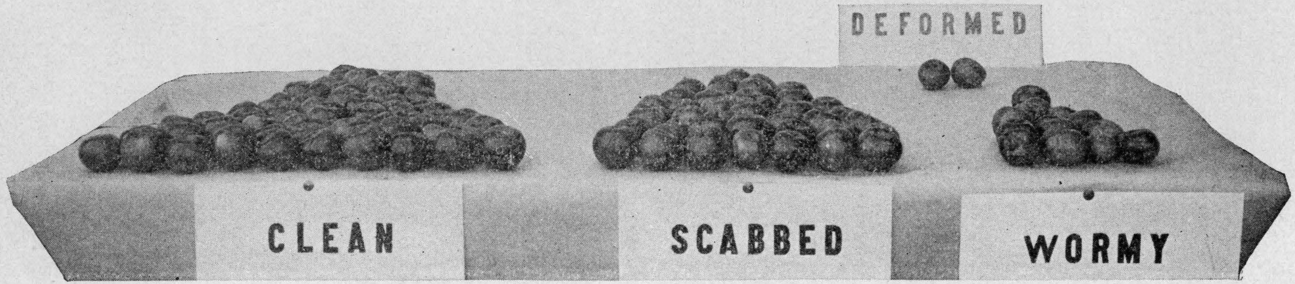


Fig. 37. Plat 1. Unsprayed, Clean 58.3%, Scabbed 41.6%, Wormy 13.7%, Deformed 1.9%.

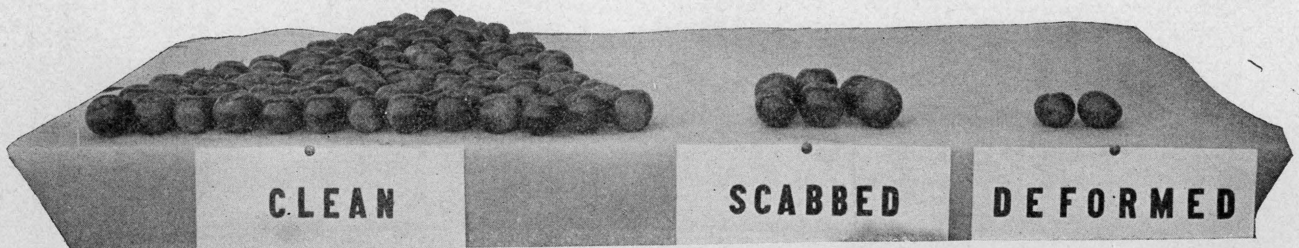


Fig. 38. Plat 2. Niagara Lime Sulphur plus Lead arsenate. Clean, 92.7%, Scabbed, 7.2%, Deformed 2.2%.

foliation was marked and from the general appearance of the plot at the close of the season it may be assumed that the vigor of the trees was considerably impaired (Fig. 56). Injury was increased by the final application, although this was at a greater dilution than the weakest strength recommended by the manufacturers.*

In comparison with the lime-sulphur sprays the bordeaux plots showed a markedly greater degree of leaf injury, estimated at 25 per cent. The characteristic leaf spotting was produced (Fig. 47), followed by a moderate amount of yellowing and leaf fall to a lesser degree. (Fig. 58.) No difference in effect on foliage was noted between the two strengths of bordeaux. The foliage suffered markedly in comparison with the lime-sulphur plots, after allowing for differences in appearance due to the color of the two sprays.

The adhesive quality of all the commercial solutions as well as the home-boiled concentrate was excellent on leaves and fruit, and compared well with bordeaux. The self-boiled mixture was inferior in this respect.

Effect on Fruit. Contrary to the experience of most investigators, all the plots showed injury to fruit.** Not even the self-boiled sulphur plot was free in this respect. The injury was of two kinds; one a russeting, roughening and pustulation of the skin, frequently accompanied by malformation and practically identical with the several degrees of bordeaux injury. The most severe injury on any of the lime-sulphur plots was somewhat less than the greatest injury from bordeaux (Fig. 51). No cracking or folding of the skin accompanied the former, and while russeting was quite common, it was of a nature in cases where malformation was absent to detract but slightly from the market value of the fruit.

The other form of spray injury, confined to fruit sprayed with sulphur solutions, occurred without exception at the calyx end, and will be designated as calyx injury.

---

*The manufacturer's directions accompanying "Sulfocide" give Paris green as the insecticide to be used with it. Lead arsenate was used in this experiment to determine its action, as no field test of such combination seems to have been reported.

**Note.—It should be borne in mind that the Ben Davis is especially susceptible to spray injury, as compared with some other varieties.

Fig. 39. Plat 3. Bowker Lime Sulphur plus Lead Arsenate. Clean 93.3%, Scabbed 6.6%, Deformed 3.5%.

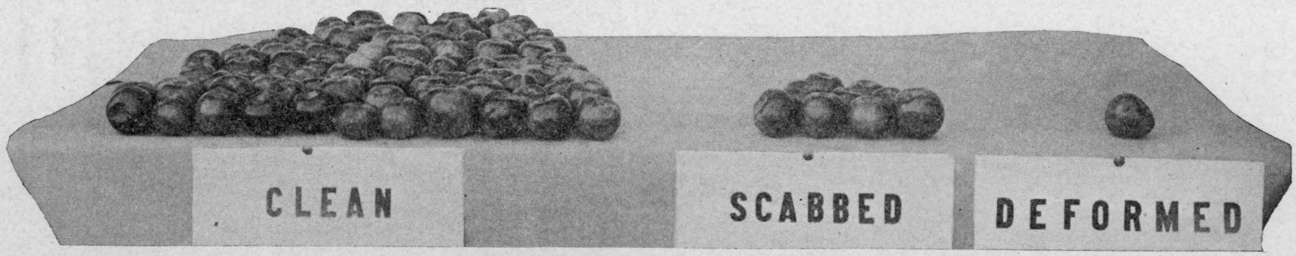


Fig. 40. Plat 6. Blanchard Lime Sulphur plus Lead Arsenate. Clean 91%, Scabbed 8.9%, Deformed 1.6%.

When this fruit was about one-third full size a dark brown discoloration of the tissues immediately surrounding the sepals was observed. This was on the average one centimeter in diameter and fairly regular and circular in outline. As the season advanced it did not increase noticeably in size, but became blacker. Such tissue was hard, tough and very resistant to pressure; an axial section showed that the injury was confined to the skin and to a very minute part of the sub-epidermal tissues. The macroscopic appearance of such tissues was in accord with the descriptions of "corked" tissues on other parts of bordeaux injured apples.

When this injury first became noticeable it was invariably accompanied by a bright carmine aureole upon the edge of the basin. This was the certain index of calyx injury on fruit hanging high enough on the tree to obscure the other indications. This aureole disappeared entirely with the growth of the fruit.

The blackened areas become somewhat depressed and frequently showed a tendency to separate and curl away slightly from the normal skin adjacent.

In rare cases this form of injury spread well into the basin, was irregular in outline and confined to one side of the calyx. Two examples of the more severe type of calyx injury are shown (Fig. 52).

Cases where the splitting of the skin at the edge of the injury gave opening for fungous infections resulted a little before harvest in the production of a very small amount of rot.

Injury from bordeaux mixture was of the nature indicated by the illustrations (Fig. 50) and tallied with the description of such injury previously given in this bulletin.

Both bordeaux and calyx injury were evidently inflicted by the second application of the spray. No further effects were noted after the final spraying.

The fruit on the "Sulfocide" plot suffered injury commensurate with that of the foliage, both in amount and degree. The burning appeared at the same time as the calyx injury already mentioned, but in this case the last application, although diluted beyond the specified recommendation, produced additional injury.

Here also the damage inflicted was chiefly at the calyx. It was vastly greater than that previously described, and more-

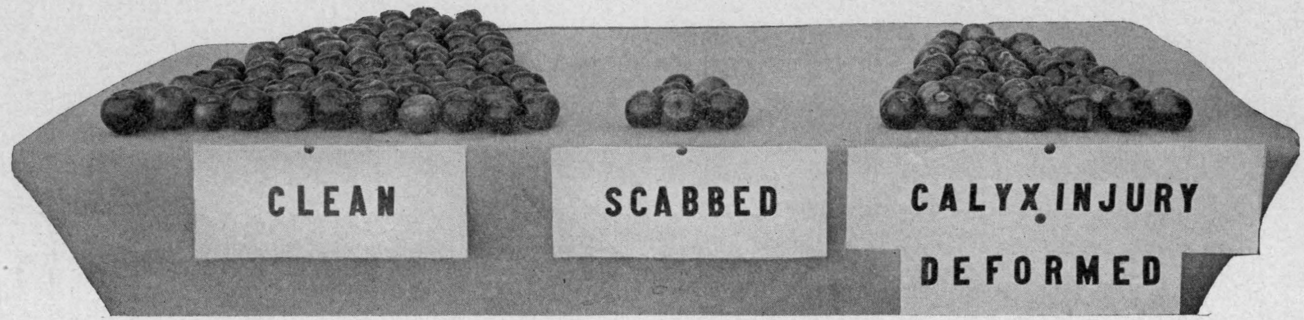


Fig. 41. Plat 7. "Sulfocide" plus Lead Arsenate, Clean 94.4%, Scabbed 5.5%, Deformed 44.3%.

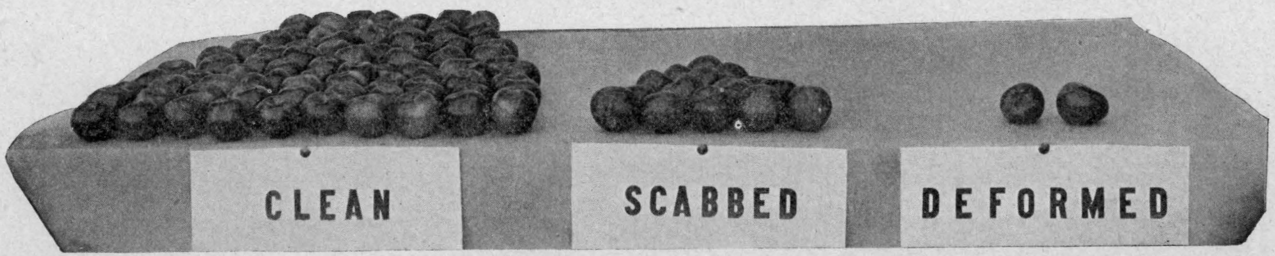


Fig. 42. Plat 8. Intensified Self Boiled Lime Sulphur plus Lead Arsenate. Clean 84.5%, Scabbed 15.4%, Deformed 2.1%.

over was not confined to the fruit basin or restricted to that part of the apple. The sides of the fruit were likewise affected and frequently deep clefts in the flesh occurred in conjunction with the burned skin. The injury when confined to the basin resulted in many cases in a marked shrinking and depression of that part. In addition, the fruit was stunted in growth and frequently misshapen. In color, texture and general characters the injury on these apples corresponded to that of calyx injury. It was, as may be seen, (Figs. 53 and 54) greater, and it also extended deeper into the sub-cuticular tissues. Rot of injured fruit at harvest was also greater on fruit from this plot.

In examining the fruit of the unsprayed plots we find evidence that must largely modify the conclusions to be drawn from this year's results. Fruit removed as completely as possible from the liability of catching spray from the other plots showed injury of the kind illustrated (Fig. 55). Aside from this, fruit not deformed showed a considerable amount of russeting, also of varying degree.

A comparison of fruit from the several plots as to general appearance was notably in favor of all the lime-sulphur sprays. The apples from such plots were larger, of better color and had an attractive waxy bloom. In this respect fruit from Plots 5, 6, 8 and 9 was especially noteworthy.

The "Sulfocide" plot produced smaller apples but on the average of still higher color. The fruit from the bordeaux plots was decidedly inferior in finish and color to any of the rest.

Effectiveness in Fungous Control.

The early part of the season was favorable for infection by scab and fruit spot (*Cylindrosporium Pomi,* Brooks), as indicated by the check plots and unsprayed trees in the vicinity of the orchards. A prolonged drought in June and July doubtless served as a check on late infections.

The leaves on the unsprayed trees were nevertheless considerably affected by scab, infection being estimated at 70 per cent, of which 50 per cent was severe.

The self-boiled lime-sulphur showed least fungous control of any spray used. Here the per cent of foliage infection was

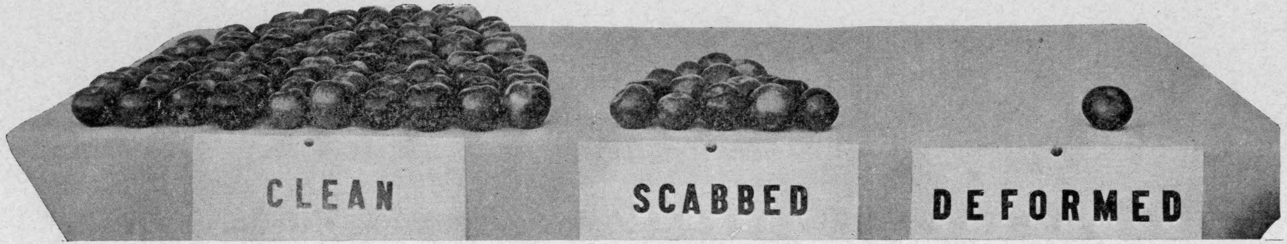


Fig. 43. Plat 9. Home Boiled Lime Sulphur plus Lead Arsenate. Clean, 85.2%, Scabbed 14.7%, Deformed 1.3%.

Fig. 44. Plat 10. Bordeaux Mixture 4-4-50 plus Lead Arsenate. Clean, 83.2%, Scabbed 16.7%, Deformed 6.7%.

estimated at 50 per cent, but none of it was of a degree severe enough to materially affect the functions of the tree.

In the other divisions control, so far as careful observations showed, was excellent and practically equal. The foliage was not entirely free from the fungus, but the infections did not become sufficiently established to do any evident damage. Such scabby foliage averaged from 4 to 8 per cent on the different plots.

In estimating the efficiency of control on the fruit, scab alone was considered. No gradations of scabby fruit were made; the resulting data therefore do not show the amount of fruit which was very slightly affected. This in practically all cases was more than 50 per cent of the scabby fruit of all sprayed plots, and should be taken into consideration.

Effectiveness of Lead Arsenate.

The results obtained indicate an almost perfect control of insects affected by arsenicals. The unsprayed plots were thoroughly infested during the season by codling moth (*Carpocapsa pomonella,* L.), yellow-necked caterpillar (*Datana ministra*), tussock moth (*Hemerocampa leucostigma*) and fall web worm (*Hyphantria cunea*). The last was extremely prevalent in Maine this season, and the check rows and unsprayed trees in the neighborhood were covered with the caterpillars. Not only leaves but fruit as well were attacked by them in Plot 1.

On the other hand, practically no trace of any of the aforementioned pests could be found on any of the sprayed plots. The cigar-case bearer (*Coleophora fletcherella*) and bud moth (*Tmetocera ocellana*) were present in all the orchards in the spring; the first spraying was not early enough to check the work of either insect, and some injury was done by the latter.

It should be noted that almost every fruit classed as wormy was in the case of the sprayed plots injured by the plum curculio (*Conotrachelus nenuphar*) and not by codling moth. The control of the latter pest was therefore practically absolute.

Russeted fruit as such was not included in the following data, as this was common to checks and sprayed trees alike, but severe deformity with russeting is given as an index of the amount of severe injury incurred. No distinction has been made between picked fruit and windfalls, as nearly all the fruit hung on the trees until a few days before picking time, when a quantity of fruit dropped during a wind storm. The windfalls were prevented from rolling by a deep cover crop, and no difficulty was found in assigning the dropped fruit to its respective plot.

Table 12.

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

* On sprayed plots 50 per cent. of respective amounts so slightly scabbed as to have fair market value.
** Deformity and calyx injury sufficiently coincident to combine in one count.

Discussion of Results.

Examination of the above data shows a small balance of scab control in favor of the lime-sulphur sprays as against bordeaux mixture. The "Sulfocide" plot shows the highest degree of scab control, but the points to be discussed later do not incline one favorably towards its use, at least with arsenate of lead.

In general the chief significance of the foregoing table is the demonstration of the high fungicidal efficiency of the lime-sulphur sprays. The per cent variations are all within the range of experimental error, and their use in making comparisons between individual plots cannot serve as the basis for warranted conclusions.

Neither of the home-made sulphur sprays were quite as effective as the commercial concentrates. On the basis of former experiments, some reduction in fungus control was to be expected in the case of the self-boiled lime-sulphur. The conclusion, however, that home-made lime-sulphur concentrate is inferior to the commercial sprays, must not be drawn from one year's results, especially in view of the many experiments already cited, pointing to the contrary. We believe that this falling off, compared with the commercial solutions, may be partly accounted for by the greater foliage density of the trees of this plot. It is reasonable to suppose that with equal care in application, such increase of leaves, especially towards the center of the tree, would not only make control of the fungus more difficult, but the greater shade and reduced aeration would render propagation easier. The same explanation, although to lesser degree, may hold for Plots 10 and 11. Plots 9 to 12 inclusive consisted of somewhat larger and denser trees which had not been quite so heavily thinned in the pruning of the preceding winter. In general, however, we may consider this year's data confirm the consensus of results obtained elsewhere as to the practical efficiency of lime-sulphur sprays in the control of apple scab and other fungi.

Injury to Foliage and Fruit.

We have already seen that the lime-sulphur sprays proved immeasurably superior to bordeaux in their effect on foliage, and this under seasonal conditions at spraying time that put all materials used to the most severe test. On the question of injury to fruit, caution is needed in drawing conclusions. This is obvious when we consider the per cent of deformed fruit on both unsprayed plots (Table 12) and note its appearance (Fig. 55). These amounts run sufficiently close to the per cents indicated for the lime-sulphur sprays to warrant the assumption that the unknown agencies classed as weather conditions were this year responsible for much of the damage on the sprayed trees. Whatever these natural agencies may be, they were this year widespread throughout the country, as shown by reports of injury to sprayed and unsprayed fruit.

We cannot, however, concur with the view taken by some workers in this field, who, on the basis of their results, do not credit lime-sulphur sprays with ability to produce fruit injury. We incline to the belief that positive results such as ours are more significant than those of a negative nature. The fact that spraying trees with lime-sulphur has resulted in no injury to fruit may mean no more than the absence of conditions necessary for producing it with the spray in question, or that in some cases it has been used on varieties not especially susceptible to spray injury.

A comparison of the injured apples from the check plots (Fig. 55) and those from the lime-sulphur plots (Fig. 51) brings out the point at issue. The unsprayed fruit shows a good amount of russeting and remarkable deformity. But laying the fact of deformity aside, we do not find on the unsprayed plots the very evident pustulation or "pimpling" of the russeted surfaces so clearly evident on fruit from the lime-sulphur plots. This, be it noted (Fig. 51), is practically identical in appearance with a moderately severe case of bordeaux injury.

Injury from lime-sulphur has moreover been reported in other states. Parrott and Schoene* recognize the russeting of apples sprayed this season with lime-sulphur. Two of the cooperative experimenters report severe russeting, although less severe than where bordeaux was used. Others report such injury to lesser degrees, and in general always less than the damage caused by bordeaux mixture.

Prof. Cordley reports fruit injury of a nature similar to our experience. In experiments conducted by him in the Willamette Valley no injury could be obtained on fruit "without using the spray at a strength sufficient to seriously injure the foliage. * * * In the Hood River Valley, where we conducted certain experiments, entirely different results were obtained. No injury whatever to the fruit was produced by the application, which was made at the time the blossom buds were opening, nor by the second application which was made after the petals fell; but serious injury to the foliage and fruit did

* Parrott, P. J. and Schoene, W. J. *loc. cit.*

result from the third application, which was made between May 23 and May 28, and which was followed immediately by a few excessively hot days—so hot in fact that some sunscald of the fruit occurred in orchards which were not sprayed. The injury in question occurred in two forms. From 2 to 5 per cent of the fruit, principally upon the southwest side of the trees, suffered seriously from what appeared to be sunscald, but which was more abundant in orchards which were sprayed with lime-sulfur than in orchards which were sprayed with some other combination. There later developed upon a considerable portion of the fruit, which at the time showed no injury, a form of 'russeting' very similar to that caused by bordeaux. Just what the explanation of this injury is, I am not prepared at this time to say, but the evidence points strongly to the conclusion that we should warn fruit growers against the use of lime-sulfur, at least at the strength at which we have been using the solutions during very hot weather."*

Fruit russeting following the use of lime-sulphur on apples has also been reported in Ohio this past season.**

These results would seem to be somewhat in accord with those obtained in Maine. The weather conditions, however, were different, and the injured fruit in our experiment was not confined to any particular side of the tree. It was, moreover, found equally on trees of thin and dense foliage.

Neither does the fact that some fruit injury was found on the intensified self-boiled lime-sulphur plot prove said injury to be solely due to weather conditions, when we recall that the mixture in this case was made with a view to getting the maximum amount of sulphur into solution.

The injury produced by bordeaux shows that it was from 2 to 5 times as great. It was also more severe. In this respect the results of this year agree with those of preceding investigators as to the evident reduction of serious damage by the substitution of lime-sulphur for bordeaux mixture as summer sprays. We believe that further work along this line will continue to furnish evidence warranting the substitution of lime-sulphur for bordeaux as a fungicide for all fruits most susceptible to spray injury.

---

* Cordley, A. B. In correspondence, Nov. 14, 1910.

** Selby, A. D. Ohio Agric. Expt. Sta. In correspondence.

We are furthermore of the opinion that when weather conditions are right for the production of spray injury, no spray material now known can be relied upon to counteract or avoid it; and this will be especially true when said conditions produce injury on unsprayed fruit, as in the past season. Indeed it is highly probable that the fruit injury obtained this year (if we disregard the one kind that was undoubtedly caused by the arsenical), was due to the application of a spray, irrespective of its composition. In other words, under the unusual conditions at spraying time, the addition of moisture may have increased the *degree* of injury which the natural agents alone were capable of inflicting. Future experiments may prove that satisfactory fungicidal effects may be secured with greater dilutions at reduced risk of injury.

Effectiveness of Lead Arsenate.

This point has already been fully discussed. The results corroborate those of experimenters previously mentioned regarding the entire efficiency with lime-sulphur sprays, irrespective of the chemical changes occurring when used together. The check plots indicate that insects destructive to fruit were not especially numerous. Codling moth, as previously noted, was perfectly controlled.

"Sulfocide" and Calyx Injury.

The fact that calyx injury was found on neither check nor bordeaux plots, together with the very severe injury of similar nature on Plot 7 inclines us to the belief that this was the result of a chemical change whereby the arsenic was set free in some form capable of causing the results. The injuries already described and more particularly those on Plot 7 bear a very striking resemblance to descriptions of a similar injury noted by Taylor at the Missouri Fruit Station on apples sprayed in a rainy season with bordeaux and Paris green. Between the second and third applications "apples were noted in the Paris green plot with blackened areas about their blossom ends. These blackened areas increased in size and became more conspicuous as the apples grew. By picking time some of the areas now shriveled had extended about the blossom end until it covered over a third of the surface of the fruit. In some cases the burned tissue at the end of the apple had dried and separated from the normal portion and fallen away, leaving the seeds exposed at the bottom of circular cup-like depressions. Some apples less seriously burned showed deeply depressed calyx basins."* Nearly one-fourth of the picked fruit from these trees treated with Paris green were reduced from first class, and many to cull grade from this cause. Trees treated with arsenate of lead developed one per cent of apples blackened at the blossom end. Rainy weather was held accountable for the intensity of the damage inflicted.

Paddock** also reports an attempt to control an alternaria rot on apples described by Longyear,*** which affected the fruit at the calyx end. Paddock concluded that much of said alternaria injury was really due to spraying with improperly prepared arsenicals, and emphasizes the necessity when using arsenite of lime on Ben Davis and Gano of spraying during fair weather only.

Scott and Quaintance† noted injury to leaves and fruit of the peach produced by lead arsenate in their 1908 experiments. Mr. J. P. Stewart of the Pennsylvania Station has observed a similar burning of peaches following the use of bordeaux and lead arsenate.

Cordley has indicated the differences in chemical reaction between lime-sulphur and the two kinds of lead arsenates, netural and acid, showing that the amount of soluble arsenic in mixtures of the fungicide with the acid arsenate is 4 to 7 times greater than when the neutral kind is used.‡

These facts are significant in view of the aforementioned injuries of this season. It is unreasonable to ascribe to a common cause injuries so much alike as the russeting from lime-

* Taylor, E. P. "Spraying Apples for Curculio and Codling Moth". Missouri State Fruit Sta. Bull. 21 (1909). p. 69.

** Paddock, W. Rept. of Field Horticulturist. Colo. Agric. Expt. Sta. Press Bull. 43 (1907).

*** Longyear, B. O. "A New Apple Rot". Colo. Agric. Expt. Sta. Bull. 105 (1905).

† Scott, W. M. and Quaintance, A. L. "Control of the Brown-Rot and Plum Curculio on Peaches." U. S. D. A. Bureau of Ent. Circ. 120 (1910).

‡ Cordley, A. B. "The Lime-Sulphur-Arsenate of Lead Mixture." Better Fruit, May, 1910, pp. 37-41.

sulphur and bordeaux mixture and this other form of damage, so markedly different, so distinctly localized and entirely absent on trees sprayed with bordeaux and lead arsenate. Evidently the answer must be sought in the reactions of the arsenates and the sulphur sprays.*

Relations of Density of Concentrate to Injury.

The degree of injury to fruit and foliage varied only in a general way with the density of the concentrates. Allowing for the factor of experimental error, the results are in accord with the present practice of increasing the dilution with the density.

CONCLUSIONS.

The experiment here recorded is the result of the first season's work and should be regarded as preliminary rather than the basis for final conclusions. In general the data presented show that lime-sulphur preparations may be efficiently used as summer sprays, and that with weather conditions liable to produce spray injury lime-sulphur does less damage than bordeaux mixture both qualitatively and quantitatively.

Further data are needed regarding variation in the effect of sulphur sprays on different varieties. Other questions are those concerning the minimum effective dilution and the action of different arsenicals in combination with them.

Arsenate of lead proved as effective with lime-sulphur as with bordeaux mixture. The use of a neutral lead arsenate is recommended in order to reduce any tendency to arsenical injury.

"Sulfocide" with lead arsenate gave unfavorable results on

---

* NOTE.—This is indicated by tests made by the chemists of this station. "Sulfocide" and an acid arsenate of lead used in the orchard experiments were mixed in the dilutions used in spraying, and allowed to stand. At the end of half an hour 100 cubic centimeters of the mixture after filtering showed 94 milligrams of soluble arsenious oxide. After standing for three days an equal volume yielded 104 milligrams, largely in the form of sodium arsenate.

The same test was made with the lead arsenate and one of the commercial lime-sulphur concentrates. Practically no arsenic was found in solution. Nevertheless the calyx injury on the commercial lime-sulphur plots must be ascribed to a reaction between the concentrate and the arsenate.

foliage and fruit. Its use with Paris green was not attempted. Favorable results have in some cases been reported by growers when used with the latter arsenical.

Unusual conditions favorable to the production of injury were prevalent this season. It is believed that future work with more dilute solutions will furnish still better reasons for the use of lime-sulphur as an orchard fungicide. The many experiments referred to, as well as the favorable reports of practical orchardists throughout the country, warrant Maine fruit growers in giving the new sprays a thorough trial. Aside from the experimental plots, this Station purposes using home boiled lime-sulphur of 31° to 34° Beaumé density at a 1-40 dilution on all its orchards.

The additional advantage of the sulphur sprays lies in their combined insecticidal and fungicidal powers. The same stock solution used to control fungous diseases in summer is successful at greater strength as an insecticide for sucking insects against which arsenicals are ineffective. Such strengths must be applied when the tree is not in leaf.

Home Made vs. Commercial Lime Sulphur.

Commercial lime-sulphur preparations now on the market are not superior to concentrated home made stock solutions when these are properly made and stored. The former are, moreover, considerably more expensive. At present prices of material the home made concentrate can be made at a cost of one-third to one-fourth that of an equal volume of a commercial solution if the materials are bought in quantity. This does not include the original outlay for a cooker and barrels for storage. The commercial preparation is a convenience, requiring nothing but a knowledge of its density before diluting. The home made concentrate can be made at any time and if properly barreled and kept from freezing can be stored indefinitely. Home made lime-sulphur can also at present be made cheaper than the home-prepared bordeaux mixture, so far as cost of ingredients are concerned. The choice on grounds of economy is, therefore, merely between the expenditure of money or time and labor.

Directions for Making Lime-Sulphur Solutions.

The materials necessary for making these sprays are a good stone lime, free from grit or dirt, testing not less than 90 per cent calcium oxide and not more than 5 per cent magnesium oxide, and sulphur. Sulphur may be in the form of flowers of sulphur or sulphur flour.

*Self-Boiled Lime-Sulphur.**

Use 10 pounds sulphur and 10 pounds of good stone lime to 50 gallons of water.** These quantities may be increased to any desired amount provided the proportions are maintained.

"Place the lime in a barrel and pour on enough water (about 3 gallons to 20 pounds) to start it slaking and to keep the sulphur off the bottom of the barrel. Then add the sulphur which should be worked through a sieve to break up the lumps and finally enough water to slake the lime into a paste. Considerable stirring is necessary to prevent caking on the bottom. After the violent boiling which accompanies the slaking of the lime is over the mixture should be diluted ready for spraying, or at least enough cold water added to stop the cooking. Five to 15 minutes are required, according to whether the lime is quick acting or sluggish. The intense heat seems to break up the particles of sulphur into about the physical condition of precipitated sulphur and the violent boiling makes a good mechanical mixture of the lime and sulphur. Only a small percentage of the sulphur—enough to improve the adhesiveness of the mixture—goes into solution, but if the hot mass is allowed to stand as a thick paste the sulphur continues to unite with the lime and at the end of 30 to 40 minutes enough of the reddish liquid is produced to burn peach foliage and even apple foliage in some cases. * * *

The mixture should be strained through a sieve of 20 meshes to the inch in order to remove the coarse particles of lime, but all the sulphur should be worked through the strainer.

The amount of water required to make the best mixture de-

---

* Adapted from the several publications of W. M. Scott, Bureau of Plant Industry, U. S. D. A.

** An 8-8-50 formula is recommended by Scott in his latest report on peaches. 10-10-50 is doubtless none too strong for the apple.

pends largely upon the lime. Some grades of lime respond quickly and take a large quantity of water, while others heat up slowly and are easily 'drowned' if too much water is added at once. Hot water may be used to good advantage in preparing the mixture with sluggish lime, but with quick-acting lime hot water is not necessary and is more likely to bring too much of the sulphur into solution. If desired the mixture may be kept for a week or more without deterioration, but should be thoroughly stirred before using."

In applying the self-boiled mixture the spray pump should be equipped with a good agitator, as the mixture settles to the bottom of the tank. In order to be evenly applied it must be well agitated.

It is to be noted that this mixture has been found less effective for apple scab than the boiled preparation.

Home Boiled Concentrated Lime-Sulphur.

Sulphur	110 pounds.
Lime, best grade	55 pounds.

Water sufficient to make 60 gallons.

"Slake the lime, mix the sulphur into a thin paste with a little water, add it to the lime, add sufficient water to make 60 gallons, bring to a boil and boil vigorously for 30 to 45 minutes. The sediment is then allowed to settle, after which the clear dark amber-colored liquid is drawn off and may be stored in casks for future use."*

In making this solution a large iron kettle or cooker of some sort is necessary. A stock feed cooker of large capacity will answer. Fig. 45 shows a satisfactory form which can be had of Montgomery Ward & Co., Chicago, Ill.; The Wagner Manufacturing Co., Sydney, Ohio; Farmers' Supply Co., Philadelphia, Pa.; or R. B. Dunning & Co., Bangor, Maine. The solution can also be made with the use of direct steam, and this means has been frequently employed when large quantities of the material are made.

Diluting Concentrated Solutions for Use.

With our present knowledge, the strength of lime-sulphur to use depends upon its density. This may be determined by a

*Cordley, A. B. "Insecticides and Fungicides." Oregon Agric. Expt. Sta. Bull. 108 (1910).

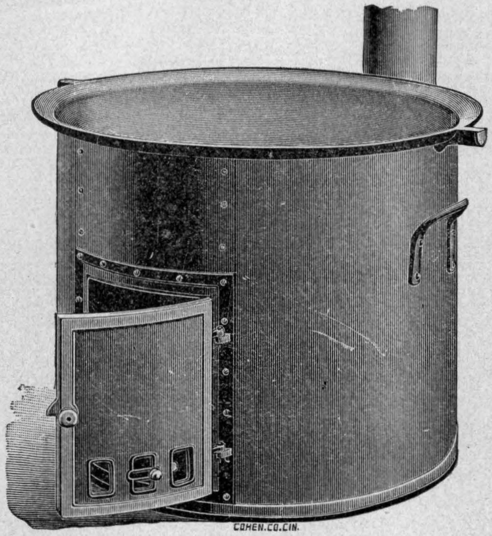


Fig. 45. Lime Sulphur Cooker.

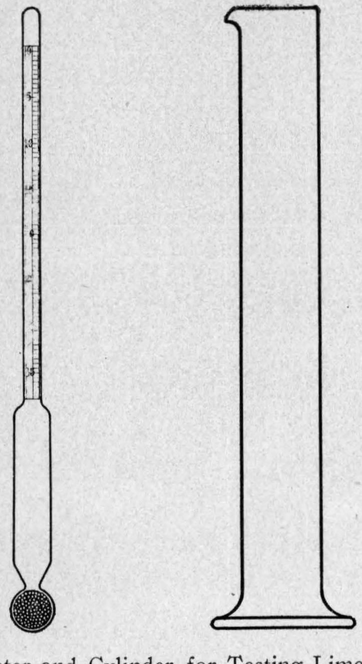


Fig. 46. Hydrometer and Cylinder for Testing Lime-Sulphur Densities.

cheap and simple instrument called the hydrometer. This consists of a hollow glass tube, its lower end terminating in a weighted bulb (Fig. 46). Placing this in a liquid, it sinks until the liquid displaced equals its own weight. In light solutions, therefore, it will sink deeper than in heavy or dense ones. The gradations to be read are marked on the scale on the neck of the instrument and are in degrees Beaumé or in terms of specific gravity. Some instruments give both scales. The Beaumé is the one most generally used.

These instruments cost about $1.00 and may be had of the Bausch & Lomb Optical Co., Rochester, N. Y., or other dealers in scientific apparatus. They are absolutely necessary for the proper use of lime-sulphur solutions. The contents of several casks from one manufacturer may vary in density, and experiments have shown that home boiled solutions will differ considerably in this respect even when the same amount of material and time of cooking are employed.

The solutions should be tested at a temperature of about 60 degrees, Fahrenheit. Density should never be determined when the solution is hot.

The following is a table of dilutions.*

Table 13.

Hydrometer Reading, Degrees Beaumé.	Number of gallons water for one gallon concentrated solution.	
	Winter Strength (Insecticide)	Summer Strength (Fungicide)
32	12	30
31	11	29
30	10	28
29	9½	27
28	9	26
27	8½	25
26	8	24
25	7½	23
24	7	22
33	6½	21.
22	6	20

*Cordley's figures.

It will be noted that the dilution at 32 degrees Beaumé is stronger than that used in the Maine experiments on the Ben Davis. A dilution of 1-40 for a concentrate testing about 32 degrees is recommended for trial in this state on the more susceptible varieties of apples.

The concentrate should always be tested for density at the time of using. It is also a good plan to mark the density of each barrel-full at the time it is made.

Arsenate of lead should not be added until the solutions are diluted and ready for use.

If the concentrated solutions are to be stored for some time before using, the barrels should be entirely filled to exclude air. If this is not feasible, or when a part has been withdrawn for use and the balance is to be held for a considerable time, it should be protected from the air with a thin coating of paraffin oil or other heavy oil. If made during the winter it should not be allowed to freeze.

Time and Methods of Application.

Successful results from spraying operations depend upon three factors: properly prepared mixtures, timeliness and thoroughness of application. Too much emphasis cannot be laid upon them. Failure to observe these conditions may be held accountable for the great majority of cases where spraying has not given the results desired.

For the proper preparation or dilution of spraying mixtures it is only necessary to follow the directions given. Guesswork or slipshod methods should not be tolerated. The formulæ which have been and are being derived are the results of experiment and experience. Improvements may be made in the future. These the progressive orchardist will learn by obtaining the station bulletins on the subject as they appear.

Timeliness of application demands merely a knowledge of the orchard enemies to be fought. These are described and means of control recommended in former publications of this station.* When the grower finds evidence of insect or fun-

* Morse, W. J. and Lewis, C. E. "Maine Apple Diseases," Bull. 185 of this Station.

Patch, E. M. and Johannsen, O. A. "Apple Tree Insects of Maine," Circular 383.

gous injury the cause of which he does not know, the necessary information can be obtained by sending specimens to the station. Timeliness means protection by prevention.

Thoroughness of application* is largely a matter of experience and until this is acquired the idea of thoroughness will be that of the man who does the work. The amount necessary for each tree will depend upon the density of the foliage and the way it has been kept open by proper pruning.

Three important factors to be kept in mind in applying sprays are the maintenance of a high pressure, the use of the most efficient types of nozzles and the constant agitation of the liquid.

A pressure of less than 100 pounds is not likely to produce the best results, and the insoluble nature of the insecticide in the liquid makes constant agitation necessary to keep the arsenical in suspension.

With 100 pounds pressure and the improved type of nozzle the proper spraying of a large tree is a matter of very short time. The nozzle should deliver with considerable carrying power a spray of fine mist in the form of a hollow cone. Under these conditions it will be found necessary to keep the spray rod constantly in motion in order not to drench any part of the tree.

Whether hand pumps or power machines are desirable depends upon the size of the orchard and its location. Engine power sprayers will be found most economical in large plantations where their use is practicable. In small orchards, or in large ones located on very steep, rough slopes, the hand pump with its small spray tank may be best adapted. The greatest disadvantage of the average barrel pump is the difficulty of maintaining the high pressure necessary for good work, although some of the improved hand machines may meet the requirements. In large orchards the hand pump, unless attached to a large spray tank, involves much loss of time due to the necessity of repeated filling.

* See Maine Station Bulletin 185, p. 391.

Summary.

Spray injury inflicted by properly prepared bordeaux mixture on fruit and foliage is primarily due to part of the materials composing it, and cannot be avoided by any known means when weather conditions following the spraying are favorable for injury production.

The lime-sulphur sprays in the course of many experiments have been found in the majority of cases to be satisfactory substitutes for bordeaux mixture in controlling fungous diseases in orchards.

Some injury to foliage has been incurred with the use of lime-sulphur sprays. Part of such injury has been due to the use of too concentrated solutions or to leaf injuries caused by insects and fungi before the spray was applied. In practically all cases where proper dilutions were used leaf injury on apple trees was so slight that it could be entirely neglected.

Results of many experiments show absence or reduction of fruit russeting with the use of lime-sulphur.

The experiments at this station point to the following conclusions:

The commercial lime-sulphur sprays were satisfactory as fungicides and were superior to bordeaux mixture in their effect on foliage and fruit.

The home boiled concentrate was also satisfactory. The intensified self-boiled lime-sulphur mixture was less effective and less adhesive than any of the sprays used.

Lead arsenate was entirely effective as an insecticide when combined with the sulphur sprays.

Foliage injury occurred on all sprayed plots; it was more severe where bordeaux mixture was used. Leaf injury on the lime-sulphur plots was small in amount and not lasting in its effects.

Injury to fruit was of two kinds. One was very evidently due to the arsenical used with the sulphur spray. The other form was similar to bordeaux injury, but less severe.

Unsprayed fruit suffered severe russeting and malformation, due probably to weather conditions.

Comparison of injured fruit from sprayed and unsprayed trees showed a greater degree of injury to the russeted surfaces on sprayed fruit. Such increase of injury may be due to the nature of the spray, or merely to the addition of moisture at a time when atmospheric conditions could increase the *degree* of an injury which they could inflict without such addition.

Injuries ascribed to arsenicals are undoubtedly due to changes taking place when lead arsenate is combined with the lime-sulphur solutions. A neutral lead arsenate is recommended to reduce the possibilities of injury. The amount of this injury was this season small, and from the reports of other work is not a common occurrence.

The use of "Sulfocide" with lead arsenate was decidedly injurious.

On the basis of other experiments, the use of a carbonic acid gas sprayer is not recommended in applying lime-sulphur with lead arsenate.

In conclusion we would encourage the trial of the lime-sulphur solutions, home made or commercial, as substitutes for bordeaux mixture, especially on varieties of apples where bordeaux injury has been noted. The general results of this season's experiment coincide with the many others reported in this bulletin regarding the effectiveness of lime-sulphur sprays as fungicides, and the reduction of injury to foliage and fruit. It should be remembered that the natural conditions that caused much damage on unsprayed fruit this past season are not of common occurrence, and still more favorable results may be looked for in the future.

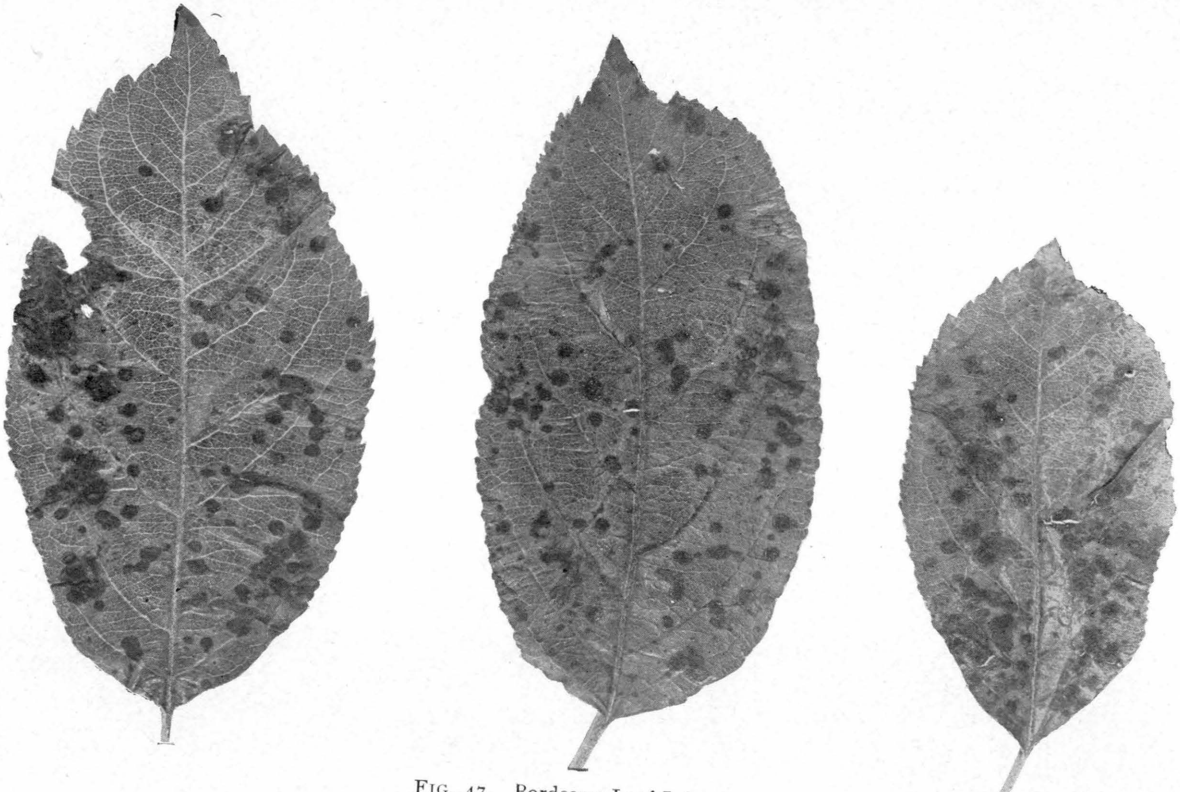


FIG. 47. Bordeaux Leaf Injury.

Fig. 48. Lime-Sulphur Leaf Injury.

FIG. 49. "Sulfocide" Leaf Injury.

Fig. 50. Bordeaux Injury on Ben Davis

Fig. 51. Lime-Sulphur Injury on Ben Davis

Fig. 52. Calyx Injury (Lime-Sulphur Plus Lead Arsenate)

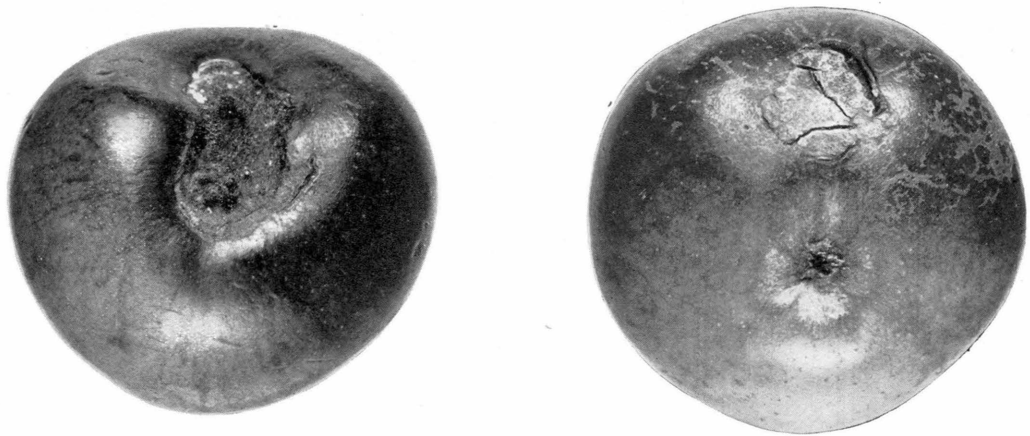


Fig. 53. Injury from "Sulfocide" Plus Lead Arsenate

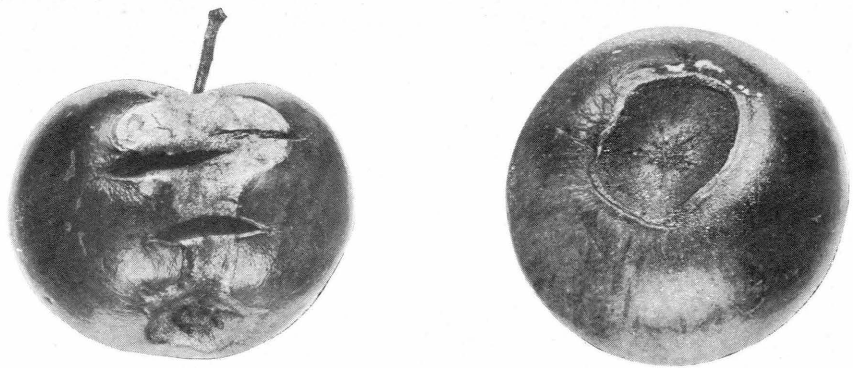


Fig. 54. Injury from "Sulfocide" Plus Lead Arsenate

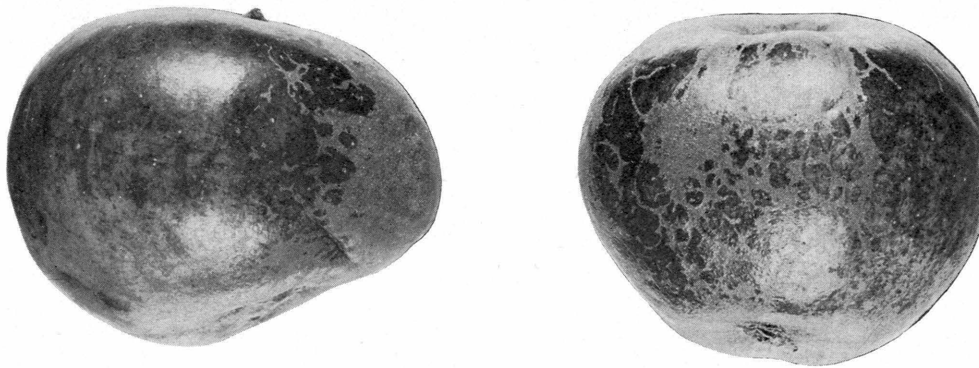


Fig. 55. Injury on Unsprayed Fruit

Fig. 56. Defoliation on " Sulfocide " Plot

Fig. 57. Home-Boiled Lime-Sulphur Plot

Fig. 58. Partial Defoliation on 4-4-50. Bordeaux Plot

BULLETIN 190.

MACROSIPHUM DESTRUCTOR AND MACROSIPHUM SOLANIFOLII.*

EDITH M. PATCH.

Because of their similarity and the consequent lack of satisfactory specific characters in descriptions, many of the aphides belonging to the genus *Macrosiphum* have become confused both as to their status in literature and in collections. Some 12 years ago I questioned one of our most careful aphidists concerning *M. pisi* and he replied with a laugh, "Pisi! Well, that's a composite species all right. All big green *Macrosipha* not otherwise easily placed are *pisi*."

A few years ago a second aphidist who has spent many years working over these insects told me with a half whimsical shrug of despair, "If an aphid is a *Macrosiphum,* then I do not know the species."

It was with this confusion in mind that a critical examination of *solanifolii* was undertaken for characters which would separate it from closely allied species. I found that this aphid has been listed as *"pisi"* in certain aphid collections and presume that it may be mixed with *"pisi"* in literature. What *pisi* Kaltenbach is I do not know. There seems to be no reason to be sure that *pisi* has not been a composite species in Europe as well as in America both in collections and in literature. It is on account of this uncertainty that in this paper the whole *pisi* proposition is relegated to Europe where it should first be straightened out and "the destructive green pea-louse" of

*Papers from the Maine Agricultural Experiment Station: Entomology No. 47.

America is discussed under the name of *M. destructor* (Johnson) which is conservative and safe for the present.

Both *destructor* and *solanifolii* may be characterized as large green *Macrosipha* with not infrequently color varieties of bright pink or soft yellow. For the most part the characters which separate them are relative, as *destructor* is in general larger with longer, more slender cornicles and a longer cauda. The antennal characters differ somewhat, the most distinctive difference being in the sensoria of the spuriae, this form in *solanifolii* having the sensoria of III about 3 to 6 and arranged at the base of the segment more in a row than in *destructor,* the spuriae of which have the very few sensoria (1 to 3 or 4) of III rather bunched at base of segment. But the most definite and easily observable of characters which will serve to differentiate these two species is the presence or absence of reticulation of the cornicles, a character mentioned by Sanderson (1910a) in his interesting and suggestive comparative study of European and American specimens of *"pisi."* Mr. Sanderson, however, did not consider this character to be of specific importance although he mentions the presence or absence of reticulations in his descriptions and figures of the cornicles with reference to this character, and gives (Sanderson 1901a p. 74) *reticulata* as a variety name to those *Macrosipha* (chiefly from lettuce) having reticulated cornicles and more numerous sensoria on antennal segment III of the apterous viviparous form, (Sanderson 1901a p. 38).

Whether *reticulata* Sanderson may prove to be *solanifolii* or not, I have at present no biological evidence to indicate; but the structural characters of antennae and cornicles would separate *reticulata* from *destructor* and show that it is at least closely allied to *solanifolii.* What the full synonomy of any of these similar species of *Macrosiphum* may be it would be folly to guess until the whole group is more thoroughly understood; but it does not seem futile to attempt to characterize *destructor* and *solanifolii* so at least that these two species may not be confused regardless of the host plant upon which they are taken.

Mr. Sanderson in concluding his careful and valuable paper (1901a pp. 38-39) writes: "For the present, therefore, from the material studied, we are obliged to consider all of these specimens as varieties of *N. pisi* Kalt. A larger series and further observation of their life histories may reveal specific distinctions. The present account is published merely to show the extreme variability of this species (or, as it may prove to be, the likeness of several species), and the necessity of a careful study of it and allied species."

The purpose of this present paper is merely to add one more chapter toward the interpretation of two similar species, a chapter that seems necessary in connection with the biological and food plant data of these species which is needed before the economic status of these insects can be clearly understood. In regard to the need for further host plant data Mr. Chittenden (1909) writes:

"The subject of alternate host plants is an important one, since the pea, being an annual, is not available as food for this aphis during the winter. It is desirable to ascertain all of the host plants of the pea aphis, and more especially the weeds, as some one or more of these may be factors of importance in the life economy of the species. It might be necessary in the future, should the depredations of this insect increase, to limit the growing of clover and other legumes, as well as their alternate host plants, if such be found, in the vicinity of pea fields. If all of the principal alternate plants could be discovered this might furnish a solution of the problem of how to deal with the insect."

The futility from an economic standpoint of compiling a series of host plants for a "composite species" is apparent.

The descriptions of *destructor* in the Bibliography appended with especial reference to the beautiful figures (Folsom 1909) in the Illinois Report are still easily available and suffice, together with Miss King's figures of the cornicles in this present paper, sufficiently to characterize the Destructive Green-Pea-louse. The imbrications of the cornicles extend clear to the tip in both apterous and alate forms, there being no terminal area of reticulation as is the case in *solanifolii*.

This imbricated character of the *destructor* cornicle holds good in forms much diversified as to color and size, as both pink and green varieties are alike in this structure. It also holds good for the progeny individuals transferred from pea to shepherd's purse and clover. The distinctions between the reticulated and imbricated cornicles of any species of *Macrosiphum* come out only in the mature insect and do not hold useful for the nymphs.

In general *Macrosiphum solanifolii** is a large, active species, usually green but very often pink, and sometimes yellowish, especially the young of the pink individuals.

Decidedly pink individuals occur both with the winged and apterous viviparous females. At Houlton, August 17, 1905, a pink-winged viviparous female was taken with 12 young, 7 of which were decidedly green and 5 decidedly pink. About 20 pink viviparous specimens collected at Maple Grove, August 19, 1906, were placed upon potato in the insectary. Some were winged and some were apterous. On August 29 the young of these were all found to be pink, though many were toning into pale yellow. The insectary specimens of oviparous females were largely pink, though many were yellow, and a few distinctly green.

Macrosiphum solanifolii. Winged viviparous female.—Head yellowish green. Antennae, proximal segments pale green, distal segments dark; length of segments: III, .88 to .96 mm.; IV, .76 to .9 mm.; V, .64 to .72 mm.; VI, .16 to .2 mm.; VII, .96 to 1.12 mm.; total length I to VII, 3.6 to 4.05 mm. Prothorax and thorax light yellowish green. Wings hyaline, veins dark brown, very slender, stigma pale brown. Total wing expansion 8.1 mm. Legs with proximal part of femora and tibiae pale, tarsi and distal part of femora and tibiae dark. Tarsi .16 to .2 mm. Abdomen light green unmarked dorsally or ventrally. Cornicles, with proximal portion green and distal portion dark brown, imbricated along the center but strongly reticulated at tip, cylindrical, length .95 mm. or about five times length of tarsus. Cauda light green, ensiform, length .48 mm. or about one-half length of cornicles. Total length of body to distal tip of cauda and exclusive of antennae 2.9 to 3.37 mm.

Winged viviparous female, pink individual.—Head light yellowish. Antennae with I and II light yellowish, rest dark. Prothorax and thorax light yellowish pink. Abdomen pale pink. Cornicles light yellow with tips dusky and strongly reticulated. Cauda pink.

---

* For a fuller discussion of this species the reader is referred to Bulletin 147 of the Maine Agricultural Experiment Station.

Apterous viviparous female.—Color as with the winged viviparous form. Antennae, length of segments: III, .8 to .96 mm., IV, .72 to .88 mm., V, .56 to .72 mm., VI, .16 to .2 mm., VII, .96 to 1.2 mm., total length of segments I to VII, average about 4.05 mm. Cornicles .96 to 1.04 mm. in length, and strongly reticulated at tip. Cauda .56 mm. Total length of body to distal tip of cauda and exclusive of antennae, 4.05 mm.

Apterous oviparous female.—Head pale, nearly white. Antennae with proximal joints pale, distal half dark. Length of segments: III, .68 to .88 mm.; IV, .56 to .68 mm.; V, .52 to .64 mm.; VI, .16 mm.; VII, .96 to 1.04 mm.; total antennal length I to VII average about 3.6 mm. Prothorax and thorax pale like head. Legs with femora and tibiae, proximal portion pale, distal portion dusky. Tarsi dark, .16 mm. long. Hind tibiae conspicuously darker and much swollen and thickly set with sensoria. Abdomen light salmon pink. Cornicles pale at base, distal half dark and reticulated at tip; length .6 to .8 mm. Cauda salmon pink, ensiform, length .32 to .4 mm. Total body length to tip of cauda, antennae excluded, 2.13 to 2.15 mm. The size of the hind tibiae of this form makes it readily distinguished from the apterous viviparous form and young, even to the unaided eye.

The pink variety has been described because these predominate among the oviparous females. The color scheme of the green and yellow forms can be determined merely by substituting these colors for the salmon pink of the individual described, the dark coloration being the same for all 3.

Winged male.—Head and antennae dark brown. Length of antennal segments: III, .72 to .8 mm.; IV, .48 to .64 mm.; V, .48 to .6 mm.; VI, .16 mm.; VII, 1.04 to 1.28 mm.; total antennae length I to VII, 2.93 to 3.60 mm. Prothorax and thorax dark brown. Wings deflexed, hyaline, veins dark and very slender, stigma pale brown. Legs brown, darker at tips. Abdomen brown. Cornicles pale brown, dark distally and reticulated, cylindrical, .48 to .56 mm. long. Total body length exclusive of antennae and cornicles, 1.12 to 1.57 mm. The thorax is large and strong, the abdomen much shrunken and is rendered conspicuous only by the long cornicles. The male is described from specimens in copulation, in order that no mistake as to the identity of the species might occur.

Insectary Host Plant Tests for M. sonalifolii.

(July-October, 1907.)

By planting potatoes in the insectary often, the plant lice were supplied with fresh plants which were colonized by the individuals which deserted the plants they had rendered sickly.

Buckwheat was sown among the potato plants in the insectary and about 200 young and clean plants of shepherd's purse were put into trays. Peas were also sown at the same time. By the time the buckwheat and peas were well up about 100 fresh potato plants were available, and the *M. solanifolii,* deserting the older potato stalks, colonized thoroughly the fresh potato vines, pea vines, and the shepherd's purse apparently with no preference. Both winged and wingless forms were found for the rest of the season rearing contended progeny upon potato, and shepherd's purse, and also upon the young pea vines. Except for stray individuals which, of course, would be found upon everything in the crowded insectary, the buckwheat remained apparently untouched. Whether *M. solanifolii* would have accepted the blossom tips of the older buckwheat or not was not demonstrated, as the buckwheat, although it lived, did not make much growth.

October 11. Insectary search showed the Macrosiphum eggs near some of the oviparous forms both upon potato and shepherd's purse (*Capsella Bursa-pastoris*). Many of the eggs were glistening brownish black of well hardened eggs but some were pellucid green, showing that they had very recently been deposited. They were upon the plants indiscriminately on leaves and stalks. Males and oviparous females were present upon both these plants.

The appearance of the oviparous females and the deposition of eggs with the uncaged material at practically the same time as that of the forms that had been prisoners for 2 months would indicate that these dates are about normal. In the insectary the migration from overcrowded potato stalks to fresh plants seemed to take place irregularly and not at any stated times, the condition of the infested plant apparently influencing these movements. The fact that they seemed to seek the fresh potato plants almost as readily as the peas or the shepherd's purse might seem to indicate that if a similar succession of new potatoes were supplied them in the field they might not seek another host even there. As it is a wholesale migration has taken place each of the seasons these plant lice have been under observation.

The fact that *M. solanifolii* colonized readily upon garden peas in the insectary while *M. destructor* refused the potato (see page) is not without interest.

Insectary Host Plant Tests for M. destructor.

(July-August, 1908.)

The plants used for these tests were grown from seed and were kept in quarantine for the purposes of this test so that no infestation of the plants by other than the desired aphides was possible.

From Peas to Red Clover. Pisum sativum L. to Trifolium Pratense.

(a) July 21. A lot of mature specimens and nymphs, removed from peas to red clover. July 27. Mature individuals all dead. Nymphs feeding along the clover stems. Aug. 10. One winged form developed. Several living nymphs present in clover. Aug. 12. Aphides all dead. (26-08.)

(b) Aug. 10. A lot of 15 alate forms which had deserted peas (to migrate) and were present on cloth ceiling of pea-vine cage were transferred to red clover. In less than an hour these had deserted the clover as they had the peas and had gone to the sides and top of cage. No young were produced on the clover. (50-08.)

(c) Aug. 12. A lot of 10 migrants from peas placed on clover. They deserted the clover at once and did not produce. (50-08.)

From Peas to Potato Vines (Solanum tuberosum L).

(d) July 15. A lot of 20 nearly mature apterous individuals transferred from peas to potato plants. July 17. All 20 dead. No feeding on the potato took place. They would not remain on the potato but deserted it. (26-08.)

(e) July 21. A lot of 50 mature apterous individuals transferred from peas to potato. All died without feeding or producing. (43-08.)

(f) Aug. 12. A lot of 14 alate individuals (migrants from peas) placed on potato. All died without feeding. No progeny. (50-08.)

(g) Aug. 25. A lot transferred from peas to potatoes. All died without feeding. No progeny. (50-08.)

(h) Aug. 25. A lot of apterous adults and half grown nymphs transferred from peas to potatoes. All died without feeding. No progeny. (26-08.)

From Shepherd's Purse (Capsella Bursa-pastoris (L.) to Potato.

(i) Aug. 11. A lot of 5 alate individuals removed from shepherd's purse to potato. These died without producing. (43-08.)

From Peas to Shepherd's Purse.

(j) July 17. A lot of apterous viviparous individuals and nymphs transferred from peas to shepherd's purse. In 15 minutes nearly all the aphides had already settled on the plants and begun feeding. July 21, Old aphides dead. Stalks fairly well covered with nymphs. July 31. Nymphs thriving though of a yellowish color. Aug. 6. Mature apterous and alate forms are present. These are hardly more than one-half the size of the parent forms from peas. Aug. 25. This colony still represented by alate and apterous forms feeding on shepherd's purse and producing. (26-08.)

(k) July 21. A lot of mature apterous individuals transferred from peas to shepherd's purse. July 27. Mature individuals all dead. Good thrifty colonies of greenish yellow nymphs present. Aug. 11. Seventeen winged forms present and some pupae. These are much smaller than their parents from peas. Five of these alate forms removed to fresh shepherd's purse where they at once settled and began producing, and by August 25 had developed a few winged and mature apterous descendants which were producing yellowish nymphs. (43-08.) Aug. 11. Five of the 17 alate forms (see the foregoing Aug. 11) were transferred to young pea vines where they settled, fed and produced. (43-08.)

(l) Aug. 12. A lot of 30 alate individuals transferred from peas to shepherd's purse. Aug. 25. The progeny of the foregoing are small and yellowish but a healthy, vigorous colony.

From Peas to Various Plants.

On Barley.

(m)—(x). Twelve tests were made attempting to transfer *M. destructor* from peas to barley (*Hordeum vulgare* L.). The barley was 6 inches high at time of tests and growing well. The aphides deserted the barley and crawled to the sides of the cage where they died within a few days.

On Wheat.

Four tests were made attempting to establish colonies on wheat. Two lots of 10 apterous adults were transferred from sweet peas to wheat July 27. July 31 these and their progeny were dead. One lot of 10 alate aphides was placed on wheat July 27 and by July 31 these had died. August 10 several hundred specimens were taken from peas and transferred to wheat. August 11 scarcely any aphides could be seen on the plants. August 15, aphides all dead. Wheat was 6 inches tall at time of test and growing well.

On Oats.

July 27, a lot of 10 apterous adults transferred from peas to oats. July 31, aphides all dead.

On Purslane.

July 17, a lot of 15 apterous adults transferred from peas to common purslane (*Portulaca oleracea* L.). July 21, adults all dead. No young to be found.

On Beets.

August 10, a lot of 15 alate individuals which had migrated from peas to cloth on the cage were transferred to beets in small cage. These did not remain on the beet plants but flew to sides of cage where they died before August 15.

On Squash.

August 11, a lot of 15 alate individuals transferred from peas to squash. They died within a few days without starting colonies on the squash. Test repeated with 30 nearly grown nymphs, all of which died within a few days.

* * * * * * *

As a check against the foregoing tests, 7 lots under the same conditions in other respects were transferred from garden peas to sweet peas and from sweet peas to garden peas. All these lots established healthy colonies and thrived.

While failure to establish colonies under these conditions is not a conclusive proof that *M. destructor* never feeds on the plants refused in these tests, it is certainly strongly indicative in that direction. On the other hand, there is no reason to believe that any species of aphid will establish thriving colonies on a plant in confinement that it would not accept in the open.

EXPLANATION OF FIGURES.

Figs. 59 and 60. *M. solanifolii.* Cornicle of male and tip of same, showing reticulation. No. 22-07.

Figs. 61 and 62. *M. solanifolii.* Cornicle of apterous oviparous female and tip of same, showing reticulation. No. 22-07.

Figs. 63 and 64. *M. solanifolii,* pink variety. Cornicle of alate viviparous female and tip of same, showing reticulation. No. 106-06.

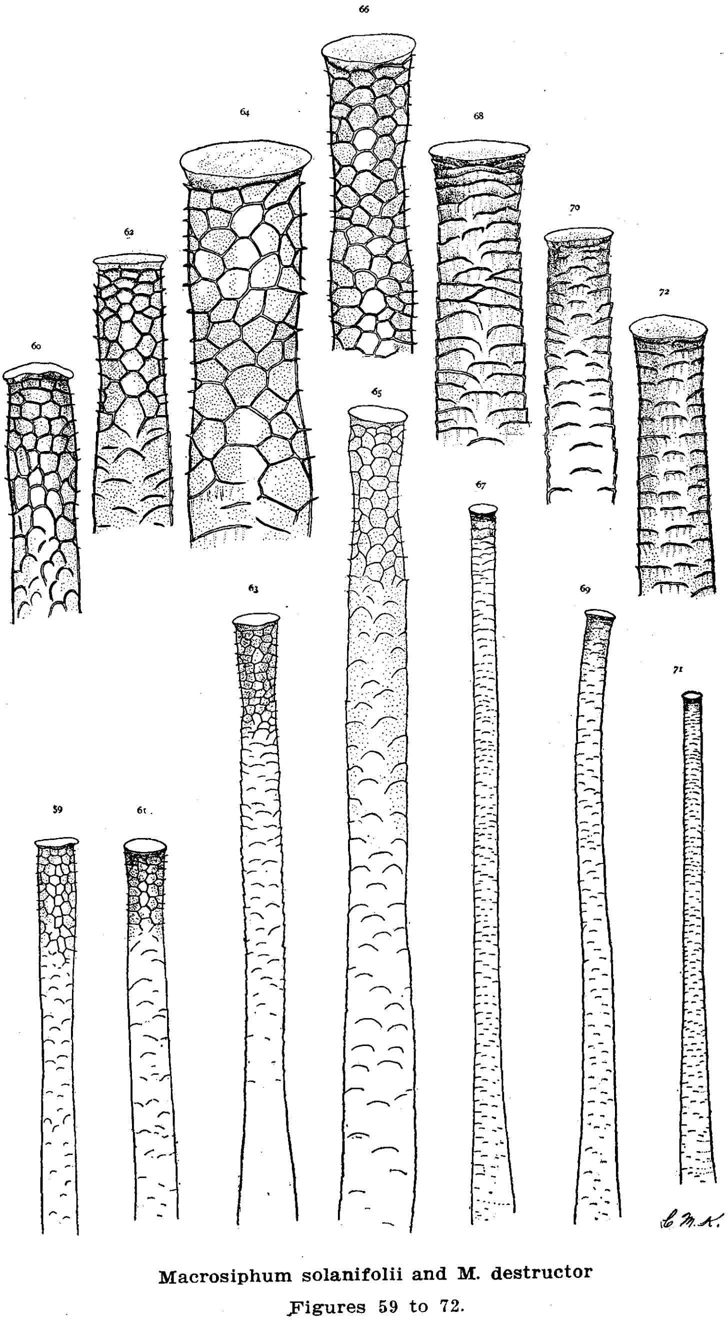
Figs. 65 and 66. *M. solanifolii,* green variety. Cornicle of apterous viviparous female and tip of same, showing reticulation. No. 50-05.

Figs. 67 and 68. *M. destructor.* Cornicle of apterous viviparous female and tip of same, showing imbrication. No. 19-07. Collected from garden pea.

Figs. 69 and 70. *M. destructor.* Cornicle of alate viviparous female and tip of same, showing imbrication. No. 19-07.

Figs. 71 and 72. *M. destructor.* Cornicle of alate viviparous female and tip of same, showing imbrication. No. 104-06. Collected from sweet pea.

(Figures were drawn by Miss Charlotte M. King.)



Macrosiphum solanifolii and M. destructor

Figures 59 to 72.

BIBLIOGRAPHY.

For the purposes of this paper the following references are of chief importance.

1900. Johnson. Nectarophora destructor. Can. Ent. Vol. 32, pp. 56-60. Figs. 4-6. Original description.

1900. Sanderson. Nectarophora pisi. Delaware College Agricultural Experiment Station. Bulletin No. 49.

1901. Chittenden. Nectarophora destructor. U. S. Dept. Agric. Bureau of Entomology, Circular No. 43.

1901a. Sanderson. Nectarophora pisi. Can. Ent. Vol. 33, pp. 31-39 and 74, figures.

1901b. Sanderson. Nectarophora pisi. 12th Ann. Rept. Del. Col. Agric. Expt. Sta., pp. 169-186. Plate II.

1909. Chittenden. Macrosiphum pisi. U. S. Dept. Agric., Bureau Ent. Circular No. 43, 2nd ed.

1909. Folsom. Macrosiphum pisi. In the 25th Report of the State Entomologist on the Noxious and Beneficial Insects of Illinois.

* * * * * *

1882. Ashmead. Siphonophora solanifolii. Can. Ent. Vol. 14, p. 92. Original description of apterous, viviparous form. The description of so-called "male" is some other species.

1905. Fletcher. Nectarophora solanifolii. Ann. Rept. on Expt. Farms for 1904, p. 228.

1907. Fletcher. Nectarophora solanifolii. Ann. Rept. on Expt. Farms for 1906, p. 210.

1907. Patch. Nectarophora solanifolii. Me. Agr. Expt. Sta., Bulletin 147, pp. 235-257. Figs. 25-33.

BULLETIN No. 191.

AN ACCURATE METHOD FOR DETERMINING THE WEIGHT OF THE PARTS OF THE EGGS OF BIRDS.*

BY

MAYNIE R. CURTIS.

During the past four years the biological work of the Maine Experiment Station has included a considerable amount of biometrical work on the egg of the domestic fowl. In 1910 an investigation of the size relations and proportion of the parts of successive eggs of the same individual hen was undertaken. This work when completed will include a study of all the eggs laid during the first or pullet year by a flock of over twenty Barred Plymouth Rock hens. In this work it is necessary to get accurate determinations of the weight of the albumen, yolk and shell of each egg.

In order that the data for this study might be accurate it was essential at the outstart to determine satisfactory methods, first, for preserving eggs for a few hours with practically no change in weight and, second, for accurately separating the parts of the egg. Since the results of the entire investigation cannot be published for some time, and since the methods worked out have proved useful in other investigations now in progress in this laboratory, it seems advisable to publish a discussion of them at this time.

METHOD FOR PRESERVING EGGS TO INSURE A MINIMUM LOSS IN WEIGHT.

It is often impossible to take data on eggs as soon as they are laid. In order to have comparable data it is therefore necessary to reduce as much as possible the error due to loss of weight from unequal evaporation. The amount of loss by

*Papers from the Biological Laboratory of the Maine Agricultural Experiment Station. No. 27.

evaporation depends upon several factors. The most important of these are: first, the length of time which has elapsed since the egg was laid, second, the humidity and temperature of the surrounding atmosphere and the rapidity with which the air surrounding the egg changes, third, the character of the shell, and, fourth, the amount of exposed surface, i. e., the size of the egg.

It seemed reasonable to suppose that the loss from evaporation would be reduced if the eggs were placed in small sealed jars immediately after laying. A preliminary experiment was performed to compare the loss of weight of eggs so preserved with that of eggs kept in the open air. September 9, 1910, twenty eggs were brought to the laboratory soon after they were laid. These were all Barred Plymouth Rock eggs laid between 8 and 11 o'clock on that morning. No two, of course, were from the same hen. The eggs were divided into two groups of ten each. The first group was numbered from 21 to 30 inclusive. Each of these eggs was sealed in a half pint Lightning fruit jar. Each jar contained a small amount of cotton to keep the egg from breaking when it was dropped into the jar. The ten eggs of the other group were numbered from 31 to 40 inclusive, and were placed in a wire basket on the laboratory table. The eggs were weighed* each day for four days, being removed from the jars just before and replaced directly after weighing. The weighing was begun at the same hour and proceeded in the same order (according to serial number of the eggs). At the end of the fourth day the eggs which were sealed in the jars were used in the separation experiment described later, but the eggs kept in the air were weighed also on the fifth and sixth days. Table No. I shows for each egg kept in the open air, (a) its daily weight; (b) its loss at each weighing from the first weight; (c) its loss in each 24 hours and its mean daily loss for both four and six days; (d) the mean loss for the ten eggs on each day; and (e) the mean daily loss on them for four and for six days. Table No. II gives the same data for the eggs kept in sealed jars except that it includes data for only four days.

---

*A chemical balance was used in all the weighing of eggs and parts of eggs. The weights were taken to hundredths of a gram.

TABLE I.

Data on the Weight of Eggs Kept in the Open Air.

Egg No.	31	32	33	34	35	36	37	38	39	40	Means.
Weight fresh	56.01	50.15	57.88	50.94	58.03	59.84	56.36	72.05	67.62	47.71	57.6590
Weight after 24 hours	55.90	50.05	57.77	50.85	57.94	59.74	56.25	71.92	67.52	47.66	57.5600
Loss in first 24 hours	0.11	0.10	0.11	0.09	0.09	0.10	0.11	0.13	0.10	0.05	0.0990
Weight after 48 hours	55.79	49.94	57.64	50.77	57.86	59.64	56.16	71.81	67.43	47.56	57.4600
Loss in 48 hours	0.22	0.21	0.24	0.17	0.17	0.20	0.20	0.24	0.19	0.15	0.1990
Loss in second 24 hours	0.11	0.11	0.13	0.08	0.08	0.10	0.09	0.11	0.09	0.10	0.1000
Weight after 72 hours	55.70	49.85	57.56	50.69	57.79	59.60	56.06	71.70	67.33	47.49	57.3770
Loss in 72 hours	0.31	0.30	0.32	0.25	0.24	0.24	0.30	0.35	0.29	0.22	0.2820
Loss in third 24 hours	0.09	0.09	0.08	0.08	0.07	0.04	0.10	0.11	0.10	0.07	0.0830
Weight after 96 hours	55.61	49.76	57.48	50.63	57.74	59.54	55.98	71.59	67.26	47.43	57.3020
Loss in 96 hours	0.40	0.39	0.40	0.31	0.29	0.30	0.38	0.46	0.36	0.28	0.3570
Loss in fourth 24 hours	0.09	0.09	0.08	0.06	0.05	0.06	0.08	0.11	0.07	0.06	0.0750
Mean daily loss for 4 days	0.1000	0.0975	0.1000	0.0775	0.0725	0.0750	0.0950	0.1150	0.0900	0.0700	0.0893
Weight after 120 hours	55.54	49.69	57.40	50.58	57.69	59.49	55.91	71.50	67.19	47.37	57.2360
Loss in 120 hours	0.47	0.46	0.48	0.36	0.34	0.35	0.45	0.55	0.43	0.34	0.4230
Loss in fifth 24 hours	0.07	0.07	0.08	0.05	0.05	0.05	0.07	0.09	0.07	0.06	0.0660
Weight after 144 hours	55.47	49.61	57.33	50.52	57.61	59.44	55.84	71.41	67.13	47.31	57.1670
Loss in 144 hours	0.54	0.54	0.55	0.42	0.42	0.40	0.52	0.64	0.49	0.40	0.4920
Loss in sixth 24 hours	0.07	0.08	0.07	0.06	0.08	0.05	0.07	0.09	0.06	0.06	0.0690
Mean daily loss for 6 days	0.0900	0.0900	0.0917	0.0700	0.0700	0.0667	0.0867	0.1067	0.0817	0.0667	0.0820

Table II.

Data on the Weight of Eggs Kept in Sealed Jars.

Egg No.	21	22	23	24	25	26	27	28	29	30	Means.
Weight fresh	66.77	*48.39	55.36	56.26	62.73	63.94	53.93	53.36	72.59	61.93	59.526
Weight after 24 hours	66.76	48.36	55.33	56.23	62.69	63.92	53.93	53.34	72.56	61.91	59.503
Loss in first 24 hours	0.01	0.03	0.03	0.03	0.04	0.02	0.00	0.02	0.03	0.02	0.023
Weight after 48 hours	66.74	48.35	55.30	56.20	62.68	63.90	53.91	53.34	72.54	61.88	59.484
Loss in 48 hours	0.03	0.04	0.06	0.06	0.05	0.04	0.02	0.02	0.05	0.05	0.042
Loss in second 24 hours	0.02	0.01	0.03	0.03	0.01	0.02	0.02	0.00	0.02	0.03	0.019
Weight after 72 hours	66.71	48.31	55.28	56.17	62.66	63.87	53.88	*53.33	72.50	61.85	59.456
Loss in 72 hours	0.06	0.08	0.08	0.09	0.07	0.07	0.05	0.03	0.09	0.08	0.070
Loss in third 24 hours	0.03	0.04	0.02	0.03	0.02	0.03	0.03	0.01	0.04	0.03	0.028
Weight after 96 hours	66.69	48.28	55.27	56.15	62.64	63.85	53.86	53.31	72.47	61.83	59.435
Loss in 96 hours	0.08	0 11	0.09	0.11	0.09	0.09	0.07	0.05	0.12	0.10	0.091
Loss in fourth 24 hours	0.02	0.03	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.021
Mean daily loss	0.0200	0.0275	0.0225	0.0275	0.0225	0.0225	0.0175	0.0125	0.0300	0.0250	0.0228

* These eggs were accidentally cracked at the time of the weighing indicated.

A comparison of these tables shows that eggs kept in the open air lose daily from 0.04 gr. to 0.13 gr. with a mean for the first four days of 0.0893, while eggs kept in sealed jars lose daily from 0.00 to 0.04 gr. with a mean for the first four days of 0.0228. That is, keeping the eggs sealed in jars reduces the evaporation to one-fourth that which occurs in the open air.

In this laboratory egg data are usually taken within 24 and always within 48 hours after the egg is laid. The error due to evaporation which is likely to influence our results is, therefore, the loss within the first 48 hours. In this time the eggs kept in the open air lost from 0.15 gr. to 0.24 gr. with a mean of 0.199, while those kept in jars lost from 0.02 gr. to 0.06 gr. with a man of 0.042. By keeping the eggs in jars the error due to this cause was reduced to nearly one-fifth that for eggs kept in the open air. The error 0.042 is too small to influence any conclusions likely to be drawn from the data. The method of preserving the egg in sealed jars is, then, sufficiently accurate for the present work.

Tables I and II show further that there are individual differences in the amount of weight lost by eggs kept under identical conditions. For eggs kept in the open air the minimum mean daily loss for the first four days was 0.07 (egg no. 40) and the maximum was 0.115 (egg no. 38). On the sixth day these two eggs still represent the extremes* with mean daily losses of 0.0667 and 0.1067 respectively. For the eggs kept in sealed jars the minimum mean loss per day for four days was 0.0125 (egg no. 28) and the maximum was 0.03 (egg no. 29).

These individual differences are no doubt due largely to variation in the character of the shell in the eggs of different individual birds. The fact that—especially in the eggs exposed to the open air—the loss of weight in heavy eggs is greater than that in light eggs indicates that the amount of exposed surface and consequently the size of the egg is another factor. The relation between size of eggs and loss of weight is shown graphically in Fig. 73.

*Egg no. 36 also has a mean daily loss of weight of 0.0667 for six days.

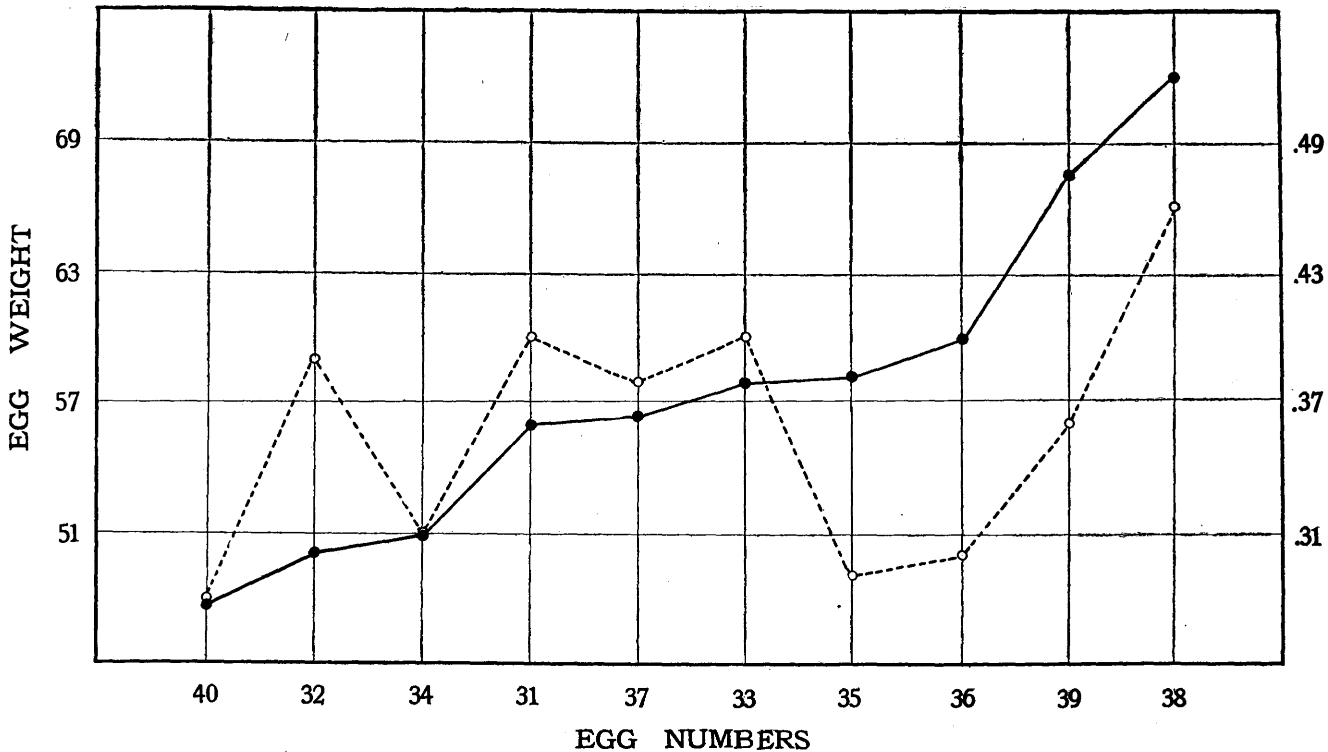


Fig. 73. Showing the relation between size of egg and its loss of weight by evaporation in open air. Explanation in text.

This diagram shows the weight of the egg and its loss of weight in four days (96 hrs.) for the set of eggs kept in the open air. The continuous line represents the weights of the eggs plotted in the order of their magnitude. The broken line represents the loss in weight in 96 hours of the same eggs. The general trend of the lines indicates that there is some positive correlation between the weight of the egg and its loss in weight by evaporation. The amount of data is too small to admit of measuring this correlation satisfactorily but the fact of its existence appears to be clear. The exceptions are such as would be expected on the assumption that the character of the shell is also an important factor.

That the comparative loss on different days must be to some extent influenced by atmospheric conditions seems reasonable, but no experiment has been performed to measure this influence. The eggs kept in sealed jars show a small variation in the daily means which cannot be analyzed by any data in hand. The mean daily loss in weight in the case of the eggs kept in the open air varies from 0.1 gr. on the second day to 0.066 gr. on the fifth day. The means for the first and second day (0.099 gr. on first and 0.1 gr. on the second) are much higher than those for the fifth and sixth (0.066 gr. and 0.069 gr. respectively) while the means for the third and fourth are intermediate (0.083 and 0.075) respectively. That is, there is a decrease in the absolute loss in weight after the second day. This is also shown by comparison of the individual means on the fourth and sixth days. In the case of every one of the ten eggs the mean daily loss is less when calculated on six days loss than when calculated on four days loss. The mean daily loss for all the ten eggs is 0.0893 when calculated on four days loss and 0.0820 when calculated on six days loss. This result might reasonably be expected since the more concentrated the albumen becomes the less rapidly would it evaporate.

Methods of Separating Eggs.

Before a study of the proportion of parts of eggs can be made it is necessary to determine an accurate method for separating these parts. In the boiled egg it is comparatively easy to separate them accurately. This method of separation was employed in some extensive but as yet unpublished work done in this laboratory. In this work the eggs were weighed fresh and dropped into boiling water; allowed to boil twenty minutes and cooled, usually, in the open air and weighed again before the parts were separated. These eggs showed a loss of from 1 gr. to 1.5 gr. in weight due to boiling and cooling. An egg that is still hot weighs more than before it is boiled but loses weight rapidly in cooling. An experiment was undertaken to test different methods of cooling the eggs.

Fourteen* eggs (nos. 6 and 8-20) were weighed and then boiled twenty minutes. Five (nos. 16-20) of these were cooled in the open air; five (nos. 11 to 15) in sealed half pint Lightning fruit jars and four (nos. 6 and 8-10) under water. Table III shows the loss of weight** of each of these eggs.

Table III.

Showing the Comparative Loss in Weight Due to Different Methods of Cooling Boiled Eggs.

Method of cooling.	Egg no.	Loss in boiling and cooling.	Method of cooling.	Egg no.	Loss in boiling and cooling.	Method of cooling.	Egg no.	Loss in boiling and cooling.
In water.	6	.91	In air.	11	1.51	In sealed jars.	16	1.76
In water.	8	1.25	In air.	12	1.75	In sealed jars.	17	1.79
In water.	9	1.08	In air.	13	1.60	In sealed jars.	18	1.68
In water.	10	1.33	In air.	14	1.54	In sealed jars.	19	1.27
			In air.	15	1.49	In sealed jars.	20	1.58
Mean loss........		1.1425	Mean loss....		1.578	Mean loss............		1.616

This table shows that the eggs cooled in the open air lost from 1.49 to 1.75 gr. with a mean of 1.578. Those cooled in sealed jars lost from 1.27 gr. to 1.79 gr. with a mean of 1.616,

*The experiment started with fifteen eggs but egg no. 7 was cracked when the eggs were put into the boiling water.

**Complete data for these eggs are given in table IV.

and those cooled under water lost from 0.91 gr. to 1.33 gr. with a mean of 1.1425. This experiment shows that the loss of weight in boiling and cooling is not decreased when the eggs are cooled in small closed chambers. The slight difference (0.038 gr.) in the amount of loss in the two cases is too small to be significant when such small numbers are concerned. When the eggs were cooled under water there was a decided decrease in the loss of weight. The two means are 1.578 in the case of the eggs cooled in air and 1.1425 in the case of those cooled under water. The mean loss is thus reduced by cooling in water to about three-fourths the loss when the cooling is in air. However, a loss of more than one gram in weight is too large to be overlooked in a quantitative study of the proportion of parts of eggs, and therefore any plan which involves the boiling of the eggs must be discarded in accurate work.

With a little care and practice fresh eggs can be separated accurately. This may be accomplished by a slight modification of the housewife's method. An egg should be broken near the center allowing the albumen to run into a receiving dish, holding the yolk in one half of the shell. Then turn the yolk into the other half shell and empty into the receiving dish the albumen which remained with the yolk. The chalazæ may usually be cut off by allowing each of them to slip over the shell so that they hang free with the yolk end on the broken edge of the shell. If the weight of the chalaza is insufficient, pressure may be applied at the edge of the shell or each chalaza may be clipped off with scissors. The chalazæ are allowed to fall into the receiving dish. The yolk is then poured out of the half shell on to a filter paper and rolled on the paper until the last trace of albumen is removed. It is then dropped onto the scale pan. The shell is also wiped with filter paper to remove the adhering albumen. The weight of the parts of the egg may thus be determined by weighing the egg before it is broken and then weighing the yolk and shell, which have both been dried of adhering albumen with filter paper. The weight of the albumen is then obtained by difference.

While this is obviously the most accurate method of determining the weight of the fresh albumen, it is impossible to determine the error in weighing the parts of the egg unless all the parts are weighed. The purpose of some of the preliminary investigations was to compare the error in weighing the parts of a boiled egg with the error in weighing the parts of an egg separated fresh. The weight of the fresh albumen may be determined by using a scale pan to receive it when the egg is broken, and weighing with it the filter with which the yolk and shell are dried. This filter should either be previously balanced by another filter which is placed on the weight pan, or it may be weighed before use and its weight subtracted from the weight of the albumen and filter.

Balancing or weighing the filters was found by experience to require about one minute each. An experiment was undertaken to determine the error which would be involved in considering filters taken from the same package to be of equal weight. This experiment involves two assumptions. The first is that the weights of 50 filter papers taken in succession from one package of 100 filters is a random sample of the weights of the filter papers of the same make, number and size. The second is that the distribution of the filters (as to weight) in the package depends entirely on chance, i. e., is random. The filters used were Carl Schleicher and Schull's No. 597, diameter 150 mm. Fifty filters were weighed. The weights ranged from 1.33 to 1.83 gms. The mean weight was 1.5636. The weight of each of these fifty papers was written upon a card, and these cards were then shaken in a cylindrical box. Four wires were stretched through the box in different planes and at different levels. One hundred drawings of two cards at a time were then made, the two cards drawn being returned to the box and the box shaken between successive drawings. The difference between the weights recorded on the two cards drawn together ranged from 0.00 gr. to 0.40 gr. The mean difference was 0.1346 gr. In 88 of the 100 drawings the difference was below 0.25. In other words this indicates that if one takes a pair of filter papers at random from a package and assumes that they are the same weight he will be in error in his weights because of this assumption 0.1346 gr. on the average.

In five (26 to 30 Table IV) of the eggs separated fresh the filters used to balance the ones on which the yolk and shell were dried were taken from the pile without weighing or balancing. The error in weights is not perceptibly more in these than in the other cases where weighed or balanced filters were used.

Twenty-nine eggs were used in the experiment to compare the error in weighing in eggs separated before and after boiling. Fifteen of these eggs were separated fresh and fourteen were separated after boiling. The data collected in this experiment are shown in Tables IV and V.

TABLE IV.

Data on Eggs Separated Fresh.

Egg No.	Weight of egg.	Weight of albumen.	Per cent. albumen.	Weight yolk.	Per cent. yolk.	Weight shell, etc.	Per cent. shell, etc.	Error in weight.	Per cent. error in weight,
1........	67.59	41.06	60.75	18.76	27.76	7.00	10.36	0.77	1.14
2........	47.43	28.81	60.74	13.22	27.87	5.28	11.13	0.12	0.25
3........	55.30	32.20	58.23	15.57	28.16	7.08	12.80	0.45	0.81
4........	57.25	35.20	61.48	15.80	27.60	5.93	10.36	0.32	0.56
5........	61.11	36.69	60.04	16.85	27.57	7.43	12.16	0.14	0.23
21*.......	66.69	41.48	62.20	17.86	26.78	7.15	10.72	0.20	0.30
22........	48.28	26.80	55.51	16.39	33.95	4.93	10.21	0.16	0.33
23........	55.27	32.51	58.82	16.55	29.94	6.15	11.13	0.06	0.11
24........	56.15	33.13	59.00	16.89	30.08	6.01	10.70	0.12	0.21
25........	62.64	38.19	60.97	17.24	27.52	6.63	10.58	0.58	0.93
26†... ...	63.85	38.38	60.11	17.72	27.75	7.59	11.89	0.16	0.25
27........	53.86	31.10	57.74	16.51	30.65	5.99	11.12	0.26	0.48
28........	53.31	31.73	59.52	15.97	29.96	5.34	10.02	0.27	0.51
29........	72.47	46.01	63.49	18.21	25.13	7.79	10.75	0.46	0.63
30........	61.83	36.14	58.45	18.72	30.28	6.90	11.16	0.07	0.11
Mean....	58.87	35.30	59.80	16.82	28.73	6.48	11.01	0.28	0.46

* The weight of eggs 21 to 30 are the weights after they had been kept in sealed jars for 96 hours. See Table II.

† In separating eggs 26 to 30 the filters used to balance those on which the yolk and shell were dried were taken from the package and were neither weighed nor balanced.

Table V gives the data for the fourteen eggs separated after boiling. It gives the weight of each egg fresh, its weight boiled, the loss of weight due to boiling and cooling, the weight of albumen, yolk, shell and membranes, the error in weights (i. e., the differences between the sum of the weights of the parts and the weight of the boiled egg), the percentage of the parts of the boiled egg, and the percentage error in weights.

Table V.

Data on Eggs Separated after Boiling.

Egg No.	Weight of egg fresh.	Weight of egg boiled.	Loss of weight in boiling and cooling.	Weight albumen.	Per cent. albumen.	Weight yolk.	Per cent. yolk.	Weight shell, etc.	Per cent. shell, etc.	Error in weights.	Per cent. error in weights.
6..........	64.99	64.08	*0.91	38.55	60.16	18.36	28.65	6.71	10.47	0.46	0.72
8..........	48.99	47.74	*1.25	26.47	55.45	15.36	32.17	5.62	11.77	0.29	0.61
9..........	59.08	58.00	*1.08	33.96	58.55	17.74	30.59	5.78	9.97	0.52	0.90
10..........	57.03	55.70	*1.33	31.38	56.34	17.93	32.19	5.90	10.59	0.49	0.88
11..........	49.61	48.10	**1.51	27.00	56.13	15.63	32.49	5.14	10.69	0.33	0.69
12..........	50.91	49.16	**1.75	27.05	55.02	15.94	32.42	5.75	11.70	0.42	0.85
13..........	49.70	48.20	**1.50	30.47	63.22	11.85	24.59	5.52	11.45	0.36	0.75
14..........	50.74	49.20	**1.54	27.10	55.08	16.28	33.09	5.41	11.00	0.41	0.83
15..........	50.75	49.26	**1.49	27.75	56.33	15.94	32.36	5.27	10.70	0.30	0.61
16..........	58.75	56.99	†1.76	33.39	58.59	17.54	30.78	5.87	10.30	0.19	0.33
17..........	59.31	57.52	†1.79	35.40	61.54	16.59	28.84	5.22	9.08	0.31	0.54
18..........	55.70	54.02	†1.68	30.04	55.61	17.69	32.75	6.11	11.13	0.18	0.33
19	54.04	52.47	†1.57	29.70	56.60	16.39	31.24	6.22	11.85	0.16	0.30
20..........	53.67	52.09	†1.58	30.34	58.25	16.17	31.04	5.38	10.33	0.20	0.38
Means.....	54.52	53.04	1.48	30.61	57.63	16.39	30.94	5.71	10.80	0.33	0.62

* Cooled in water. ** Cooled in air. † Cooled in sealed jars.

A comparison of the two tables shows that in the case of eggs separated fresh the errors in weights ranged from 0.06 gr. to 0.77* gr. with a mean of 0.28, while in the case of the boiled eggs the errors in weights ranged from 0.16 gr. to 0.52 gr. with a mean of 0.33. These errors in weights were all negative. The mean error of weighing is not greater in eggs separated fresh than in those boiled before separation. It should be said, however, that in the data here presented the error of weighing does show a greater range of variation in the case of the eggs separated fresh. This is probably due entirely to chance and is of no significance. The fact that the mean error of weighing is actually less in the case of the eggs separated fresh is not significant. This is shown by the amount of variation. If a single large error like that in egg 25 had occurred instead of either of the small errors in eggs 23 or 30 the mean would have been greater than that for the boiled eggs. The errors are, however, smaller in a majority of the eggs separated.

The difference between the sum of the weights of the parts and the weight of the whole is approximately equal in eggs separated fresh and in those separated after boiling. When we consider that in the case of the eggs separated after boiling we must add to this error the also constantly negative error due to the loss in weight from boiling and cooling, it becomes apparent that the method of separating the eggs fresh involves less loss of weight. In the 14 boiled eggs used in this experiment the mean loss of weight due to boiling and cooling was 1.48 or almost five times the error in weighing.

The difference between the sum of the weights of the parts and the weight of the whole does not take into account a possible incomplete separation. That is, it is still possible that in the fresh egg a part of the albumen was weighed with the yolk and a part with the shell. If now we compare the two methods we find 59.80 as the mean percentage of albumen in the eggs separated fresh and 57.63 in the eggs separated after boiling. The mean percentage of yolk is 28.73 in the fresh eggs and 30.94 in the boiled eggs and the mean percentage of shell is

*This was the first egg separated and there was some delay due to lack of experience. A drying of the albumen may be responsible for this high loss in weight.

11.01 in the fresh egg and 10.80 in the boiled egg. That is, the percentage of albumen is higher and the percentage of yolk lower in the fresh egg than in the boiled egg. This is exactly the reverse of what would be expected if a part of the albumen had, as a matter of fact, been weighed with the fresh yolk. The percentage of shell is higher in the case of the egg separated fresh. This is what would happen if all the albumen was not removed.

There must be some explanation for this difference in the percentage of parts. An inspection of the data suggests two possibilities, each of which seems to be partly responsible for the difference in the percentage of parts in the fresh and boiled eggs which were used in this experiment. These may now be considered. (1) In spite of their large individual variability heavy eggs tend to have a higher percentage of albumen and a smaller percentage of yolk than light eggs. The group separated fresh contained a larger number of heavy eggs than the group that were boiled before separation. (2) In eggs of equal weight, those boiled before separation contained a lower percentage of albumen and a higher percentage of yolk than those separated fresh. This led to the suspicion that the loss in weight due to boiling and cooling was largely, at least, a loss to the albumen.

Figure 74 is a graphical representation of the relation between the weight of the eggs which were separated fresh and the percentages of their parts. The weights of the eggs are plotted in the order of their magnitude. They are shown by the solid black line. The line of dashes shows the percentage of albumen, the line of dots the percentage of yolk, and the dot-dash line the percentage of shell. Figure 75 shows the same thing for the eggs boiled before separation.

Both of these diagrams show considerable individual variability in the percentage of parts, but they indicate in general a positive correlation between the weight of the egg and the percentage of albumen, and an equal negative correlation between the weight of the egg and the percentage of yolk. The data here plotted showed no correlation between the weight of the egg and the percentage of shell.

The graphs also show that the group of eggs separated fresh contained several eggs heavier than the heaviest eggs in the

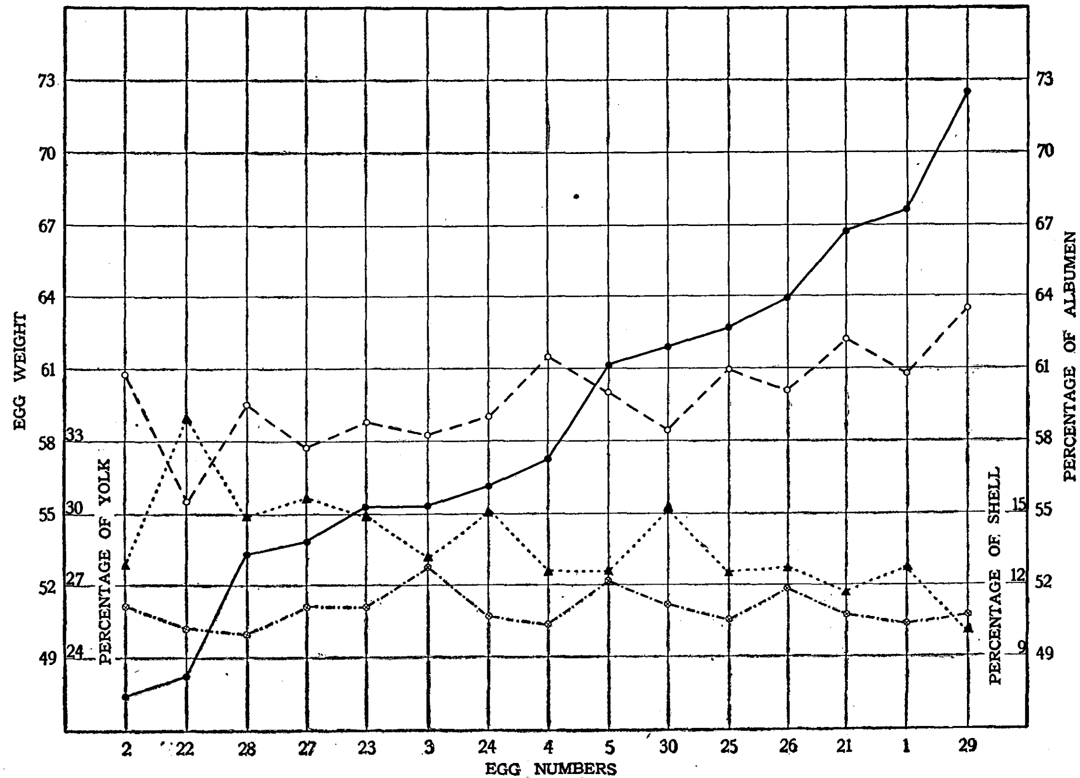


Fig. 74. Diagram showing the relation between the weight of the whole egg and its parts in eggs separated fresh. The significance of the lines is as follows: Solid, weight of egg, dash, percentage of albumen, dot, percentage of yolk, dot-dash, percentage of shell. For further explanation see text.

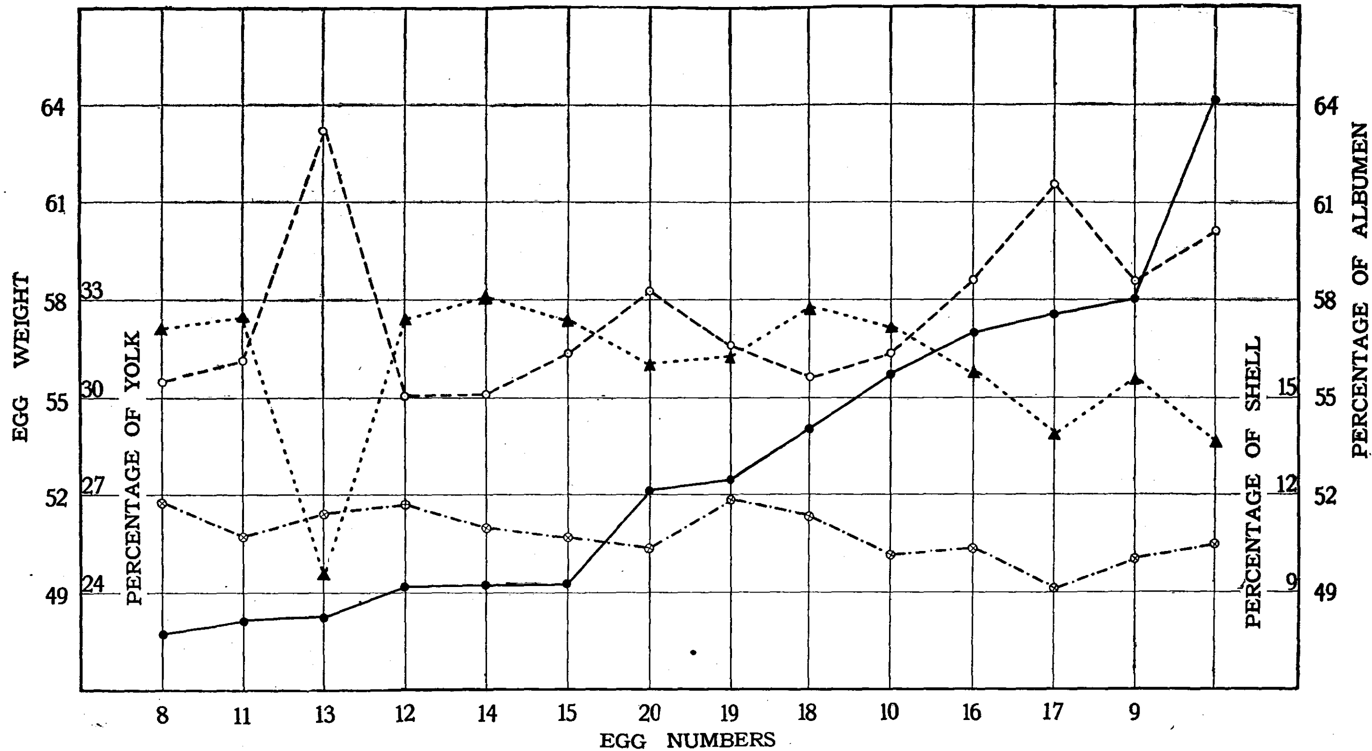


Fig. 75. Diagram showing the relation between the weight of the whole egg and its parts in eggs separated after boiling. The different lines have the same significance as in Fig. 2.

other group, while the group boiled before separation contained several more very light eggs than the group separated fresh.

A comparison of the lines showing the percentage of albumen and the percentage of yolk in the two figures shows that for a given weight of egg the percentage of albumen is higher and the percentage of yolk lower in the fresh than in the boiled egg.

If the loss of the egg in weight due to boiling and cooling is a loss in weight of albumen, the data from fresh and boiled eggs should be comparable if the eggs are of approximately equal weight and a correction factor is applied. To make this correction the loss in weight due to boiling and cooling should be added to the weight of albumen, and the percentage of parts then calculated on the basis of the fresh weight of the egg. In order to test this hypothesis seven eggs were selected from the middle of each group. These eggs in the two groups were of approximately the same weight. In the group separated fresh they varied from 53.31 gr. to 61.11 gr. with a mean of 56.04. In the other group they varied from 53.67 gr. to 59.08 gr. with a mean of 56.80. The data for these eggs is given in Tables VI and VII.

Table VI gives for the seven eggs selected from the group separated fresh the data tabled for each of the fifteen eggs in Table IV. Table VII gives the same data for the seven eggs selected from the group boiled before separation. In addition it gives the figures after correction on the assumption discussed above that the loss of weight due to boiling and cooling is a loss to the albumen. That is, the "corrected" weight of albumen given in Table VII is the weight of boiled albumen plus the total loss of weight of the eggs due to boiling and cooling. The "corrected" percentage of albumen is the percentage that this "corrected" albumen is of the weight of the fresh egg. The "corrected" percentage of yolk, of shell and membrane, and of error in weights is the percentage that each of these is of the fresh weight of the eggs.

The following relations are seen from a comparison of Tables VI and VII. The assumption made changes the mean percentage of albumen of the eggs boiled before separation from 57.93 to 59.07. The mean percentage of albumen of the eggs separated fresh is 59.26. The mean percentage of yolk of the boiled eggs is lowered from 31.06 to 30.22. The mean percentage of yolk in the eggs separated fresh is 29.14. The mean corrected percentage of shell of the boiled eggs is 10.20 while the uncorrected is 10.49. The percentage of shell of the fresh egg is 11.18.

TABLE VI.

Data on Selected Eggs Separated Fresh.

Egg No.	28	27	23	3	24	4	5	Means
Weight of egg	53.31	53.86	55.27	55.30	56.15	57.25	61.11	56.04
Weight of albumen	31.73	31.10	32.51	32.20	33.13	35.20	36.69	33.22
Per cent. of albumen	59.52	57.74	58.82	58.23	59.00	61.48	60.04	59.26
Weight of yolk	15.97	16.51	16.55	15.57	16.89	15.80	16.85	16.31
Per cent. of yolk	29.96	30.65	29.94	28.16	30.08	27.60	27.57	29.14
Weight of shell, etc	5.34	5.99	6.15	7.08	6.01	5.93	7.43	6.28
Per cent. of shell, etc	10.02	11.12	11.13	12.80	10.70	10.36	12.16	11.18
Error in weights	0.27	0.26	0.06	0.45	0.12	0.32	0.14	0.23
Per cent. error in weights	0.51	0.48	0.11	0.81	0.21	0.56	0.23	0.42

TABLE VII.

Data on Selected Eggs Separated after Boiling.

Egg No.	20	19	18	10	16	17	9	Means
Weight of egg fresh	53.67	54.04	55.70	57.03	58.75	59.31	59.08	56.80
Weight of egg after boiling	52.09	52.47	54.02	55.70	56.99	57.52	58.00	55.26
Loss in boiling	1.58	1.57	1.68	1.33	1.76	1.79	1.08	1.54
Weight of albumen	30.34	29.70	30.04	31.33	33.39	35.40	33.96	32.03
Per cent. of albumen	58.25	56.60	55.61	56.34	58.59	61.54	58.55	57.93
Weight of yolk	16.17	16.39	17.69	17.93	17.54	16.59	17.74	17.15
Per cent. of yolk	31.04	31.24	32.75	32.19	30.78	28.84	30.59	31.06
Weight of shell, etc	5.38	6.22	6.11	5.90	5.87	5.22	5.78	5.78
Per cent. of shell, etc	10.33	11.85	11.31	10.59	10.30	9.08	9.97	10.49
Error in weights	0.20	0.16	0.18	0.49	0.19	0.31	0.52	0.29
Per cent. error in weights	0.38	0.30	0.33	0.88	0.33	0.54	0.90	0.52
Weight of albumen corrected	31.92	31.27	31.72	32.71	35.15	37.19	35.04	33.57
Per cent. albumen corrected	59.47	57.86	56.95	57.36	59.83	62.70	59.31	59.07
Per cent. yolk corrected	30.13	30.33	31.76	31.44	29.86	27.97	30.03	30.22
Per cent. shell, etc., corrected	10.02	11.51	10.97	10.35	9.99	8.80	9.78	10.20
Per cent. error in wts. cor'cted	0.37	0.30	0.32	0.86	0.32	0.52	0.88	0.51

It is then apparent that this correction brings the percentage of albumen and yolk of the eggs separated after boiling much nearer the percentage of the same parts in eggs separated fresh. Yet the percentage of albumen is still slightly greater and the percentage of yolk smaller in the eggs separated fresh. This is directly opposite to what one would expect if there had been an incomplete separation of the fresh egg and a part of the albumen had been weighed with the yolk. It is also directly opposite to what would be expected from the slight difference in weight in the two groups. The mean weight of the eggs separated fresh is slightly less than the mean of the other group. It would therefore be expected that the mean percentage of albumen would be less and the percentage of yolk greater than in the other group. This difference is probably due to chance individual variations although it is possible that the yolk actually gains weight at the expense of the albumen when the egg is boiled.

The mean percentage of shell before correction, and even more after, is slightly less in the boiled than in the fresh eggs. This is what we should expect if the separation between this and the albumen were incomplete. This is, indeed, the most probable explanation of the fact. The fresh shell has a damp appearance even after it has been wiped as dry as possible with filter paper. The boiled shell looks almost dry. It is possible that the shell is somewhat dissolved in boiling and also possible that some of the difference is due to chance individual variation. All the work on the weights of the parts of eggs done at this laboratory shows that the chance individual variation in shell weight of eggs of equal weight is very large.

To summarize this portion of the work it may be said that a comparison of the method of separating the parts of eggs fresh with the method of separating them after boiling shows that the error of weighing (i. e., the difference between the sum of the weights of the parts and the weight of the whole) is not essentially different in either case. Certainly this error is not larger when the eggs are separated fresh. Further, when the eggs are separated fresh there is no appreciable loss of albumen due to drying. When eggs are separated after boiling there is *in addition* to the irreducible error in weighing an error five times as large, viz., the loss in weight due to the boiling and cooling. This error is not distributed *pro rata* between the different parts of the egg but is largely a loss to the albumen. The data here studied indicate that the yolk may even gain weight at the expense of the albumen although the range of variation and the small number of eggs considered make a positive conclusion on this point impossible.

The weight of the shell can undoubtedly be found a little more accurately in the boiled egg. Even when the shell of a fresh egg is carefully wiped with filter paper the separation between it and the albumen is less perfect than when the albumen is coagulated. The error in shell weight in the fresh egg is, however, several times less than the error in weight of albumen in the boiled egg, the percentage of albumen being much greater in the fresh egg in spite of the small amount which is weighed with the shell.

SUMMARY.

The purpose of this paper is to present the results of a study of methods by which an accurate determination of the weight of the several parts (albumen, yolk and shell) of the hen's egg might be made. Such methods involve (a) the prevention of loss of weight by evaporation, pending the weighing of the egg, and (b) the accurate separation of the parts of the egg for weighing. After a trial of various plans to meet these two needs the following were found to be the most accurate of any which were practicable.

1. A practical method of preserving eggs for a few hours which reduces the loss of weight by evaporation to a negligible minimum is to seal each egg as soon as possible after it is laid in a half pint Lightning fruit jar containing a cushion of absorbent cotton.

2. An accurate method of separating the parts of the egg is as follows: Break the egg near the center and allow the albumen to run into a receiving dish. Keep the yolk in one half of the shell. Then turn it into the empty half. The yolk is then dried on a filter paper. The shell is also dried on a filter. The yolk and shell are then weighed. The difference between the sum of their weights and the original weight of the unbroken egg gives the weight of albumen.

BULLETIN No. 192.

BREEDING POULTRY FOR EGG PRODUCTION. *

BY

RAYMOND PEARL.

PART I.

SUMMARY OF EARLIER WORK.

Since 1898 an investigation in breeding Barred Plymouth Rock fowls for increased egg production has been in progress at the Maine Station. This work was put under the direction of the present writer in 1907. No systematic or detailed report of the results obtained was made until 1909. Since that time a number of papers have been published dealing with one phase or another of these experiments. A list of these papers follows.**

1. Data on the Inheritance of Fecundity obtained from the Records of Egg Production of the Daughters of "200-egg" Hens. Maine Agl. Exp. Stat. Ann. Rpt. for 1909, pp. 49-84, (Bulletin 166).

2. A Biometrical Study of Egg Production in the Domestic Fowl. I. Variation in Annual Egg Production. U. S. Dept. Agr. Bur. Anim. Ind. Bulletin 110, Part I, pp. 1-80, 1909.

3. A Biometrical Study, etc. II. Seasonal Distribution of Egg Production. *Ibid.* Part II, pp. 81-170, 1911.

4. Is there a Cumulative Effect of Selection? Data from the Study of Fecundity in the Domestic Fowl. Zeitschr. f. ind. Abst. u. Vererbungsl. Bd. 2. pp. 257-275, 1909.

---

* Papers from the Biological Laboratory, Maine Agricultural Experiment Station, No. 32.

** Dr. Frank M. Surface, formerly Associate Biologist of this Station, is a joint author (with R. Pearl) of Nos. 1-5 inclusive of the papers listed. The other papers cited are by R. Pearl.

5. Studies on Hybrid Poultry. Maine Agr. Expt. Stat. Ann. Rpt. for 1910, pp. 84-116, 1910. (Pp. 100-106 deal with fecundity).

6. The Relation of the Results Obtained in Breeding Poultry for Increased Egg Production to the Problem of Selection. Rpt. 30th Meeting Soc. Proc. Agr. Sci. pp. (of reprint) 1-8.

7. Inheritance in "Blood Lines" in Breeding Animals for Performance, with Special Reference to the "200-Egg" Hen. Ann. Rpt. Amer. Breeders Assoc. Vol. VI, pp. 317-326, 1911.

8. Inheritance of Fecundity in the Domestic Fowl. Amer. Nat. Vol. XLV. pp. 321-345, 1911. (This paper is reprinted in full as Part IV of the present bulletin).

9. Biometric Arguments Regarding the Genotype Concept. Amer. Naturalist, Vol. XLV, pp. 561-566, 1911.

Most of these papers cited above deal with certain essentially negative results obtained in the earlier years of the experiments. It seems desirable, as an introduction to the positive results now reported, to review briefly the entire history of the work at the Maine Station in the experimental breeding of poultry with reference to the character fecundity or egg production. Another reason for publishing the present bulletin lies in the fact that most of the papers in which the original data and results have been presented are not easily accessible to the agricultural public. It is hoped that this bulletin may help to meet the demand for information on the part of that public in regard to the progress of the breeding work at the Maine Station. Finally it is desired to present at this time some data not hitherto published regarding obscure and doubtful points of interpretation and suggested criticisms of the experiments in breeding.

For detailed evidence on any point discussed, except such as are here presented for the first time, the reader is referred to the original papers listed above.

PLAN OF EARLIER WORK.

The earlier work of the Station on this subject, which covered the years 1898 to 1907 inclusive, was concerned, and executed in conformity, with the then prevailing views respecting the effectiveness of mass selection. The underlying idea which dominated these earlier experiments was that by breeding consistently year after year from the highest layers, regardless of all other considerations, there must be brought about a definite and steady, if gradual, improvement or increase in the average annual egg production per bird.

Two distinct and separate experiments were carried out during the period of the investigation prior to 1908. These may be designated as follows:

I. Experiment in continued selection of fluctuating variations in fecundity.

II. Experiment regarding the inheritance of fecundity.

I. *Experiment in continued selection of fluctuating variations in fecundity.* In 1898 there was begun at the Maine Agricultural Experiment Station an experiment to determine whether egg production in the domestic fowl could be increased by the continued selection of the highest egg producers as breeders. This experiment was planned and started by Director C. D. Woods and the late Professor G. M. Gowell.* An exact record was made of the egg production of each hen during the first year of her life; trap nests being used to furnish the individual records. The plan of the experiment begun in 1898 was to make from a strain of Barred Plymouth Rock hens, which had been "pure" bred, i. e., without introduction of strange "blood," for a long time by Professor Gowell, a continuous close selection with reference to egg production. The practice in breeding was to use as mothers of the stock bred in any year only hens which laid between November 1 of the year in which they were hatched and November 1 of the following year, 150 or more eggs. After the first year, all male birds used in the breeding were the sons of mothers whose production in their first laying year was 200 eggs or more. Since the normal average annual egg production of these birds may be taken to have been about 125 eggs, it will be seen that the selection practiced was fairly stringent.

Close inbreeding was not designedly practiced. It was always in theory possible to avoid this, since after the first four

* The present writer had *nothing whatever* to do with the planning of this experiment, nor with its conduct prior to December 1907. Therefore, he cannot justly be held accountable, as he has been by some critics, for real or supposed defects in the plan and earlier conduct of this experiment. The responsibility for the statistical analysis of the results is his, however.

years of the experiment the flocks were large (always containing more than 300 birds and usually nearer a thousand). While there was no close inbreeding no "new blood" was introduced into the strain from the outside during the period of the experiment.

II. *Experiment regarding the inheritance of fecundity.* In 1907 the experiment described above, having led to definite results was brought to an end. There was planned for 1908 a new experiment designed to test from another standpoint the conclusions which had been tentatively reached from the earlier experiment. In the conducting of the long selection experiment the females used as breeders were grouped into two classes, viz., (a) "unregistered" or birds laying 150 to 199 eggs in the pullet year, and (b) "registered" or birds laying 200 or more eggs in the pullet year.

It had been noted that the daughters of the so-called "registered" hens (namely hens that had produced 200 or more eggs each in the pullet year) did not usually make high egg records. The "200-egg" birds which made up the "registered" flock came, in most instances, from the "unregistered" mothers.

Experiment II was planned primarily to answer the following question: Will the daughters of high laying hens ("200-egg" birds) on the average produce more eggs in a given time unit than will birds of less closely selected ancestry?

The experiment was carried out according to the following plan: On the first of November, 1907, there were put into house No. 2, of the Station plant, 250 pullets. Each of these was the daughter of a hen that had laid approximately 200 eggs in her pullet year. As a matter of fact 11 of the 33 hens which produced these 250 "registered" pullets had each laid a few eggs less than 200 in a year forward from Nov. 1 of their pullet year. The writer has been criticized for including these birds in the work. When carefully considered such criticism appears to be without any real significance. In the first place nearly all of these 11 birds *were* "200-egg" hens in the sense that they laid this number of eggs (or more) in a period of 365 days following the laying of their first egg. The records were for the sake of uniformity in presentation and analytical discussion in (1)* and (4) taken as from November 1 of the pullet year to November 1 of the next year. That the records are taken in this way in no wise interferes with the fact that these birds were heavy layers. The further fact which entirely suffices to justify the inclusion of these 11 birds with the 22 which laid 200 or more eggs in the year from November 1, flows from the comparison of the *daughters* of the 11 with the *daughters* of the 22 in respect to average egg production. Table I of (1) shows that the mean winter production of all "registered" pullets was 15.29. The mean winter production of the 67 daughters of the 11 mothers under discussion was 16.03, and the mean winter production of the 125 daughters of the other 22 mothers was 14.87. So far, then, from the low average winter production of all "registered" pullets in this experiment taken together being due to the inclusion of these 11 mothers, whose November 1 to November 1 record fell a little below 200 eggs, and their daughters, actually this group of progeny had a *higher* winter production than the remainder of the "registered" flock.

These pullets were divided into flocks of 50 each and were fed and handled in every way exactly alike. At the same time that these 250 "registered" pullets (so-called because from "registered" mothers), were put into the house there were also put in 600 other Barred Plymouth Rock pullets. These other pullets were of approximately the same age as the 250 "registered" pullets and differed in their breeding only in respect to their mothers. They came from hens that had laid less than 200 eggs during the pullet year and more than 160. "Registered" cockerels (from the "200-egg" line) were used as the male parents for all the pullets both "registered" and "unregistered." The 600 "unregistered" birds were divided into flocks as follows: Two flocks of 50 birds each were kept in two pens in house No. 2, exactly like the pens in which the "registered" birds were kept. The remaining 500 birds were divided into four flocks—two of 100 birds each and two of 150 birds each and housed in the four pens of house No. 3. These pens are essentially like those of house No. 2, differing chiefly in the

* Figures in parenthesis refer to the papers in the list of literature at the beginning, p. 113.

matter of size. A trap nest * record was kept of the exact individual egg production of each of these birds.

RESULTS OF EARLIER WORK.

The essential results of the two lines of investigation described above may be very briefly set forth here. Greater details are given in papers (1-8) cited above. These results are:

1. That mass selection for high egg production on the basis of the trap nest record of the individual alone *did not,* as a matter of fact, result in a steady, continuous improvement in average flock production, though it was continued for a period of ten years.

2. That, as a matter of fact, the daughters of "200-egg" hens with from 6 to 9 years of mass-selected ancestry (on the basis of trap nest records) behind them were *no better layers* on the average than birds bred from the general flock.

Now whatever opinion anyone may hold as to the biological interpretation of these results he must not after all forget that they are *facts.* While it has been argued that 10 years is far too short a time to learn anything about the effect of selection it should be remembered that he who makes this argument is really discussing a very complex *theoretical* matter. An unbiassed examination of the literature on the subject indicates that the length of time which is considered necessary to prove experimentally the effectiveness or non-effectiveness of mass-selection depends almost entirely upon which way the results are coming. If after following a plan of mass selection for even 3 or 4 years one finds that concurrently there has been an improvement in the character selected for, he almost invariably and quite humanly concludes that the selection is the *cause* of the improvement. Just why, however, *post hoc* should be considered to be *propter hoc* when it happens to be "your" *hoc* but not at all so when it is "my" *hoc* that is concerned has never been clear to the writer. It certainly seems fair to suppose that it requires just exactly as many years *critically* to prove by experiment that mass selection in a particular case *is* effective

* For a description of the trap nest used in the breeding work of the Station see "Appliances and Methods for Pedigree Poultry Breeding" by R. Pearl and F. M. Surface. Me. Agric. Exp. Station. Bulletin 159, pages 239-274. 1908.

as it does to prove in another case that it is *not* effective. The situation here is precisely as broad as it is long.

Practically, from the standpoint of the plain poultryman, whose interest in poultry keeping is confined to some part of the span of an ordinary lifetime, these results at the Maine Station give little encouragement to the idea of wholesale trapnesting with the expectation of thereby increasing the egg production of the flock. That the trap nest has a place in poultry husbandry is certain. It is equally certain, however, that trapnesting for the purpose of improving egg production by the selection of the best layers has not that degree of practical usefulness and importance which it was popularly supposed to have some ten years ago when the work of the Maine Station in breeding for egg production was being so extensively exploited by the agricultural press and by institute workers all over the country. It seems now to be quite generally agreed that about the only profitable function of the trap nest in practical or commercial (as distinguished from experimental) poultry keeping is in connection with special needs or problems, as for example, in the work of the fancier, who desires to keep individual pedigrees of his stock. There does not exist any critical evidence that the selection of the highest laying birds on the basis of the trap nest record as breeders will insure or guarantee any definite, permanent improvement in average flock production.

Since as a matter of fact, as the work at this Station shows, this method of selecting breeders has very little, if any, real relation to the average production of subsequent flocks, it is obvious that, as a mere matter of chance, temporary improvement in production might be expected to follow this plan of breeding in about 50 percent of all flocks on which it was tried, and a temporary decline in production in the other 50 percent. This appears to be the actual state of the case. Some practical poultrymen who have tried trapnest selection of the best layers as breeders have obtained improved average egg yields for a time at least. They attribute the improvement to the selection, though without any critical evidence, of course, and are enthusiastic believers in the gospel of the trap nest. Other equally competent poultrymen have failed to get any such improvement and have discarded the trap nests, though sometimes, it must be confessed, clinging firmly to the theory of breeding which their own experience has shown to be at least *practically* inadequate to meet their needs.

Not only was there no improvement in average flock production following the method set forth in the preceding section, but actually there was a slight decline in production during the selection period. No particular importance, however, is, in the writer's opinion, to be attached to this decline. It probably is to be regarded as due to chance, i. e., to a number of accidental causes operating together. (See p. 156 for further discussion of this matter.)

The results of this earlier work aroused a good deal of protest and criticism on the part of ardent believers in the efficacy of mass selection under all circumstances. Furthermore many persons have offered tentative explanations as to why these experiments in selecting for improved egg production resulted as they did. Some of these suggested criticisms and explanations have been published, but most of them have not, but instead have been confined to verbal discussions among workers interested in the problems of breeding.

No attempt has been made by the writer to answer criticisms of this work.* The discussion which follows has no polemic object. When, as in the present case, the point at issue is the critical interpretation of admitted results which are (and must be in nearly all cases) in some degree incomplete no amount of argumentation as to what "might" or "ought" to obtain, really helps very much in getting at the true facts. The most useful course would seem to be first to examine critically all possible interpretations and then devise if possible ways of testing experimentally which, if any, of these interpretations are really valid. With the presentation of the evidence so obtained the scientific case must rest, it seems to me, until additional and directly pertinent evidence can be brought forward. While the search for data bearing critically on the interpretation of breeding experiments on fecundity at this Station is by no means completed, yet it seems desirable now that certain of the positive results of the later experiments are to be presented to consider critically the possible interpretations of the earlier work, and to bring forward some of the evidence which has led the writer to the opinion which he holds.

* With the exception of the paper numbered 9 on the list at the beginning. That paper deals only with a few special points.

PART II.

Critical Consideration of Possible Interpretations of Earlier Work.

The critical interpretation of the results of the mass selection experiment described in the preceding section is by no means a simple matter. As to the bare facts as such there can be no question, but how shall they be interpreted? What really do they mean?

There are two principal general interpretations or explanations which may conceivably be given for the selection experiments at the Maine Station between 1898 and 1907 turning out in the way which they did. On the one hand it may be said that the results indicate that the general theory of the effectiveness of selection, or even more broadly the theory of breeding, which was at the foundation of this experiment, is, in greater or less degree, inadequate or incorrect. That is to say, the experiment may be interpreted, as it has been by the writer, as showing that it is doubtful whether the picking out by selection of minute favorable variations has in reality any cumulative or additive effect, so far as concerns the hereditary or germinal constitution of an animal, at least with reference to the character fecundity or egg production in fowls.

Before reaching such a conclusion, however, one must consider on the other hand, alternative interpretations and see whether the facts cannot be equally well or better explained in some other way. A number of such alternative explanations may be thought of. Nearly all of these explanations which suggest themselves fall into one category. This category is, to characterize it in a word, *the effect of environment.* In general terms this explanation of the results obtained would run something like this: that in reality the selection for increased egg production practiced during the years 1898-1907 was inherently or potentially effective, but that during this same period of years one or another or a combination of environmental circumstances became progressively worse, so that the gain which may be supposed to have been made each year as a result of the selection was masked or hidden by the untoward effect of the environment which prevented the hens from laying up to what was their true or innate capacity in the way of fecundity.

Specifically the possibilities here are large. There are many sorts of things by which a hen's laying may be disturbed and reduced. The action of such environmental circumstances furthermore cannot be prevented nor their disturbing influence upon a selection experiment eliminated by "keeping the environment constant" during the course of the experiment. This, of course, is the usual experimental method of attempting to safeguard against environmental factors disturbing the interpretation of the results of an experiment having to do with inheritance. But, as a matter of fact, leaving aside as of no real importance in the present discussion the fact that with such animals as poultry certainly it is physically impossible to obtain anything more than *average* uniformity of environment during a long period of years, there is a further point not to be lost sight of. This is that the effect of any *adverse* environmental circumstance acting upon an animal during the course of a long continued experiment in selection *must tend to become progressively cumulative as time goes on, if it be really efficiently adverse at all.*

What is meant is this: Suppose at the outstart of the experiment something in the method of feeding, or in the method of incubation, or of rearing the chicks was of a character such as to affect adversely, even to a slight degree, the vitality or constitution of the birds. Even without any true inheritance of this effect nevertheless its action must necessarily tend to become cumulative for purely physiological reasons, because (to confine the discussion to the case in hand, namely the domestic fowl) it admits of no question that a constitutionally weak or debilitated fowl lays an egg which is "weak" also. The elaboration of the yolk and of the albumen takes place within the hen's body. These substances serve as the food of the developing embryo. It is certain from observation of both egg and chick that the same kind or quality of food is not furnished to the embryo by the egg manufactured in the body of a strong fowl as is furnished in an egg manufactured in the body of a weak fowl. This is a fact which is well known to everyone who has had experience in the hatching and rearing of poultry. To analyze minutely all of the biological and chemical factors involved would certainly be a very difficult, indeed an almost impossible task, yet because such analysis is not easily possible in no wise militates against the fact itself.

Furnished with a qualitatively inadequate food supply the developing embryo either dies before hatching or hatches into a weak, debilitated chick. This badly nourished, weak chick grows into an adult fowl which is weak in constitution; usually weaker and to a greater degree lacking in vitality than the parent. The reason is that the unfavorable environmental factor has had a double action upon the adult offspring. Not only did it start life as an improperly nourished weak embryo, but throughout its post-embryonic development to the adult condition the same unfavorable environment which acted adversely upon its mother has been acting upon it and undoubtedly with increased efficiency because of the initial weakness of the embryo. This offspring bird may thus be expected to produce a still less normal supply of nutriment in its eggs than did *its* mother, since it is less vigorous and normal than she was.*

Thus the weakness is passed on from generation to generation tending all the time to become greater. I think that it must be obvious in view of these considerations that any environmental condition which is adverse to general constitutional vitality, if it is effective at all, must tend to become cumulatively so, even though every effort be made to keep environmental conditions uniform during the experiment. In fact the more uniform the environment is kept the more certainly will there be a cumulative effect of any unfavorable factor in it.

Obviously such a result as that under discussion has no real relation to the problem of the inheritance of acquired characters, though the objective result itself is precisely that which would be expected if a weakness induced by the environment were inherited. But actually the factor here dealt with is a purely nutritional one, and has nothing whatever to do with germinal constitution. This fact that any adverse environmental factor tends to produce an effect on the organism (at least among birds and mammals) which is persistent and in greater or less degree progressively cumulative, so long as the environment is

---

* Certain of these matters are being made the object of special investigation from a practical standpoint by Prof. Rice of Cornell University. Cf. Rice, J. E., and Rogers, C. A., Importance of Constitutional Vigor in the Breeding of Poultry. Cornell Reading Course for Farmers. No. 45. 1909 pp. 777-796.

kept constant and the factor continues to act, is, of course, one reason why it is so exceedingly difficult to get really critical evidence on the question of the inheritance of acquired characters.

In addition to the cumulatively adverse effect of environment as an explanation of the results of the earlier work at this Station another possible interpretation which is essentially physiological in its nature occurs to one. It is that any favorable progress in the way of increasing egg production by the selection was offset in the experiment by the weakening and debilitating effect upon the birds of the inbreeding which it might be contended was practiced during the experiment (see p. 115 above for facts on this point).

Another suggestion which has been made is that while there was no progressive increase in egg production following the mass selection this has no bearing on the question of the effectiveness of the selection of minute fluctuating variations because the character fecundity or egg productiveness is not inherited in the domestic fowl at all.

It is the purpose of this section to discuss these various suggestions one by one, presenting evidence which it is hoped will help to throw light on the subject. The evidence on the last mentioned criticism (that having to do with the non-inheritance of fecundity) will be presented in Part IV.

ARTIFICIAL HATCHING AND REARING.

The practical management of poultry naturally and obviously divides itself into three great divisions, namely (1) housing, (2) feeding, (3) incubating and rearing the chicks to replenish the flock. In considering the possibility that in the experiments under discussion some adverse factor in the environment (which broadly-speaking in the case of poultry on an intensive plant means the management) masked or concealed a favorable effect of the selection, it will be well to deal with each of these three divisions of management separately.

The methods of *housing* or *feeding* the stock practiced during the period of the selection experiment cannot, I think, reasonably be held to have had any adverse effect upon, or to have masked or covered up, any innate, inherited improvement in egg production conceived to have resulted from the selection. The reasons why this would seem to be the case are as follows: The system of housing in the so-called "curtain front" type of house which has been used at the Maine Station practically from the beginning of these experiments has been widely adopted by practical poultrymen all over this country and indeed in all parts of the world. It was the first attempt at the "fresh air" principle in housing poultry and has, with some modifications in recent years, grown steadily in favor in the minds of practical poultrymen who know that this method of housing, so far from adversely affecting egg production instead actually promotes a better egg production because it helps to keep the birds in a better general physiological condition than in any type of house yet devised.*

The same consideration applies with reference to the method of feeding used throughout the selection experiment. The Maine Experiment Station's dry mash has been very widely used indeed as a laying feed. It is a feed calculated for, and in actual practice shown to be excellently adapted to, stimulating the birds to something approaching the maximum of production of which they individually are constitutionally or hereditarily capable.*

This brings us to a consideration of the third of the great divisions of poultry management, namely, the hatching and rearing of the chickens. Here there are two methods: (a) the natural, in which the eggs are incubated by a brooding hen and the chickens are reared by a hen; and (b) the artificial, in which the eggs are incubated in incubators and the chickens are reared in brooders. Each of these methods is widely practiced and each has its staunch adherents. There is, however, a very wide spread feeling amongst poultrymen that artificial hatching and rearing has, in the long run, an injurious effect upon the stock. This injurious effect, they will grant, may not be apparent at once. But if artificial methods are persisted in for a long period of time those holding this view maintain that the

---

* This statement is intended to include "fresh air" houses of the Tolman and other patterns in the same *general* category as the "curtain front" house.

* This, of course, does not mean that *any* of the records of egg production ever obtained at the Maine Station approach the *physiological* limits of fecundity of the domestic fowl as a *class*. Cf. on this point (9).

result will be a steady and definite, if gradual, deterioration of the stock in respect to vitality or constitutional vigor and productiveness.

Now since a time previous to the beginning of the selection experiment at this Station in 1898 no chicken has ever been hatched on the Experiment Station plant except in an incubator nor reared in any other way than in a brooder. That is to say, the flock of hens on the Experiment Station plant in 1911 represents the end link in an unbroken chain of more than 13 years (which here mean "generations") of continuous artificial incubation and artificial rearing. It is quite evident, I think, that if these processes do bring about deterioration of the stock in vitality and productive qualities such deterioration ought by this time to be beginning at least to make itself apparent.

The possibility that such a deterioration in vitality and productiveness due to continued artificial incubation and rearing was the real reason why during the period of mass selection from 1898 to 1907 there was no improvement in the average egg production of the flock but instead a slight decrease certainly demands careful consideration. This interpretation of the results has specially appealed to a number of poultrymen. Thus Dryden * says (*loc. cit.* p. 382): "In the nine years breeding work at the Maine Station artificial methods were used in hatching and brooding the chicks, and while we are guessing at the failure to secure high egg yield in this experiment I venture to guess the failure was due to a gradual lowering of vitality in the stock by artificial incubation."

The question then to be considered, in light of all the available facts, is as to whether there was during the course of the experiment in selection any lowering of vitality due to this cause, and further whether this can be regarded as the explanation of the failure of an increase in average egg production to appear during the selection period.

From the nature of the experimental work which it was desired to do it was impossible practically to employ natural methods of hatching and rearing when the writer took charge

* Dryden, J. Artificial vs. Natural Incubation. Rpt. Am. Breeders' Association. Vol. V. pp. 380-382, 1909.

of the work in 1907. Artificial incubation had to be continued. It would seem that there are two lines of approach to the question as to whether the failure of the selection experiment to result in increased yields was due to deterioration following artificial incubation. On the one hand may be considered the actual facts regarding other evidence of deterioration besides egg production. While egg production is one index of vitality and constitutional vigor it is by no means the only one. Mortality and morbidity are other indices; so also is the hatching quality of eggs. Did the flock show evidence of a real constitutional degeneration, as indicated not alone by egg production, but by these other factors as well?

In considering this whole question it should be recognized that there is a difference between real constitutional degeneration and merely a state of temporary low condition due to an unfavorable immediate environment. The one is permanent and the other is only transitory. The one is truly constitutional, the other superficial. This brings us to the consideration of the second line of evidence which it is possible to get on the problem under discussion. If the real cause of the persistently low egg production during the selection experiment was artificial hatching and rearing merely changing the method of breeding without changing the method of incubation or rearing would certainly be expected to produce no effect. If a purely *environmental* matter such as artificial hatching and breeding is an efficient check to improvement by one method of breeding, it ought if unchanged to act with equal effectiveness against any other system of breeding. If it does not so act one is forced to the conclusion that it was not really an effective factor in determining the results of the first method.

Let us now turn to the data. In regard to the first line of evidence, namely facts presented by other indices of general vigor and vitality besides egg production, adult mortality may be first considered. Table A gives the number of adult females put in the laying house, the number of these which died and the percentage mortality for each of the years covered by the mass selection experiment. The "number of adult females" means the number of pullets put into the laying house each year at the average age of about 6 to 7 months. They are the same birds whose egg records during the same period are shown in fig. 80, (p. 157).

TABLE A.

Mortality Records of Adult Females During the Period 1898 to 1907.

Laying year.	Total number of birds put in house.	Number which died during year.	Percentage mortality.
1899–1900	81	8	9.9
1900–'01	100	14	14.0
1901–'02	55	3	5.5
1902–'03	160	13	8.1
1903–'04	300	44	14.7
1904–'05	550	33	6.0
1905–'06	700	64	9.1
1906–'07	700	44	6.3
1907–'08	850	69	8.1

The percentage mortality data are shown graphically in fig. 76. The straight line is the graph of the equation $y=11.18-0.42x$ where y denotes percentage mortality and x number of years since 1898-'99. The line is fitted to the observations by the method of least squares.

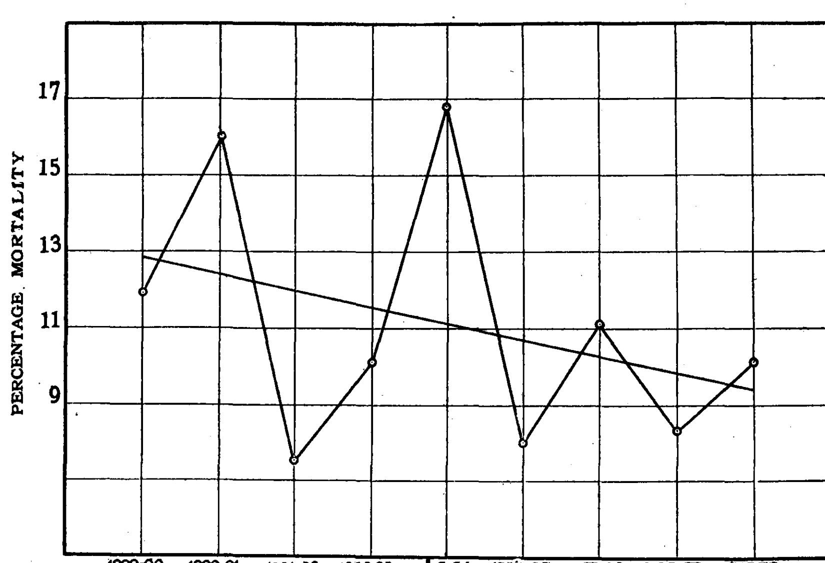


FIG. 76. Diagram showing the percentage mortality of adult female birds during the course of the selection experiment.

From the table and diagram the following points are to be noted:

1. As would be expected, the percentage mortality is seen to fluctuate in amount from year to year. These variations are without doubt to be accounted for by differences in general environmental factors in different years, and to accidents.*

2. The general trend, however, of the percentage mortality is plainly *downward* during the period covered by the experiment in mass selection. That is, during the period from 1899 to 1908, when the egg production was showing a slightly downward trend the adult mortality was also distinctly diminishing.

3. There is no evidence from the figures of adult mortality to indicate either that artificial incubation and rearing or any other environmental condition adversely affected the constitutional vigor of the strain during the course of the mass selection experiment, or (b) that in such action is to be found in the explanation of the failure of that experiment to result in increased annual average egg production.

The percentage mortality figures are given here only for the period covered by the selection experiment in order that direct comparison may be made between the trend of the egg production during that period (see fig. 80, p. 157) and the mortality curve. It may be said, however, that since the laying year 1907-'08 the mortality of adult birds has fluctuated about the same average as during the three years preceding. During the laying year 1910-11 the adult mortality has been quite exceptionally low.

Having now considered adult mortality as an index of general vitality and constitutional vigor attention may next be turned to the records of the hatching quality of eggs and the mortality of chicks. It needs but little practical acquaintance with poultry for anyone to recognize that in these two things exists one of the most precise measures of the general vitality or constitutional vigor of a strain or flock that it is possible to get. If a relatively large percentage of eggs hatch, and the chickens are strong and vigorous, and only a small proportion of them die it puts the question of the vitality of the stock beyond cavil.

---

* Cf. (2), pp. 16-19.

It would be highly desirable if records could be presented for the hatching of eggs and the mortality of chicks during the whole period covered by the mass selection experiment. Unfortunately it is impossible to do this since no such records were kept prior to the hatching season of 1908 (laying year 1907-08). Data on these points have been kept since that time, however. The figures for the hatching seasons of 1908 and 1909 have already been published.* For comparison with these, and to serve as a basis for a discussion of the present condition of the stock, in respect to these matters and in relation to the method of breeding now being followed, similar data will be given here for the hatching season of 1911 (laying year 1910-11).

Tables B and C give the hatching records for the season of 1911 for birds belonging respectively to high and low fecundity lines. All of the birds in Table B belong to pedigree lines in which the mean winter egg production of all females for four generations has been high. These are the birds used in 1911 to propagate the "high lines," the egg production of which is discussed farther on. All of the birds in Table C belong to pedigree lines in which the mean winter production has been uniformly low for four generations. The females in these two tables represent of course only a part of all birds bred in 1911, but they are the only ones whose hatching records are pertinent to the present discussion. Cross-bred birds and Barred Rocks in other lines of experimentation do not concern us here. As a matter of fact, the averages of Table B represent about the average hatching and rearing record of all birds bred in 1911. Some groups of birds did conspicuously better, especially on the rearing records.

---

* Pearl, R. and Surface, F. M. Studies on the Physiology of Reproduction in the Domestic Fowl. IV. Data on certain Factors Influencing the Fertility and Hatching of Eggs. Ann. Rpt. Me. Agr. Expt. Stat. for 1909, pp. 105-164.

From these tables the following matters are to be noted:

1. The percentage of infertile eggs is distinctly high, being

TABLE B.

Hatching Records of Barred Rock Females of High Fecundity Lines. Season of 1911.

Hen No.	Eggs set.	Infer-tile.	Per cent infertile.	Died in shell.	Hatched.	Per cent fertile eggs hatched.	Chicks died in 3 weeks.	Per cent died in 3 weeks.
4	43	2	4.6	15	26	63.4	3	11.5
9	57	10	17.5	19	28	59.5	3	10.7
10	69	20	28.9	20	26	53.1	1	3.8
11	18	5	27.7	6	7	53.8	0	0
12	60	2	3.03	10	48	82.7	6	12.5
14	64	14	21.8	8	42	84.0	3	7.1
18	43	7	16.2	34	2	5.1	0	0
19	48	3	6.2	13	32	71.1	2	6.2
20	45	1	2.2	24	20	45.4	3	15.0
22	38	4	10.5	32	2	5.8	1	50.0
25	53	7	13.2	22	22	47.8	2	9.1
27	57	19	33.3	25	13	34.2	0	0
28	45	4	8.8	15	25	60.9	2	8.0
29	53	9	16.9	14	29	65.9	3	10.3
36	47	4	8.5	11	32	74.4	4	12.5
39	43	8	18.6	33	2	5.7	0	0
41	51	0	0	30	20	39.2	0	0
46	40	30	75.0	5	4	40.0	1	25.0
53	38	8	21.1	18	12	40.0	2	16.6
62	52	21	40.3	13	15	48.3	3	20.0
76	46	7	15.2	8	31	79.4	4	12.9
77	34	33	97.1	1	0	0	0	0
81	37	3	8.1	6	27	79.4	1	3.7
85	56	15	26.7	27	13	31.7	2	15.3
117	50	4	8.0	13	33	71.7	5	15.1
134	50	28	56.0	18	4	18.1	0	0
165	38	3	7.8	11	24	68.5	1	4.1
196	42	10	23.8	12	20	62.5	5	25.0
198	46	5	10.8	24	17	41.4	3	17.6
273	46	22	47.8	7	16	66.6	1	6.2
1138	35	2	5.6	3	29	87.8	2	6.8
1156	37	13	35.1	8	10	41.6	4	40.0
1169	42	6	14.2	24	11	30.5	2	18.1
1170	40	0	0	5	35	87.5	2	5.7
1191	51	2	3.9	25	23	46.9	13	56.5
1196	42	5	11.9	6	30	81.1	0	0
1203	40	5	12.5	16	19	54.2	4	21.0
1213	48	3	6.2	22	24	53.3	10	41.6
1225	40	6	15.0	25	9	26.4	2	22.2
1232	39	1	2.5	13	24	63.1	4	16.6
1255	21	10	47.6	7	4	36.3	0	0
1256	42	3	7.1	11	28	71.7	2	7.1
Totals and weighted averages	1886	364	19.3	659	838	55.1	106	12.6

19.3 percent in one case and 18.8 percent in the other. This, however, does not mean, as might at first thought be supposed that there is some weakness on the part of the males or females bred. As a matter of fact the explanation of this poor record of fertility is that when the pens were mated up early in February no interval of time was allowed for the establishment of fertility before beginning to save eggs for hatching. That is to say, the eggs were saved and incubated from these breeding pens on the very same day that the male bird was put in the pen, and in a few instances it is probable that eggs were actually included from hens which had never been with a male bird at all. Every practical poultryman knows that on the average it takes from 6 to 10 days to establish good fertility in eggs

TABLE C.

Hatching Records Barred Rocks Females of Low Fecundity Lines. Season of 1911.

Hen No.	Eggs set.	Infertile.	Per cent infertile.	Died in shell.	Hatched.	Per cent fertile eggs hatched.	Chicks died in 3 weeks.	Per cent died in 3 weeks.
3	27	1	3.7	15	11	42.3	1	9.1
34	39	2	5.1	17	20	54.0	2	10.0
45	49	22	44.8	12	15	55.5	3	20.0
55	53	36	67.9	13	4	23.5	1	25.0
56	55	4	7.2	32	19	37.2	1	5.2
118	43	0	0	21	21	48.8	4	19.0
142	38	2	5.2	23	13	36.1	1	7.6
188	69	2	2.8	23	43	64.1	0	0
221	57	12	21.1	36	9	20.0	3	33.3
232	68	9	13.2	32	27	45.7	3	11.1
249	32	5	15.6	14	13	48.1	3	23.0
430	53	34	64.1	2	17	89.4	3	17.6
477	38	1	2.6	25	12	32.4	1	8.3
479	54	11	20.3	18	25	58.1	8	32.0
481	59	2	3.3	24	33	57.8	3	9.1
546	48	15	31.2	27	6	18.1	1	16.6
1221	43	3	6.9	22	17	42.5	5	29.4
1238	49	4	8.1	22	23	51.1	7	30.4
Totals and weighted averages	874	165	18.8	378	328	46.2	50	15.2

after birds are mated together. As a result of this incubating of the eggs taken from the time that the male and female birds were put together the record of fertility suffers a heavy handicap. Actually after fertility was once established (that is, after the male bird had been in the pen about 10 days) the average percentage of infertile eggs for the remainder of the season was about that which is considered normal in the work of this Station. This figure is on the average about 10 percent of the eggs infertile.

The reader may be disposed to wonder why eggs which were practically certain to be infertile were incubated. The reason was primarily that it was desired to get just as many chicks as possible hatched April 1 or within a few days of that time. Experience has shown that, under the environmental conditions which obtain here, that time is the best to hatch chickens which are to be used in fecundity work. Such birds come into laying at the proper time without either forcing or retarding. Now it is a fact that while, on the average, it takes from 6 to 10 days to get fertility well established after a mating is made, yet there are individuals in which the very next egg laid after the first copulation will be fertile. Because of this consideration all possible eggs were saved from the beginning of the matings, with the certain knowledge that while the *relative* or percentage fertility of these early eggs would be low, yet *absolutely* a few chicks would be obtained. The desire to get these chicks far outweighed any idea of making a maximum record of fertility of eggs, the latter, in fact, not entering into consideration at all.

2. The hatching quality of the eggs as indicated by the percent of fertile eggs hatched is again somewhat below what may be considered normal for the Maine Station stock at the present time. With large numbers of eggs the normal hatching percentage of fertile eggs is on the average a little over 60, taking the whole season through. Toward the last of the mating season (the month of May) the hatching percentage normally rises considerably.

Here, just as in the case of fertility, the records tabled bear a rather heavy handicap, which could have been avoided had the only purpose been to bring out the best record of which the birds were capable. The factor in question here is the holding of the eggs before incubation from the first week in February on. No eggs were put in incubators until March 7. More than half of the eggs set at this time were over two weeks old when put in the incubator. Everyone who has dealt practically with incubation knows that this means a serious reduction in the percentage of fertile eggs hatched. The reason for managing in this way was again to get the greatest possible *absolute* number of chicks hatched about April 1, regardless of the *relative* proportion of chicks to eggs set.

3. Taking all the records together and using the averages in the computations it appears that, even with the handicaps mentioned, *in the high fecundity lines it required only 2.6 eggs in the incubator in 1911 to produce one chicken three weeks old. In the low fecundity lines it required 3.2 eggs to make one*

*chicken three weeks old.** These figures are for the whole of the hatching season of 1911, that is, from February 1 to June 1. They do not represent the normal reproducing ability of the stock because of the heavy handicap explained above. In spite of this fact, however, these records can only be regarded as indicating an excellent performance.

Certainly these figures for hatching and rearing give no support to the view that the constitutional vigor or vitality of the Station Barred Plymouth Rock stock has been impaired by many years of continued artificial incubation and rearing. When it takes but three eggs or less to produce a chick three weeks old the stock cannot be said to be in a condition of reduced vitality.

4. It is plain that there is no substantial difference between the females of the high fecundity lines and the females of the low fecundity lines with respect to hatching records. What small differences there are indicate that birds of the high fecundity lines are on the whole somewhat surer reproducers than those of the low fecundity lines. While the percentage of infertile eggs is smaller in the low fecundity lines, on the other hand the percentage of fertile eggs hatched is also lower and a slightly larger percentage of chicks died during the first three weeks of their lives. Particular attention is called to this matter here because it has been alleged by one critic that selection for high egg production was inimical to reproductive capacity in the domestic fowl. As a matter of fact, as the present figures show, this is not at all the case. The criticism was based upon a fact previously brought out ** that there is a negative correlation between winter egg production and the hatching quality of eggs in the subsequent breeding season. This, however, is purely a physiological and not a genetic matter. High laying during the winter months undoubtedly tends to bring about a somewhat fatigued condition of the whole reproductive system with the result that the eggs in the subsequent spring do not hatch quite so well as under other circumstances. This, however, has nothing to do with the innate hereditary capacity of these same birds in respect to fecundity. This fact is indeed so

* As is well known three weeks covers nearly the entire chick mortality. The subsequent death rate among chicks which at three weeks of age are in full health and vigor is relatively insignificant.

** Cf., Pearl and Surface, *loc. cit.*

evident from Tables B and C as not to require further discussion.

We come now to the consideration of the last point in connection with artificial incubation. As was pointed out above (p. 127), if this had been the cause of the failure to increase egg production during the mass selection experiment, it ought to act as an equally efficient cause to prevent increase of egg production by any other method of breeding. As a matter of fact it did not so act, as is proven by the data given in Part IV of this bulletin. Without any change whatever from artificial methods of incubation or rearing it has been possible to isolate and breed from the Maine Station stock strains or lines in which *high* fecundity has been maintained during four generations at least. If the reader will study the diagram on p. 168 (fig. 84) remembering that during the *whole* period covered by the diagram there has been nothing but artificial incubation and rearing practiced he will find it difficult to believe that this factor has influenced, either one way or another, the results of the breeding experiments on fecundity at the Maine Station.

INBREEDING.

It has been pointed out above in the description of the mass selection experiment that no "new blood" was introduced into the flock during the course of that experiment. That is to say, no new additions were made to the hereditary constitution of the birds during that period. This certainly represents a condition of some degree of inbreeding, at least, in spite of the fact that an effort was made never to breed close relatives together. As a matter of fact, because of a lack of an adequate system of individual pedigree records during this mass selection experiment, it probably happened on several occasions that quite close relatives were bred together. Whether or not this occurred, it is certain that during 9 years only the "blood"* of relatively few original individuals was represented in the flock, and since all this breeding was in one line, the result can certainly be regarded only as a narrow-bred flock. Whether one chooses to call this "inbreeding" or not depends on his definition of the term. The biological condition and not the term

* Meaning *germ-plasm.*

used to designate it is the important thing. That condition was as described.

It amounts to a truism to say that it is one of the strongest and most ancient of breeding traditions that inbreeding is in and of itself harmful, and inevitably results in deterioration. This being so it is clear that a possible interpretation which demands careful attention is that the real reason for the failure of the mass selection experiment to produce increased mean annual production was to be found in the blighting effect of the inbreeding or narrow-breeding (as one chooses) which had been practiced. The deterioration from this cause would be held, on this view, to balance or offset the potential gain assumed to have resulted from the selection.

It seemed very important at the outstart of the new period in the breeding work at this Station, to test carefully the validity of this interpretation. In order to do so the experiment to be described was planned and carried out in 1908 and 1909. The essential point to this experiment was to compare in respect to egg production the offspring of two sorts of matings. In one set of these matings both the male and female mated together were from the Station flock and might be very closely related (even brother and sister). In the other set of matings the female in each case was from the Station flock but the male was a pure-bred Barred Rock cockerel purchased from one or another among the then more or less prominent breeders of this variety in the eastern United States. It will be seen that in the first case the progeny of the matings represent the continuation to the full degree of the narrow breeding practiced during the preceding 9 years. In the second case the progeny represent the widest breeding possible. That is, the male and female are absolutely unrelated and come from entirely distinct strains. If the narrow breeding during the selection experiment was really inimical to high egg production, and brought about deterioration, it would be expected that progeny from parents of absolutely unrelated "blood" would show marked superiority to those from a continuation of the narrow breeding. The maximum effect in the way of rejuvenation from "out-crossing" should show itself here.

In carrying out the experiment 8 Barred Rock cockerels were purchased in the early spring of 1908 from as many different breeders of this variety. These birds will be designated in what follows as "foreign" cockerels. Their sources are indicated in the following list.

Cockerel No.	Source.
56	Mr. C. H. Welles, Stratford, Conn.
57	Pine Top Poultry Farm, Hartwood, N. Y.
58	Gardner & Dunning, Auburn, N. Y.
60	L. J. Bundy & Son, Silver Springs, N. Y.
61	Mr. Geo. E. Mann, Dover, Mass.
65	Mr. Wesley B. Barton, Dalton, Mass.
68	Mr. Geo. W. Hillson, Amenia, N. Y.
70	Mr. M. L. Chapman, Mount View, Farmington, Conn.

All of these males, it may be said, were first-class, vigorous birds.

The breeding in 1908 was done in a house known as No. 1 which has since been destroyed. It was not adapted for use as a breeding house, and the results obtained as to fertility and hatching of eggs were as a consequence poor.* In this house there were 14 pens each accommodating one male and ten females. In addition there were 5 larger pens, each holding one male and 14 females. Four of the small pens were used for cross-breeding work and had no part in the present experiment. In addition to the hens in house No. 1, two breeding pens were mated up in house No. 2 which is of the curtain front, fresh air type, which experience has shown to be much better suited, both to breeding work and to egg production. In each of these two pens one male and 15 females were placed.

The arrangement of the pens relative to the hereditary constitution of the birds is shown in the following scheme.

It will thus be seen that in No. 1 house, pens headed by foreign cockerels and by Station cockerels alternated, whereas both pens in No. 2 house were headed by Station males. For each of the first 7 foreign cockerels there was a Station cockerel working under the same environmental conditions. During the course of the breeding season it was necessary to withdraw a number of the females from each pen and substitute others in their place.

In selecting the females to be bred to these various cockerels it was attempted to make as even a distribution between foreign

* Cf. Pearl, R., and Surface, F. M., *loc. cit.* p. 109.

and Station cockerels as possible. It is essential in such an experiment that the average age, health, vigor, size, and egg-production should be approximately the same in the females mated

House No.	Pen No.	Foreign Cockerels.	Station Cockerels.	Females.
1	5	D70		All females from Station stock.
	6		D2*	
	7	D60		
	8		D32	
	9	D65		
	10		D5	
	11	D56		
	12		D11	
	13	D58*		
	14		D16	
	15	D61		
	16		D35	
	17	D57		
	18		D17	
	19	D68		
2	20		D26	
	21		D31	

* This bird got no adult ♀ progeny in 1908 and is dropped from further discussion here. See text.

to the one class of cockerels as in those mated to the other class. Data regarding this and other matters related to the breeding history of the birds in this experiment are given in Table D. One of the foreign cockerels (No. D58) and one of the Station cockerels (No. D2) produced no adult female

TABLE D.

Data Regarding Breeding History of Individuals in Inbreeding Experiment.

ITEM.	Foreign Cockerels.	Station Cockerels in House No. 1.	Station Cockerels in House No. 2.
Number of ♂♂ in experiment	7	6	2
Number of ♀♀ mated with these ♂♂ *	120	93	33
Number of ♀♀ which produced adult daughters	26	17	15
Percentage of ♀♀ which produced adult daughters	21.7	18.3	45.5
Mean winter egg production of all ♀♀ mated	33.26	31.96	27.70
Mean winter egg production of all ♀♀ which produced adult daughters	44.31	39.53	28.27

* This is the *total* number of ♀♀ mated during the whole season and includes individuals put in to replace those removed. The number of ♀♀ with each male in the pen was *at any given time* only the number stated above (p.137).

progeny in 1908 and hence do not appear in the discussion of the fecundity of narrow and broad bred females. On this account they are dropped out of Table D.

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

1. The number of females in this experiment which succeeded in producing adult daughters is relatively small with reference to the total number of females bred. That is to say, there is a rather stringent genetic selection here. Examination of the table shows that this is due to the unfavorable environmental conditions which existed in house No. 1. This was obvious from direct observation during the course of the experiment. The way in which it is shown in the table is that whereas but 21.7 per cent and 18.3 percent respectively of the females mated with foreign and Station cockerels in No. 1 house got adult female progeny, on the other hand 45.5 percent of the females mated in house No. 2 got adult daughters. This record of 45.5 per cent for the females in house No. 2 is itself lower than it would have been had not one of the males used in No. 2 house (No. D26) proved to be a rather unsatisfactory bird, which did not make a very good record either in respect to fertility or hatching quality of eggs.

2. The rather stringent genetic selection brought about by the unfavorable conditions in house No. 1 does not interfere with the experiment in regard to the effect of inbreeding because the force of this selection was substantially the same in the case of females mated in No. 1 house with foreign cockerels and females mated in the same house with Station cockerels. The difference is only 3.4 percent and cannot be regarded as significant.

3. With respect to the mean winter egg production of the mated females it is seen that the averages for the females which were originally mated with foreign cockerels, and that for the females in house No. 1 originally mated with Station cockerels are substantially the same. What advantage there is is in favor of the foreign cockerels, that is, of the broad-breeding side of the experiment. The probable errors of these averages of egg production lie in the neighborhood of 1.2. It is obvious that the difference (1.30) between the mean production of the two sets of females in No. 1 house is only such as might be expected to arise from random sampling. The females mated with Sta-

TABLE E.

Frequency Distributions of Egg Production of Daughters from Out-cross and Narrow Matings.

NUMBER OF EGGS LAID.	WINTER PERIOD.				SPRING PERIOD.			
	Daughters of foreign ♂♂ (out-cross)	Daughters of Station ♂♂ in house No. 1 (narrow-bred)	Daughters of Station ♂♂ in house No. 2 (narrow-bred)	Daughters of *all* Station ♂♂ (narrow-bred)	Daughters of foreign ♂♂ (out-cross)	Daughters of Station ♂♂ in house No. 1 (narrow-bred)	Daughters of Station ♂♂ in house No. 2 (narrow-bred)	Daughters of *all* Station ♂♂ (narrow-bred)
0–4	20	17	30	47	4	2	1	3
5–9	10	14	11	25	1	2	–	2
10–14	17	19	15	34	1	4	1	5
15–19	16	12	7	19	1	1	1	2
20–24	14	14	13	27	3	3	7	10
25–29	21	8	9	17	5	7	5	12
30–34	15	10	22	32	11	11	9	20
35–39	10	8	7	15	13	6	12	18
40–44	7	5	7	12	24	6	18	24
45–49	6	5	5	10	21	13	14	27
50–54	5	6	3	9	12	14	13	27
55–59	4	3	4	7	13	17	21	38
60–64	2	3	4	7	21	16	14	30
65–69	5	2	2	4	5	7	11	18
70–74	3	1	5	6	5	4	3	7
75–79	2	2	3	5	1	2	1	3
80–84	1	–	–	–	–	–	–	–
85–89	–	–	–	–	–	–	–	–
90–94	1	–	–	–	–	–	–	–
Totals...........	159	129	147	276	141	115	131	246

tion cockerels in house No. 2 have a somewhat lower mean winter production than those in No. 1 house. These were the last two pens to be mated and it was then not possible any longer to select as many high layers to offset (in the average) the low layers as had been done in mating up the pens in No. 1 house.

4. Considering next the females which produced adult daughters, the differences in winter production are much more marked than when all mated females are taken together. The means in this case, however, stand in the same relation to each other as when all females are included. As would be expected the mean production of the *mothers* of adult daughters is higher than the mean production of all females bred in the same class. This merely means that the better a hen lays the more likely she is to have adult progeny, because she has more chances. The mothers of adult daughters of foreign cockerels have a mean winter production more than 16 eggs higher than that of the mothers of daughters of the two Station males in house No. 2. The difference is much smaller between the two sets of mothers in house No. 1 though there it is probably statistically significant. The females in the out-cross matings which produced adult daughters thus have the higher egg production records. If this factor has any influence at all it would evidently act in accord with any beneficial result of the outcrossing itself to help to produce higher laying in the progeny.

Let us turn next to the results of the experiment. The frequency distributions for the winter * and spring (March 1 to June 1) egg production of the daughters of (a) foreign cockerels, (b) Station cockerels in house No. 1 and (c) Station cockerels in house No. 2 are given in Table E.

The usual biometric constants for these distributions are presented in the following table.

The means of Table F are shown graphically in fig. 77.

---

* Cf. p. 154 *infra*.

TABLE F.

Constants of Variation in Egg Production of Progeny of Out-cross and Narrow Matings.

CONSTANT.	WINTER PERIOD.				SPRING PERIOD.			
	Daughters of foreign ♂♂ (out-cross)	Daughters of Station ♂♂ in house No. 1 (narrow-bred)	Daughters of Station ♂♂ in house No. 2 (narrow-bred)	Daughters of *all* Station ♂♂ (narrow-bred)	Daughters of foreign ♂♂ (out-cross)	Daughters of Station ♂♂ in house No 1 (narrow-bred)	Daughters of Station ♂♂ in house No 2 (narrow-bred)	Daughters of *all* Station ♂♂ (narrow-bred)
Mean (or average)....	28.03 ± 1.07	25.14 ± 1.12	26.45 ± 1.16	25.83 ± 0.81	46.68 ± 0.86	47.24 ± 1.08	48.11 ± 0.84	47.70 ± 0.68
Standard deviation...	19.92 ± 0.75	18.85 ± 0.79	20.77 ± 0.82	19.91 ± 0.57	15.14 ± 0.61	17.12 ± 0.76	14.33 ± 0.60	15.70 ± 0.48
Coefficient of variation	71.0 ± 3.8	75.0 ± 4.6	78.5 ± 4.6	77.1 ± 3.3	32.4 ± 1.4	36.2 ± 1.8	29.8 ± 1.3	32.9 ± 1.1

From these data it appears that there is no substantial difference in egg production, either in the winter or the spring periods, between the pullets which came from entirely unrelated parents on the one hand, and those whose parents both belonged to the Station strain on the other hand. In the winter period

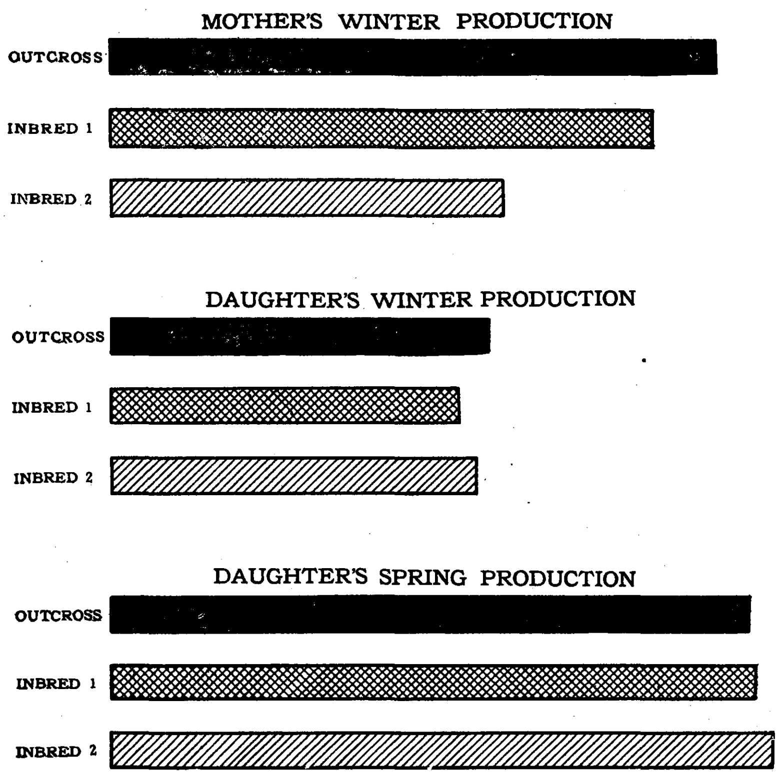


FIG. 77. Diagram showing the mean winter and spring egg production of the daughters of outcross and narrow matings.

it is true that the birds from out-cross matings have a slightly higher mean production than either group of narrow-bred daughters. The difference, however, is too small to be significant. Thus the greatest difference in the table is between the winter means for the out-cross matings and the narrow matings in No. 1 house. Here, however, the difference is but 2.89 ± 1.55, an amount less than twice its probable error. In the spring period the daughters from out-cross matings actually laid a little less than those from the narrow matings.

An examination of adult mortality records leads to the same conclusion as the fecundity records. The percentage mortality amongst the adult daughters from out-cross matings was 11.3 per cent. Among the daughters from narrow matings in house No. 1, the mortality was 10.8 per cent. For the daughters of *all* narrow matings the mortality rate was the same, viz. 10.8. Thus it is clear that as measured by this index the out-crossed stock was no more vigorous than the narrow bred.

It may further be said that not only was there no difference in the first generation between the offspring of out-cross and narrow matings, but further there was no difference in the progeny in subsequent generations. Putting in "new blood" did not improve or rejuvenate the stock. One must then conclude either (a) that the stock was so hopelessly and completely degenerate as to be past any benefit from infusion of new "blood," or (b) that the stock was *not* deteriorated in respect of constitutional vigor or vitality and that therefore it could not be expected that out-crossing would have any rejuvenating effect. The first conclusion certainly cannot be deemed the correct one in view of the evidence presented in this bulletin in respect to mortality, egg production, etc. The stock has never been in the condition of excessively low constitutional vigor which would be demanded by such a conclusion.

It would then appear that *there is no evidence that the amount of inbreeding practiced during the mass selection experiment had any unfavorable influence on either the egg production or the general vitality of the stock.*

PART III.

NEW PLAN OF BREEDING FOR EGG PRODUCTION.

At the end of the period from 1898 to 1907 during which the mass selection experiment had been carried on it seemed advisable to inaugurate a change in the plan of investigation. Considering the results obtained, and the fact that a large amount of statistical data had been accumulated and was available for analysis, it appeared unlikely that further continuation of mass selection would yield results of sufficient value to warrant carrying on the work. The ultimate object of the work at the Maine Station in this field was, and is, to get at the underlying principles of the inheritance of fecundity in fowls. One set of facts having been accumulated, efforts were turned towards getting more data of a somewhat different character.

The keynote to the new line of investigation has been the analysis of the inheritance of fecundity by means of *individual pedigrees*. By this method one determines precisely the behavior of each individual in inheritance. Those individuals of like hereditary behavior or performance may then be lumped together for statistical treatment if desired. The "individual pedigree" is the nearest approach which can be made in an organism in which each individual is of one sex only to the *genealogical* unit termed by Johannsen a "pure line" in self-fertilizing plants. Its employment in the analysis of inheritance in animals has underlying it the same considerations which make the "pure line" so potent an instrument of research in plants and non-sexually reproducing animals.

In order that what follows in Part IV may be more readily understood it is desirable here to explain fully the working hypothesis which the present study in the inheritance of fecundity is testing. To put the matter most briefly it may be said that this hypothesis is an adaptation to the particular case in hand of the genotype concept of Johannsen. In more detail the case is as follows.

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

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

* Johannsen, W., Ueber Erblichkeit in Populationen und in reinen Linien, Jena, 1903.

The nature of Johannsen's results on this point have been very cleverly set forth in the accompanying diagram which is taken from a paper by Wood and Punnett.*

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

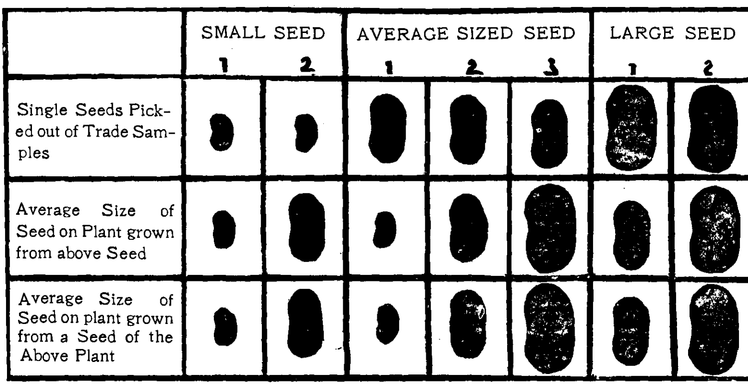


FIG. 78. Diagram to illustrate Johannsen's results with beans. (From Wood and Punnett).

3. That when mass selection alters the population type it does so by a process of isolating from the mixture certain strains whose own types are different from the original general population type, and which differ in the direction towards which selection was made. Thus if one begins in a general mixed population of beans to select for planting the largest beans, and by so doing increases the average size of bean in the crop, what he really does is gradually to throw away all beans except those

* Wood, T. B., and Punnett, R. C., Heredity in Plants and Animals. Mendel's Principles and their Bearing on Agricultural Problems. Trans. Highland and Agr. Soc. Scotland. Ser. 5, Vol. XX. pp. 36-86, 1908.

which belong to strains having large beans as the type. Having isolated from the population one of these component strains which breeds true to a definite type no amount of further selection will modify that strain. In other words Johannsen showed that, in beans at least, selection is only effective to isolate or pick out what heritable variations were already present as components of the population to begin with. Selection within a line or strain is ineffective.

These and other results of recent work (particularly that along Mendelian lines) lead to a new conception of the mechanism of heredity which differs markedly from older views. The keynote to this conception is that it is the germ cell (egg or sperm) and not the body or soma which is the factor of primary importance in inheritance. What the individual is like in respect to its personal, somatic * characters is not determined by the somatic characters of its parents, but by the composition or constitution of the parental gametes. Thus the size of a bean is determined not by the *size* of its parent bean, but by the gametic constitution of the latter.

Experimental breeding along Mendelian lines has shown very clearly that many characters of organisms are inherited as separate units, so that by proper cross-breeding new combinations of characters may be made. Thus, for example, suppose one crosses together a Barred Rock, which is a barred bird with a single comb, and a Cornish Indian Game, which is a non-barred bird with a pea comb. In the second generation he will have barred birds with pea combs, barred birds with single combs, non-barred birds with pea combs and non-barred birds with single combs occurring in certain definite proportions to each other. This result shows beyond question that, whatever the mechanism, comb form is inherited separately from plumage pattern. These characters behave as separate units.

* For the reader not familiar with the technical terminology of biology, it may be said that "somatic" is used in designation of those characters of the organism which pertain to all parts except the reproductive or germ-cells. These reproductive cells are called "gametes." We then have the adjective "gametic," meaning "pertaining to the germ cells," in contrast to "somatic" meaning "pertaining to any or all parts of the organism *other than* the germ cells."

Each character of an organism which is inherited must, in some manner, be represented by a factor in the germ cell. For each of these gametic factors Johannsen proposes the name *gene*. A gene then is that factor in the germ cell or gamete the presence of which (and therefore its taking part in gametic reactions) is connected with the existence of a particular somatic character or set of characters. All of these unit factors or genes taken together constitute the *genotype* of the organism. The *genotype* then represents the hereditary or gametic constitution of the individual as distinguished from the somatic.

Johannsen's experiments show that in the organisms with which he has worked genotypes cannot be modified by selection. That is, given a group of a thousand individuals all of the same genotypical constitution, and no amount of selection of somatic variations within this group will produce any permanent or inherited effect. The offspring of the selected individuals will be, on the average, like the offspring of other individuals which had the same genotypical constitution. The sole function of selection then becomes the *isolation* and propagation of strains composed of individuals having the desired genotypical constitution.

It may be said that confirmation of one or another of the essential features of the genotype concept of Johannsen, has come not only from his work with beans and barley, but also from the work of Nilsson-Ehle, Jennings, Shull, East, Hanel, Roemer and others on a variety of plants and animals.

Suppose this general conception of the mechanism of inheritance to be taken as a working hypothesis (to be tested by experiment) in attempting to increase or decrease egg production in the domestic fowl by breeding. To what sort of picture of the make-up of a flock does it lead? First of all it may be assumed that a number of distinctly different genotypical constitutions will be represented in the flock. By way of concrete illustration let us suppose a population or flock to be made up of individuals representing seven marked genotypical differences. Each set of individuals of like genotypical constitution may be considered to form a "line" or "strain" in the breeder's sense. There will then be seven lines which may be designated as *A, B, C, D, E, F,* and *G*. (See fig. 79). The general average production for the population as a whole is 130. The geno-

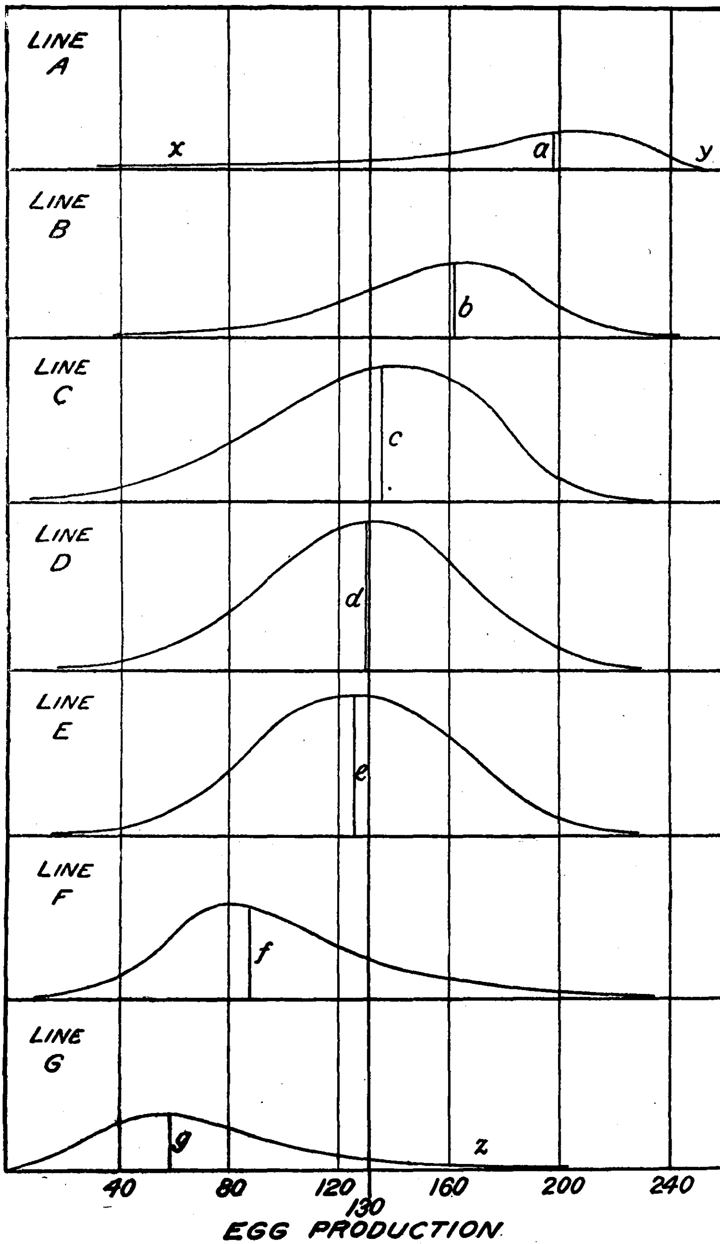


FIG. 79. Diagram to illustrate hypothesis regarding inheritance of egg production.

types of the several lines, are however, quite different. We may consider these genotypes to be given by the small letters, *a, b, c, d, e, f, g*. It is seen that three of the lines have genotypes corresponding closely to the general flock average 130. Two genotypes are well above the general average of the flock, and two others below. Now the basic idea of the pure-line concept as here applied is that if, for example, two individuals of line *A* are bred together, the average productivity of the offspring will be approximately *a* (say 197 eggs) regardless of the egg record of the particular female bird bred. That is, it is to be expected that the average productivity of the progeny of a female of line *A* with an egg record at *x* (say 80 eggs) and of a female with a record at *y* (say 240 eggs) *will be the same* provided both are mated to male birds from the same line as themselves, that is, the *A* line.

The same idea may be illustrated in another way. It is to be expected that in such a population as that illustrated in the diagram the average egg production of the daughters of 200-egg hens will be as indicated in the following table:

If a "200-egg" hen comes from—	The probable average production of her daughters will be about—
The A line, and is mated with an A line male....	197
The B line, and is mated with a B line male....	162
The C line, and is mated with an C line male....	134
The D line, and is mated with a D line male....	130
The E line, and is mated with a E line male....	125
The F line, and is mated with an F line male....	88
The G line, and is mated with a G line male....	58

Similarly we have according to the pure-line concept the following expectation regarding the progeny of poor producers:

If a "75-egg" hen comes from—	The probable average production of her daughters will be about—
The A line, and is mated with an A line male....	197
The B line, and is mated with a B line male....	162
The C line, and is mated with a C line male....	134
The D line, and is mated with a D line male....	130
The E line, and is mated with an E line male....	125
The F line, and is mated with an F line male....	88
The G line, and is mated with a G line male....	58

In other words it would be expected on the hypothesis set forth, and in so far hypothesis and actual fact are in precise accord, that the record of egg production in and of itself alone is not a criterion of particular signficance in selecting females for breeding for improved egg production in the flock. It appears to be of vastly more importance to know the genotype of the line to which the individual belongs. This idea is already perfectly familiar to the successful breeders of poultry for fancy points. What is here called "blood line" they usually call a "strain."

In 1907-08 a plan of breeding designed to test the general hypothesis above set forth was put into operation. A statement of a portion of the results which have been obtained to date is given in Part IV. This part of the bulletin is a reprint of an address given before the American Society of Naturalists in December, 1910. It seems advisable to reprint it in entirety here, though to do so involves some repetition of points already brought out in this bulletin. For this the author would ask the reader's pardon.

PART IV.

INHERITANCE OF FECUNDITY IN THE DOMESTIC FOWL.*

There are under discussion at the present time two general views regarding certain fundamental points in heredity. Each of these points of view has its zealous adherents. On the one hand is what may be designated the "statistical" concept of inheritance, and on the other hand, the concept of genotypes. By the "statistical" concept of inheritance is meant that point of view which assumes, either by direct assertion or by implication, that all variations are of equal hereditary significance and consequently may be treated *statistically* as a homogeneous mass,

* Papers from the Biological Laboratory of the Maine Experiment Station, No. 25. This paper was read at the meeting of the American Society of Naturalists at Ithaca, December, 1910. It was first published in the American Naturalist, Vol. XLV, pp. 321-345, June, 1911, and is here reprinted without change except that the numbers of the figures are here changed to accord with the preceding figures in this bulletin. Figures 1 to 5 inclusive of the original publication become figs. 80 to 84 respectively in this reprint.

provided only that they conform to purely statistical canons of homogeneity. This assumption of equal hereditary significance for all variations is tacitly made in deducing the law of ancestral inheritance, when individuals are lumped together in a gross correlation table.* The genotype concept, on the other hand, takes as a fundamental postulate, firmly grounded on the basis of breeding experience, that two sorts of variations can be distinguished, namely those (*a*) that are represented in the germinal material and are inherited without substantial modification, as in "pure lines," and those (*b*) that are somatic and are not inherited. By anything short of the actual breeding test it is quite impossible to tell whether a particular variation observed in the soma belongs to the one category or to the other. As I have tried to emphasize in other places, it is both to be expected on this view of inheritance, and is also the case in actual fact, that the somatic manifestation or condition of any character is a most uncertain and unreliable criterion of the behavior of that character in breeding. Finally under the genotype concept, of course, the whole array of facts brought out by Mendelian experiments find their place.

Now while certain adumbrations of the genotype concept have long been current in biological speculations in regard to heredity, this general view-point owes its grounding in solid facts primarily to Johannsen's work with beans and with barley. It is to be noted that in these cases, as well as in most of the investigations of the pure line theory which have followed Johannsen's work, the organisms used have been such as reproduced either by self-fertilization, or by fission, or by some vegetative process. This brings us to the consideration of a question of great importance, both theoretical and practical. In cases of diœcious organisms, where a "*pure*" pedigree line in the sense that such lines are found in beans or in Paramecium by definition can not exist, has the genotype concept any bearing or significance? In a general way it obviously has. Probably no one (except possibly some of the ultra-statistical school) could be found who would deny that in general a distinction is to be made between variations having a gametic and those hav-

* For a more detailed discussion of this point see a paper by the present writer entitled "Biometric Ideas and Methods in Biology; their Significance and Limitations," in the *Revista di Scienza* (in press).

ing merely a somatic basis. But specifically how far has the genotype concept any application in case of "non-selfed" organisms? Johannsen in his "Elemente" has thoroughly analyzed Galton's material and shown that it is capable of a satisfactory and reasonable interpretation on the genotype hypothesis, and East and Shull have gone far in the analysis of genotypes in maize. This, however, is only a beginning. There is the greatest need for careful, thorough investigations of the inheritance of characters showing marked fluctuating variation in organisms having the sexes separate. Here lies one of the crucial fields in the study of inheritance to-day. Through the brilliant results in Mendelian directions and from the study of really *"pure"* lines we are getting clear-cut ideas as to the inheritance of qualitatively differentiated characters, such as color, pattern and the like, on the one hand, and in regard to the inheritance of quantitative variation in self-fertilized or non-sexually reproducing organisms, on the other hand. But beyond all these lie the difficult cases where in diœcious forms quantitative variations must be dealt with. If these can be cleared up and brought harmoniously into a general scheme or view-point regarding inheritance, we shall have gone a long way in the solution of this world-old biological problem.

For some four years past the writer has been engaged in a study of the inheritance of fecundity in the domestic fowl. The problem presented here is an important one from the practical as well as the theoretical standpoint. If definite and sure methods of improving the average egg production of poultry by breeding can be discovered it will mean much to the farmers of the nation. At the same time egg production is a character admirably adapted to furnish definite and crucial data regarding inheritance. Variations in egg production are readily measured, and can be directly expressed in figures.

The general results of this study of the inheritance of fecundity may be said, in a word, to be so far as they go in entire accord with the genotype concept, and not to agree at all with the "statistico-ancestral" theory of inheritance. Indeed so ill is the accord here that the chief exponent of the latter doctrine has recently attempted to throw the whole case out of court * by

* Pearson, K., "Darwinism, Biometry and some Recent Biology, I," *Biometrika,* Vol. 7, pp. 368-385, 1910.

asserting that fecundity is not inherited in fowls, and that the present writer's investigations show essentially nothing more than that. It will be the purpose of this paper to present some figures sufficient to indicate with some degree of probability, I think, first that egg production in fowls *is* inherited, and second that it is probably inherited in accord with the genotype concept, in spite of the fact that we do not and can not here have "pure lines" in the strict sense of Johannsen's definition. In the present paper, owing to limitations of space, the whole of the data in hand obviously can not be presented. Only a few illustrative cases can be given here.

Before entering upon the discussion of the evidence it is necessary to call attention to two points. The first is in regard to the unit of measuring egg production used in the work. For reasons which have been discussed in detail elsewhere * the unit of study has been taken as the egg production of the bird before March 1 of her pullet year. This "winter production" is a better unit for the study of the inheritance of fecundity than any other which can be used practically. All records of production given in this paper are then to be understood as "winter" records, comprising all eggs laid up to March 1 of the first year of a bird's life. It may be said that the "normal" mean winter production of Barred Plymouth Rocks (the breed used in this work) is fairly indicated by the 8-year average of the Maine Station flock. This average November 1 to March 1 production is 36.12 eggs.* This figure is based on eight years continuous trapnesting of the flock with which the present work was done, carried out before these investigations were begun.

In the second place it is desirable to call attention to some of the difficulties which attend an attempt to analyze the inheritance of the character egg production. The most important of these is the fact that this character is not visibly or somatically expressed in the male. A male bird may carry the genes of high

* Bull. Me. Agr. Exp. Sta., No. 165. U. S. Dept. Agr. Bur. Anim. Ind., Bul. 110, Part II.

* It should be said that up to and including the winter of 1907 only the November 1 to March 1 records are available as a "winter" record. Since that time the small number of eggs laid before November 1 (on the average two or three per bird) are included in the "winter" totals. These, then, give, as stated, the total production up to March 1.

fecundity, but the only way to tell whether or not this is so is to breed and rear daughters from him. All Mendelian workers will agree that it is sometimes difficult enough to unravel gametic complexities in the case of characters expressed somatically. It is vastly more difficult when only one sex visibly bears the character. In the second place a very considerable practical difficulty arises from the fact that egg production is influenced markedly by a whole series of environmental circumstances. The greatest of care is always necessary, if one is to get reliable results, to insure that all birds shall be kept under uniform and good conditions. Further, on this account, it is necessary to deal with relatively large numbers of birds. Some of the important conditions to be observed in work on fecundity have been discussed elsewhere * and need not be repeated here.

Turning now to the results we may consider first

THE EFFECT OF SELECTION FOR FECUNDITY IN THE GENERAL POPULATION.

On the "statistico-ancestral" view of inheritance it would be expected that if fecundity were inherited at all this character would respond to continued selection. That is, it would be expected, if the highest layers only were bred from in each generation, that the general flock average would steadily, if perhaps slowly, increase and that any level reached would be at least maintained by continued selection. In 1898 an experiment in selecting for high egg production was begun at the Maine Station. In this experiment only such females were used as breeders as had laid over 150 eggs in their pullet year (corresponding roughly to an average winter production of 45 or more eggs) and the only males used were such as were out of birds laying 200 or more eggs in the year. This experiment was continued until the end of 1908. The selection, be it understood, was based on the egg record alone, and no account was kept of pedigrees or of genotypes. Every female with a record higher than 150 eggs in the year was used as a breeder regardless of whether her high fecundity was genotypic or phænotypic.

The results of this selection experiment covering a period of nine years have been fully reported elsewhere.* Here it needs

* Me. Agr. Exp. Sta. Ann. Rept. for 1910, p. 100.

* U. S. Dept. Agr. Bur. Anim. Ind., Bul. 110, Parts I and II, 1909 and 1911. *Zeitschr. f. indukt. Abst. u. Vererb.-Lehre,* Bd. 2, 1909, pp. 257-275.

only to be said that the net outcome of the experiment was to show that there was no *steady* or *fixed* improvement in average flock production after the long period of selection. There was no *permanently* cumulative effect of the eight (in the last year) generations of selected ancestry. So far from there having been an increase there was actually a decline in mean egg production concurrent with the selection, taking the period as a whole. During parts of the selection period, however, as for example the years 1899-1900 to 1901-'02, inclusive, and the years 1902-'03 to 1905-'06, inclusive, an improvement from year to year was to be noted, but in each case the flock dropped back in intervening years. This is an important point, the meaning of which is now clear. The flock average from year to year depended largely upon *whether the breeders of the year before had had their high fecundity genetically represented or only somatically*. In some years the selection was fortunate in getting nearly all the breeders from good (*i. e.*, "high production") genotypes or from good *combinations* of genes. In other years just the opposite thing happened; the high layers chosen as breeders came from low genotypes or combinations of genes. The general upshot was that while the selection of *high layers* merely as such was systematic year after year the result attained in the general flock production was entirely haphazard and uncertain. This is exactly what would be expected on the genotype hypothesis, but not on the "statistico-ancestral."

TABLE I.

MEAN WINTER (NOVEMBER 1 TO MARCH 1) EGG PRODUCTION DURING THE SELECTION EXPERIMENT.

Year	Mean Winter Production
1899-1900	41.03
1900-01	37.88
1901-02	45.23
1902-03	26.01
1903-04	26.55
1904-05	35.04
1905-06	40.66
1906-07	21.44
1907-08	15.92

The actual course of the average winter egg production (not hitherto published) during the period is given by the figures of Table I and shown graphically in fig. 80.

Certainly the first line of evidence, derived from a long-continued experiment, involving more than 2,000 individuals, gives no support to the "statistico-ancestral" theory and indeed is in flat contradiction to one of the most fundamental tenets of that faith.

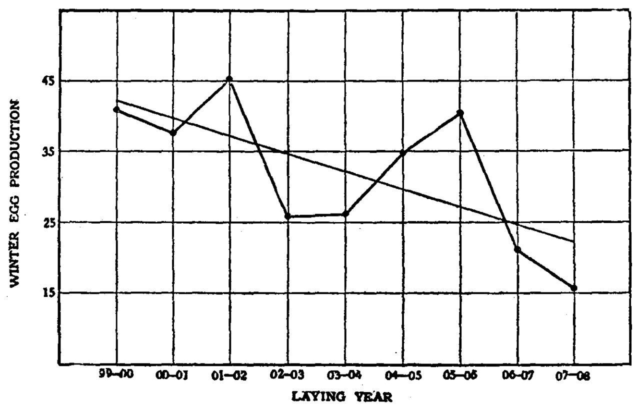


FIG. 80. Diagram showing the course of average winter egg production during the period covered by the mass selection experiment.

Let us next consider the question,

ARE SOMATICALLY EQUAL VARIATIONS IN FECUNDITY OF EQUAL HEREDITARY SIGNIFICANCE?

In the spring and summer of 1907 were reared 250 pullets, all of which were the daughters of hens that had laid approximately 200 or more eggs in the first year of their life. This group of mothers was reasonably homogeneous in respect to records of egg production. All had laid about the same number of eggs. Their daughters were, however, far from a homogeneous lot with respect to egg production.* It is plain from the results obtained in that experiment that the egg record of a hen is a most unreliable criterion of the probable number of eggs which her daughters will lay. This is demonstrated by examination of individual cases. Thus consider the two mothers Nos. 253 and 14. Their winter production records were nearly identical (65 and 66 eggs, respectively). Their daughters' aver-

* Full details regarding this experiment have been published as Bulletin 166, Me. Agr. Exp. Sta., 1909. See particularly Table I.

age winter productions were 23.87 and 2.40 eggs, respectively! Certainly it seems reasonable to conclude that the gametic constitutions involved in the breeding of 253 and 14 were quite different, though both these hens laid the same number of eggs. Again, take birds No. 386 and 911. One had a winter record of 55 and the other of 52 eggs. Yet their daughters' average winter productions were, respectively, 4.88 and 27.33 eggs. Many more instances of this kind could be brought forward. Taken together, the whole evidence shows beyond the shadow of a doubt that the presence of high fecundity in an individual, and that factor which makes high fecundity appear in the progeny, are two very different things, either of which may be present in an individual without the other. We plainly have here the basis for the distinction of phænotypes and genotypes just as in beans.

THE INHERITANCE OF EGG PRODUCTION IN PEDIGREE LINES.

Let us now consider some of the evidence that such things as genotypes of fecundity really exist in fowls. We may first examine some representative pedigrees covering four generations

PEDIGREE LINE D5D39

- ♀ **D39**(*62*) × ♂ *D5*
  - ♀ **E232**(*69*) × ♂ *555*—0
  - **237**(*55*) × ♂ *554*
    - ♀ **F255** (*48*) × ♂ *564*
      - ♀ **G 10**(*100*), **14** (*99*), **88** (*23*), **524** (*16*)
    - **303** (*64*) × ♂ *563*
      - ♀ **G 12** (*16*), **19** (*70*), **39**(*100*), **53** (*44*), **81** (*34*), **85** (*73*), **192** (*57*), **213** (*29*)
    - **136** (*48*)
    - **347** (*69*) × ♂ *562*
      - ♀ **G 18** (*61*), **27** (*83*), **46**(*116*), **196** (*56*), **211** (*36*), **248** (*67*)
    - **363** (*74*) × ♂ *567*
      - ♀ **G 11** (*47*), **134**(*111*), **165** (*35*), **198** (*39*), **506** (*16*)
      - *Mean= 57.74*
    - *Mean=61*
  - *Mean=62*

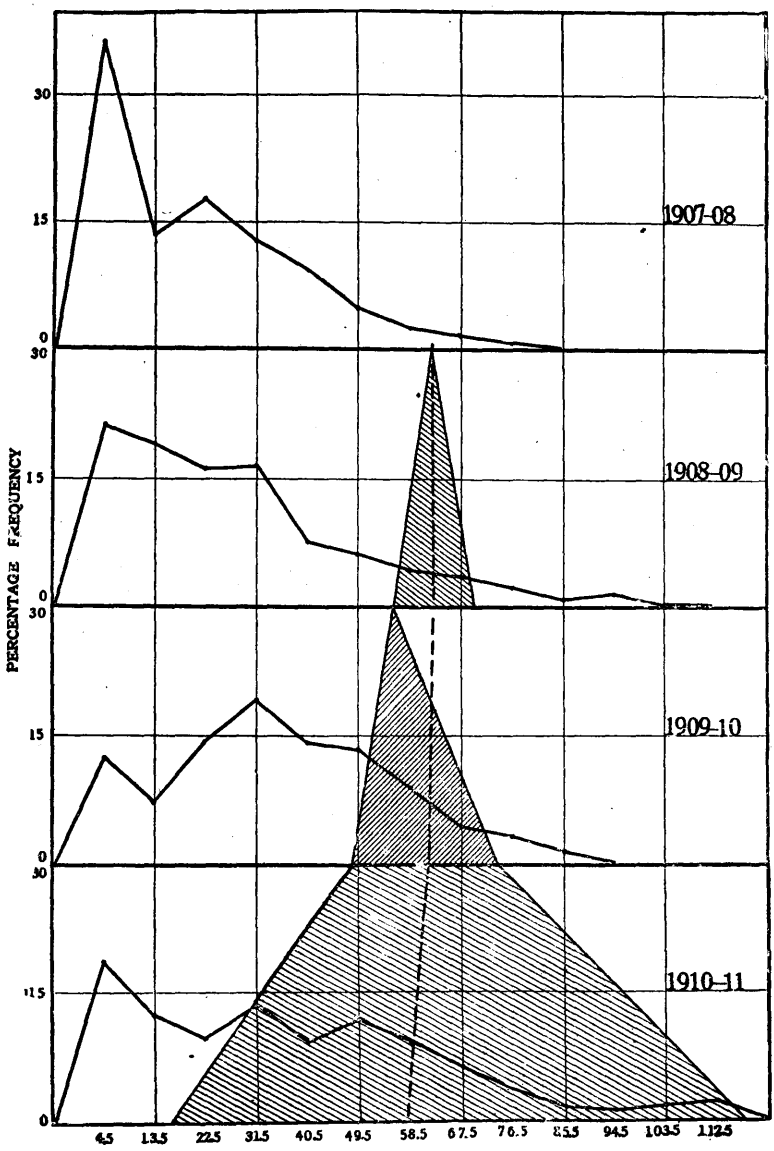


FIG. 81. Diagram showing range of variation and mean fecundity in each generation of line D5D39. The main polygons of variation give the distribution of fecundity in the general flock in each generation. The cross-hatched areas represent the pedigree line, and the heavy dotted lines through these areas represent the mean fecundity of the line in each generation. [It should be understood that in this and the following line diagrams the cross-hatched areas are *not* frequency polygons. They merely give (a) the upper and lower ends of the *range* of variation in the line in each generation, (b) the mean of the line, and (c) the portion of the range which was bred from in each generation to produce the next generation. Note added in reprinting.]

and showing the occurrence of high and low fecundity lines.

As a typical example of a high fecundity pedigree line in which the high fecundity is genotypic, line D5D39 may be considered. In the presentation of this and other pedigree tables the following conventions are adopted. The band numbers of the birds are in bold-faced type, and following the band number of each female, her winter egg record is given in italic figures enclosed in parenthesis. The band numbers of males are given in italics.

This line is shown graphically in Fig. 81.

Little comment on this pedigree line is necessary. We see a certain high degree of fecundity faithfully reproduced generation after generation. Different males were used with different females, but in every case the males used were from high fecundity lines and were believed to carry this quality in their germ cells either in homozygote or heterozygote condition.

In marked contrast to the last example let us consider the *low* fecundity lines D61D168. It is a troublesome matter to propagate the low fecundity lines, because of the difficulty of getting a sufficient number of eggs during the early part of the breeding season. The line D61D168 is of interest not alone as an illustration of a typical low line, but also because there appeared in it a mutation, or something very like one. We will consider here only the main line and not the mutant.

PEDIGREE LINE D61D168

♀**D168**(*33*)×♂*D61*	♀**E231** (*25*)×♂*552*	♀**F233**(*32*)×♂*573*—0	
	419 (*9*)×♂*551*	♀**F165**(*7*)×♂*569*	♀**G221**(*16*) **430**(*12*) **477** *1* *Mean=9.67*
	209 (*38*)×♂*555*—0		
	313 (*26*)×♂*554* **363** (*11*)×♂*550*	**174**(*21*) ♀**F249**(*30*) *Mean=22*	
	15 (*18*) **163** (*9*) **200** (*12*) **141** (*0*) **116** (*28*) **151** (*11*) **24** (*23*) *Mean=17.5*		
	♀**E248** (**48**)*		

* This was the mutant referred to. Its progeny will be considered later. See p. 161.

This line is shown graphically in Fig. 83, in which the mutant and its progeny are also shown.

A low line in which no mutant has appeared, but in which also the mean production is not so low as in line D61D168 is D65D366. Since the egg production has not been so low in the

PEDIGREE LINE D65D366

♀**D366**(*33*)×♂*D65*	♀**E239**(*24*)×♂*553*	♀**F309**(*OD*)*	
		263(*44*)	
		362(*43*)	
		216(*41*)×♂*569*	♀**G 34** (*4*)
			42 (*37*)
			56 (*40*)
			164 (*5*)
	224(*43*)×♂*554*	♀**F301** (*7*)	
		223(*14*)	
		221(*42*)	
	354(*15*)×♂*551*	♀**F242**(*21*)	
		221(*39*)×♂*566*	♀**G 65**(*28*)
			209(*33*)
			267(*25*)
			502(*21*)
			544 (*8*)
	331(*31*)×♂*552-0*		
	344(*17*) ×♂*550*	♀**F271**(*37*)	
	344(*17*) ×♂*528*	♀**F171**(*46*)	
	Mean=26	*Mean=33.4*	*Mean=22.33*

early part of the breeding season with this line it has been easier to propagate it.

This line is shown graphically in Fig. 82.

In the examples thus far given we have had to do with pedigree lines in which a given degree of fecundity reappeared from generation to generation with practically no change. In two instances quite certainly, and possibly in several others, a new and distinct variation has suddenly appeared within a line and thereafter bred true, thus presenting the characteristic phenomena of mutation. The most striking instance of this sort occurred in line D61D168 and may be given here in detail. The main part of this line has already been discussed (p. 160). It will be recalled that it is a line of low fecundity. In 1908 there appeared in it one individual of distinctly higher fecundity than any other bird in the large family of that year. This individual when bred produced only high layers. In the next generation two of these daughters were bred to males known to belong to high fecundity genotypes (♂♂ 554 and 566). One of these matings unfortunately produced no adult female offspring. The

* Bird died during winter period.

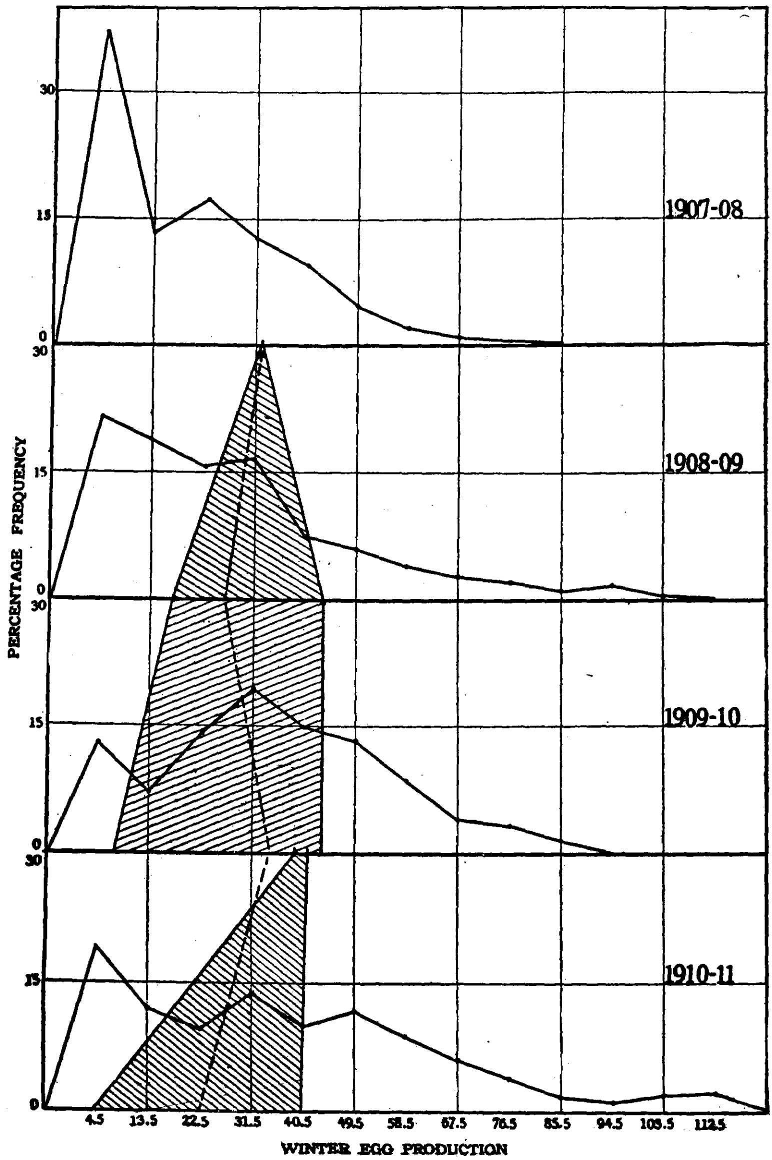


FIG. 82. Diagram showing range of variation and mean fecundity in each generation of line D65D366. Significance of lines and cross hatching as in Fig. 81, *q. v.*

other led to the production of six adult daughters, all of which are relatively high layers, with the single exception of G495, which has a record of only one egg, and that record is doubtful. This bird has probably never laid an egg, and almost certainly is pathological.

Leaving this bird out of account because pathological, the mean winter production of the family is 52.8 eggs, very strikingly different from the average (9.67 eggs) of the birds of the same generation in the main low line in which the mutation appeared.

Two other daughters of the mutant E248 were mated to ♂ D31, a bird known not only to belong to a genotype of mediocre to low fecundity, but to be remarkably prepotent in respect to this character, so that practically regardless of the females with which he has been mated the get has been uniformly poor in respect to egg production. Four adult females resulted from the two matings under discussion. They have an average winter production of 23.75 eggs. There are several possible explanations of this result, but the most probable is that we have here simply one more instance of the extraordinary prepotency of ♂ D31.

The last of the daughters of the mutant was mated to a cross-bred male, No. 578, and consequently the progeny can not fairly be compared with the pure Barred Rocks in respect to fecundity.

The facts here briefly discussed are shown in the following table and graphically in Fig. 83.

It is apparent from the table and the diagram that the main line and the "mutant" line are entirely distinct. Indeed they do not overlap in their ranges even excepting only the pathological individual G495. The "mutant" pullet E248, for some reason or other, possessed the capacity both to lay a relatively large number of eggs, and the genes necessary to make this quality appear in her progeny. Whether this individual is to be regarded as a true "mutation" would appear to be largely a question of definition. In the writer's opinion the most probable explanation is that E248 is a Mendelian segregation product. That is, let it be supposed that both D168 and D61 were heterozygous with respect to degree of fecundity, and were producing in some (unknown) ratio both "high fecundity" and "low fecundity"

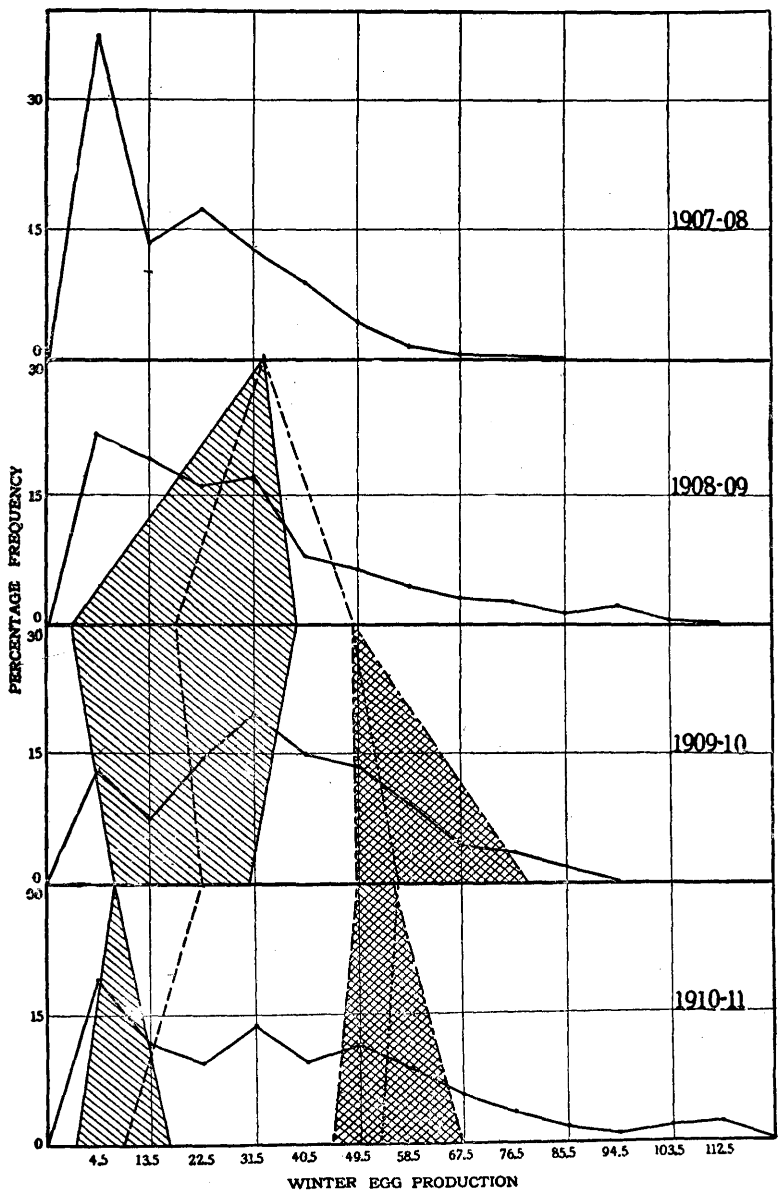


FIG. 83. Diagram of pedigree line D61D168. The significance of lines is the same as in Figs. 81 and 82, except that the mutant line is double cross hatched. For the sake of simplicity E495 and the daughters of D31 are omitted in the 1910-11 generation.

PEDIGREE LINE D61D168 (COMPLETE)

- ♀**D168**(*33*)×♂*D61*
  - ♀**E248** (*47*)×♂*553*
    - ♀**F308**(*78*)×♂*554*-O
    - **354**(*55*)×♂*566*
      - ♀G **30**(*45*)
      - **62**(*58*)
      - **117**(*46*)
      - **197**(*66*)
      - **428**(*49*)
      - **495** (*1*)
      - *Mean of high line=52.8**
    - **166**(*49*)×♂*D31*
      - ♀**G204** (*41*)
      - **254** (*15*)
    - **141**(*51*)×♂*D31*
      - ♀**G229** (*28*)
      - **458** (*11*)
      - *Mean of D31's daughters=23.75*
    - **172**(*50*)×♂*578--Cross*
    - *Mean of mutant (high) line=56.5*
  - ♀**E231** (*25*)×♂*552*
    - ♀**F233**(*32*)×♂*573*--O
    - **419** (*9*)×♂*551*
      - ♀**F165** (*7*)× *569*
        - ♀**G221** (*16*)
        - **430** (*12*)
        - **477** (*1*)
        - *Mean of main (low) line=9.67*
    - **209** (*38*)×♂*555*-O
    - **313** (*26*)×♂*554*
      - ♀**F250**(*20*)
      - **174**(*21*)
    - **363** (*11*)×♂*550*
      - ♀**F249**(*30*)
      - *Mean of main (low) line=22.0*
    - **15** (*18*)
    - **163** (*19*)
    - **200** (*12*)
    - **141** (*0*)
    - **116** (*28*)
    - **151** (*11*)
    - **24** (*23*)
    - *Mean of main (low) line=17.5*

gametes. Then E248 may be supposed to have originated from the union either of two "high fecundity" gametes or one high and one low fecundity gamete. She then would be either a DD or a DR bird, on the assumption, which the facts seem to support, and which I have more fully discussed elsewhere,** that high fecundity is dominant over low.

* Omitting G495. See text.

** "Inheritance in 'Blood Lines' in Breeding Animals for Performance, with Special Reference to the '200-egg' Hen," Rept. Amer. Breeders' Assoc., Vol. VI, 1911 (in press).

The subsequent breeding history of E248 indicates that it was probably a DD bird, though the reasons for this opinion can not be fully gone into here. The general view, recently emphasized by Nilsson-Ehle,* that phenomena of mutation are, in many cases at least, merely cases of Mendelian segregation has much evidence in its favor.

The pedigrees which have been given are merely illustrations. Many other similar ones might be cited from the records in hand did space permit. In the experiments during the past three years the attempt has been made to propagate separately lines of high, medium and low fecundity. In the course of this work it has been found that lines of high fecundity were nearly if not quite as likely to have originated with individuals of a low record of production as with those of a high record. Similarly, many low fecundity lines have originated with individuals which were themselves exceedingly high layers. Indeed one of the highest winter layers which have ever appeared in the stock evidently belonged to a genotype of very low fecundity, since it has never been able to produce progeny of anything but the poorest laying capacity. The breeding history of this bird (D352) is indeed so interesting that it may be briefly discussed here. This bird in her pullet year laid 98 eggs between November 10 and March 1 and made a record for the year of over 200 eggs. She was mated and produced plenty of eggs during the hatching season, but they hatched very badly. Only one female worth putting in the house was obtained. This pullet (E356) made a winter record of only 39 eggs, just about the general flock average. E 356 was not mated. Her mother (D352) was kept over and bred to another male the next year, in the hope that as a fowl she might produce more and better chickens than she had as a pullet. As a matter of fact she was again able to produce during the whole breeding season only one pullet worth putting into the laying house. This pullet (F163) made a winter record of but 11 eggs. F163 was bred in 1910, but produced only one daughter worth saving. This daughter, G429, has made a winter record of 18 eggs. It would be hard to get clearer evidence than that afforded by this breeding history that

* Nilsson-Ehle, H., "Kreuzungsuntersuchungen an Hafer und Weizen," *Lunds Univ. Arsskr.*, N. F., Afd. 2, Bd. 5, Nr. 2, 1909, pp. 1-122.

D352 belonged to a low fecundity genotype, in spite of her individual high laying record.

THE EFFECT OF THE SELECTION OF FECUNDITY GENOTYPES.

Let us now consider the bearing of the results so far set forth on the problem of selection. Taking first the question of the effect of selection for fecundity within a population it is plain that if different degrees of fecundity have a genotype basis, as the facts above presented and a considerable mass of data of a similar kind, which owing to lack of space can not be given here would appear to indicate, then the results following selection will depend entirely upon the genotypic constitution of the population. If high fecundity genotypes are present they can be isolated by selection. If they are not present selection of high laying hens will not change the average production of the flock.

The aim of the selection experiments since 1907 has been to discover and propagate separately genotypes of high fecundity and genotypes of low fecundity, all the birds being taken from the same general flock. The results of this work are shown in the following table and in Fig. 84. This table is to be regarded as a continuation of that given on p. 156, *supra,* which shows the results of mass selection for high fecundity in the same stock.

EFFECT OF SELECTION FOR FECUNDITY WITHIN THE POPULATION

1907-08.	Mean winter production of general population	15.92
1908-09.	Mean winter production of all high fecundity lines	54.16
1908-09.	Mean winter production of all low fecundity lines	22.06
1909-10.	Mean winter production of all high fecundity lines	47.57
1909-10.	Mean winter production of all low fecundity lines	25.05
1910-11.	Mean winter production of all high fecundity lines	50.58
1910-11.	Mean winter production of all low fecundity lines	17.00

The results indicate the effectiveness of this method of selection. It should be understood, of course, that only those pedigree lines are included in the high line averages which uniformly *in each generation* show high fecundity. A similar consideration applies to the low line averages.

Let us now consider briefly the question of the effectiveness of selection *within* the genotype. According to the "pure line" concept we should not expect selection of high or low individuals belonging to the same genotype to produce any effect, except in cases where segregation has occurred and the selected individuals are really gametically different, though having the same pedigree. An example of this sort has been given in the case of line D61D168 (cf. p. 165, *supra*). The ineffectiveness of selection within the line when something of this sort does not occur is illustrated by line D56D407. In the F_1 generation in this line there were four birds, of which three were good layers and one was a poor layer. Two of the good layers and

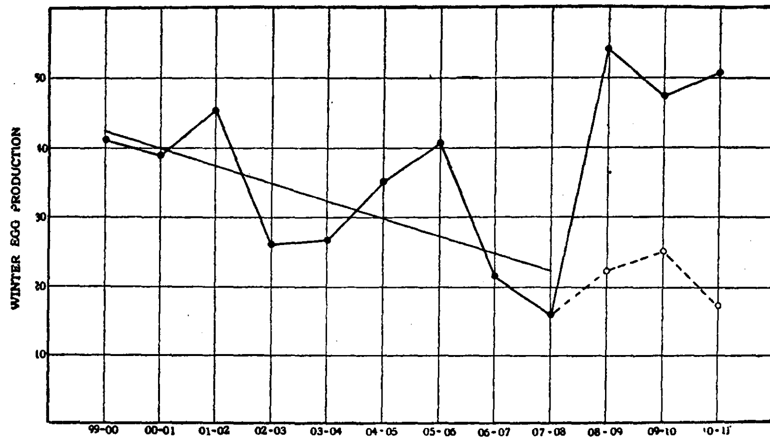


FIG. 84. Showing the effect of selecting high and low fecundity on a genotypic basis. The solid line denotes means of all "high lines;" the dotted line means of all "low lines." Up to 1907-08 the attempt had been to increase egg production by breeding merely from the highest layers, regardless of pedigrees. In 1907 and subsequent years the attempt has been to isolate genotypes of high and low fecundity which shall breed true, each to its own type.

the poor layer were bred. Large families were reared in F_2 and F_3. The average results in the three generations are given in the following table.

EFFECT OF SELECTION OF GOOD AND POOR WINTER LAYERS IN THE SAME LINE, D56D407

Generation	F_1	F_2	F_3
Mean winter record of *good* layers and their progeny	76.0	46.7	35.57
Mean winter record of *poor* layers and their progeny	26.0	52.0	36.75*

It is evident that selection within the line here was quite without effect.

Another example of the same thing from line D31D447 may be given by way of further illustration. In this line there was in the F_1 generation a family of ten daughters. Of these some were very good and some were poor layers. All were bred. The mean results are shown in the next table.

EFFECT OF SELECTION OF GOOD AND POOR WINTER LAYERS IN THE SAME LINE, D31D447

Generation	F_1	F_2	F_3
Mean winter record of *good* layers and their progeny	62.5	23.75	22.00
Mean winter record of *poor* layers and their progeny	32.0	28.75	14.75

Here again it is plain that selection within the line was without effect. Many more examples of the same sort might be given from the records did space permit. In general there is no evidence whatever that the selection of individuals of different laying records, but belonging to the same fecundity genotype, produces any definite or permanent effect whatever.

DISCUSSION AND CONCLUSIONS.

Taking into consideration all the facts which have come out of this study, one is led to the following view as to the composition of a flock of fowls in respect to fecundity. In the average flock we may presume that there will probably be represented a number of fecundity genotypes, some high, some low, and some intermediate or mediocre. In an ordinary flock these genotypes will be greatly mixed and intermingled. Further, the facts in hand indicate that the range of variation in fecundity *within* the genotype is relatively very large, nearly as great, in fact, as in the general population. Thus while fecundity genotype *means* may be and usually are perfectly distinct, there

---

* If one family of four birds, which ought not in fairness to be included here because they were extremely inbred (brother-sister mating) in connection with another experiment, is excluded this average becomes 49.0.

is much overlapping of individuals in the different lines. In consequence it results that the egg record of an individual bird is of almost no value in helping to tell in advance of the breeding test to what fecundity genotype it belongs. Essentially this same fact has been brought out in all of the work which has been done with pure lines. The only difference in the present case lies in the fact that the range and degree of variation within the line appears to be relatively greater in the case of fecundity than in the case of most characters hitherto studied, as, for example, size relations in beans or *Paramecium*.

The most serious difficulty which confronts one in the attempt to analyze the inheritance of a character like fecundity lies in the almost inextricable mingling of genotypes in the great majority of individuals. This, of course, is a direct consequence of the manner of reproduction. The germ plasm of two separate individuals must unite to form a new individual. By prolonging incestuous mating one may in theory come indefinitely close to reproductive purity, but in practice even this is extremely difficult, if not impossible of accomplishment on any large scale or through any long period of time. The fact simply is that a "pure line" in the strict sense of Johannsen * can not by definition exist in an organism reproducing as the domestic fowl does. This, however, by no means indicates that the inheritance of fecundity does not rest on a genotype basis, or, in other words, that fowls do not carry definite genes for definite degrees of fecundity.

We touch here upon an important point; namely, the relation of the mode of reproduction to the mode of inheritance. As one reflects upon the matter it becomes clear that it is only in the sense of a *reproductive* line that we can not, by definition, have pure lines in organisms where the sexes are separate. It is perfectly possible to have a line of such organisms in which all the individuals are *gametically* pure with reference to any particular character. For example, it is the simplest of matters to establish a line of horses pure in respect to chestnut coat color. Any individual in such a line mated to any other will

---

* Johannsen's definition is as follows: "Mit einer reinen Linie bezeichne ich Individuen, welche von einen einzelnen selbstbefruchtenden Individuum abstammen." ("Ueber Erblichkeit in Populationen und reinen Linien," p. 9.)

never produce anything but chestnut offspring. So similarly with any other character, it is only necessary to obtain homozygous individuals in respect to any character in order to form a gametically pure strain with reference to that character.

It must further be kept clearly in mind that a reproductive "pure line" (in the sense of Johannsen's definition) may be made up of individuals *not* gametically pure (*i.* e., homozygous). Thus suppose one crosses a yellow and green pea and then takes an F_2 heterozygote individual seed which originated from a self-fertilized F_1 individual as the "single, self-fertilized individual" with which to start a line. The individual which starts such a line arose by self-fertilization and is selfed to produce progeny and would thus fulfil every requirement of a *reproductive* "pure line" as defined by Johannsen. Yet it would produce both yellow and green offspring. On the other hand, as already pointed out, a line which is not, and from the nature of its mode of reproduction never can be, reproductively "pure" may be gametically so (*i. e.,* have none but homozygous individuals with respect to any character).

We then see that the fact that in fowls the sexes are separate and we therefore can not have reproductive "pure lines" gives, *per se,* no reason to suppose that fecundity is not inherited on a genotypic basis. We have to consider the problem of genetic or gametic purity. Do we have homozygote lines in such cases as those discussed in this paper? It plainly is the fact that one can get lines of birds which, broadly speaking, will breed true (perhaps throwing occasionally a few individuals not true to the type of the line) to definite degrees of fecundity. The same thing is true of milk production in dairy cattle, speed in race horses, etc. What are these lines gametically? Theoretically the formation of gametically pure (homozygote) lines with respect to definite degrees of fecundity is simple. Practically it is exceedingly difficult to do this, owing to the fact that (*a*) the character studied is not expressed in the male, and (*b*) it is subject to a wide fluctuating variability caused by environmental conditions. The question as to the gametic constitution of the fecundity lines here discussed obviously can not be answered finally now. It is a matter for much further research. One may, however, form a general conception of the probable gametic constitution of such lines, which has much evidence in its support. The essential points in such a conception are:

PART V.

GENERAL SUMMARY.

It is the purpose of this bulletin to present in summarized form the essential results of the experiments in breeding poultry for egg production which have been carried on at the Maine Station during a period of 13 years. These results may be briefly stated here as follows:

1. An experiment in which the highest laying hens were used as breeders showed that mass selection for high egg production on the basis of the trap nest record of the individual alone did not, as a matter of fact, result in a steady continuous improvement in average flock production, even though it was continued for a period of ten years.

2. A further experiment along the same line showed that the daughters of "200-egg" hens with from six to nine years selected ancestry (on the basis of trap nest records) behind them were no better layers, on the average, than birds bred from the general flock.

3. There is no evidence that either (a) the method of housing, or (b) of feeding, or (c) the fact that the chicks were throughout the period of the experiment hatched in incubators and reared in brooders, or (d) the fact that some degree of inbreeding was practiced during the mass selection experiment had anything whatever to do with the outcome of that experiment. It is specifically shown in this bulletin that during the period of selection the adult mortality decreased. It is further shown that at the present time, in spite of the fact that there has been no change in the method of hatching and rearing by artificial means, the records of hatching and of chick mortality are such as to give no indication whatever that the strain of Barred Plymouth Rocks which has been used in all the work in breeding for egg production has become in any way deteriorated through the action of environmental or other factors. It is further specifically shown, by an experiment in out-crossing involving a large number of individuals, that the infusion of new blood into this stock failed to produce any change in the egg production of the progeny. Such a result makes it impossible to suppose that the degree of inbreeding practiced during the mass selection experiment can have had anything whatever to do with the results of that experiment.

4. In the laying year 1907-08 a new plan of breeding was adopted as a working hypothesis to be tested by experiment. This plan is based on the employment of individual pedigree records and has its theoretical foundation in the genotype concept of Johannsen. This working hypothesis is fully explained in Part III of the present bulletin. It involves the following factors:

(a) That the egg record of an individual hen gives no definite indication whatever as to what the probable laying of her daughter will be. Examination of hundreds of pedigree records leaves no doubt as to the truth of this fact. Individual birds with high egg records are as likely as not to produce daughters that make poor egg records and vice versa. From the laying record of an individual hen it is quite impossible for anyone to tell whether its progeny will be good layers or poor layers.

(b) A flock of hens, no matter how "pure bred" it may be, is really not a homogenous, unitary aggregation, but instead it is made up of a varying number of lines or strains, each of which tends to breed true to a certain or definite degree of egg productiveness or fecundity. In other words such a flock is a mixture of several component lines. The individuals in each line tend to produce offspring true to the type of the line rather than to the type of the population as a whole, excepting in cases where by chance the population type and the type of one or more lines happen to be the same.

(c) When mass selection alters the population type it does so by a process of isolating from the mixture certain strains whose own types are different from the original general population type and which differ in the direction toward which selection is made. The thing to be sought then in the practical breeding of poultry for increased egg production is to discover by means of pedigree analysis those individuals of the general flock which possess high fecundity in inheritable form. These individuals may then be isolated and propagated and improvement thus brought about.

5. It is shown that by the application of this new plan of breeding it has been possible to isolate from the same stock of birds, which was used in the mass selection experiment, pedi-

gree lines or strains which for four generations (the time covered by the experiment to date) have bred uniformly true to definite degrees of egg production. In this work there have been isolated and are now being propagated lines carrying high egg productiveness, and lines carrying low productiveness, the character apparently being definitely fixed in the pedigree line or strain in each case.

6. In order to determine the mechanism by which fecundity is inherited more data are needed. From the evidence in hand, however, it appears to be the case that this character is inherited fundamentally according to Mendelian principles, though it is not yet clear as to what may be the number and nature of the factors involved. There is, however, clear evidence that high fecundity and low fecundity segregate definitely following crosses between breeds of poultry bearing these characters as definite breed characters. Further studies on this phase of the problem are now in progress.

BULLETIN No. 193.

POULTRY NOTES—1910.

Raymond Pearl.

The purpose of this bulletin is to present a brief report of the progress of the work of the Station with poultry during the year 1910. The publication of such summary reports annually is a definite policy of the Station. It is the object of these reports not only to give an account of the work done, but also to present a more or less complete account of various points regarding poultry management, which arise incidently in connection with the main lines of investigation which are being followed with poultry. These main lines of investigation are poultry breeding, particularly for increased egg production, and the physiology of egg production. No topics will be discussed in this bulletin which have been, or are to be treated in other bulletins of the Station.

A Fresh Air Brooder.

For a number of years prior to 1910 the Maine Station used in rearing chickens a commercial, hot air, brooder known by the trade name "Peep-o'-Day." 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 "Peep-o'-Day" type. These are: (1) in order to get a sufficiently high temperature 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 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

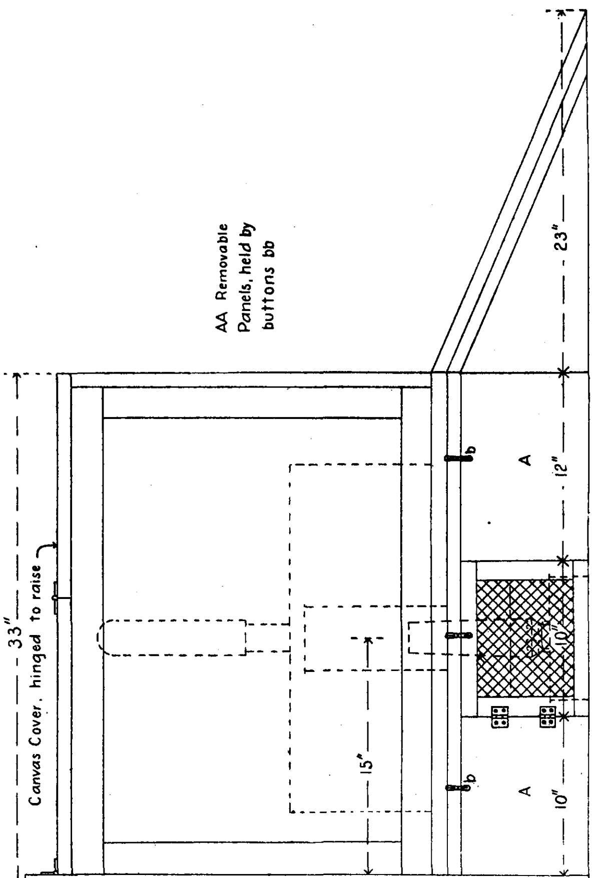


FIG. 85. End elevation of brooder. Note sloping run to floor, hinged cover, removable side panel *AA* on base of brooder. In the center of this is a small door made of 1-4 in. mesh galvanized wire. Through this door the lamp is withdrawn for filling and cleaning. The panel *AA* is removed from the brooder is dismantled, and the whole superstructure is then packed away under the base. See text for further explanation.

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 Peep-o'-Day 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 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

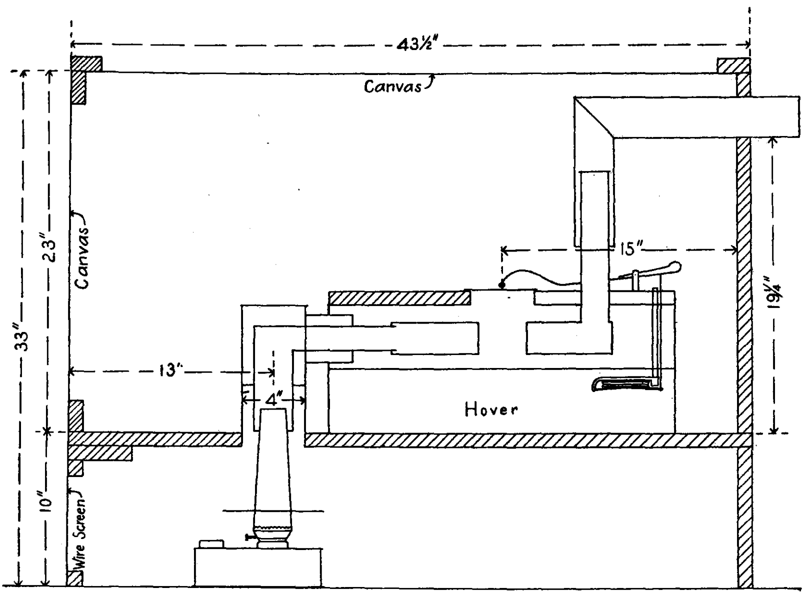


FIG. 86. Section through middle of brooder. Note cloth cover and side, large space between floor of brooder and floor of house, in which the lamp is placed while the brooder is in operation, and which serves as a storage place for the whole upper part of the brooder when the latter is not in use.

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 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. Of course it will be understood that this criticism does not apply to Peep-o'-Day brooders alone but to all indoor brooders on the market known to the writer.

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

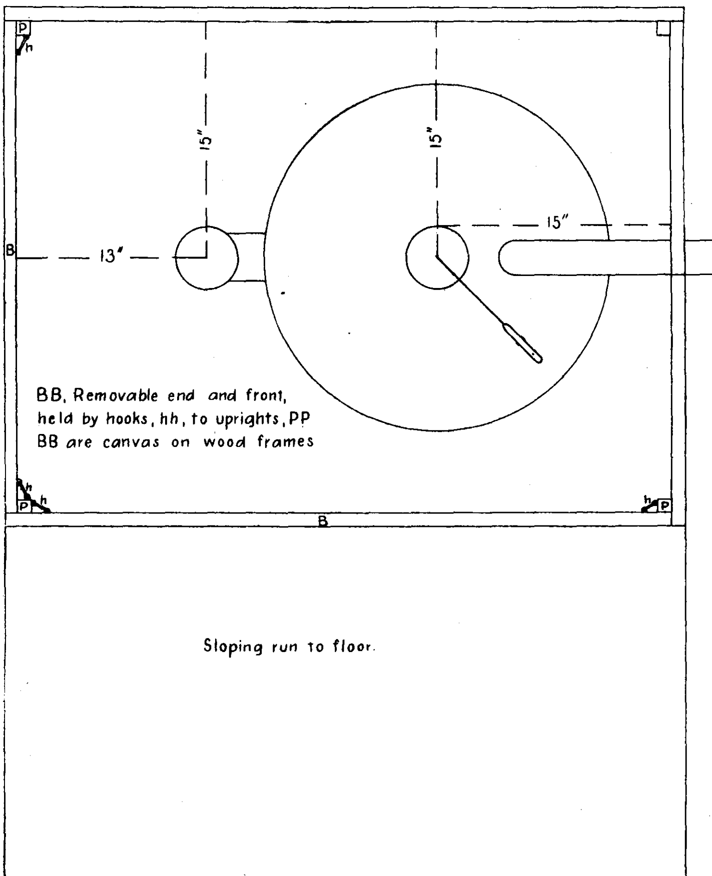


FIG. 87. Floor plan of brooder. For further explanation see text.

try on an experimental scale a brooder devised to overcome the objections mentioned above to brooders of the Peep-o'-Day type. Accordingly 6 brooders were constructed embodying the essential features of that to be described below, and were put in use during the hatching season of 1910. During that year it was possible to compare the work of these 6 brooders with the Peep-o'-Days under the same conditions and with uniform lots of chicks. The results obtained were strikingly favorable to the new brooders. At the same time this practical test brought out clearly a number of minor points in which the new brooder could be improved. In the fall of 1910 all of the Peep-o'-Day brooders which had been used by the Station were discarded and a complete equipment of the

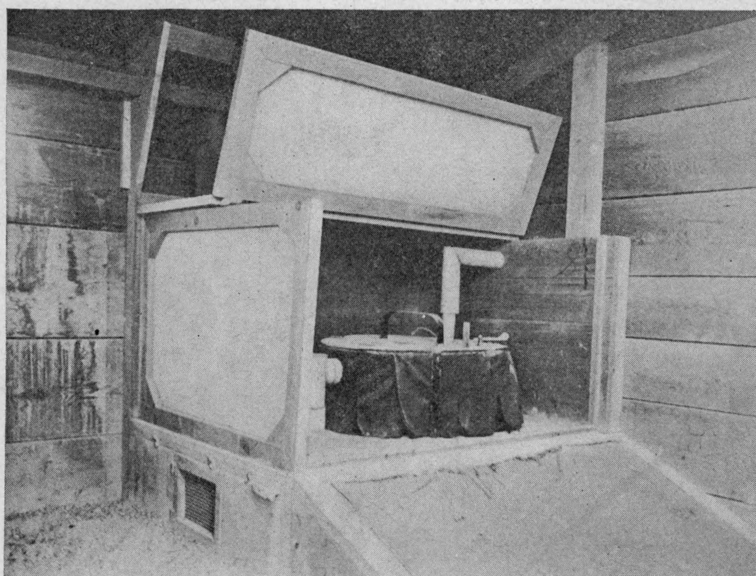


FIG. 88. Showing brooder installed and ready for operation.

brooder to be described was installed. It is proposed in this bulletin to give 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 Peep-o'-Day 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 removed from the house where it is operated means a decided economy.

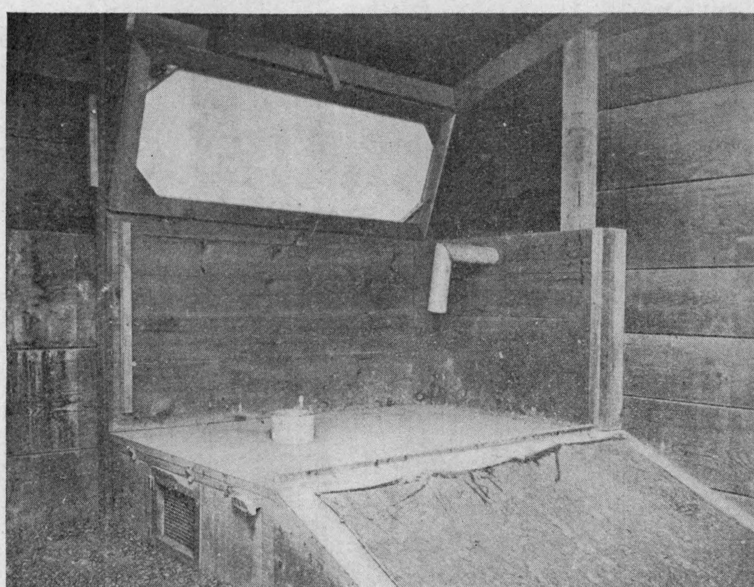


FIG. 89. Showing brooder dismantled and parts stored in base.

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 permanently into 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. 87). 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 Prairie State Universal Hover made by the Prairie State Incubator Company, Homer City, Pennsylvania. 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 the Universal hover. The lamp in this brooder is in the house directly under the brooder just as in the case of the Peep-o'-Day. 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. 85. 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 the 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 removable 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. 85 shows the end elevation of the brooder; fig. 86 shows a section through the middle of the brooder; fig. 87 shows a floor plan; fig. 88 shows the brooder in operation; and fig. 89 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.

The Abandonment of the Roosting Closet.

In the curtain front type of house used at this Station a feature of the original plan on which considerable stress was laid was the canvas curtain in front of the roosts.* This curtain, together with the back wall of the house and the droppings board under the roosts formed a closet in which the birds were shut up at night during cold weather. When the curtain-front house was first devised it was thought essential to provide such a closet 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 house, 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.

* See Farmers Bulletin 357.

On the Accuracy of Trap Nest Records.*

All experimental studies of any magnitude on fecundity in the domestic fowl must rest ultimately upon trap nest records. In spite of the fact that so much trap nesting work has been done in the various Experiment Stations there has never been any careful study, so far as the writer is aware, of what may be called the *residual error* of trap nest records. By "residual error" is meant that error which remains after all instrumental sources of error, such as, for example, failure of a nest to operate owing to its being out of repair, have been eliminated. It will always be the case that some birds will at some times lay outside the trap nest. The important point to anyone concerned in the accuracy of the records relates to the amount of this error. It is proposed here to present some data collected at the Station regarding this matter. Prior to the fall of 1908, what was known as the Maine Station type of trap nest * was in use over the whole plant. A very slight study of the matter convinced one that the instrumental error involved in the use of this nest was too large, both absolutely and relatively. This resulted from several factors but the following defects were most serious. (1) The hens would lay in the front compartment of the nest and not get trapped. (2) The door would fail to lock when the nest was sprung, and thus while the hen inside could not get out, another one (or more) could get inside. (3) In general the nests very easily got out of repair, and then failed to work properly. While in theory it ought to be easy to repair immediately all such nests, in practice it was impossible to prevent there being constantly on the plant a few nests not working properly and needing repairs.

It was believed that with a more efficient trap nest the number of unrecorded eggs could be reduced. Accordingly a new trap nest was devised. This has been described elsewhere.* These nests were installed in the fall of 1908, so that the pullets put into the house that year had nests of the new pat-

* Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 30.

* For original description see Me. Agr. Expt. Stat. Ann. Rept. for 1898, pp. 141-143.

* U. S. Dept. Agr. Farmer's Bulletin 357, pp. 36-39, 1909.

tern. Since the writer took charge of the work an accurate, permanent record has been kept of all eggs laid elsewhere than in a trap nest (i. e. in such way as to make it possible to know the hen which laid the egg). Because records of this kind were

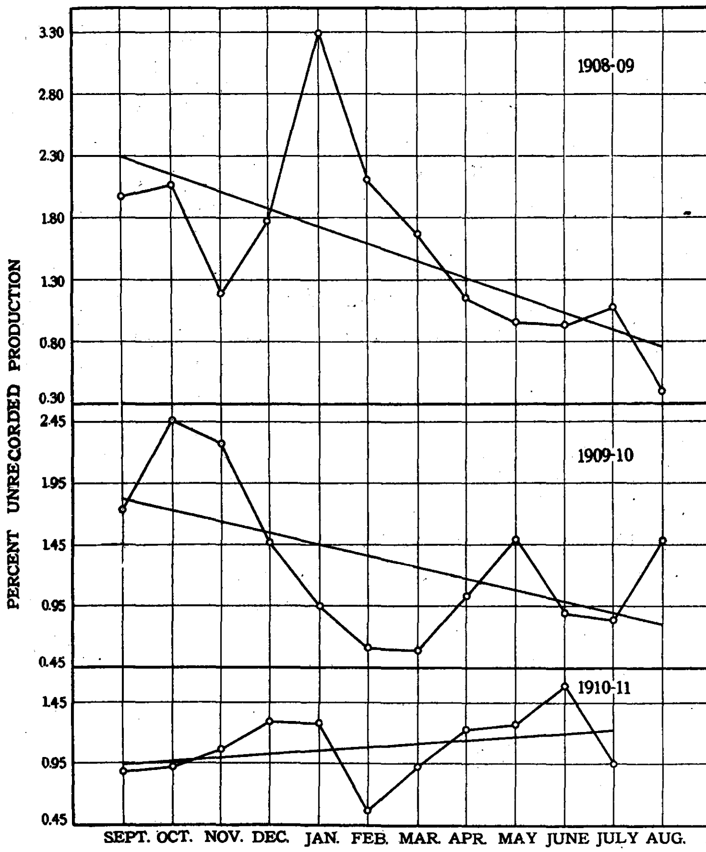


FIG. 90. Diagrams showing the trend of the relative (percentage) amount of unrecorded eggs during the successive months of the laying year, for the laying years, 1908-09, 1909-10, 1910-11.

not preserved prior to the month of January, 1908, the only period for which figures are available regarding the accuracy of the old type of nest as compared with the new is from January to June, 1908.

The following table gives the data from January, 1908, to the present (August, 1911,) regarding the accuracy of the trapnests in use on the Station plant. The figures given include *all* eggs laid on the plant regardless of what experiments the birds were in. The number of birds on the plant varied from time to time, so that the totals in this table are not to be used as an index of the laying of the stock. For example it will be noted that whereas in July, 1909, 6106 eggs were obtained, in the following month there were only 504. This might be taken to indicate a tremendous drop in the rate of fecundity of the birds, but actually it merely means that on August 1, 1909, the houses were cleaned out and all the laying birds were sold except a small number kept over for breeding purposes. In this table the column headed "Nest Eggs" gives the number of eggs laid in the trap nests in such way that the bird which laid each of these eggs was known. The column headed "Unrecorded Eggs" gives the number of eggs laid on the floor of the pen or in some other situation such that it was not possible to know the individual hen which laid each egg.

In order that the data set forth in this table may be more readily comprehended fig. 90 has been prepared. In this diagram the trend of the percentage figures during the last three years is shown. The zigzag line in each case represents the observations. The straight lines are fitted to these observation lines by the method of least squares. The equations to these lines are as follows, y denoting "percentage of unrecorded eggs the nest eggs," and x denoting months, the origin of x being taken as one month before the first observation of the laying year, viz. that for September:

1908-09	$y=2.44-.14\ x$
1909-10	$y=1.93-.094x$
1910-11	$y=0.92+.029x$

This table and the diagrams show that:

(1) The residual error was more than three times as great with the old type of trap nest as it is with the new. Taking the three laying years, 1908-09, 1909-10, and 1910-11, together the grand totals are: 151,355 nest eggs and 1881 unrecorded

TABLE I

Showing the Residual Error of Trap Nest Operations from January, 1908, to July, 1911

MONTH.	1907–1908.			1908–1909.			1909–1910.			1910–1911.		
	Nest eggs.	Unrecorded eggs.	Per cent unrecorded to nest.	Nest eggs.	Unrecorded eggs.	Per cent unrecorded to nest.	Nest eggs	Unrecorded eggs.	Per cent unrecorded to nest.	Nest eggs.	Unrecorded eggs.	Per cent unrecorded eggs to nest.
September............	–	–	–	742	15	1.98	677	12	1.74	1685	15	0.88
October..............	–	–	–	945	20	2.07	1217	3	2.46	2796	26	0.92
November............	–	–	–	1067	13	1.20	1243	29	2.27	2771	30	1.07
December............	–	–	–	2587	46	1.78	3622	54	1.47	3146	41	1.29
January.............	5172	189	3.52	4896	167	3.30	4471	43	0.95	3854	50	1.27
February............	6946	277	3.83	5145	111	2.11	3601	22	0.61	5713	33	0.57
March...............	13111	561	4.10	7938	136	1.68	5921	35	0.59	9408	88	0.93
April...............	12474	510	3.92	7721	91	1.16	6130	64	1.03	8898	109	1.22
May.................	11757	504	4.11	7155	69	0.96	4883	74	1.49	8136	104	1.27
June................	8914	395	4.24	6200	59	0.94	4009	36	0.89	6424	102	1.59
July................	–	–	–	6040	66	1.08	4061	34	0.83	6221	59	0.95
August..............	–	–	–	502	2	0.40	1530	23	1.48	–	–	–
Totals and means	58374	2436	4.01	50938	795	1.53	41365	429	1.03	59052	657	1.11

eggs; giving a percentage of 1.24 unrecorded eggs. We then have for the ratio of efficiency of old nest to new:

$$\frac{\text{Old trap nest}}{\text{New trap nest}} = \frac{4.01}{1.24} = 3.23$$

(2) The relative amount of unrecorded egg production is not closely related to the total egg production. This is indicated by the fact that the curves of unrecorded eggs by months do not at all parallel the familiar curve of the seasonal or monthly distribution of egg production.* The absolute number of unrecorded eggs tends to increase as the nest eggs increase, and diminish as the latter diminishes. But there is no indication whatever in the figures that *proportionately* more eggs are unrecorded when the laying is heavy than when it is light, and *vice-versa.*

(3) There is plainly in the years 1908-09, and 1909-10 a tendency for the unrecorded production to diminish relatively as time elapses from the beginning of the laying year. That is to say, the longer the same individual birds use the trap nests, the smaller becomes the production of unrecorded eggs. This suggests what is actually the fact, that there is an element of learning in the operation of trap nests, looked at from the standpoint of the bird. In a lot of several hundred pullets put into the *laying* house in the fall there will always be a few who have to be *taught* to use trapnests, or for that matter, any kind of a nest. Usually such birds learn fairly rapidly to lay in nests. There are occasional lapses, but the number of these tends to become smaller the longer the bird has used a nest. It is on this account that the relative proportion of unrecorded eggs tends to diminish during the course of the laying year.

(4) The year 1910-11 seems to furnish a contradiction to the statements made in (3). In that year the proportionate number of unrecorded eggs was actually greater towards the end of the laying year than at the beginning, though the amount of the change was so small as not to be significant. Practically the line is horizontal. It is not possible to state posi-

---

*Cf. Pearl and Surface, U. S. Dept. Agr. Bur. An. Ind. Bul. 110. Part II, p. 90.

tively all the factors which are concerned in the failure of the unrecorded eggs to diminish during the year 1910-11.

Direct observation indicates, however, that the chief cause of the relatively high amount of unrecorded production towards the end of this year (April, May and June) is to be found in the behavior of certain cross-bred birds with respect to broodiness. A number of these birds would show all the symptoms of a severe attack of broodiness, yet after being put into the broody coops to be "broken up" would continue to lay regularly on the floor of the coop. This happened so many times as to leave no doubt as to the fact, nor as to the relatively frequent occurrence of this type of behavior among the cross-bred birds. Owing to its unexpectedness we were not prepared this year to keep any exact records respecting the phenomenon. To do this involves penning each broody bird alone. Next year it is proposed to do this, and thus get precise records on a matter regarding which we have so far only general observations. From the evidence now in hand it seems probable that what we have here is an effect of the separate Mendelian segregation of "broodiness" and "fecundity." In the care of these F_2 birds of the peculiar behavior described we apparently have individuals carrying *both* "high fecundity" and "high broodiness" genes. The resulting behavior is a sort of compromise between the two tendencies. It might be thought that such a result would be a physiological impossibility. This is not so. Paradoxical the result certainly is, but plainly not impossible, since it is actually the case that these birds have every physiological attribute of broodiness, and yet lay regularly. In this connection it should further be said that a study of a large mass of unpublished quantitative data on broodiness shows that the physiological correlation between the function of laying and that of brooding, is by no means perfect. Perfect "broodiness" may be developed before any egg laying has occurred. Further as in the present cases, broodiness and egg laying may coexist over long periods. The writer hopes to be able shortly to publish in full the data on the physiology and inheritance of broodiness which have accumulated during the past four years.

DISCUSSION.

From the figures given above it appears that, on the average, during the past three years, there has been for every 100 eggs laid on the Station plant only one and a quarter eggs which it was not possible to credit to the individual bird. This probably represents something approaching the irreducible minimum of error in trapnesting work on any large scale. The reason that it is believed to be substantially irreducible is that further to increase the proportion of recorded eggs would involve the intelligent coöperation of the hen, a factor not easily controlled. In this 1 1-4 percent of unrecorded eggs only a very small fraction (less than one percent) is chargeable to instrumental errors. It is probably safe to say that no trapnest (or other piece of machinery) can ever be devised which will effectively meet all situations which will arise. In a very few instances, amounting as has been said to less than one percent of the *unrecorded* (not the total) egg production, two hens will go precisely together into the trapnest, or one will sit on the door while another walks in, lays, and walks out again. The new Maine Station nest has, however, reduced the instrumental error practically to nothing.

With no instrumental error, however, there remains some unrecorded egg production. This arises in the main from the following factors:

1. *Laying on the floor of the house.* This may be due to
   - (a) Instinct to "steal a nest." This can be cured if taken in hand early.
   - (b) Purely physiological inability to hold up the egg longer. This may happen when all the trap nests are full and a hen wanting to lay cannot get in, or it may happen when an attendant throws out of the nest a bird which has been on the nest for some time, has not yet laid, but is just on the point of doing so. These are purely accidental matters and cannot be entirely controlled though with care they may be largely so.
   - (c) Lack of familiarity with nests. Common in young pullets, which have to be "taught" by direct methods to use nests.
2. *Laying in "broody coops."* This has already been discussed.

3. *Dropping eggs while on roosts.* Eggs are sometimes found on the roost boards in the morning. They indicate a disturbance of the normal laying rhythm.

From this enumeration it is plain that full control of the matter demands intelligence and coöperation on the part of the hen.

It should, of course, be understood that the sources of error here discussed are not the only ones in trapnesting. They are merely the ones which are *peculiar* to that work. It is always possible to misread a leg band or to set down an incorrect number on the record sheet. Here the skill and experience of the recorder are the important factors. It is believed as a result of studying a great many records, and applying many different sorts of checks that in this respect as well as in the other the Maine Experiment Station trap nest records during the last three years, as made by Mr. Walter Anderson, have attained a minimum of error, which, considering the scale of operations, is humanly not substantially reducible.

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 past year.

THE SEASONAL DISTRIBUTION OF EGG PRODUCTION.

During the year Part II of the "Biometrical Study of Egg Production in the Domestic Fowl" * has been issued. This part deals with the distribution of egg production during the different parts of the laying year. Summarized the results of this study are as follows:

The data on which this study is based are the trap nest records of Barred Plymouth Rocks collected at the Maine Experiment Station, involving detailed monthly egg records of more than 2,400 birds, collected in a period of nine consecutive years.

---

* U. S. Dept. Agr. Bur. An. Ind. Bulletin 110, Part II, pp. 81-170. 1911.

The chief results of this analysis are summarily stated in the following paragraphs:

1. The mean or average monthly egg production exhibits the following characteristic changes in the course of the laying year:

(a) The lowest mean production of the year is in the month of November.

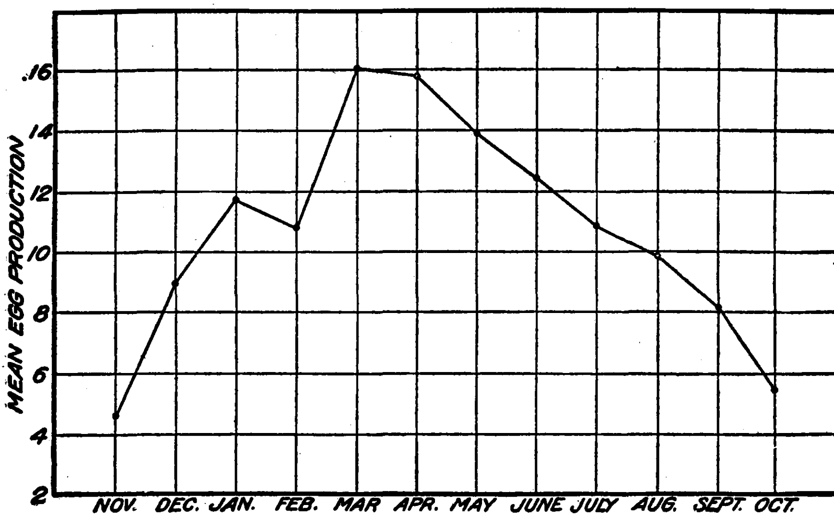


FIG. 91. Diagram showing the weighted mean monthly egg production for each month of the pullet year.

(b) The mean monthly production increases in December and January at a relatively very rapid rate.

(c) There is a slacking up in the rate of increase in February, which probably represents the point of the ending of the first, or winter, cycle of egg production. This February slacking up amounts in many cases to an actual decrease in productiveness as compared with the point attained in January.

(d) The mean production reaches a maximum in March.

(e) While the mean production for April is practically the same as that for March, there is a steady decline after April on to the end of the laying year in October.

(f) There is a tendency toward a slightly larger drop in mean production in May. This is the period of natural broodiness.

2. The present data indicate that only a trifle more than a quarter of the total eggs produced are laid in the winter third of the year (November 1 to March 1). In the first two-thirds of the laying year approximately three-fourths of the total eggs are produced.

Diagrams showing the nature of the seasonal distribution of egg-production are presented in figs. 91 and 92.

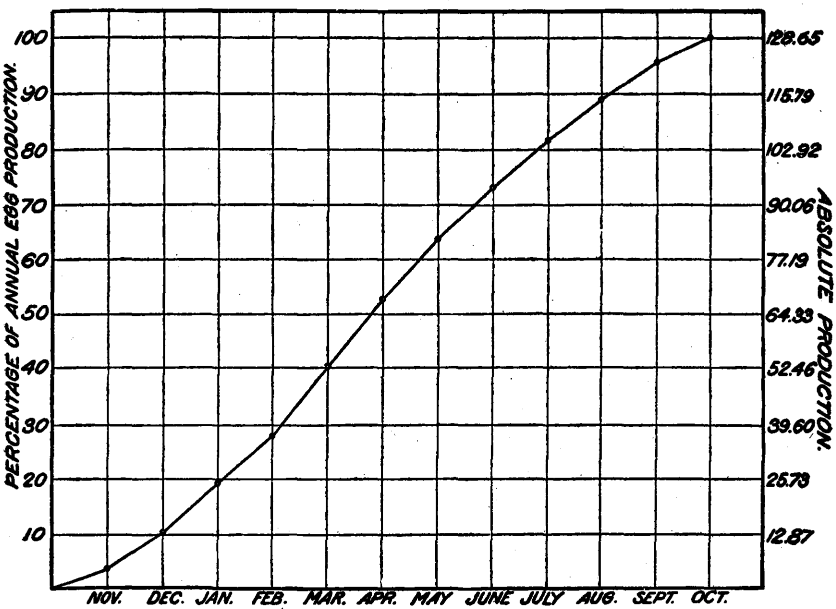


FIG. 92. Integral curve of weighted mean monthly egg production, showing the absolute and relative number of eggs laid from the beginning of the laying year up to the end of each month.

3. The month of maximum productivity varied in the experiments furnishing the present data with the methods of housing. In a closed, warmed house the month of maximum production was April; in a curtain-front house it was March.

4. The greatest relative variability in egg production is at the beginning of the laying year (month of November). The month of lowest variability, both absolute and relative, is April.

5. The laying year may be divided into four natural periods or cycles with reference to egg production. The first of these periods (roughly November 1 to March 1) is the winter period, wherein egg production is essentially a non-natural (i. e., forced

or stimulated) process. The second or spring period (March 1 to June 1) is the natural laying period of the domestic fowl in its normal reproductive cycle. The third (roughly June 1 to September 1) and fourth (roughly September 1 to October 31) periods are not sharply separated from one another. The summer egg production represents in part a natural continuance of the normal breeding season (rearing of a second brood by wild *Gallus*) and in part a stimulated process. This period is terminated by the molt, which is the characteristic feature of the fourth period.

6. There is no evidence that the continued selection for higher egg production practiced during the eight years covered by the experiment produced any increase whatever in the mean egg production of any month in the year. On the contrary, the mean production in all but two of the months actually decreased during the period of selection.

7. So far as there was any change whatever in variability in monthly egg production during the period when selective breeding was practiced, this change was not in the direction of a reduction as a result of the selection, but, on the contrary, there was an actual increase in variability in all but one month of the year, and here the platted variability line did not sensibly deviate from the horizontal.

8. The present statistics show no bad effect on egg production in the winter months (November to March) of keeping birds in large and crowded flocks (up to the limits included in the present study). On the other hand, overcrowding tends distinctly to lower summer (and to a smaller extent spring) egg production. It is chiefly as a result of this effect on summer production that the mean annual production is lower in the large flocks, as shown in Part I of this work (Bureau of Animal Industry Bulletin 110, Part I, pp. 58-61).

9. The excess in relative variability of egg production of the larger flocks (100 and 150 birds) over the smaller (50 and 100 birds) observed in the annual records (see Part I) is found upon analysis to be on the whole fairly evenly distributed over the whole year. In the period of the year in which there is the heaviest production, such environmental differences as are implied in the different flock sizes in the experiment do not appreciably affect the relative variability of production.

10. The polygons of variation in monthly egg production are all bimodal, though homogeneous. The position of the mode changes in a regular manner during the course of the laying year, as does also the skewness of this portion of the distributions. These monthly distributions may be described as S-shaped, and are in general of the same type in the different months, though different in detail.

11. By a process of mathematical reasoning set forth in detail in the original paper it is shown that the observed facts regarding the character of the distributions of variation in monthly egg production are adequately accounted for by an hypothesis which includes the following points. These statements are therefore set down as conclusions of this study:

(a) That variation or changes in the rate of fecundity in the hen are fundamentally or innately continuous (in the mathematical sense), though the objective manifestation of fecundity is discontinuous, i. e., expressed in discrete units.

(b) That visible egg production in each individual bird tends to occur in definite cycles or periods of varying length which alternate with nonproductive periods.

(c) That the rate of fecundity (amount of egg production per unit of time, conceived in the sense of the differential calculus) is in any bird at a minimum at the beginning of a cycle of production, increases to a maximum at what may be termed the height of the cycle, and decreases to a minimum (usually quite rapidly) as the end of the cycle is approached.

(d) That each of the monthly fecundity distributions is compound, and made up of two parts. In one part are included all birds which are well along in a period of laying activity (or cycle of fecundity). The other part includes those birds not laying at all (that is, in a non-productive condition or period) and those that have just emerged from this condition of zero fecundity and started on a laying cycle.

(e) That (1) the proportion of the whole flock which falls into each of these two classes, and (2) the particular rate of fecundity which marks the boundary between the two classes, are not constant, but, on the contrary, change in a definite and orderly manner in the different parts of the laying year.

(f) That the distribution of frequency within each of the two hypothetical components of the monthly fecundity distributions follows a simple, unimodal skew frequency curve, and that the curve describing the entire monthly fecundity distribution is in each case the sum of two skew frequency curves.

DOES "PROTECTIVE COLORATION" IN POULTRY REALLY PROTECT?

It is an obvious and easily demonstrated physical fact that fowls with a barred or broken color pattern are relatively inconspicuous as compared with birds with either solid black or white plumage, or so dark in general color that any pattern which may be present is not visible except on close examination. Does the inconspicuousness of barred birds protect them against their natural enemies, such as crows, hawks, foxes, rats, etc.?

Some two years ago C. B. Davenport published a short note regarding the relative number of self-colored and of "pencilled or striped" chicks killed by crows one afternoon, at Cold Spring Harbor. The rather striking result was that out of 24 birds killed, only one was other than self-colored. The communication closes with the following words: "This fragment, then, so far as it goes, indicates that the self-colors of poultry, which have arisen under domestication, tend to be eliminated by the natural enemies of these birds, and the pencilled birds are relatively immune from attack because relatively inconspicuous."

Records kept at this Station in connection with the breeding work throw light on this matter. A discussion of these records has recently been published.* The results may be summarily stated as follows:

We have the following figures, it being understood that "eliminated" means "killed by natural enemies" with the inclusion of the small number of birds which lost their bands. (See original for details).

Total number of birds on range	=3,343
Number of *barred* birds	=3,007
Number of *solid-colored* birds	= 336
Total number of eliminated birds	= 325
Number of *barred* birds eliminated	= 290
Number of *solid-colored* birds eliminated	= 35

* Data on the Relative Inconspicuousness of Barred and Self-colored Fowls. American Naturalist, Vol. XLV, pp. 107-177. 1911.

The above figures include *all* eliminated birds, those killed by recorded and unrecorded enemies together. If we take only those killed by recorded enemies, which under the conditions prevailing on the plant in 1909 means practically those killed by rats, we have:

Number of *solid-colored* birds eliminated by recorded enemies =6.

Number of barred birds eliminated by recorded enemies =68.

From these figures the following proportions are derived: Of the *total number* of birds 10.05 per cent. were *solid-colored.*

Of all the *eliminated* birds 10.77 per cent. were *solid-colored.*

If we consider by themselves the birds eliminated by recorded enemies, we have:

Of the birds *eliminated by recorded enemies* 8.11 per cent. were solid-colored.

Putting the figures in another way we have:

Of the *solid-colored* birds 10.42 per cent. were eliminated by *all* enemies.

Of the *barred* birds 9.64 per cent. were eliminated by *all* enemies.

Of the *solid-colored* birds 1.79 per cent. were eliminated by *recorded* enemies (chiefly rats).

Of the *barred* birds 2.26 per cent. were eliminated by *recorded* enemies.

Of the *solid-colored* birds 8.63 per cent. were eliminated by *unrecorded* enemies (chiefly predaceous birds).

Of the *barred* birds 7.38 per cent. were eliminated by *unrecorded* enemies (chiefly predaceous birds).

The conclusion to be drawn from these figures, which involve a large number of individuals, is obvious. It is that *the relative inconspicuousness of the barred color pattern afforded its possessors no great or striking protection against elimination by natural enemies, during the season (April 1 to October 1) of 1909 on the poultry range of the Maine Experiment Station.* It might be objected that if the eliminations by predaceous birds alone could be separately recorded it would then be found that against this class of enemies the barred pattern had great protective value, as suggested by Davenport's figures. This, however, can hardly be the case in the present statistics since if it be assumed that predaceous birds killed relatively few barred chicks and relatively many solid-colored, then it must also be assumed that the other unrecorded enemies showed a *preference* for barred birds, since with all enemies taken together substantially equal proportions of both kinds of birds were eliminated. In other words, if we assume a selective elimination in the case of predaceous birds, we are obliged to assume an *equal* and *opposite* selective elimination on the part of other unrecorded enemies. There is no evidence on which such an assumption could be based.

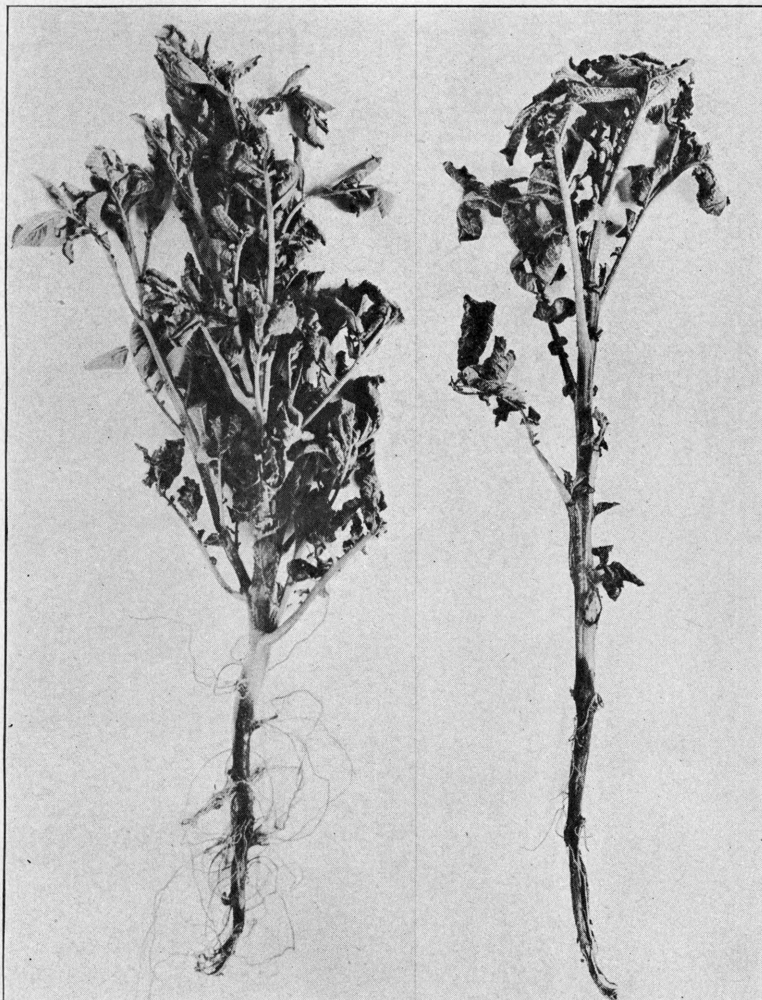


FIG. 93 Two potato plants showing advanced stages of the blackleg disease. Note the decided blackening at the base of the stem.

BULLETIN No. 194.

CONTROL OF THE BLACKLEG OR BLACK-STEM DISEASE OF THE POTATO.

W. J. Morse.

Bulletin 174 of this Station, issued December, 1909, discussed the character and appearance, means of distribution, distribution in America and economic importance of the blackleg disease of the potato. At the same time methods for prevention and eradication were outlined and discussed. It was then stated that these recommendations were made on more or less empirical grounds and were not based upon regularly conducted experiments. It is now proposed to give the results of certain field trials and experiments whereby these recommendations were tested on a large scale under actual farm conditions. Before taking up the details of these experiments and the results obtained therefrom it is perhaps best to summarize some of the more important parts of Bulletin 174 and to give a brief account of certain preliminary studies which led up to the experiments mentioned.

"Blackleg," "black-stem," "black stalk-rot" or "stem-rot" is a bacterial disease which attacks both the stem and tuber of the Irish potato. Various investigators, mostly in Europe, have isolated from the diseased plants and described under different names bacteria which were again capable of causing very similar effects upon the host upon inoculation.* Hence so far as our present knowledge goes blackleg, strictly speaking, is a general term applied to a type of bacterial disease which attacks and destroys the base of the potato stem, producing a characteristic blackening of the diseased tissues, rather than a term applied to a single disease caused by a specific organism. However, the organisms are so near alike and are so nearly identical in their

* *B. phytophthorous* Appel, *B. solanisaprus* Harrison, *B. atrosepticus*, van Hall, *B. melanogenes* Pethybridge and Murphy, etc.

effects upon the host that so far as the practical agriculturalist alone is concerned the distinctions made are, in the opinion of the writer, of little consequence. Preventive measures which are effective with one under Maine climatic conditions would be, in all probability, equally applicable to all. Blackleg is not the same as the Southern bacterial disease of the potato stem and tuber caused by *B. solanacearum* Smith.

Both stems and tubers are attacked. The diseased plants as observed in Maine * first appear more or less unthrifty and usually undersized. The branches and leaves, instead of spreading out normally, tend to grow upward, forming a more or less compact top, frequently with the young leaves curled and folded up along the mid-rib. Later they become lighter green or even yellow and the whole plant gradually dies. If the disease progresses rapidly the plants may fall over suddenly and wilt with very little previous signs of disease. The same general symptoms may be produced by certain other stem diseases, or even mechanical or insect injuries of the stem at or below the surface of the ground.

The appearance of the diseased stems at once differentiates blackleg from other described potato diseases. Stems so attacked are characterized by an inky-black discoloration (See Fig. 93) extending from the base of the stem, where it attaches to the seed piece, up sometimes one, two or even three inches above the surface of the ground. Under favorable weather conditions the disease may, in exceptional cases, follow up the stem for several inches, or even out on the larger branches. The seed pieces from which the diseased plants spring are invariably decayed, and young tubers which have been formed before the destruction of the stem may sometimes be attacked by a soft rot caused by the bacteria being conveyed to them along the underground branches of the stem upon which they are produced.

The disease is carried over from year to year by the organisms living in decaying, bruised, cracked or otherwise imperfect seed potatoes. They are readily killed by drying and are probably incapable of existing in a living state on the surfaces

* The following discussion should be understood as only applying to the character of the disease as observed by the writer in this State.

of dry, sound potato tubers. Under ordinary conditions blackleg has not been observed in Maine to spread from hill to hill in the field and, as will be shown later, there is quite conclusive evidence that the germs do not live over winter in the soil under the climatic conditions which exist in this State.

Observations extending over 5 years indicate that the disease is much less prevalent in those seasons which have relatively little rainfall between planting and blossoming time. While it is quite generally distributed over the potato growing sections of the State and sometimes, in very wet seasons, fields may be found which show 10, 15 or even 20 per cent. of diseased plants, as a general rule it occurs only as occasional, affected stalks scattered over the fields. Only in exceptional cases is the crop materially reduced from this cause.

The writer has had opportunity to study numerous outbreaks of rot in potato fields and in storage in Maine and other parts of New England during the last 15 years and has yet to see the first case of a severe epidemic of this kind that could be traced to the blackleg or stem rot disease. These epidemics are invariably preceded by outbreaks of the late blight fungus *Phytophthora infestans* DeBary on the foliage, and occur with equal frequency on fields which are free from blackleg as upon those which are attacked with this disease. Moreover such epidemics were as common long before the blackleg disease made its appearance, and now occur in those parts of New England where blackleg has never been seen, whenever the weather conditions are favorable for outbreaks of late blight on the foliage, and spraying with bordeaux mixture is not thoroughly done. The nature of the decay in such cases may be soft and foul-smelling and large numbers of bacteria may be found in the decayed tissues, but the writer has failed in repeated trials to isolate bacteria from such tubers which, upon inoculation to sound tubers, would produce alone and unaided any disease whatever. In all probability the soft rots observed in epidemics of this kind are caused by saprophytic bacteria of the soil which follow after and farther break down the tissues of the tuber after they have been killed by the late blight fungus.

It is perfectly possible however, as has already been stated, for the bacteria associated with the blackleg disease of the stem to produce a rapid and complete soft rot of the tuber under favorable conditions of temperature and moisture if they come in contact with the interior tissues. Therefore, there is no doubt that some of the soft rot in storage may come from this source. It is also evident that diseased plants only spring from tubers produced by previously diseased plants, or from tubers infected in storage or while being cut for seed purposes by coming in contact with those already diseased.

So long as Maine growers confined their efforts to the production of table stock, blackleg was not one of the more important potato diseases and attracted little attention. When the value of northern-grown potatoes for southern planting began to be appreciated an entirely new situation developed. The southern trade demanded early varieties, the favorite among which is the Irish Cobbler which is much more susceptible to the blackleg disease than the Green Mountain and certain other, late varieties commonly grown for table stock. Moreover blackleg appears to be much more destructive in Virginia and other southern States, where most of the seed tubers are sold, than in Maine. Consequently from the standpoint of the seed potato trade this disease has become one of considerable importance. If Maine seed potatoes for southern planting are to retain the place that their various superior qualities have secured for them it is absolutely essential that this disease be eliminated from among them. In other words, from a financial standpoint this is the most important disease problem that the seed potato growers are facing at the present time. It is believed that the experiments here reported demonstrate that any farmer can entirely eradicate the disease from his seed and from his farm in from one to 2 years and that so long as he keeps this seed pure and uncontaminated he may feel assured of immunity from blackleg.

Preliminary Experimental Work.

After isolating the bacteria associated with the disease in Maine and demonstrating by inoculation that they were capable of causing the typical blackening and decay of the stem as well as the soft rot of the tuber the first matters to determine before attempting to devise methods of control were the resistance of the organisms to drying, to exposure to sunlight, and to disinfectants and germicides. It was found that they were readily killed by drying, but broth cultures retained their vitality until all of the moisture was evaporated—ten months or more, or longer than the organisms would be required to remain alive in infected tubers. Exposure to sunlight for 60 minutes in petri-dish cultures killed all the organisms even in the less intense light of November and December. They were also readily killed when transferred to very weak formaldehyde solutions. At no time have any of the different strains studied been observed to form spores.

Spraying sound tubers with fresh, virulent cultures in 1909 and allowing them to dry and remain in an open shed away from direct sunlight for a week before planting failed to convey the disease to the resulting plants. This gave additional evidence that the organisms cannot remain alive for any length of time on the dry unbroken skin of healthy tubers. Wetting healthy seed pieces, after cutting, with cultures and watery extracts of diseased stems followed by keeping the soil constantly moist led to the production of diseased plants. Evidence was also constantly accumulating to show that seed tubers were the chief, if not the only source of infection. Therefore, it seemed conclusive that it was only those tubers which were partly decayed, cracked or imperfect which provided the proper conditions for harboring the germs alive and in condition to communicate the disease to the growing plants. As will be pointed out later there is every reason to believe that the germs are spread from diseased to healthy seed pieces by means of the knives used in cutting and by the freshly cut surfaces of the seed pieces coming in contact in the storage barrels and in the planters. If the cut seed tubers are allowed to "heat" a little before planting, on account of being barreled up too long, this danger of transference of the disease to healthy seed pieces is greatly increased.

In the fall of 1909 three barrels * of seed potatoes were obtained in Presque Isle from a field where a large percent of the plants had been killed by blackleg the summer before. Unfortunately late blight was very prevalent on this field during

* A barrel of potatoes as the term is here used is approximately equal to 2 3-4 bushels or 165 pounds.

the latter part of the season, resulting in a large amount of rot developing in storage and over half of the tubers were sorted out as entirely decayed during the winter. The most of this rot resembled that produced by *Phytophthora infestans.* At planting time these tubers were first sorted into 2 lots, those which were entirely sound and those which were partly decayed or were in some way imperfect. One-third of each lot was exposed to formaldehyde gas, one-third treated by immersing in formaldehyde solution in the usual way before planting and the remainder planted without any treatment. At the same time on the same field, which had not grown potatoes for many years, plots of equal size were planted with healthy seed tubers from 2 different sources.

A small amount of blackleg developed on parts of the field where the untreated, diseased seed was used, but the results were very unsatisfactory and inconclusive. This work was done at Orono, but unfortunately, the writer had very little control over the experiment beyond furnishing the seed. The ground allotted to the experiment was heavy clay, improperly prepared for the crop, very dry and filled with large clods of earth at planting time. The field was neglected and not properly cultivated—the potatoes were at times overrun with weeds and badly injured by potato beetles.

Coöperative Experiments.

Therefore, it was thought best to ask the potato growers to coöperate in testing the preventative measures outlined, on a sufficiently large scale and upon enough different farms to make the combined results conclusive. This might be objected to by some as placing certain important details of the work in the hands of individuals not trained in exact experimental methods. Granting this objection to be valid it would simply be operative in case the results were inconclusive. On the other hand if the results were comparatively clear-cut and conclusive they would be of additional value as indicating the probable success or failure of the average farmer in carrying out the remedial measures recommended. Moreover those who volunteeered to assist in carrying on these coöperative experiments are specialists in potato growing and are among the most progressive and up-to-date farmers in the State. They are very familiar with the character and importance of the disease and were intensely interested in the success of the experiments.

These coöperative experiments were conducted by Mr. O. J. Parsons, Patten; Mr. O. L. Donaldson, Presque Isle; Mr. J. F. Hussey, Mr. Ira J. Porter, Mr. W. T. Good, E. L. Cleveland Company, Mr. H. Edblad, and Mr. W. S. Blake, Houlton. The writer takes this opportunity to express his appreciation and thanks to these gentlemen for the careful and painstaking manner in which they carried out their portion of the work, upon which the entire success of the experiment depended. Collectively these gentlemen disinfected seed tubers sufficient to plant 142 acres. Formaldehyde solution was used for 88 acres and formaldehyde gas for 54 acres. On the different experimental fields taken together as large if not a larger area was planted with untreated tubers. However, on some farms only enough treated seed tubers were used to plant a few acres while on others they were all treated except enough to provide a check plot of suitable size.

Methods Used in the Coöperative Experiments.

Before starting the experiments the writer conferred with each individual experimenter and explained fully the methods proposed and in all but one instance visited the potato houses or farms and advised and assisted in starting the disinfecting work. In addition a typewritten outline was furnished to each. The following is a brief summary of this:

The seed * used should come from fields where the disease appeared the year before. In each case a check plot of untreated seed from the same source as the treated and selected seed should be planted at the same time and on the same field under identical conditions except for treatment. The different plots must be plainly marked and labeled by proper stakes driven into the ends of the rows.

A part were requested to carefully sort out before disinfection all badly bruised or cracked tubers and all that appeared

* The term "seed" is in common use in the potato growing sections for potatoes used for seed purposes. Although botanically incorrect, for convenience it will be so used in the following discussion.

in any way diseased or decayed. Others to disinfect and plant the seed tubers just as they came from the bin, and others were to try both methods. Those who were intending to plant only selected, treated seed were advised to reject all tubers when cutting which showed any discolored areas in the flesh, particularly those which showed browned or blackened rings at the stem end, no matter how slight. As a farther precaution it was recommended that extra knives and a jar of formaldehyde solution be provided when cutting seed and if, by chance, a diseased tuber was cut the knife blade could be dropped into the disinfecting solution for a time and another used in its place. Some were to disinfect by means of formaldehyde solution and some were to use formaldehyde gas. It was also suggested that selection of sound tubers without disinfection be compared with the forms of treatment mentioned.

The experimenters were cautioned not to allow treated seed tubers to come in contact with tools, baskets, or barrels which had been used for diseased or untreated seed. It was advised that all containers for treated seed either be exposed to formaldehyde gas in a disinfecting chamber or washed out thoroughly with formaldehyde solution. Planters recently used for contaminated seed were to have the parts which come in contact with the seed pieces thoroughly washed and scrubbed in formaldehyde solution.

Those who used the liquid treatment immersed their seed 2 hours in a solution of one pint of 40 per cent. formaldehyde in 30 gallons of water. Where the formaldehyde gas treatment was used the tubers were placed in open, slat-work crates and exposed to the gas generated by means of potassium permanganate, for from 12 to 24 hours in a tightly closed room constructed for the purpose. For each 1000 cubic feet of the disinfecting chamber 3 pints of 40 per cent formaldehyde and 23 ounces of potassium permanganate were used. When, as in some cases, a large proportion of the space in the disinfecting chamber was occupied by crates of potatoes only about three-fourths of the given amounts of the chemicals were used to avoid too great concentration of the gas and possible resulting injury to the germinating quality of the seed.

There was little variation in soil conditions. According to the map of the Soil Survey of the Caribou Area, Maine,* Mr. Donaldson's field consisted entirely of the Caribou loam which is the type of the best Aroostook potato soil. This was the only field which was included in the soil survey but so far as could be determined the soil on all the other experimental fields was either identical or conformed very closely to this type. In each case the fields were well cared for, were well drained, and consisted of either level or slightly rolling land.

DETAILS OF THE COÖPERATIVE EXPERIMENTS.

The Parsons Experiment.

Mr. Parsons' field consisted of about 11 acres of sod land. The portions where the treated seed was used comprised 7 rows near the East side and 15 rows near the middle, running entirely across the field, and together constituting about one and one-tenth acres. The seed was treated by soaking in formaldehyde solution and was carefully sorted when cut, Mr. Parsons looking after this himself. Untreated but selected seed was used on the remainder of the field. None was planted without selection.

The field was visited on July 5 but the plants were not sufficiently advanced to show the maximum amount of blackleg. Hence no records were made at this time except to note that the disease was beginning to appear on the untreated portions. On July 17 approximately one-half acre of each on adjoining portions of the treated and untreated plots was carefully examined for blackleg with the following results.**

---

* Weston, H. L. and Rowe, R. W., Advance Sheets Field Operations of the Bureau of Soils, 1908, Washington, 1910.

** On each farm care was taken to select portions of the plots of equal size and in every way uniform except as for seed treatment upon which to make the records. Of necessity the area of the portions so selected varied on the different farms. For convenience in comparison the records made have been reduced to numbers of diseased plants per acre. A superficial examination of the field as a whole or certain portions of it was made in each case to ascertain if the portions selected for detailed examination represented average conditions. Moreover with few exceptions the owner or his personal representative was present and assisted at each examination of the experimental fields. In each case a preliminary draft of the write-up of the different experiments was submitted to the owner of the field for his approval before it was incorporated in this report.

Seed tubers untreated, selected. Diseased plants per acre	87
Seed tubers treated (formaldehyde solution), selected. Diseased plants per acre	0

The Donaldson Experiment.

Mr. Donaldson planted 270 barrels of seed of which 260 barrels were treated by soaking in formaldehyde solution. The remaining 10 barrels were planted without treatment.

Where the disinfection experiment was tried Irish Cobbler was the variety planted. The seed was grown on the same field in 1910. In writing to the Station under the date of August 15, 1910, Mr. Donaldson stated that on this field he counted on an average about 20 diseased plants per row 60 rods in length. The seed on the main portion of this field in 1911 was soaked in formaldehyde solution for 2 hours and then turned out on a clean platform to dry *before cutting*. The cutting was done by hired help but under the owner's supervision. Each seed cutter was given directions to discard all tubers which were in any way imperfect, and if by chance he cut a tuber which showed any signs of decay or browning in the flesh to discard it and place the knife he was using in a jar of formaldehyde solution which was provided. Extra knives were supplied so that there was always a sterile knife in the disinfecting solution in case the one in use became contaminated. Mr. Donaldson stated that it was practically impossible to hire seed cutters who would constantly observe these precautions and doubtless this may account for the very small amount of blackleg on the main field.

For the chief experiment one barrel of badly bruised and one barrel of selected seed was sorted out. One half of each lot was cut and planted without treatment. The other half of each lot was soaked for 2 hours in formaldehyde solution *after cutting*. The advantage of this latter variation from the usual practice of disinfecting before cutting is that much of the chance contaminations of healthy seed pieces while cutting can be overcome in this way. As will be seen later (p. 224) no detrimental results with regard to germination were secured from this treatment.

The four lots of treated and untreated seed were planted in four rows, each row being equivalent to about one-tenth of an acre. The field was examined on July 6 and 18 with the following result.

Seed tubers bruised, untreated. Diseased plants per acre	70
Seed tubers bruised, treated (formaldehyde solution). Diseased plants per acre	20
Seed tubers selected, untreated. Diseased plants per acre	10
Seed tubers selected, treated (formaldehyde solution). Diseased plants per acre	0

An examination on July 6 of about one-half acre of the immediately adjoining portion of the main field where the seed was soaked *before cutting* showed only 2 affected plants per acre, while an examination of an equal area on a different portion of the same field on July 18 failed to reveal any diseased plants.

It should be remembered that the season before on this same field and where the seed for this year's planting was produced there were according to Mr. Donaldson's estimate nearly 300 diseased plants per acre—a decrease of over 99 per cent. A part of this decrease may, as compared with 1910, be due to unfavorable weather conditions. As has already been pointed out blackleg never does so much damage if the early part of the growing season is dry.

No blackleg was observed on the volunteer plants which came up between the rows and hills from tubers which remained in the soil over winter from the crop of the season before. This taken together with the fact that practically no diseased plants were found over the entire 50 acres where the treated seed was used is additional evidence that the disease did not live over in the soil where it appeared last year but was communicated to the crop of the present year by means of the regular seed tubers.

The Hussey Experiment.

1911 was Mr. Hussey's second year of formaldehyde disinfection for blackleg. In 1909 he observed some of the disease on his field with the Irish Cobbler variety. In 1910 from the crop of the season before he carefully selected sound and perfect tubers sufficient to plant about one-fourth of a 4-acre field. These were then soaked 2 hours in formaldehyde solution one pint to 30 gallons of water. The remainder of the field was planted with seed tubers from the same lot just as they came from the bin without selection or disinfection. They were, he said, such as would generally be classed, so far as appearance goes, as good quality of seed stock.

Mr. Hussey made frequent and careful examinations of this field during the summer and reported that from 5 to 8 percent of the plants where the untreated seed was used were killed by blackleg. Only 2 plants so affected were observed during the entire season on the acre where the selected and treated seed was used.

In 1911 Mr. Hussey experimented with both Irish Cobblers and Green Mountains. The Irish Cobbler field was sod land and consisted of about 5 1-2 acres planted with seed from the treated portion of last year's field. The treated and untreated portions were located in alternate strips across the field, thus making a very fair test with regards variation in soil conditions. This field was given a superficial examination on July 6 and a thorough examination on July 19. No blackleg could be found on the entire field on either visit. Mr. Hussey stated that he had examined the field several times during the season and failed to find any diseased plants, thus showing that selection and disinfection in 1910 entirely eliminated the disease from his crop. Unfortunately there was none of the crop from the untreated portion of the 1910 field planted this year as a check, but past experience makes it absolutely certain that if planted it would have produced quite a percentage of diseased plants this year.

Mr. Hussey's experiment with the Green Mountain variety was upon land where potatoes were grown last year and more or less blackleg was observed. It furnished the most striking example in the series of the effectiveness of disinfection when properly done. The field consisted of about 6 acres. About 2 acres in the middle was planted with untreated tubers. The remainder on either side being disinfected.

On July 6 no accurate record was made but it was noted that the disease was quite frequent on the untreated portion and no affected plants could be found where treated seed tubers were used. On July 19 approximately one-third acre each of adjoining portions of the treated and untreated strips were examined with considerable care with the following result expressed in numbers of diseased plants per acre.

Seed tubers untreated. Diseased plants per acre 163
Seed tubers treated (formaldehyde solution).
Diseased plants per acre 0

Examination of other different portions of the field taken at random at both visits indicated that the above represented very accurately the condition of the field as a whole. *No diseased plants could be found on any part of the field where treated seed was used.* In a letter received from Mr. Hussey Aug. 29, he stated that he had just observed several full grown plants on the portion of the field where the untreated seed was used, which were just beginning to show the disease but he could find none on the treated portions which were attacked.

The Porter Experiment.

Mr. Porter's experiment especially aimed at securing data as to the relative value of careful selection of sound and perfect tubers as compared with disinfection alone of seed potatoes just as they come from the bin. The potatoes used, however, apparently did not carry much disease in the beginning, hence the results are not so marked nor so conclusive as might have been the case had the seed tubers been less healthy. Irish Cobbler was the variety planted and the liquid method of disinfection was used. The plots were examined July 7 and 19.

In one large field adjoining plots, consisting in all of about one and one-third acres were planted with, first untreated tubers as they came from the bin, second selected, sound tubers untreated, and third selected, sound tubers treated by soaking in formaldehyde solution for two hours. The results obtained from the examination of these plots were as follows:

Seed tubers untreated, not selected. Diseased plants per acre 24
Seed tubers untreated, selected. Diseased plants per acre 0
Seed tubers treated (formaldehyde solution), selected.
Diseased plants per acre 0

In another field consisting of about 4 acres were three other experimental plots. The first was planted with untreated seed tubers just as they came from the bin. The second was the same as the first except the seed tubers were soaked in formaldehyde solution. On the third plot were used small, inferior potatoes sorted from the same source of supply as one and two and given the same treatment as regards disinfection as in the case of plot two.

On July 7 only plots one and two were examined. At this time the disease had not made much progress. No diseased plants were found on a half acre of plot 2 but 2 were found on an equal area of plot one. On July 19 a careful record was made of the number of diseased plants on one-fourth acre of each plot. Calculated in numbers of diseased plants per acre this shows:

Seed tubers untreated, not selected. Diseased plants per acre 24
Seed tubers treated (formaldehyde solution), not selected.
Diseased plants per acre 4
Seed tubers treated (formaldehyde solution), small and inferior.
Diseased plants per acre 20

No effort was made to have the plots of the same size in the two different experiments which were located from one-third to one-half of a mile apart. However, when the number of diseased plants found on the two different plots where untreated tubers were used just as they came from the bin were reduced to numbers per acre the results were found to be identical. Mr. Porter stated that the seed in each case came from the same bin.

The Good Experiment.

Mr. Good's field consisted of about 50 acres partly of Green Mountains and partly of Irish Cobblers on sod land on the Donahue farm in Ludlow. The experiment was conducted with the Cobblers. About 50 barrels of this variety were disinfected by soaking in formaldehyde solution and the remainder planted without treatment. The treatment was performed under Mr. Good's supervision as was the seed cutting but on account of the amount of seed used (250 barrels or more) it was impossible to obtain seed cutters who would reject entirely all unsound seed. However, as will be noted below, even under these conditions, over 90 percent of the disease was eliminated by the treatment.

The field was visited on July 6 but on account of not being able to determine the exact boundary between the treated and untreated portions of the field, accurate comparisons between adjoining portions could not be made. However, an examination of a portion of the extreme western part of the field where the treated seed was known to have been used revealed no diseased plants while on the other side of that part of the field planted to Cobblers where untreated seed was planted several diseased plants were seen on an equal area.

On July 19, the limit of the areas upon which treated and untreated seed was used having been accurately determined, approximately one acre of each was critically examined with the following result:

Seed tubers untreated. Diseased plants per acre	53
Seed tubers treated (formaldehyde solution). Diseased plants per acre	5

The Cleveland Company Experiment.

On the Cleveland Company farm disinfection was performed by means of formaldehyde gas and two varieties of potatoes were used. These were the Irish Cobblers and the White Rose, sometimes called the Ensign Bagley.

The field of Irish Cobblers consisted of about 20 acres, the larger portion of the seed for which was treated. This field was visited the first time and quite carefully inspected on July 19. At least some portion of nearly every acre was critically examined, but in no case could hills affected by blackleg be found, either where the treated or untreated seed was used. This indicated that the seed was originally free from the disease and in this case treatment was unnecessary so far as blackleg was concerned.

The White Rose seed was known to be considerably affected with blackleg and it was with this seed that the real test was made. This portion of the field consisted of about 10 acres of which all but about one acre was planted with disinfected seed. After being satisfied that the plots selected were representative of the different parts of the field as a whole with regards amount of blackleg about one-tenth acre each, of plants from treated and untreated seed, was carefully examined. The results obtained were as follows:

Seed tubers untreated. Diseased plants per acre 390
Seed tubers treated (formaldehyde gas).
Diseased plants per acre 150

While there was a considerable number of diseased hills on the treated portion of the field the fact should not be overlooked that over 60 percent of the disease as compared with the plants grown from the untreated seed was eliminated by the treatment. As is stated elsewhere in this paper while the large amount of blackleg on the treated seed, compared with the results obtained in the Parsons, Donaldson and Hussey experiments, may indicate that the gas treatment is less effective than the liquid treatment. It should be noted that in these last mentioned experiments the owners were able to either cut the seed themselves or have it done under their immediate supervision.

The Blake Experiment.

Mr. Blake treated sufficient selected seed to plant about 20 acres of Irish Cobblers. About half of this was soaked in formaldehyde solution and the remainder given the gas treatment in the Edblad disinfecting room. Unfortunately no untreated check plot was planted at the same time with the same lot of seed. Such a plot was planted some 10 days or 2 weeks later and there was also some doubt as to whether the seed was from the same source as that originally planted. Obviously this could not be used as a check on the treated portion. The field was carefully examined first on July 7 and again on July 20 as it represented the only case where the liquid and gas methods of treatment were applied to seed on the same field. No comparisons between these could be made, however, for only two plants showing the disease could be found on the whole 20 acres. This disease was said to have been observed on the crop of the year before from which the seed was obtained, therefore it would seem that its absence the present season must be the result of seed selection, disinfection or both.

The Edblad Experiment.

Mr. Edblad disinfected all of his seed by the formaldehyde gas method except about 1 barrel of the Irish Cobblers which was not treated, and planted the following varieties: Green

Mountain 9 1-2 acres, Irish Cobblers 4 acres, Early Rose, 2 acres, Beauty of Hebron 1 1-2 acres, Twentieth Century 1 acre.

Since the Irish Cobbler was the only variety treated where a check plot was saved this is the only case in this experiment where accurate comparison could be made between treated and untreated seed from the same source. However, since the disease did develop on the other portions of the field with other varieties which had been treated it is of interest to note these facts as bearing upon the effectiveness of the gas method of disinfection. While the results with some of the varieties in this experiment were not equal to the expectations of the writer, Mr. Edblad expressed himself as entirely satisfied with the results from a commercial standpoint and stated that he felt that he had profited sufficiently to more than pay for the expense and trouble involved in treating his seed.

The field was visited on July 7 but on account of not being able to definitely locate the boundaries of the different plots no accurate record was made at that time. On July 20 the field was examined in the company of Mr. Edblad by carefully going over representative plots of each different variety of one-fourth to one-half acre in size. Calculated in number of diseased plants per acre there was:

Seed tubers untreated, Irish Cobbler.	
Diseased plants per acre	96
Seed tubers treated (formaldehyde gas), Irish Cobbler.	
Diseased plants per acre *	0
Seed tubers treated (formaldehyde gas), Green Mountain.	
Diseased plants per acre	0
Seed tubers treated (formaldehyde gas), Early Rose.	
Diseased plants per acre	18
Seed tubers treated (formaldehyde gas), Twentieth Century.	
Diseased plants per acre	40

No record was made as to the amount of blackleg on the one and one-half acres of Beauty of Hebron. Mr. Edblad

* The record was taken for the treated and untreated Irish Cobblers on adjoining plots July 20. At the time of the early visit (July 7) a few diseased hills were seen on another part of the field where treated Irish Cobblers had been used, so the effectiveness of the treatment in this case was doubtless not quite so great as the figures would indicate.

stated that the seed tubers of this variety were in very poor condition when he received them, and he only planted them in order to get a start with this variety. He exposed them to formaldehyde gas for the same length of time as his other

Tabular Summary.

Experiment.	Variety.	Condition of Seed.	Treatment.	No. diseased plants per A.
Parsons	Green Mountain	Selected	None	87
	" "	"	Formaldehyde solution	0
Donaldson	Irish Cobbler	Bruised	None	70
	" "	"	Formaldehyde solution	20
	" "	Selected	None	10
	" "	"	Formaldehyde solution	0
Hussey	Irish Cobbler	Selected	None	0*
	" "	"	Formaldehyde solution	0*
	Green Mountain	Not selected	None	163
	" "	" "	Formaldehyde solution	0
Porter	Irish Cobbler	Not selected	None	24
	" "	" "	Formaldehyde solution	4
	" "	Selected	None	0
	" "	"	Formaldehyde solution	0
	" "	Small, inferior	Formaldehyde solution	20
Good	Irish Cobbler	Not selected	None	53
	" "	" "	Formaldehyde solution	5
Cleveland Co.	Irish Cobbler	Not selected	None	0*
	" "	" "	Formaldehyde gas	0*
	White Rose	" "	None	390
	" "	" "	Formaldehyde gas	150
Blake	Irish Cobbler	Selected	Formaldehyde solution	0**
	" "	"	Formaldehyde gas	0**
Edblad	Irish Cobbler	Not selected	None	96
	" "	" "	Formaldehyde gas	0***
	Green Mountain	" "	" "	0**
	Early Rose	" "	" "	18**
	20th Century	" "	" "	40**

* Seed used was apparently not diseased in the beginning. In the Hussey experiment it had been eliminated through treatment the year before.

** No satisfactory check plot of the variety available for comparison.

*** See note on page 217.

varieties to obtain what beneficial effects that he could from the treatment. He did not, however, select out and plant only the perfect tubers and did not save a check plot planted with untreated seed.

When examined on July 7 and 20 there was a large amount of blackleg on this field, fully 20 per cent of the hills either failed to grow or the plants had been destroyed by the disease.

Discussion of Results.

Effectiveness of the treatment: Taken as a whole the results of the coöperative experiments are sufficiently clear-cut and conclusive to indicate that the preventative measures outlined are exceedingly efficient. In fact the uniformity of the results is surprising when it is remembered that so many individuals, including the men employed to cut the seed, were responsible for them. It will be noted that in every case where both selected and treated seed was used the disease was absolutely eliminated and in every case where either selection or disinfection was practiced alone and proper check plots planted for comparison the amount of blackleg was materially reduced, except where the small, inferior seed was used in the Porter experiment. However, it should be remembered that the check plot here is the seed just as it came from the bin, and that the small seed in question represents practically the poorest grade that could be sorted from it. Had Mr. Porter planted an untreated check plot of this small, inferior seed also it doubtless would have carried considerably more disease than the treated plot. The case would have been similar to the one where Mr. Donaldson compared plots planted with treated and untreated seed which was bruised and otherwise imperfect.

While not a part of the experiments here recorded certain observations made on the John Watson farm in Houlton during the past five years have a bearing on this subject. In 1907 in connection with certain experiments then being carried on a special disinfecting room was constructed on this farm in which to treat seed potatoes for scab.* Every year since that time all the seed used on this farm has been disinfected with formaldehyde gas, primarily as a protection against scab. Both Green Mountains and Irish Cobblers have been planted, the latter entirely during the last 2 years. A part of the time the seed tubers used were picked up from various sources without knowledge of the conditions under which they were grown.

* Bul. Me. Exp. Sta. 149: 304-314 (1907).

During this period blackleg has been observed but once and then only three or four plants were seen on a 20-acre field—a record, so far as observed, not equalled by any other field in the immediate neighborhood where untreated seed tubers were used.

Selection versus Disinfection: An analysis of the data furnished by these experiments does not lead one to any very definite conclusion as to the relative value of selection of sound, perfect seed potatoes for planting as compared with disinfection with formaldehyde alone. As has been pointed out above both apparently are necessary. In the Porter experiment, where the seed carried only a small amount of disease in the beginning, disinfection alone failed to eliminate all of it while selection did. On the other hand in the Hussey experiment with Green Mountains where the seed carried considerable disease it was absolutely eliminated by treating with formaldehyde solution alone. However, the writer believes that careful selection of seed tubers and rejecting for planting all that are in any way cracked, bruised, discolored or decayed is absolutely essential and no amount of disinfection with present known methods can be relied upon to entirely take the place of it. On the other hand the formaldehyde treatment appears to be equally essential and must be practiced to supplement selection of seed.

Gas versus formaldehyde solution: In no case except the Blake experiment were adjoining plots planted to compare the relative effectiveness of formaldehyde gas and solution. Here practically no disease developed on either piece and the check did not admit of accurate comparison. The writer was present when Mr. Blake's crew were treating and cutting seed and knows that it was quite carefully selected. Doubtless much of the freedom from disease in this instance was the result of seed selection. In the Cleveland Company and Edblad experiments, the only ones in which gas alone was used, the results are not so uniformly effective as in the case of the experiments where the seed tubers were soaked in formaldehyde solution. In each case where the best results were obtained with formaldehyde solution the owner of the potatoes was able to either cut the seed himself or be present and personally superintend the work at all times. This was not the case where the gas alone was used and the average man employed to cut seed cannot be depended upon to throw away all tubers which show diseased areas in the interior to which the disinfecting agent could not possibly penetrate.

That formaldehyde gas generated by means of potassium permanganate is exceedingly efficient in killing the germs of many contagious diseases of man, which are much more resistant than the bacteria associated with the blackleg disease of potatoes, is well known. Moreover it has been shown that for a surface disinfectant of potatoes for scab formaldehyde gas generated in this way and by simple evaporation of the concentrated liquid by heat gives as good results as the ordinary method of soaking the seed tubers in dilute formaldehyde solution.* The method recommends itself for practical work on account of its *apparent* simplicity and the ease and rapidity by which disinfection can be accomplished by its use. However, its use in the hands of practical farmers develops certain fundamental difficulties which are not present when the liquid method of treatment is used. There is very little opportunity or excuse for one to fail to follow directions in the case of the latter. It was found in these experiments and in others where the formaldehyde-permanganate method of gaseous disinfection has been used for potato scab that it was almost impossible to get the men in charge of the work to comply with *all* of the requirements necessary. Frequently the rooms used for the purpose are too cold and no provision is made for a moist atmosphere. There is also a tendency to pile the tubers too deep in the crates and to place the crates too close together and too close to the wall to allow for complete circulation and penetration of the gas to all parts of the surface of each and every potato. Where the tubers are immersed in the dilute formaldehyde solution for 2 hours there is a certainty that the entire surface of each potato comes in contact with some of the disinfecting agents.

Blackleg Not Carried Over in the Soil in Maine.

Field observations extending over 5 consecutive years have failed to reveal a single case where there was any evidence to

---

*Jones, L. R. and Morse, W. J., Repts. Vt. Exp. Sta. 16: 165-168 (1903), 17: 397-402 (1904), 18: 287-291 (1905). Morse, W. J., Potato Diseases in 1907, Bul. Me. Exp. Sta. 149: 304-316 (1907).

show that the disease had been carried over in the soil and the growing crop infected by that means. On the other hand the appearance of the disease on fields not planted with potatoes for years or never before planted with any agricultural crop, and on farms for the first time following the use of seed from a different source all indicate the seed tubers as the source of infection. Moreover, as has already been mentioned, the disease does not occur in patches but in scattered hills all over a given field, and always begins at the base of the stalk where it joins with the seed piece, which latter is invariably destroyed by a soft rot.

Two of the experimental fields used this season gave very positive evidence in support of this view. Mr. Donaldson's Irish Cobbler field and Mr. Hussey's Green Mountain field were both planted the second time in succession. In both cases the disease appeared on the field in considerable amounts in 1910 and a part of the crop there produced was used for seed purposes in 1911. Where the seed was treated it was practically eliminated on Mr. Donaldson's entire field of 50 acres. On Mr. Hussey's field no diseased plants could be found where the treated seed was used and 163 per acre appeared where the seed was planted without disinfection. On such fields there are always quite a percentage of "volunteer" plants which spring from tubers which were either not brought to the surface or were covered up by the digger and remained in the soil all winter. These are frequently easily recognized on account of their springing up irregularly on the sides of the rows or between the hills. On the two fields mentioned not a plant of this kind was observed to be attacked with the disease.

Infection of Healthy Seed-pieces at or Following Cutting.

The bacteria causing this disease multiply fairly rapidly in the presence of a sufficient food and moisture supply at temperatures of from 65° to 75° F. and with great rapidity at from 76° to 85° F. At the temperatures usually maintained in the potato houses for winter storage—often but a few degrees above freezing—they multiply very slowly but are capable of remaining alive under these conditions for considerable periods of time, provided they are not allowed to dry out. Doubtless the reason why infected tubers are not entirely destroyed by the disease before planting time or at least before the young plants which spring from such tubers can reach the surface of the soil is that, while sufficient moisture is present to keep the organisms alive, the temperature conditions are not right for their rapid multiplication till the soil in which the tubers are planted becomes thoroughly warmed up.

There is every reason to believe that in cutting seed the disease may be spread from diseased to healthy seed pieces by contact of their freshly cut, moist surfaces and less frequently from the hands of the operator or through the medium of knives used. It is a common practice to cut seed tubers and place them in barrels some weeks, or even months, before they are needed for planting. Although plaster or lime is usually sprinkled over such seed, which forms a more or less dry, protective coating over the cut surfaces, the conditions for the rapid multiplication and spread of bacteria are often very favorable. Seed cut in this way is very likely to "heat," especially if a few days of warm weather are experienced before planting, unless they are daily turned out of the barrels and exposed for a time to the air.

On one of the farms visited there was accidentally provided an excellent opportunity to observe how the blackleg disease may spread from diseased to healthy seed tubers after cutting and while being planted. The variety in this case being Carmen No. 1, planted without disinfection. During the planting the man in charge of the work was taken suddenly ill. After 2 or 3 days a substitute was obtained. but in the meantime several barrels of cut seed were allowed to remain in the field, covered with canvas. This provided right conditions of warmth and moisture in the barrels for rapid multiplication of any bacteria which might be present, and signs of "heating" and decay were evident when the barrels were opened again. Before the foreman of the farm was aware of it the new man in charge of the planting had planted 4 to 6 barrels of this seed. He at once ordered it stopped and substituted freshly cut tubers from the same bin from which the first lot was obtained.

The field was examined by the writer on July 19. Where the freshly cut tubers were used there was hardly a plant missing from the whole field and only about 15 or 20 plants per acre showed blackleg. On the adjoining portion where the tubers were used which remained out in the barrels after being cut about 20 per cent of the hills had either failed to germinate or were attacked by blackleg. Somewhat less than one-third of an acre was examined and the diseased plants counted, giving 325 per acre where the "heated" seed was used.

It was evident that the seed tubers in this instance were quite free from disease. To the casual observer there appeared to be an absolutely perfect stand over the entire field except where the seed had been injured by standing in the barrels. The small amount of blackleg that the potatoes originally carried was largely increased as the result of the germs of the disease multiplying in and on the infected pieces and then being communicated to the healthy seed pieces in handling and planting.

No doubt quite a proportion of the failures to germinate were due to the same cause. However, other bacteria and fungi are, as a rule, associated with germination failures and seed potato decay after planting. It is well known that poor stands will result where cut seed tubers are allowed to stand in barrels or in piles for any length of time without proper attention, even where blackleg is entirely absent.

Treating Seed Potatoes with Formaldehyde Solution After Cutting

It is the universal practice to recommend that potatoes be soaked in formaldehyde solution *before* cutting when treating for scab. The writer has followed this procedure in advising treatment for blackleg. It is obvious that soaking *after* the seed is cut possesses decided advantages, provided the seed pieces are not injured thereby. If the latter process is followed more thorough disinfection would result and much, if not all, of the danger of chance contamination of healthy seed pieces would be avoided. Realizing the advantages of this method Mr. Donaldson tried it experimentally with very successful results. Not only were the germinating qualities of the tubers not injured but a more even stand was secured and, as will be seen in the next section, they were stronger and more vigorous during the early part of the season.

It is not safe to make general recommendations on the strength of this single trial alone but those who are treating their seed with formaldehyde solution are advised to try it in a small way experimentally. If successful it could be done just before planting, the seed being soaked and dried in the sun as fast as needed for planting. It would not be practical to attempt to disinfect cut seed by the gas process.

Vigor of Plants as Affected by Formaldehyde Disinfection.

The writer has used formaldehyde experimentally as a disinfectant for seed potatoes nearly every year for the past ten years and before the present season has never observed any marked difference in the germinating qualities or rapidity of growth of plants from treated and untreated seed. If short sprouts have started at the time of treatment these are partly or wholly killed back, hence on theoretical considerations one would assume that the untreated tubers would have a slight advantage.

In the Parsons, Porter and Donaldson experiments the plants from the treated seed tubers germinated first and were plainly stronger and more vigorous during the early part of the season. This was especially marked on the Donaldson farm. Here both the poor and the good seed which was treated gave more vigorous plants than the portion of the same lot of tubers which was not treated. This was so marked that it could be detected some distance from the field even up to the middle of July. There was nothing to indicate that the formaldehyde produced a stimulating effect similar to etherization, but rather that the result was due to freeing the seed pieces from bacteria and fungi which might attack them and set up an early decay. In opposition to this hypothesis it is hard to see how these would be likely to carry, aside from the germs of the blackleg disease, any bacteria or spores of fungi which would not exist in abundance in the soil in which they were planted. However, when the weaker plants from the untreated seed were dug up in July the seed pieces were usually decayed while those from the more vigorous plants where the treated tubers were used were quite free from decay at this time.

Method of Eliminating Blackleg from Seed Potatoes.

From the foregoing discussion it is evident that if seed potatoes are carefully selected so that only those which are absolutely sound and perfect are used for seed purposes and these treated with formaldehyde that the disease can be eliminated in from one to two year's time.

For home use it is strongly recommended that only formaldehyde solution be employed. This consists of one pint of 40 per cent. formaldehyde in 30 gallons of water in which the potatoes should be soaked 2 hours and then spread out on a clean place to dry, preferably in the sun. Exposure to sunlight will also assist in destroying the bacteria causing the disease and tend to hasten germination.

It is only advised that the formaldehyde gas method be used by the large seed dealers who must pick up a considerable amount of their stock under conditions which preclude a knowledge of the amount of disease which appeared on the fields where the stock was grown. In such cases a special disinfecting room should be provided and fitted up with provisions made for the proper regulation of the temperature and moisture conditions during treatment. This work should be placed in the hands of a competent man who thoroughly understands each step and detail of the process. All seed tubers which are not known to be free from the germs of blackleg and potato scab should be disinfected in this way before being shipped.*

There seems to be a general misapprehension among potato growers as to the cost and amount of labor involved in the liquid method of treatment. Mr. Donaldson, following suggestions furnished him by the writer, worked out a satisfactory method adapted to his conditions whereby he was enabled to treat 260 barrels of seed potatoes for a total cost of about $10.00 for labor and formaldehyde, a little less than 4c. per barrel or about 20c. for each acre planted. The following is Mr. Donaldson's account of how this was done:

---

* For a detailed description of the method of disinfecting seed pototoes with formaldehyde gas generated by means of potassium permanganate the reader is referred to page 324 of Bulletin 174, or to page 9 of Miscellaneous Publication No. 375 of this Station.

"First I bought 20 molasses barrels at 50c. each—got molasses and sugar enough out of them at 30c. a gallon to pay for them. I soaked them out clean and mixed the solution using one pint of formaldehyde to 30 gallons of water.

"For a platform to set the barrels on while soaking the potatoes I used my bobsleds with a long body and raised them off the ground by putting pieces of board or plank under the runners as the case might be to make them set level and keep them off the ground. I then bored a one inch hole in the side of each barrel, near the bottom, and put in a cedar plug. Ten of the barrels were then placed on the elevated sled body with the plugs to the outside and filled with potatoes. Ten molasses casks held about 16 standard barrels of potatoes. The solution was then put into these 10 barrels enough to cover the potatoes and let stand for 2 hours. It was then drawn off from the holes in the bottom into pails and turned into the other 10 barrels which had already been filled with potatoes and were set up on the sled platform the same as the first 10. Of course, there was a little waste each time and enough new solution was added each time to cover all of the potatoes. As soon as the solution was drawn off from the first 10 barrels the potatoes were turned down on another platform to dry. This platform was 15 x 20 feet and for a floor had inch boards nailed to plank stringers which had good bearings underneath. Around the platform were nailed pieces of 2 x 4 on edge to keep the potatoes from rolling off.

"I used 3 gallons of formaldehyde which cost me $6.00 to soak 260 barrels of potatoes.* My potatoes were clean, having been put over a rack once in the winter and once before cutting. I always do this because they can be made almost perfect in this way if they are good potatoes at the start. If the potatoes are clean the solution can be used over and over again without becoming dirty. * * * * * The cost of the labor the way I handled it would not be over one-half hour for two men, or 20c. for each batch of about 16 barrels. I had the lumber and have it now, so the cost of that was nothing. I was about

* The cost of the formaldehyde varied in the different experiments from 25c. to 75c. per pint or pound. The latter price is much too high. Formaldehyde can be sold at retail for 25c. a pint at a fair profit.

one-half day getting ready, making an additional expense of about one dollar."

By proceeding in a manner similar to that just described seed potatoes can be disinfected with formaldehyde solution quite rapidly and with comparatively little expense. Any sound cask such as a molasses, kerosene, or alcohol barrel can be used and with good care these should last for many years. The number of barrels needed will be from 2 up, varying with the number of barrels of potatoes to be treated and the rapidity with which the seed is needed for planting. The use of two lots of barrels is essential to rapid work. By this means the solution is made to work all of the time—one-half of the barrels can be emptied and filled again with a fresh lot of potatoes while the solution is acting on the other lot. Placing the barrels on a low platform enables the operator to quickly and easily draw off the solution without waste into pails from which it is turned into the other barrels which contain another lot of potatoes to be treated. Generally this platform consists of a single wide plank, elevated a little higher than the top of a common pail, and the barrels are placed in a row upon it.

Adjoining the narrow platform on which the barrels stand should be another which is large and broad, and upon which the disinfected tubers are poured out to dry. This larger platform is not absolutely necessary. A piece of canvas spread on the ground will serve the same purpose or the potatoes may be dried on clean, dry grass land.

BULLETIN No. 195.

INSECT NOTES FOR 1911.*

O. A. JOHANNSEN,
EDITH M. PATCH.

The miscellaneous notes here presented are for the most part abstracts from our Station records for the current year. Though some of the items are trivial they contain data by way of direct observation, locality or host plant record which give them a certain significance for our own State. Many of the notes are rendered more complete by the summer collections and insectary work of Mr. William C. Woods to whom as well as to various voluntary collectors throughout the State, a general acknowledgment is due.

COLEOPTERA.

ELATERIDAE.

Wire worms in corn.

In the spring of 1911 a two acre plot was planted with sweet corn at Highmoor Farm, Monmouth, Maine. Owing to the great number of wire worms present, many of the seeds were so badly eaten that they failed to germinate and many of the plants showed such feeble growth that only a partial stand on the lower and none upon the upper portion of the plot was obtained. This circumstance gave us an excellent

* Papers from the Maine Agricultural Experiment Station: Entomology No. 48.

opportunity to experiment under Maine conditions with various methods which have been recommended for the extermination of wire worms in the past as well as to try out newer methods.

It may be stated that the plot had been in potatoes last year and in sod for a number of years previously. Last fall (1910), the field was plowed late, after the ground was stiffened by frost.

The upper part of the field was divided into 20 plots, each 9 feet wide by about 200 feet long, the lower part into plots 6 feet wide by 100 feet long.

On the 25th of July, the few stunted plants still remaining on the upper part of the field were hoed down and the plots without previous plowing were planted as follows, alternate plots being left fallow.

Plot 1. Grains coated with tar and Paris green.
Plot 3. Grains coated with arsenate of lead.
Plot 5. Check row, grains not treated.
Plot 7. Canada field peas.
Plot 9. Plowed July 27 and weekly thereafter for 6 weeks.
Plot 11. Check row, grains not treated.
Plot 13. Handful of tobacco dust placed in each hill; grains not otherwise treated.

Plot 15. Handful of slaked lime placed in each hill; grains not otherwise treated.

Plot 17. Check row, grains not treated.

Plot 19. Handful of "bug death" placed in each hill; grains not otherwise treated.

The remaining plots on the lower part of the field were planted in the same way and in the same order, as a check, and in addition 3 shorter plots were added in which Sherwin-Williams Soil Fungicide was used in the hills.

Germination tests upon the seeds show them to be of good quality.

Record of results.

Plot 1. Grains coated with gas tar, then rolled in Paris green until well covered. Grains failed to germinate as they were too heavily coated. Wire worms were still present in September.

Laboratory check test. Several wire worms were placed in a small covered jar with several similarly coated grains on Oct. 26. The larvae avoided the grains. A month later Paris green-coated grains were put into the same jar; these were likewise avoided. Later still sprouting grains were taken, covered with Paris green but leaving the root and sprout unpoisoned. The larvae in this case attacked sprout and root but left the grain untouched.

Plot 3. Grains were rolled in a paste of arsenate of lead of the consistency of cream and allowed to dry before planting. Resulting stand of corn very poor, no better than the check rows.

Laboratory check. Several wire worms were placed in a small jar with some grains with which special pains were taken to coat them heavily with arsenate of lead. Several days later, some larvae were seen, each half buried within the grain, the hull intact except for a small hole the diameter of the insect's body. A month later only the hulls of the grains remained. All the wire worms were still alive and apparently healthy.

Plots 5, 11, and 17. Check plots in which untreated corn was planted. Stand very poor in September; wire worms present.

Plot 7. Planted with Canada field peas. Stand excellent in September. Only a few wire worms found and these at the lower end on the margin of the plot.

Plot 9. Plowed weekly from July 27 to about Sept. 1. To be planted next year to determine effect of excessive cultivation of the soil upon wire worms.

Plot 13. A handful of tobacco dust was placed in each hill with the corn. Stand very poor in September. The tobacco when put into the ground was very strong but when the plants were examined for wire worms it was found to be almost odorless, at which time the wire worms were apparently attracted by the tobacco as they were especially abundant in it.

Plot 15. A handful of slaked lime was placed in each hill with the corn. Stand very poor in September. Wire worms were found among the roots of the plant surrounded by the more or less caked lime, apparently not inconvenienced thereby.

Plot 19. "Bug death" instead of lime; otherwise as in Plot 15. Stand very poor in September; wire worms present.

Plot X. Sherwin-Williams Soil Fungicide used instead of lime; otherwise as in Plot 15. Stand very poor in September; wire worms present.

Corresponding results were obtained on the second series of plots.

An additional laboratory experiment was made to determine the effect of calcium carbide upon wireworms present in the soil.

(a) Several wire worms were placed in a shallow uncovered dish, 75 mm. in diameter, with a piece of calcium carbide weighing about 6 grams and covered with earth. The small amount of moisture present was sufficient to disintegrate the carbide and fumes were no longer given off at the end of 24 hours. The wire worms were active and unaffected by the treatment.

(b) One wire worm was exposed to the fumes of 2 grams of the carbide in a 25 cc vial tightly corked. After 3 hours the larva was motionless, but fully recovered after a few hours when placed in a clean vial.

From the foregoing account it will be seen that the poisons and repellants used, usually so successful in combating insects under other conditions, were not efficient against wire worms in our tests. The successful growth of the peas leads one to believe that a rotation involving peas, or possibly peas and oats, a common fodder crop in this state, or clover, may be effectively employed though whether wire worms are thereby actually reduced in number in the field so they may be less injurious upon susceptible crops planted later, future experiments alone will decide.

Experiments along these lines are planned for next year, following in part, some suggestions made in the papers on wire worms published by the Cornell and the Illinois Experiment Stations.

It may be of interest to note that the adult beetles *Melanotus fissilis, Asphes brevicollis,* and *Corybites cylindriformis* have been captured at Highmoor Farm. The larvae found, also represent 3 species, an *Asphes* (or *Corybites*), a *Melanotus* and one resembling *Agriotes mancus* as figured in Forbes' 7th Report. Adults from these have not yet been reared.

The same species of larval Elaters were found in adjacent potato fields causing some injury to the crop (Fig. 93).

Melanotus fissilis.

That Elaters have been active in diverse ways this season is further indicated by a complaint which accompanied some adult beetles of this species from Auburn, August 12. They were accused by the sender of eating his plums about as fast as they ripened. Lot 1383.

Nitidulidae.

Carpophilus sp.

On the 17th of July a number of cones from red spruce (*Picea rubra*) were brought into the laboratory for examination by Professor M. A. Chrysler of the University of Maine. The cones were all seriously affected by a rust and also honeycombed by insects. A subsequent examination showed that most of the cones on several trees on Standpipe Hill, Orono, Me., were thus injured. Besides the larvae of 2 species of Tineids (not yet reared), a species of Sap beetle (*Carpophilus sp.*) apparently undescribed, was found. This insect resembles *C. marginatus* in color and size but differs in the form of the lateral margins of the thorax, which are more curved than in *C. marginatus*. In addition to these, 2 hymenopterous parasites, a Chalcid and a Braconid noted elsewhere were obtained. Lot 1386.

Ptinidae.

Ptinus fur.

This old world pest was found over-running a store at Ellsworth Falls Oct. 16, 1911, where the owner reported it as infesting grain and flour in storage, and troublesome in sugar, meal, crackers, clothing, papers, etc. A similar infestation was reported from Ellsworth Falls, Oct. 27, 1906. Lots 1436 and 1436 Sub. 1.

Chrysomelidae.

Haltica carinata as an Elm Leaf Pest.

In 1907 and again in 1911 the elms near Orono were attacked so extensively by a leaf beetle that an account of the insect and its work in this locality seems desirable.

The adult beetles are found feeding upon the elm leaves in June, and the field notes for 1907 record them as mating on June 14. On June 26 of the same year, one of the writers observed their yellow eggs in rows along the midrib and other veins of the elm leaves. The adult beetles feed upon the elm leaves at this time and Fig. 94 shows the character of their injury.

But, as would be expected, the chief damage is done by the larvae which skeletonize the leaves as shown in Fig. 95. So abundant was this insect in 1911 about Orono that the foliage of some elms was very seriously damaged in this way, the injury presenting identically the appearance of that caused by the imported elm-leaf beetle. The larvae of this *Haltica* become full fed late in July and descend to the ground for pupation which takes place for the most part before August. This season larvae were bred in the insectary where the adult beetles began to emerge August 15. A field excursion resulted in the capture of adult beetles in the infested region August 23.

The beetles collected at Orono in 1907 and 1911 are burnished copper with dark blue reflections or dark metallic blue with bright coppery red reflections. They measure from a little less to a little more than 4 mm. The collection of 1907 was determined by Mr. E. A. Schwarz as *Haltica carinata* Germ. We have as yet no Maine record of their appearance in anything but *Ulmus americana*. Lots 29, 1393, 1403.

The larvae resemble those of *Galerucella luteola* in appearance but differ in being a little smaller and paler, and in having smaller tubercles, each of which is provided with but 2 or at most 3 small setae instead of from 4 to 6 on each tubercle as is possessed by the imported elm-leaf beetle larva. The larva of *H. carinata* somewhat resembles that of *H. ignita* figured by Chittenden in Bul. 23, N. ser. U. S. Div. Ent.

Galerucella luteola.

The imported elm leaf beetle was present in Fryeburg, Me., this season and adults were captured in October in houses where they had entered for hibernation as is their custom. Lot 1418.

CURCULIONIDAE.

Cryptorhynchus lapathi.

The poplar weevil, an imported insect, the larva of which bores in poplar and willow and which is in some localities a serious pest, is widely distributed through Maine as is indicated by specimens of the adults collected this season at Orono, Augusta and Presque Isle, late in July and in August. The specimens from Presque Isle were reported from Carolina poplar.

SCOLYTIDAE.

Xyleborus dispar.

Specimens of shot-borers were received June 19 from West Stoningham with the report that they had caused the death of a young Bismarck apple tree. Lot 1359.

ORTHOPTERA.

Crickets and Roman Wormwood.

Late in September the contented chirp of our common Gryllus along the roadside drew our attention to great numbers of these fat bodied crickets perched among the branches of the Roman wormwood, *Ambrosia artemisiifolia,* where they were gorging themselves with the fruit of this pestiferous ragweed. Both males and females were so intent upon their meal that they could be collected by hand with no precautions as to alarming them. A number of the crickets were watched in the laboratory for a week or so where they continued their feast with an evident enjoyment.

HOMOPTERA.

PSYLLIDAE, APHIDAE AND COCCIDAE.

Aphalara polygoni Mally (Förster?)

A large collection of the species well figured by Mally 1894 (1895) as *polygoni* was made October 18 at Orono from *Polygonum* near the bank of the Stillwater River. Both winged insects and pupae were abundant at date of collection chiefly along stem at leaf axil and in dried and crumpled leaves. Lot 1341 Sub. 7.

Aphis pomi.

At Highmoor Farm, June 28, colonies of the green apple aphis were abundant on leaves near the fruit and also present in great numbers feeding on the green fruit itself. On September 9 the apterous form and pupae of this species were found colonizing on late tender growth of twig and on ventral side of leaves of *Spiraea Van Houttii* at Orono. Aphid Nos. 17-11 and 75-11.

Maerosiphum crataegi Monell.

This pretty yellow species with bright green abdominal spots was common near Orono this season, collections having been made from *Crataegus* at frequent intervals from July 15 to August 10. Aphid Nos. 30-11, 50-11, 58-11.

Schizoneura lanigera.

The woolly aphid of the apple was present this season late in August at Orono, Maine, in conspicuous colonies on Crataegus and mountain ash (*Pyrus sitchensis*) and two other cultivated species of mountain ash. Aphid Nos. 63-11, 64-11.

Pemphigus rhois.

The large and beautiful galls of this sumach aphid were sent in from Machias, Maine, Sept. 5.

Pemphigus venafuscus.

Fall migrants of this large aphid were on the wing in Orono during the entire month of October. They were seeking ash trees (*Fraxinus*), lilac, and mock orange (*Philadelphus coronarius*). On account of the flocculent wax attached to their bodies they resembled drifting snowflakes.

Pemphigus tessellata (acerifolii).

In order to ascertain whether the advent of the maple migrant is an annual necessity for the development of the species on the alder, a vigorous colony of hibernating nymphs was enclosed in a screen house in the spring of 1909; and protected for 2 years against migrants from the maple. The colony existed for these 2 years in a healthy condition. It is of interest to note that both falls in the third generation, winged migrants left the alder and not being able to reach the maple, died on the inside of the screen in great numbers. A more detailed account of this work will be found in the second part of this bulletin.

Aspidiotus perniciosus (San Jose Scale).

The occurrence of this orchard pest in Maine was recorded in Bul. 177 p. 28. This spring (1911) some infested twigs were sent in from an orchard near West Baldwin, Maine, about 12 miles from the locality where the species was first discovered. Lot 1354.

Eulecanium cerasifex.

E. canadense, E. caryarum, E. corylifex, E. cynosbati, E. fraxini, E. guiguardi, E. juglandis, E. maclurarum, E. websteri, E. fitchii, and E. pruinosum are all given as synonyms on page 70 of the 41st report of the Entomological Society of Ontario, 1910.

The species is apparently on the increase, more specimens having been sent in for identification than in previous years. We have records of its occurrence this year from elm, honey locust, ash, plum, and maple, from various localities in the State. Lot 1362.

DIPTERA.

CULICIDAE.

Culex pipiens, Aedes trichurus, A. atropalpus.

In the vicinity of Orono, the most common mosquito during May and early June was *Aedes trichurus* (*cinereoborealis*) the larvae of which were extremely abundant in the swamps on the margins of the woods. During the summer the vicious *Aedes atropalpus, A. subcantans* or a related species, and the house mosquito *Culex pipiens* appeared in annoying numbers, the last being still prevalent in October.

MUSCOIDEA.

Hypoderma lineata (Ox bot-fly).

Bot-flies were abundant this spring at Orono, cows in pastures adjacent to woods were said to be particularly affected.

Cuterebra sp. from a mouse.

A larva belonging to this genus was sent July 31 by a correspondent from Brooklyn, Me., with the remark that 2 specimens were taken; stating further "——— they had eaten a hole from under the left foreleg to the mouth of the mouse." The writer did not say whether the mouse was the common *Mus musculus* or a native species.

Phorbia fusciceps.

The bean maggot was again reported from various parts of the state doing much damage to young plants. Some growers reported the loss of half the plants. Injury to seed potatoes was also recorded.

Pegomyia vicina.

Many leaves of the beets growing on the University farm at Orono were found with the beet leaf miners. Some parasites belonging to an undescribed species of *Opius* were bred from this species. Lot 1392.

Rhagoletis pomonella.

As in the past the apple maggot continues to be by far the most serious dipterous pest in Maine. No better remedy than that of the destruction of windfalls either by pasturage or by gathering, advised by Professor Harvey years ago, can at present be recommended. The announcement made 2 years ago by Mally of South Africa that certain fruit flies related to our *Rhagoletis* were controlled by poisoned sweetened bait has led several entomologists in this country to experiment along this line. The Cornell (N. Y.) and the N. H. Stations in preliminary notices give hopeful accounts of their experiments. Our own experiments made this season upon two Talman sweet apple trees, using a spray of arsenate of lead and brown sugar in solution gave discouraging results. If circumstances permit these experiments will be repeated upon a larger scale next season, with a modification of the spray formula.

LEPIDOPTERA.

Items of at least local interest are recorded of several species of butterflies and moths some of which were particularly significant in 1911.

Anosia plexippus.

Great migrating swarms of monarch butterflies were reported to be passing through the southern end of Orr's Island late in August and to be still flying in great numbers Sept. 15.

Autographa brassicae.

The cabbage looper was collected from lettuce in Orono and moths of the bred specimens emerged August 29. Lot 1401. For a record of parasites of this species see *Amblyteles montanus*.

Bucculatrix canadensisella.

The birch leaf bucculatrix was as conspicuously abundant during the season of 1911 as during the preceding two summers when widespread devastations of foliage in late summer occurred as recorded in Bulletins 177 and 187 of this Station.

Bucculatrix pomifoliella.

At Winthrop, Maine, August 21, the apple leaf bucculatrix was found to be a very troublesome orchard pest. Lot 1384.

Cacoecia rosaceana.

The oblique banded leaf-rollers were reported as numerous in apple orchards June 13, at Newburg. Lot 1364.

Clisiocampa americana and *C. distria.*

Both the orchard tent caterpillar and the forest tent caterpillar were abundant in June about Orono and elsewhere.

Coleophora fletcherella.

The cigar case-bearer was numerous in Maine apple orchards in certain localities in June. Lot 1427.

Coleophora laricella.

As usual for Maine the larch case bearer was generally abundant on *Larix laricinia* in June. Lot 1360.

Datana ministra.

A colony of yellow necked apple caterpillars were found feeding on *Amelanchier canadensis* August 23 at Orono. Lot 1387.

Ephestia cautella.

Specimens of this moth were bred from dried figs in February. Lot 1352.

Euproctis chrysorrhea.

A remarkable circumstance in the development of the browntail moth in Maine this season should be recorded. Since the moth first entered Maine the caterpillars have not been recorded as feeding to a very troublesome extent in the fall and they have apparently been uniform in hibernating early in the third instar when about 1-4 inch in length. This fall, however, in many localities, they entered the fourth instar and were feeding freely enough upon the trees to be troublesome at apple picking and to destroy the foliage to a considerable extent. This circumstance is doubtless to be accounted for by unusual weather conditions. Whether the winter mortality will be higher for these caterpillars hibernating in a more advanced stage remains to be seen. While this fall growth of the caterpillars was common enough to call for wide spread comment, it was not universal, for colonies were also found to be wintering at the ordinary size.

For an encouraging record of parasites hibernating in the winter nests of the browntail moth, the reader is referred to the discussions of *Monodontomerus aereus* under the Hymenoptera.

Euvanessa antiopa.

The spring caterpillars of the mourning cloak butterfly were more abundant this spring than for several seasons.

Falcaria bilineata.

In July and August caterpillars of this species were collected from *Betula populifoliae* and bred. The moths for the most part emerged during August. Lots 1391 and 1391 Sub. 1.

Galleria mellonella.

Bee-moths were received from Presque Isle, Aug. 3. Lot 1380 Sub. 1.

Hyphantria cunea.

In contrast with the past three years the fall web-worm was conspicuous by its scarcity during the summer of 1911.

Oedemasia concinna.

The red-humped caterpillar usually abundant in Maine and commonly parasitized by *Limneria guignardi* had the additional interest this season of being attended by hyperparasites which apparently have not previously been recorded in this connection.

Phobetron pithecium.

A full fed caterpillar of the hag moth was collected August 22 from apple. Lot 1389.

Pholus pandorus.

The woodbine sphinx is apparently not common in Maine. A fully grown caterpillar was collected from *Ampelopsis quinqui foliae* in South Union, September 30. Lot 1421.

Tmetocera ocellana.

The apple bud moth was, as usual, destructive in many localities in June.

Tortrix fumiferana.

The spruce bud moth occurred in alarming numbers in the State this year. Reports of the devastations caused by the larvae on spruce and balsam fir from numerous localities were received and during the first two weeks in July the moths were reported as extraordinarily abundant at Castine and in the region of Greenville. The following extract from a letter of July 5 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. R. We have not heard of any of the worms north of Moose River.

We cannot say how far south they are, but the centre of the infestation seems to be in the vicinity of Parlin Pond. 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."

Some pupae received from Greenville Junction were parasitized by *Pimpla inquisitor* and a Braconid parasite was also present in the State this season. Lots 1366 and 1381.

HYMENOPTERA.

TENTHREDINIDAE.

Craesus latitarsus.

Larvae of this species were common upon the birch (*Betula populifolia*) in the vicinity of Orono in August and September. Adults appear in September. Lot 1420.

Nematus Erichsonii.

This species is apparently again on the increase, many larch trees (Larix laricina) were observed near Houlton July 20, to be badly attacked. Lot 1372.

ICHNEUMONIDAE.

Limneria guignardi and Hemiteles sp.

The first named species is not uncommonly found as a parasite of the red-humped caterpillar (*Oedemasia concinna*). This season, (August to October) cocoons were received from several localities. From some parasitized caterpillars sent from Easton, Maine, were obtained specimens of *Limneria* and also two hyperparasites belonging to the genus *Hemiteles,* resembling *H. sessilis* and *H. nemativorus* but differing from each. An examination of the cast skins revealed the hyperparasitic character of Hemiteles. Lot 1423.

Amblyteles montanus.

This species was bred from some specimens of *Autographa brassicae* Orono, Sept. 7, 1911. Lot 1401.

Pimpla inquisitor.

Several specimens of this species were reared from pupae of the spruce-bud moth (*Tortrix fumiferana*) which were sent from Greenville Junction, Maine, in July. Lot 1366 Sub. 1.

BRACONIDAE.

Opius sp.

Several specimens of an undescribed species belonging to the above named genus were reared from the beet maggot or its pupa (*Pegomyia vicina*) July 21, Orono, Me. Lot 1392 Sub. 1.

Bracon sp.

Two specimens belonging to this genus and several Chalcids (*Elachertes sp.*) were reared from the insects which were infesting the cones of yellow spruce, noted under Coleoptera (*Carpophilus*) July-August, Orono, Me. Lot 1386 Sub. 5.

CHALCIDAE.

Elachertes sp.

Associated with the *Bracon sp.* noted above. Lot 1386 Sub. 5.

Monodontomerus aereus (*a parasite of the brown-tail moth*).

About five years ago this species was imported from Europe and distributed in Massachusetts by the Entomologists engaged in the Gypsy and brown-tail moth investigations. The species has gradually been spreading in Massachusetts and last year was discovered in Maine. In March (1911) from some brown-tail winter nests received from Walpole, Maine, a few specimens of *M. aereus* emerged. This circumstance excited our interest, and at our request through the kindness of Mr. Wm. M. King about 100 more nests from the same locality were sent us from which we obtained over 60 specimens of the parasites. This record of the natural spread of introduced species of parasites is most encouraging and augurs well for the future aid furnished in the control of pests by their natural enemies. An account of the introduction of this species in Massachusetts is found on pages 43 et seq. of a bulletin entitled "Parasites" issued in 1910, under the direction of F. W. Rane, State Forester of Massachusetts, Boston, Mass. Lot 1336.

PEMPHIGUS TESSELLATA (ACERIFOLII) on Alder and Maple.*

EDITH M. PATCH.

Since the identity of *Pemphigus tessellata* Fitch 1851 and *P. acerifolii* Riley 1879 was suggested (Patch 1908) the three succeeding years' observations confirm the previous evidence and leave no room for doubt that the alder and maple represent two hosts of a single species, the alder being the summer home of the progeny of the migrants from the maple.

But, as the life-cycle outline on page 247 indicates, we do not here have a simple case of alternate hosts; for the alder, besides serving for summer host for the progeny of the maple migrants, maintains a continuous series of apterous viviparous parthenogenetic females Thus, ignoring the maple for the present, we have on the alder for the first spring generation the hibernating nymphs which over-winter under fallen leaves or loose earth at the base of the alder. These young nymphs climb up the alder stem on the first warm spring days sometimes in late March but usually in April in the vicinity of Orono. This apterous viviparous parthenogenetic generation becomes mature late in June and the progeny, a similar generation, matures about the middle of July. The third generation of viviparous parthenogenetic females becomes mature about the first of September. Part of this third generation are apterous and the progeny of these are the hibernating nymphs which become the first generation of the following spring.

But, as is indicated, part of the generation maturing about the first of September are winged. These, sexuparae or mothers of the true sexes, migrate to the maple where they do not settle to feed but seek rough places in the bark in which to deposit the almost microscopic apterous oviparous females and the still smaller apterous males. The over-wintering eggs are very soon deposited by the minute females, which like the males, die without feeding, both being without functional mouth parts. The stem-mothers hatch from these eggs about May 6 (Aphid 2-09). Their full career has not been followed but a mature stem mother (Aphid 9-09) was found on June 11 recently set-

* Papers from the Maine Agricultural Experiment Station: Entomology No. 49.

tled on a partly grown maple leaf (the inner, newest, third pair of the cluster of maple leaves) between two ribs at the base of the leaf with her head at the angle of the ribs. She had given birth to one nymph which stood with three legs on each side of a rib and its beak plunged into the rib. The stem-mother is very much smaller than the apterous forms on the alder. The progeny of the stem-mother become winged about the middle of July or a little later at which time the infested leaf looks like the accompanying figure 96. These are the spring migrants and they desert the maple for the alder before bringing forth progeny.

In order to ascertain whether the advent of the maple migrants are an annual necessity for the development of the species on the alder, a vigorous colony of hibernating nymphs was enclosed on alder in a screen house in the spring of 1909 and protected for two years against migrants from the maple. The colony existed for these two years in a healthy condition and, protected as it was from natural enemies, thrived much better than the infested alder. It is of interest to note that both falls in the third generation winged migrants left the housed alder, and not being able to reach the maple, died on the inside of the screen in great numbers.

How long this independent apterous viviparous parthenogenetic cycle on the alder could be maintained is not known. The experiment in question showed that a large colony was in good condition at the close of the second season, but by Sept. 8 of the second year (1910) one bush had been completely killed by the sapsucking colony and the sticky honey dew and the attendant fungus. The flocculent appearance of an infested alder branch is shown in figure 97. The other stems were so sickly that they gave no promise for food a third season so the observations were closed with the evidence of two years.

A counter experiment is planned in which an uninfested alder will be caged and only the migrants from the maple admitted in order to ascertain whether their progeny will establish a continuous viviparous cycle upon the alder or perhaps it would be better stated, in order to ascertain what will happen.

The economic aspect of this species varies with the locality. In Maine the alder (*Alnus incana*) along the rivers and streams is not valued and the insects infesting this growth are not significant so far as the alder itself is concerned. However, as the cultivated cut leaved maple as well as the native variety of the same species (*Acer saccharium L dasycarpum Ehrh*) is in Maine dependent for its infestation on the fall migrants from the alder, treasured ornamental maples could be protected by destroying the alder in the vicinity. The practibility of this course would depend on the quantity of the neighboring alders.

In Minnesota (Washburn 1903) and elsewhere where the infestation of alder clumps themselves is regretted, remedial measures can often be applied directly to the alder. As the alder is a permanent host of this species, one thorough treatment should be sufficient for a year at least. The landscape gardener would perhaps save himself trouble if he withheld susceptible maples from the vicinity of native alders.

LIFE CYCLE OF PEMPHIGUS TESSELATA (*acerifolii*).

ALDER.	MAPLE.
NYMPHS (hibernating under leaves Oct. to April; becoming mature apterous viviparous parthenogenetic females, late June.)	EGGS (on bark over winter).
	STEM MOTHERS (mature June 11)
SECOND GENERATION (apterous viviparous parthenogenetic females mature mid July).	
< Migrates mid July to alder.	SPRING MIGRANTS (mature mid July).
THIRD GENERATION. Apterous viviparous parthenogenetic females, mature Sept. 1 — Alate viviparous parthenogenetic females mature Sept. 1; fall migrants, sexuparae, migrate Sept. 1 to maple...	
	APTEROUS OVIPAROUS FEMALES AND APTEROUS MALES.
NYMPHS (hibernating).	EGGS (on bark over winter).

Bibliography Since 1901.

1901. Hunter, W. D. The Aphididae of North America. Ames, Iowa, p. 77 and 79. Bibliography.

1903. Washburn, F. L. Insects Notably injurious in 1902. Bulletin No. 77 Agricultural Exp. Sta. of the Univ. of Minnesota, p. 45. Economic note and photograph.

1904. Patch, Edith M. Insect Notes for 1904. Maine Agr. Exp. Sta. Bul. 109, p. 179 and Fig. 33.

1905. Felt, E. P. Park and Woodland Insects. Vol. I. Photograph.

1906. Patch, Edith M. Insect Notes for 1906. Maine Agr. Exp. Sta. Bul. 134, p. 216. Alder Blight and Attendant Insects.

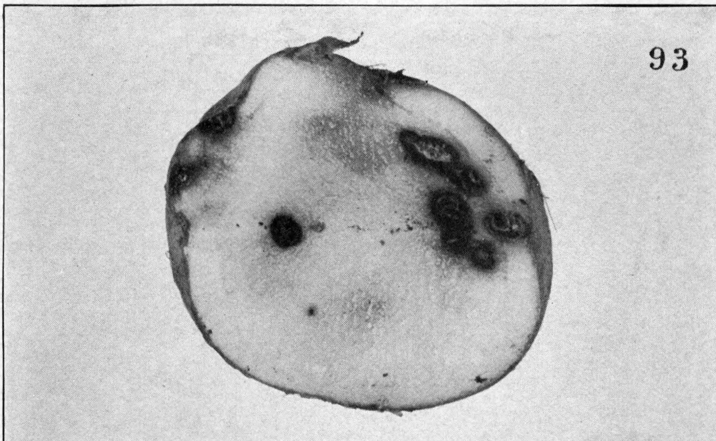
1908. Jackson, C. F. Synopsis of the Genus Pemphigus. Proceedings of the Columbus Horticultural Society, pp. 183 and 209.

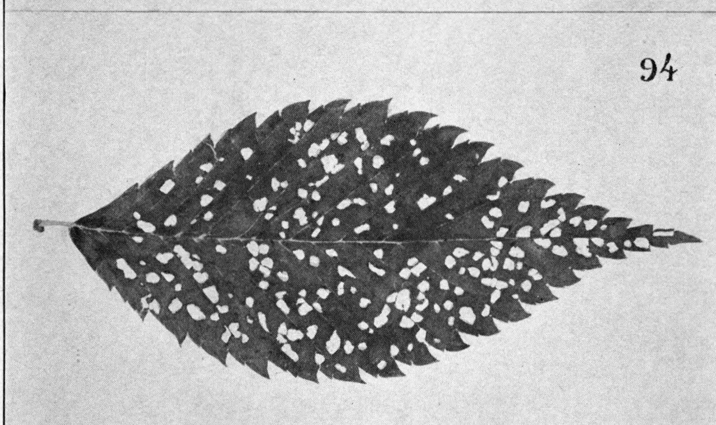
1908. Patch, Edith M. Pemphigus tessellata: Alternate Host, Migrants and True Sexes. Entomological News. Dec. 1908, p. 484. Photograph.

1909. Patch, Edith M. Pemphigus tessellata Fitch. Journal of Economic Entomology, Vol. 2, p. 35.

1909. Gillette, C. P. Plant Louse Notes, Family Aphididae. Journal of Economic Entomology Vol. 2, pp. 354 and 355. Fig. 8, Plate 12.

1910. Davis, J. J. Illinois Aphididae. Journal of Economic Entomology. Vol. 3, p. 411.





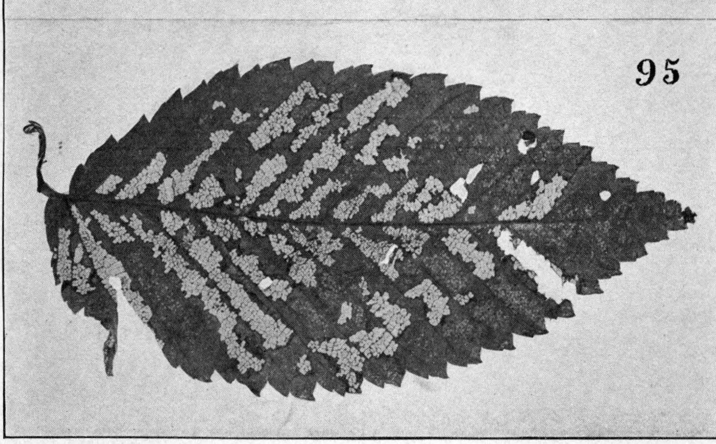
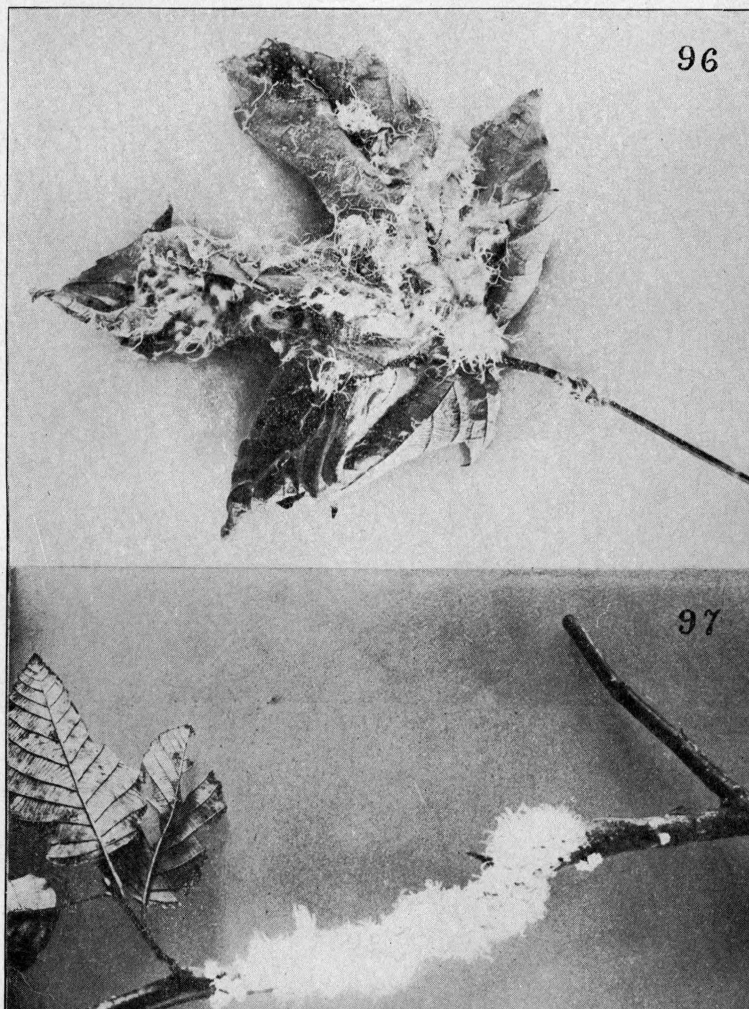


FIG. 93 Section of potato showing wire worm injury.
FIG. 94 Elm leaf injured by adult Beetle (*Haltica carinata*).
FIG. 95 Elm leaf injured by larva of Haltica carinata.



Pemphigus tessellata on Maple (FIG. 96) and on Alder (FIG. 97).

BULLETIN No. 196.

THE MYCETOPHILIDÆ OF NORTH AMERICA.

PART III.*

THE MYCETOPHILINÆ.

O. A. JOHANNSEN.

The Mycetophilinæ embrace many genera which resemble each other in possessing an unbranched radial sector and in lacking the M-Cu crossvein. The subfamily is very probably of polyphyletic origin apparently having arisen for the most part from several Sciophiline genera. It is therefore not a natural group but for practical purposes a very convenient one. In nearly all the genera the anal furrow which simulates a longitudinal vein lying immediately behind the cubitus, is present, the first anal vein though frequently strong does not reach the wing margin in any recent North American form and the second anal is less distinct or vestigal.

In all the North American genera there are 2+14 antennal joints except in the genus *Cordyla*. The middle ocellus which is present in most, is absent in *Mycetophila* and *Cordyla* and rarely present in *Dynatosoma,* and *Exechia.* The thorax is high and arched and the abdomen more or less compressed. There is one spur at the apex of each fore tibia and a pair on each of the middle and hind tibiæ. The claws have one or more basal teeth. In some *Boletinæ* and *Coelosiæ* one claw is peculiarly modified.

It is evident that there are several natural groups of genera which may be tentatively arranged according to the following

---

* Papers from the Maine Agricultural Experiment Station, Entomology No. 50. Parts I and II were published in Bulletins 172 and 180 respectively. Where the types of the new species are to be found will be stated in Part IV, now ready for the press.

scheme, though a study of the larval characters may somewhat modify this grouping.

SERIES I: *With the setulæ of the wings not arranged in distinct parallel rows; subcosta usually elongate.*

1. With a simple, unbranched cubitus. *Acnemia, Azana.*
2. With undulating Rs, detached M_1 and with numerous setæ among the setulæ of the wing. *Neuratelia, Odontopoda.*
3. No defective veins, Rs arises before middle of wing, subcosta ends in the costa; weak tibial setæ. *Boletina group.*
   a. Proboscis elongate. *Gnoriste.*
   b. Proboscis short. *Leptomorphus, Allocotocera. Boletina, Phthinia, Sackenia, Coelosia.*
4. Strong tibial setæ.
   a. Middle ocellus lower than laterals; venation defective. *Rondaniella.*
   b. Middle ocellus higher than laterals, the latter close to eye margin. *Leia.*
5. Subcosta does not end in the costa.
   a. Lateral ocelli remote from eyes. *Syntemna, Megophthalmidia.*
   b. Lateral ocelli nearly contiguous to eyes. *Docosia.*

SERIES II: *Setulæ of the wings arranged in parallel rows; subcosta usually short.*

1. Posterior basal seta of hind coxæ wanting, tibial setæ small.
   a. Antennæ and palpi normal. *Anatella, Trichonta.*
   b. Antennæ short, usually less than 15 jointed, second palpal joint enlarged. *Cordyla.*
2. Posterior basal seta of hind coxa present. *Genera 21 to 26.*
3. Posterior basal seta of hind coxa absent, tibial setæ stout.
   a. Cubitus branched. *Genera 27 to 31.*
   b. Cubitus simple. *Sceptonia, Zygomyia.*

In this as well as in the lower subfamilies the parts of the hypopygium furnish the most distinctive and easily recognizable specific characters. The homologies of these parts are as yet too uncertain and the terminology too unsatisfactory and inadequate to attempt descriptions and I have therefore only given figures illustrating specific characters. In comparing a specimen with a figure it usually will be necessary to examine a KOH preparation of the hypopygium which must be moved about under a supported cover glass until it occupies a position similar to that represented in the illustration, otherwise an erroneous impression is obtained. The ovipositor of the female in some genera appears to possess good characters but in general I have refrained from naming specimens represented by females alone.

The wing venation is usually not described but instead photographic reproductions are given of most species. The term metatarsus for convenience is retained to designate the first tarsal joint though its use in this sense is etymologically incorrect. To avoid unnecessary repetition some of the statements made in the synoptic tables of genera and species are not repeated in the description and hence it will be necessary to consider the characters given in the keys, in the tables of leg measures, together with the figures of wing and hypopygium and the diagnosis of the species, combined as constituting the description.

Following the description of a species is given in brackets the initials of the collector: J.M.A., (Prof. J. M. Aldrich); J.B., (Prof. John Barlow); J.C.B., (Prof. J. C. Bradley); C.W.J., (Mr. C. W. Johnson); J.G.N., (Prof. J. G. Needham); W.M.W., (Prof. W. M. Wheeler).

Nomenclature. The arrangement of genera given here is practically the same as that adopted by me in *Genera Insectorum* Fasc. 93, to which the reader is referred for the synonymy. It may be well to state that in this work several of Rondani's genera were recognized which necessitated a few changes; thus *Rondaniella* was substituted for the *Leia* of Winnertz, *Neuratelia* for *Anaclinia, Leia* for *Neoglaphyroptera,* while *Brachycampta* was united with *Allodia.*

Economic relations. As far as known all of the species of this subfamily pass the earlier stages in mushrooms or decaying wood. The larvæ of several species of *Exechia* and of *Mycetophila* are occasionally found in cultivated mushrooms, *M. punctata* quite frequently. This species is also particularly common in wild mushrooms, at times very few plants escaping infestation. Mushroom growers need expect but little trouble from these pests if they will provide their cellars with fine mesh wire screens.

The early stages have been briefly characterized in the introduction to Part I. Descriptions of the larvæ of various species and their habits are reserved for publication elsewhere.

Table of Genera.

a. Proboscis much longer than the head.
  b. Media and cubitus unbroken; media forks a very short distance beyond the crossvein; palpi situated near apex of proboscis. (Figs. 169, 170). 1. *Gnoriste.**
  bb. Bases of media and cubitus defective. (West Indies). 2. *Probolæus.*

aa. Proboscis not elongate.
  b. Cubitus not forked or at most its anterior branch but faintly indicated.
    c. Lateral ocelli widely remote from eye margin; costa extends beyond the tip of Rs.
      d. Subcosta extends at least to base of Rs; media 2-branched. (Fig. 171). 3. *Acnemia.*
      dd. Subcosta short; media simple. 4. *Azana.*
    cc. Lateral ocelli nearly or quite contiguous to eye margin.
      d. Cell R_1 very narrow; Rs strongly arched. 32. *Sceptonia.*
      dd. Cell R_1 not unusually narrow; Rs nearly straight. 33. *Zygomyia.*
  bb. Cubitus with 2 branches, anterior branch may be detached at base.
    c. Anterior branches of *both* media and cubitus detached at base. (Fig. 173). (Leia Winnertz). 5. *Rondaniella.*†
    cc. Both media and cubitus forked, but immediate base of the anterior branch of *one* of them may be obliterated.
      d. Subcostal vein ends in the *costa* and is at least half as long as the basal cell R.
        e. Basal section of anterior branch of media wanting.
          f. Subcostal crossvein (Sc_2) present though faint, costa slightly produced beyond tip of Rs. (Fig. 174). (=Anaclinia). 6. *Neuratelia.*
          ff. Subcostal crossvein (Sc_2) absent, costa not produced beyond tip of Rs. 7. *Odontopoda.*
        ee. Basal section of anterior branch of media present.
          f. Subcostal crossvein (Sc_2) present.
            g. Cubitus forks under or proximad of fork of media.
              h. Subcostal vein enters the costa beyond, at, or little before the base of the radial sector.
                i. Fore metatarsus distinctly longer than its tibia; petiole of the media about ½ as long as the anterior branch; costa scarcely produced beyond tip of Rs. (Fig. 177). 8. *Leptomorphus.*
                ii. Fore metatarsus shorter than its tibia.
                  j. Subcostal vein prolonged far beyond the base of the radial sector; anal vein stout; petiole of media about ½ as long as the anterior branch. (Fig. 178). 9. *Allocotocera.*

---

* Eugnoriste is a Sciarid.

† In Manota, which is a Sciarid, the petiole of the media is wanting.

jj. Subcostal vein not produced far beyond the base of the radial sector; petiole of the media less than ½ as long as the anterior branch. (Fig. 179). 10. *Boletina.*

hh. The distance between the tip of the subcostal vein to the base of the radial sector is at least 1-4 the breadth of the wing at the widest part. (Fig. 193). (Neoglaphyroptera). 11. *Leia.*

gg. Cubitus forks distad of the media, ocelli in a transverse row on the broad front.

h. Subcostal crossvein proximad of base of Rs. (Fig. 209). 12. *Phthinia.*

hh. Subcostal crossvein distad of base of Rs. *Megalopelma* (See 12, *Phthinia fraudulenta*).

ff. Subcostal crossvein (Sc_2) absent.

g. Cubitus forks proximad or under fork of the media.

h. Anal vein produced to the margin (Fossil). 13. *Sackenia.*

hh. Anal vein not produced to the margin. (Fig. 243). 10. *Boletina,* pt.

gg. Cubitus forks distad of the fork of the media.

h. The lateral ocelli remote from the eye margin; the posterior basal seta of hind coxa absent. (Fig. 210). 14. *Coelosia.*

hh. The lateral ocelli close to the eye margin; subcostal vein short only rarely reaching costa; posterior basal seta of hind coxa present. 24. *Phronia,* part.

dd. Subcostal vein *if long* then ending either in R_1 or with its end free, usually short.

e. Costal vein extends noticeably beyond tip of Rs (if but slightly then the subcostal vein is long and ends in R_1).

f. Lateral ocelli separated from the eye margins by a distance sub-equal or greater than the diameter of the ocellus; posterior basal seta of hind coxa wanting.

g. Subcostal vein at least ½ as long as the basal cell R, and ends free or in R_1. (Fig. 213). 15. *Syntemna.*

gg. Subcostal vein less than ½ as long as the basal cell R; base of fork of cubitus proximad of base of the R-M crossvein; anal vein very short. (Fig. 216). 16. *Megophthalmidia.*

ff. Lateral ocelli nearly or quite continuous to the eye margin.

g. Subcostal vein less than ¼ the length of the basal cell R *and* ending in R_1, costa produced far beyond the tip of Rs; posterior basal seta of hind coxa absent. (Fig. 217). 18. *Anatella.*

gg. Subcostal vein either longer than ¼ of basal cell or it does not end in R_1.

h. The R-M crossvein is in the same line as the second section of the radial sector, thus apparently forming the basal section of the latter; fork of the media slightly distad of the fork of the cubitus or under it, costa produced beyond Rs. (Figs. 218, 241). 17. *Docosia.*

hh. The R-M crossvein makes a distinct angle with second section of the radial sector (Rs).

i. Subcostal vein more than ½ as long as the basal cell R ending in R_1, costa produced little if any beyond the tip of Rs; basal seta of hind coxa wanting.

j. Setæ of hind tibia short, not much longer than the diameter of the tibia; three ocelli, middle one small. (Fig. 221). 19. *Trichonta.*

jj. Setæ of hind tibiæ usually arranged in 3 rows, stout, more than twice as long as the diameter of the tibia; middle ocellus rarely present; costa not produced beyond Rs. 26. *Dynatosoma.*

ii. Subcostal vein less than ½ as long as basal cell R.

j. Cubitus forks noticeably distad of fork of the media, the branches of the former widely divergent; costa but little produced; anal vein short, tibial setæ small; basal seta of hind coxa present. 24. *Phronia*, part.

jj. Cubitus forks under or proximad of the fork of the media; branches of the former make a very acute angle with each other and are but slightly divergent, setæ of hind tibiæ strong, more than twice as long as the diameter of the tibia; ocelli 3; basal seta of hind cosa absent. 29. *Epicypta*, part.

ee. Costa does not extend beyond tip of radial sector (Rs).

f. Second palpal joint much enlarged, swollen, flattened ovate; antennæ very short, but little longer than the head, 11 to 16 jointed; ocelli 2; basal seta of hind coxa wanting. (Fig. 224). 20. *Cordyla.*

ff. Second palpal joint not distinctly swollen, antennæ longer than the head.

g. Posterior basal seta of hind coxa present; ranges of setæ on hind tibiæ slender, (except in Brachypeza) usually little if any longer than the diameter of the tibia.

h. Intermediate antennal joints closely sessile; annular or torus like; tibiæ stout, noticeably enlarged at the ends, the setæ moderate; base of fork of the cubitus proximad of the proximal end of the R-M crossvein; subcostal vein ending in R_1; wing sometimes with markings. (Fig. 229). 21. *Brachypeza.*

hh. Antennal joints usually subcylindrical; and otherwise not with the above combination of characters; wings unmarked except in *Telmaphilus.*

i. Cubitus forks proximad of the fork of the media.

j. Anal vein very stout and ends abruptly, usually a little beyond the fork of the cubitus, angle between the branches of cubitus very acute at the base, the lower branch beyond its middle suddenly diverging from the upper branch, base of fork at or proximad of proximal end of the R-M crossvein. (Fig. 230). 22. *Rhymosia.*

jj. Anal vein slender (Fig. 238) (including Brachycampta). 23. *Allodia.*

ii. Cubitus forks distad of the fork of the media.

j. The media forks distad of the end of the basal cell R; costa extends very little beyond end of the radial sector; ocelli 3, middle one very small.

k. Wings hyaline; subcosta less than ½ length of basal cell. 24. *Phronia.*

kk. Apex of wings more or less clouded or smoky; subcosta end free beyond middle of basal cell. 25. *Telmaphilus.*

jj. The media forks proximad of the end of the basal cell R, the subcosta ends free; middle ocellus present or absent. (Fig. 242). 26. *Exechia.*

gg. Posterior basal seta of hind coxa absent; the ranges of setæ on the hind tibiæ conspicuously stout, setæ at least twice as long as the diameter of the tibiæ; crossvein usually with dark spots, wing often fasciate.

h. Subcostal vein ends in R_1, branches of the cubitus noticeably divergent; usually three ranges of setæ on hind tibiæ; middle ocellus usually absent. 27. *Dynatosoma.*

hh. Subcostal vein ends free.

i. Hypopygium of the male conspicuously large and husk like; female with a fringe of long setæ on ventral side of sixth abdominal segment; middle ocellus present; branches of cubitus subparallel at end. 28. *Opistholoba.*

ii. Genitalia not as described above.

j. Two ocelli, none in the middle; costa not produced beyond the tip of the radial sector; branches of cubitus usually parallel on apical third. (Fig. 245). 31. *Mycetophila.*

jj. Three ocelli present, middle one minute.

k. Branches of the cubitus make a very acute angle with each other and slightly divergent; fork usually proximad of the fork of the media; costa usually slightly produced beyond the tip of the radial sector. 29. *Epicypta.*

kk. Branches of the cubitus more or less convergent, rarely parallel, fork frequently distad of the fork of the media; costa ends at tip of Rs. 30. *Mycothera.*

1. Genus *Gnoriste* Meigen.

Syst. Beschr. 1. 243. 1818.

Proboscis slender, longer than head and thorax combined; the palpi near the apex (Part I, fig. 53); ocelli 3, the laterals remote from the eye margin. Wings large; costa produced beyond tip of the radial sector (Rs); subcostal vein long; subcostal crossvein (Sc_2) present; fork of the cubitus proximad of the fork of the media; anal vein incomplete. (Fig. 169).

Table of Species.

a. Proboscis over .7 the length of the insect to tip of abdomen; cubitus forks proximad of the proximal end of the crossvein, somewhat variable; costa distinctly produced beyond the tip of Rs; subcosta ends at or proximad of the base of Rs. N. Y.; Calif. (Fig. 169). 1. *megarrhina.*

aa. Proboscis less than ⅝ of the length of the insect.

b. Proboscis over half the length of the insect; fore metatarsus and its tibia subequal in length. 2. *groenlandica.*

bb. Proboscis less than ½ as long as the insect; fore metatarsus shorter than the tibia.

c. Cubitus forks slightly proximad of the base of Rs; the subcostal crossvein indistinct, proximad of the middle of the subcosta. (Fig. 170). 3. *macra* n. sp.

cc. Cubitus forks nearly under the base of Rs; the subcostal crossvein distad of the middle of the subcosta. 4. *apicalis.*

G. dentoni Scudder is a fossil from Utah.

1. *Gnoriste megarrhina* Osten Sacken.

Bull. U. S. Geol. Survey. Terr. III. 193. 1877.

Male and female. Length of body 7 mm.; of the proboscis 5.5 mm.; face deep velvet black, opaque; antennæ brown, second joint somewhat reddish; proboscis brown; vertex black, with a slight gray pollen; thorax brownish-yellow, with 3 black stripes on the dorsum, the intermediate geminate; in the male the thorax is nearly entirely black; abdomen dusky, in the female the segments with posterior margins yellowish. Legs yellow; tarsi infuscated, in the male one claw of each foot modified, in the fore and middle feet this claw is deep spoon-shaped, with fluted sides and serrate margin, in the hind foot it is more slender, ribbed. Wings with slight yellowish tinge, a light gray shadow along the hind margin beginning at the apex. Halteres yellow. (Fig. 169). Hypopygium (Figs. 137, 139). "California," Mass. (C.W.J.) and Ithaca, N. Y. May and June.

2. *Gnoriste groenlandica* Lundbeck.

Dipt. groenl. I, Vidensk. Meddel. nat. Foren. i. Kbhvn. 1898.

Male and female. Length 6.5 to 7.5 mm.; proboscis 4 mm. Coloring similar to *G. megarrhina*, but more cinereous. Wings hyaline slightly yellowish tinged, venation as in *G. apicalis* except that the cubitus forks nearer the base of the wing. Fore metatarsus and its tibia subequal in length. "Greenland."

3. *Gnoriste macra* n. sp.

Male. Length 6½ mm; proboscis 2 mm. Black, shining, including front and vertex; proboscis, palpi and antennæ brown; thorax with yellow hairs; legs including coxæ yellow, tarsi darker; one claw of fore and middle foot modified as in *G. megarrhina*, the hind foot is broken in the single male specimen. Wings hyaline with yellow tinge along costal margin (Fig. 170). Halteres yellow. Hypopygium yellowish resembling that of *megarrhina*, differing chiefly in the form of the forceps (Fig. 138).

Female. In coloring similar to the male but the thorax is yellow to brown with 3 shining black subconfluent dorsal stripes. Tarsal claws not modified. In both sexes the fore metatarsus is about ⅞ as long as the tibia. White Fish Bay, Wisconsin (W.M.W.) May.

4. *Gnoriste apicalis* Meigen.

Syst. Beschr. I. 243. 1. 1818.

Male and female. Length 7-8 mm. Coloring as in *G. macra* from which it differs in wing venation, the subcostal crossvein being distad of the middle of the subcosta, and the cubitus forks under the base of the radial sector. The tarsi of the fore legs twice as long as the corresponding tibiæ; the fore tibia about 1-8 longer than its metatarsus. "Europe." Said to occur also in Alaska and Colorado.

2. Genus *Probolæus* Williston.

Trans. Ent. Soc. London, p. 261. 1896.

Proboscis more than half of the length of the body, directed downwards and forwards, composed of five slender bristles; palpi wanting. Face very narrow, ocelli apparently absent. Abdomen slender, longer than the wings. Legs elongate, hind legs stouter, femora thickened, and the tibia clubbed. Neuration defective, the proximal portion of the media and the anterior branch of the cubitus wholly invisible; anal vein apparently absent; costa reaches a considerable distance beyond the tip of the radial sector. It is possible this genus should be placed with the *Sciarinæ*.

Probolæus singularis Williston.

Trans. Ent. Soc., London, 261, pl. 8, fig. 15. 1896.

Male. Length 4-5 mm. Front, face and occiput black; antennæ brown, the basal joints somewhat yellowish. Mesonotum opaque deep reddish brown, the humeri and postalar callosities yellowish; pleura brown or yellowish-brown, shining. Abdomen black, the first segment and a posterior band on the second, third and fourth segments yellow. Wings nearly hyaline, lightly clouded on the outer part. Legs, including coxæ, light yellow; the tarsi and the thickened portion of the hind tibiæ infuscated or blackish. Halteres yellow. "St. Vincent Island. Altitude 1800 feet."

3. Genus *Acnemia* Winnertz.

Verh. Zool.-bot. Ges. Wien, XIII. 798. 1863.

Ocelli 3 in number placed high upon the front, the laterals remote from the eye margin. Legs moderately long, stout; the femora, particularly the hind pair, compressed, all tibiæ with weak lateral setæ. The fore tibiæ have one range, the middle tibiæ 3, and the hind tibiæ 2 ranges of setæ, those on the inner side very minute. Wing oval; the costa extends far beyond the tip of the radial sector, ending before the tip of the wing; subcosta long; subcostal crossvein (Sc_2) present; the short basal cell ends proximad of the fork of the media; cubitus not branched; anal vein vestigial. (Figs. 171, 172).

Table of species.

a. Wings with brown crossband extending from apex of R_1 across the wing; a spot below the cubitus near apex. Length 5mm. Calif. 1. *varipennis.*

aa. Wings without bands.

b. Black, coxæ and legs yellow; costa produced 1-3 of distance to M_1; Md., N. Y., Wash. 2. *psylla.*

bb. Yellow, abdomen fasciate; costa produced less than 1-4 distance to M_1. N. J., N. Y., Mass. 3. *flaveola.*

1. *Acnemia varipennis* Coquillett.

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

Female. Length 5mm. Yellow; the antennæ beyond the second joint, a circle around each ocellus, a spot in front of each wing, the breast largely, a streak at the extreme apex, 2 longitudinal vittæ on lower half of metanotum, a spot in front of the halteres, the abdomen except bases of segments and the genitalia, the tarsi except their bases, and the knob of the halteres, black; a pair of widely separated brownish subdorsal vittæ on the mesonotum; hairs and bristles chiefly yellow. Wings grayish hyaline, tinged with yellow along the costa, base of radial sector clouded with brown, a brown crossband extends from apex of cell R_1 to apex of cell M_2, becoming grayish posteriorly, a large brown spot along under side of cubitus before its apex. "Mountains near Claremont, Calif."

2. *Acnemia psylla* Loew.

Berlin. Ent. Zeitschr. XIII. 148. 1869.

Male. Length 2.5 mm. Black, shining, pile yellowish. Head black; antennæ dusky, pale toward the base. Hypopygium rather prominent, blackish (Fig. 141). Coxæ and legs yellowish, trochanters each with a black spot, tibial spurs yellow;

tarsi subfuscous; fore metatarsus about .9 as long as its tibia. Wings grayish tinged, the heavier veins fuscous, the others paler (Fig. 171). Halteres black, with yellow peduncle. "Md.," and Ithaca, N. Y.

Var a. In a specimen from Washington (J.M.A.) the costa is slightly less produced and the dorso-mesal process of the lateral sclerite of the hypopygium acute at apex (Fig. 140 d). In the eastern species this part (Fig. 141 d) is serrate. The western specimen may represent a different species.

3. *Acnemia flaveola* Coquillett.

Proc. U. S. Nat. Museum, XXIII, 598. 1901.

Female. Length 3 mm. Yellow, the antennæ and tarsi becoming brown toward their apices, segments 2 to 6 of abdomen each with a median brown fascia, shortest on the second and third; a brown dot on under side of each trochanter; fore metatarsus less than 7-8 as long as its tibia; wings hyaline (Fig. 172). "N. J.;" Mass., (C.W.J.); R. I., (J.B.); N. C., (C. U. Coll); Ithaca, N. Y.

4. Genus *Azana* Walker.

Insect. Brit. Diptera. III. 26. 1856.

Ocelli 3, high on the front, the laterals widely remote from the eye margin. Legs stout, the femora compressed; fore tibiæ without, the middle and hind pairs each with 2 ranges of delicate setæ. Wings oval; the costa produced beyond the tip of the radial sector. Subcostal vein is shorter than the humeral crossvein and ends free. R_1 ends a little distad of the middle of the wing, the radial sector arises at about 1-3 the wing length from the base; the R-M crossvein is long, longitudinal in position, forming apparently the beginning of the radial sector; both media and cubitus are simple; anal vein wanting.

Azana sp.

I have seen a single defective specimen from Maine of a member of this genus.

5. Genus *Rondaniella* Johannsen.

Genera Insectorum, Fasc. 93. 66. 1909.

Leia (sensu Winnertz nec Rondani). Verh. Zool.-bot. Ges. Wien. XIII. 792. 1863.

Ocelli 3 in number, placed high upon the front, laterals remote from the eye margin. Legs strong, hind tibiæ with 3 ranges of strong setæ outwardly, the middle tibiæ each with a single long seta on the flexor surface beyond the middle. Wings elongate oval; subcostal vein ends at about 1-3 the length of the wing, the subcostal crossvein (Sc_2) wanting; the costa ends far beyond the tip of the radial sector, but does not reach the apex of the wing; basal cell R is about half the length of the wing; the anterior branches of both media and cubitus are detached at the base (Fig. 173).

Table of species.

a. Petiole of the media noticeably longer than the cell in the fork, which is wide open at the base; M_1 not distinctly sinuate. (Fig. 173). 1. *abbreviata.*

aa. Petiole of the media and the cell subequal, the cell narrowly open at the base, M_1 sinuate. 2. *sororcula.*

punctata Bellardi and *unicolor* Walker probably belong to *Leia.*

1. *Rondaniella abbreviata* Loew.

Berliner Ent. Zeitschrift. XIII. 147. (Leja). 1869.

Male and female. Length 2.5 mm. Pale yellow; apical portion of the antennæ, confluent thoracic stripes which are abbreviated anteriorly, metathorax and apex of each hind femur, black; each abdominal segment with subfuscous posterior margin. Hypopygium as figured (Fig. 142). Apex of wing widely fuscous, the cell Rs noticeably more than twice as long as M_1 which is wide open at the base (Fig. 173). "Middle states;" N. C., (W.B.); Wis., (W.M.W.); Selkirk Mts., B. C., (J.C.B.); Ithaca, N. Y.; and Orono, Maine.

2. *Rondaniella sororcula* Loew.

Berliner Ent. Zeitschrift. XIII. 147. (Leja). 1869.

Male. Length 2.5 mm. Pale yellow; flagella of the antennæ, posterior half of the thorax and apex of each hind femur, black; posterior margin of each of the first 4 abdominal segments, fuscous, fifth and sixth segments wholly black, apex of the wings fuscous; cell Rs about twice as long as cell M_1 which is narrowly open at the base. "New York."

6. Genus *Neuratelia* Rondani.

Dipterologiæ Italicæ, Prodromus I. 195. 1856.

Anaclinia Winnertz, Verh. Zool.-bot. Ges. Wien. XIII, 770. 1863.

Ocelli 3 in number, the laterals remote from the eye margin. Wings elongate oval; costa produced more or less beyond the tip of the radial sector; subcosta ends before the middle of the wing; subcostal crossvein (Sc_2) present though often faint; radial sector strongly undulating; anterior branch of media disconnected at the base (Figs. 174-176).

Table of species.

a. Base of each abdominal segment and larger part underneath yellow; subcostal crossvein absent. *Odontopoda sayi.*

aa. Abdomen either unicolored or apices of segments yellowish; subcostal crossvein present though sometimes rather faint.

b. Coxæ largely black; the humeri, tibiæ, inner side and narrow apices of front coxæ and the halteres, yellow, remaining parts blackish; fore metatarsus longer than its tibia. 1. *coxalis*

bb. Coxæ largely yellowish.

c. Fore metatarsus over 3-8 longer than tibia.

d. Thorax largely blackish (Calif.). 2. *silvatica* n. sp.

dd. Thorax largely yellowish (Vt.). 3. *scitula* n. sp.

cc. Fore metatarsus not more than 1-20 longer than its tibia.

d. Abdominal segments with yellow posterior margins.

e. Fore metatarsus slightly shorter than its tibia; thorax largely yellowish. (Id.). 4. *eminens* n. sp.

ee. Fore metatarsus slightly longer than its tibia; thorax mainly dark brown. (Mass.). 5. *desidiosa* n. sp.

dd. Abdomen wholly black. 6. *nemoralis.*

1. Neuratelia coxalis Coquillett.

Journal N. Y. Ent. Soc. XIII. 68. 1905 (Anaclinia).

Length 5 mm. Black, the humeri, femora, tibiæ, inner side and narrow apices of front coxæ, and the halteres, yellow. Body somewhat polished, thinly gray pruinose, the hairs yellowish. First joint of front tarsi longer than the tibiæ. Wings hyaline, venation normal. "B. C.," June and July.

2. *Neuratelia silvatica* n. sp.

Male. Length 6 mm. Blackish brown, somewhat polished; the pleura brown; the palpi, labrum, scape of flagellum, small humeral spot, coxæ, femora, tibiæ, and halteres yellow, tarsi and trochanters brown; the body hairs yellowish. Fore metatarsus over 1.4 times the tibia in length; antennæ nearly twice as long as the thorax. Wings hyaline, venation as figured (Fig. 174). Hypopygium (Fig. 143). Felton, St. Cruz Mts., Calif., May. (J.C.B.)

3. *Neuratelia scitula* n. sp.

Male. Length 5 mm. Yellowish, somewhat polished; the head and face excepting mouth parts, and abdomen dark brown; the apical half of antennæ, 3 indistinct fine lines on the mesonotum and its hind margin, some spots on the pleura, apex of scutellum, the trochanters, and tarsi paler brown; body hairs yellow. Fore metatarsus over 1.4 times the tibia in length, antennæ nearly twice as long as the thorax. Wings hyaline, veins brown, venation nearly as in *N. silvatica.* Hypopygium (Fig. 144). Brattleboro, Vt., (C.W.J.) July; N. J.

4. *Neuratelia eminens* n. sp.

Female. Length 5 mm. Yellowish, somewhat shining; head except palpi and basal antennal joints, dark brown; thorax dusky yellowish, the 3 broad stripes on mesonotum and the pleura light brown; basal 2-3 of each abdominal segment brown, the margins yellow. Legs including coxæ yellow, the trochanters and tarsi brown; fore metatarsus about 1-20 shorter than its tibia. Body hairs yellow. Wings hyaline, yellow tinged, veins brown, venation as figured (Fig. 175). Halteres yellow. Kendrick, Id., (J.M.A.).

5. *Neuratelia desidiosa* n. sp.

Female. Length 6 mm. Similar to the foregoing in venation and other characters, but the thorax is dark brown, with yellow humeri, margin of scutellum and base of metanotum. The metatarsi of all legs relatively slightly longer proportionally to their tibiæ than in *N. eminens,* the fore metatarsus about 1.04 times as long as its tibia. N. Adams, Mass. (C.W.J.), June.

6. *Neuratelia nemoralis* Meigen.

Syst. Beschr. I. 265. 1818 (Mycetophila).

Male. Length 5 mm. Black, somewhat shining; palpi, basal joints of antennæ, humeral spot, coxæ, femora, tibiæ and halteres yellow; the trochanters, front side of hind coxæ, apices of hind femora, and the tarsi more or less brown. Fore metatarsus and its tibia subequal in length. Wings hyaline with brown veins, venation figured (Fig. 176). Hypopygium resembles somewhat that of *silvatica* in having a short ventral plate but differs decidedly in the form of the claspers which are shown depressed in figure 145. "Alaska;" Selkirk Mts., B. C.; and Muir Woods, Calif., (J.C.B.)

7. Genus *Odontopoda* Aldrich.

Report of State Geologist XXI. 187. 1896.

Proanaclinia. Meunier, Monogr. Mycetophilidæ, etc., 145, 1904.

This genus differs from *Neuratelia* only in lacking the subcostal crossvein. In Williston's Manual of the Diptera (3rd ed.) they are made synonymous. The type in the museum in Indianapolis is broken, only a fragment of the thorax remaining. See table of species of *Neuratelia*.

Odontopoda Sayii Aldrich.

Report of State Geologist XXI. 187. 1896.

Male. Length 6 mm.; of wing 4.7 mm. Front black, antennæ brown, except the first 3 joints, which are yellow; mouth parts yellow; thorax and coxæ yellow, rather pale; the dorsum however more acorn-colored without distinct lines. Abdomen brown, the bases of the segments and a larger part underneath of a lighter color, seventh segment distinct, nearly as long as the sixth, hypopygium as long as the seventh, first segment over half as long as the second. Femora and tibiæ yellow, with a brownish tinge, front tarsi black (the others wanting). Wings of a clear yellow tinge, lighter posteriorly. "Marengo cave, Indiana."

8. Genus *Leptomorphus* Curtis.

Brit. Ins. 365. 1831.

Ocelli 3, the laterals remote from the eye margin. Abdomen very long, slender, nearly linear, compressed, 7 segmented. Legs long, lateral setæ of the tibiæ very minute, fore metatarsus longer than its tibia. Wings shorter than the abdomen, setulose; costa very slightly produced beyond the tip of the radial sector; subcostal vein complete; ending near the middle of the wing; subcostal crossvein present; media forks far distad of the base of the radial sector, cubitus forked under or proximad of it; anal vein does not reach wing margin (Fig. 177).

Table of species.

a. Mesonotum black (N. H.). 1. *hyalinus*
aa. Mesonotum yellow with black markings.
b. Mesonotum yellow, marked with a median Y and 2 lateral spots; scutellum black. 2. *ypsilon* n. sp.
bb. Mesonotum with 3 dark stripes, confluent posteriorly. 3. *Walkeri*.
L. parvulus belongs to *Allocotocera*.

1. *Leptomorphus hyalinus* Coquillett.

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

Female. Length 9 mm. Yellow; an ocellar dot and the mesonotum, except the lateral margin, interrupted above the insertion of wings, black; antennæ, except the 2 basal joints, brown; abdomen with indications of an irregular brown fascia at apex of each segment; body polished; wings hyaline, densely short haired. "White Mts., N. H."

2. *Leptomorphus ypsilon*. n. sp.

Female. Length 8 mm. Head and mouth parts yellow, ocelli close together, surrounded by a blackened area; antennæ about 1.7 as long as the thorax, darker on apical 2-3, the first joint with a protuberance below which is covered with a tuft of fine black setæ. Thorax yellow, shining; mesonotum with a pair of broad black bands which arise behind the humeri, meet at about the middle of the dorsum and thence continued in a single line to the scutellum; on each side of this is a large rounded spot which does not reach the posterior margin; scutellum black. Abdomen yellow, posterior 1-3 of each tergite black. Legs including coxæ yellow, extreme tips of hind femora dark brown, tarsi brownish; fore metatarsus 1.6 times the tibia in length. Wings hyaline, apex from before the tip of R_1, with pale brown cloud; venation as figured (Fig. 177). Halteres yellow. Ithaca, N. Y. (2 specimens).

3. *Leptomorphus Walkeri* Curtis.

British Entomology, 365. 1831.

Male. Length 10 mm. Ferrugineous. Head, with proboscis, palpi and basal antennal joints yellow, ocellar spot dark.

Thorax with 3 shining blackish stripes which coalesce posteriorly. Abdomen brownish yellow, hind margins of segments 1 to 5 more or less, half of the sixth and the entire seventh, dark brown. Coxæ and legs yellow, the fore metatarsus about 1.5 times the tibia in length. Wings hyaline, apex and hind margin dusky, spot covering base of Rs; base of Rs more distad in this species than in *L. ypsilon*. "Europe and New Jersey."

9. Genus *Allocotocera* Mik.

Wien. Ent. Zeitg. V. 102. 1886.

Eurycera. Dziedzicki, Pam. Fizyjogr. V. 6. 1885.

Ocelli 3, laterals remote from the eye margin. Legs of moderate length. Wings oval, the costa extends beyond the tip of the radial sector; subcosta ends in the costa, subcostal crossvein present; petiole of media long, cubitus forks proximad of the distal end of the R-M crossvein; anal vein stout but ends before wing margin (Fig. 178). The wing venation and the short legs distinguish this genus from *Leptomorphus*.

Allocotocera parvula Coquillett.

Proc. U. S. Nat. Museum. XXIII. 597. 1901 (*Leptomorphus*).
parvula, Johannsen, Gen. Ins. Fasc. 93., 75. 1909 (*Boletina*).
flavescens, Johannsen, Gen. Ins. Fasc. 93., 72. 1909.

Female. Length 3.5 mm. Head, including mouth parts, and basal antennal joints (apical joints missing), wholly yellow, excepting conspicuous dark brown spot back of and contiguous to each lateral ocellus and a smaller surrounding the middle one. Thorax, including sternum, pleura, scutellum, and metanotum wholly yellow, dorsum with faint indications of 2 brown stripes. Abdomen yellow, margin of each of segments 2 to 5 and the whole of the apical segments dark brown. Thorax and abdomen hairy rather than setose. Legs yellow, apices of coxæ and of femora slightly brownish, tarsi pale fuscous; fore and middle tibiæ each with one row of small setæ on flexor surface and 3 or 4 on extensor surface; hind tibiæ each with 3 rows on extensor surface; the longest setæ on hind tibiæ not as long as diameter of the tibia; fore metatarsus a little over 1-2 as long as its tibia; spurs pale brown. Wings with a yellowish tinge, strongly setulose; veins yellow; a brown spot covers apex of R_1 and Rs extending to the tip of the costa.

Venation as figured (Fig. 178). Halteres yellow. Wisconsin. "N. J." I have examined the type hence the synonymy.

10. Genus *Boletina* Stæger.

Kröger: Naturhist. Tidsskr. III. 233. 1840.

Palæoanaclinia Meunier, Monogr. Mycetophilidæ, etc. 143. 1904.

Ocelli 3, placed in a flattened triangle upon the broad front, the middle one small, laterals remote from the eye margin. Legs slender, fore metatarsus shorter than its tibia, one claw of each foot in the male frequently modified, scoop-like, and fluted. Wings elongate, costa somewhat produced beyond the tip of the radial sector; subcosta ends before the middle of the wing in the costa, subcostal crossvein (Sc_2) present or absent; media forks under or somewhat distad of the radial sector; cubitus forks under or proximad of the fork of the media; anal vein incomplete (Figs. 179-192).

The genus *Palæanaclinia* cannot be considered distinct, for, with the exception of the absence of the subcostal crossvein, there are no structural differences. In one species (*B. obscura*) this vein may be either present or absent; in some others it is quite faint and inconspicuous.

Table of species.

a. Subcostal crossvein (Sc_2) present.
  b. Halteres black; Sc ends in C opposite base of Rs; Sc_2 slightly proximad of proximal end of crossvein. 1. *abdominalis.*
  bb. Halteres mainly yellowish.
    c. Yellow species; hind margins of abdominal segments 2 to 5 and the whole of 6 and 7 black; wings hyaline, broad apices gray; media with long petiole. 2. *Allocotocera parvula.*
    cc. Thorax usually dark, or with dark vittæ; if not then petiole of media but little longer than the crossvein.
      d. The fork of the cubitus proximad of the proximal end of the R-M crossvein (Figs. 179-181).
        e. Subcostal vein ends in the costa distad of the base of Rs; coxæ black. 3. *obscura* n. sp.
        ee. Subcostal vein ends in the costa opposite or proximad of the base of Rs; coxæ yellow.
          f. Fore metatarsus less than 2-3 as long as tibia; pleura yellow. 4. *cincta* n. sp.
          ff. Fore metatarsus at least 2-3 as long as tibia; pleura black. 5. *melancholica* n. sp.

dd. Fork of the cubitus opposite or distad of proximal end of crossvein.

e. Thorax partly yellow, usually with black thoracic stripes; spurs brown; fore tarsi nearly or quite twice, fore metatarsus over .8 as long as the tibia; palpi usually yellow.

f. Costa but slightly produced beyond Rs; Sc_2 near middle of Sc_1.

g. Cubitus forks proximad of the distal end of the crossvein; petiole of media less than 4 times as long as basal section of Rs. 6 *imitator* n. sp.

gg. Cubitus forks nearly under the fork of the media; petiole of the media over 6 times as long as basal section of Rs. 7. *gracilis* n. sp.

ff. Costa produced at least 1-4 distance from Rs to M.

g. Sc_2 near middle of Sc_1; antennæ nearly as long as the body in the male. 8. *longicornis* n. sp.

gg. Sc_2 distad of the middle of Sc_1.

h. Subcosta ends in the costa opposite base of Rs; abdomen of female with yellow fasciæ. 9. *notescens* n. sp.

hh. Subcosta ends distad of base of Rs; abdomen of female uniformly fuscous. 9a. *notescens*, varieties.

ee. Thorax black; and usually with yellow tibial spurs, shorter tarsi and dusky palpi.

f. Subcosta ends over the base of Rs; petiole of M is shorter than the crossvein; part of third joint of antenna yellow; posterior coxæ dark; abdomen of female fasciate; Arctic species. 10. *groenlandica.*

ff. With other combination of characters.

g. Sc_1 ends in C slightly proximad of the base of Rs; petiole of M shorter than the crossvein; Sc_2 before the middle of Sc_1; abdominal sclerites margined with yellow (female); coxæ yellow; Alaska. 11. *beringensis.*

gg. With other combination of characters.

h. Costa produced at least 1-5 of distance from Rs to M_1.

i. Sc_1 ends in C distad of the base of Rs.

j. Coxæ black. 12. *Hopkinsii.*

jj. Coxæ yellow; Sc_2 distad of middle of Sc_1. 13. *sobria* n. sp.

ii. Sc_1 ends in C opposite or proximad of base of Rs; Sc_2 distad of middle of Sc_1.

j. Coxæ wholly grayish; claws in both sexes with basal tooth. Greenland. 14. *arctica.*

jj. Coxæ in large part yellow; one claw of each foot of male modified.

k. Abdomen with yellow fasciæ; palpi yellow; tarsi of female tumid.
15. *tricincta.*

kk. Abdomen black; palpi dark; fore tarsi about 1.75 times as long as the tibia.
16. *sciarina.*

hh. Costa but slightly produced.

i. Fore tarsus over twice, the metatarsus over .8 as long as the tibia.

j. Spurs pale. 17. *delicata* n. sp.

jj. Spurs dark. 7. *gracilis* n. sp.

ii. Fore tarsus less than 1.7, the metatarsus less than .75 as long as the tibia (female).
18. *obesula* n. sp.

aa. Subcostal crossvein (Sc_2) absent.

b. Subcostal vein ends distad of the base of Rs; costa noticeably produced; cubitus forks under or proximad of proximal end of crossvein. (Compare 12. B. Hopkinsii). 3. *obscura* n. sp.

bb. Subcostal vein ends at or proximad of the base of Rs; costa but slightly produced.

c. Fore tarsi not over twice, hind tarsi not as long as the tibia.

d. Subcosta ends nearly opposite the base of Rs.

e. Abdomen unicolored. 19. *inops.*

ee. Abdominal segments with yellow posterior margins (female). 19a. *inops* var. a.

dd. Subcosta ends proximad of the middle of the R-M crossvein. 20. *sedula* n. sp.

cc. Fore tarsi over twice, hind tarsi longer than the corresponding tibiæ. 21. *nacta* n. sp.

1. *Boletina abdominalis* Adams.

Kansas Univ. Science Bul. II. 24. 1903.

Male. Length 3.5 mm. Black, subshining; head and members black, except first antennal joint, which is tinged with yellow, middle ocellus very small; mesonotum black, subshining, covered with yellow pile, which are inclined to arrange themselves into rows, scutellum black, pile yellow, pleura black, without pile, metanotum black, halteres black; abdomen wholly black, subopaque, hypopygium with a yellowish tinge, pile yellow; legs yellowish, trochanters and tarsi, except base, largely fuscous; wings grayish hyaline, veins fuscous, subcosta joins the costa opposite base of Rs, subcostal crossvein slightly before the proximal end of the crossvein; furcation of the cubitus is just distad of the same, and the furcation of the media is distad of the base of Rs. "Mo." April.

2. *Boletina parvula* Coquillett.

Proc. U. S. Nat. Museum. XXIII. 597. 1901 (Leptomorphus). *parvula,* Johannsen; Gen. Ins. Fasc. 93, 75. 1909. (*Boletina*).

An examination of the type showed that this species belongs to *Allocotocera* and not to *Boletina* as I formerly believed. *A. flavescens* is a synonym.

3. *Boletina obscura* n. sp.

Male. Length 3.5 mm. Black, including the head and all its parts, thorax, abdomen and coxæ; legs paler, femora light yellow, tibiæ slightly darker, spurs white, tarsi brown; wings hyaline, cinereous tinged, veins pale brown, venation as figured (Fig. 179); halteres yellow. Antennæ long, intermediate joints over twice as long as broad. Thorax dull, hairs including those of scutellum bright yellow on the mesonotum in 3 rows; abdomen subshining, its hairs as well as those of the coxæ, pale. Hypopygium dusky (Fig. 146). One claw on each of fore and middle foot, modified, scoop-shape, fluted and with serrate margin. Hampton, N. H., April and May (S. A. Shaw); Ithaca, N. Y.; Forest Hill, N. J., (Weidt), April.

Female. Differs in having the fork of the cubitus slightly more retracted, in having relatively slightly shorter fore metatarsus, and in having unmodified claws. Brookline, Mass. (C.W.J.)

In this species the subcostal crossvein (Sc_2) is frequently absent.

4. *Boletina cincta* n. sp.

Male. Length 4 mm. Head black, face, palpi, 3 or 4 basal joints of antennæ yellow; intermediate antennal joints about twice as long as wide. Thorax yellow, mesonotum with 3 confluent black stripes; scutellum and base of metanotum black; hairs yellow; scutellar setæ black. Abdomen yellow, the dorsum of 1, the whole of 5, 6, 7 and hypopygium (Fig. 147) and large basal triangular saddles on 2, 3 and 4, black. Coxæ and legs yellow, tarsi brownish, spurs yellow, trochanters black; each tarsal claw toothed at base. Wings hyaline, slightly smoky toward the end of the costa; petiole of the media over twice as long as the crossvein (Fig. 180). Halteres yellow. Mt. Ascutney, Vt., July. (C.W.J.)

Female. With slightly shorter fore metatarsi; abdominal segments 2, 3, and 4 black, with posterior 1-3 of each segment yellow; ventral sclerite of ovipositor twice as long as the distal joint. Old Forge, N. Y. July. (J.G.N.)

5. *Boletina melancholica* n. sp.

Male. Length 4 mm. Head black, palpi and antennæ brown, intermediate joints of the latter about 3 times as long as broad, base of joint 3, yellowish. Thorax and abdomen wholly black, hairs yellow. Hypopygium black, resembles that of *obscura,* but forceps (Fig. 149) and median ventral lobe (Fig. 148) differ. Coxæ and legs yellow, tarsi brown, trochanters black, tibial spurs pale yellow; all claws scoop-like, fluted and with serrate margin. Wings hyaline, veins yellowish (Fig. 181). Halteres yellow, Dubois, Wyo., Sept. (W.M.W.)

Female. Intermediate antennal joints about twice as long as wide; venter and abdominal tergites with pale brown margins; ovipositor yellowish. Jackson Lake, Wyo., Sept. (W.M.W.)

6. *Boletina imitator* n. sp.

Male. Length 6 mm. Head brown, face, palpi and 4 basal joints of antenna yellow, intermediate antennal joints about 3 times as long as broad. Thorax yellow, the 3 stripes on the mesonotum brown, the scutellum and the metanotum largely brown; hairs yellow. Abdomen dark brown, venter paler; hypopygium as shown (Fig. 150). Coxæ and legs yellow, the trochanters, tarsi and tibial spurs, brown; tarsal claws all alike, toothed at base. Wings hyaline, veins dusky yellow (Fig. 182). Halteres yellow. Longmire's Springs, Mt. Rainier, Wash. August. (J.M.A.)

7. *Boletina gracilis* n. sp.

Male. Length 6.5 mm. Head black, pruinose, face and antennæ brown, palpi yellow, basal joints brown; intermediate antennal joints about 3 times as long as broad. Thorax dusky yellow, mesonotum with 3 broad dull black stripes, scutellum, metanotum and sternum and sometimes the pleura largely dark brown; hairs yellow. Abdomen brown, base of hypopygium and claspers (Fig. 151) dusky yellow. The hypopygium is figured in Genera Insectorum, Fascicle 93, Plate 7, Fig. 9. Coxæ and flexor surface of femora and tibia yellow, other parts of legs including spurs brownish, trochanters blackish; claws all similar, slender but slightly curved, basal tooth small. Wings hyaline, grayish tinged, veins dusky yellow. (Fig. 183). Halteres yellow, apex of knob brownish. Cal., Aug., (J.C.B.); Two-gwo-tee-e Pass, Wyo., Sept. (W.M.W.)

Female. Similar, but the yellow of the thorax is confined to the humeri. Ovipositor paler brown, the lobes yellow. Wyo.

8. *Boletina longicornis* n. sp.

Male. Length 4.5 mm. Head and face dark brown; palpi, the scape and the base of the first flagellar joint, yellow, remainder of flagellum brown; intermediate segments over 5 times as long as wide. Thorax dusky yellow, the 3 dorsal stripes dark brown; the scutellum, the metanotum and the lower half of the pleura, brownish; hairs yellowish. Abdomen dark brown, the posterior margin of the intermediate sclerites yellow; hypopygium as figured (Fig. 152). Coxæ and femora yellow, the apical half of the former and the tibia dusky yellow, the tarsi and the tibial spurs brownish; tarsal claws all similar, each with basal teeth. Wings hyaline, grayish tinged, veins dusky yellow (Fig. 184). Halteres yellow. Moscow, Id., April. (J.M.A.)

9. *Boletina notescens* n. sp.

Male. Length 5 mm. Head dark brown, face, mouth parts, and basal 1-3 of antennæ yellow, apical part of antenna brown; intermediate joints scarcely twice as long as broad. Thorax yellow, the 3 dorsal stripes reddish. Abdomen pale brown, posterior segments darker, venter and posterior margins of the intermediate dorsal sclerites yellowish; hypopygium pale brown resembling that of *B. imitator* but shorter in proportion to the width, and with shorter and stouter forceps (Fig. 153). Coxæ and legs yellow, trochanters blackish, tarsi and tibial spurs brown; claws all similar, each with one strong and several minor basal teeth. Wings grayish, hyaline; veins dusky yellow (Fig. 185). Halteres yellow. Ithaca, N. Y. June.

In another specimen from Massachusetts the face, basal portion of each abdominal tergite and thoracic stripes are dark brown but otherwise does not differ. It is possible that the Ithaca specimen is teneral.

Female. Similar to the Massachusetts specimen in coloring.

Var. a. Female. Similar to the foregoing but abdomen is wholly black. Mt. Greylock, Mass., June. (C.W.J.) Ovipositor is shown in Fig. 161.

Var. b. Female. Similar to Var. a. but the subcostal vein is produced a little distad of the base of Rs. Friday Harbor, Wash. (J.M.A.)

10. *Boletina grœnlandica* Stæger.

Naturh. Tidsskr. I. 356. 1845.

Male and female. Length 5 mm. Head and palpi blackish; antennæ of the male over twice as long as the thorax, immediate base of joint 3 reddish, remaining joints fuscous. Thorax and abdomen blackish, abdomen of the female with posterior margins of segments 2-6 yellow. Halteres pale. Legs yellow, posterior coxæ, and all trochanters and tarsi blackish; tibiæ testaceous, spurs yellow; posterior femora blackish at apex. "Greenland."

11. *Boletina beringensis* Coquillett.

Diptera of Commander Isl. 342. 1898.

Female. Length 4.5 mm. Head black, opaque gray pruinose, antennæ blackish brown, the second joint yellow, proboscis blackish brown; palpi yellow; thorax, scutellum and abdomen black, the hairs yellow, mesonotum marked with 3 black vittæ, posterior margins of the abdominal segments 2 to 6 and the genitalia yellow. Coxæ, femora and tibiæ yellow, the trochanters black; tarsi except the base, brownish black. Wings hyaline, the costal cell yellowish, veins yellow, the basal third of M_2 colorless; tip of Sc_1 slightly before base of Rs, Sc_2 a short distance before the middle of Sc_1; M and Cu forking slightly before the base of Rs, the forking of M more proximal than that of Cu; anal vein extending a short distance beyond the forking of Cu. Halteres yellow. "Bering Isl." July-Aug.

12. *Boletina Hopkinsii* Coquillett.

Canadian Entomologist. XXVII. 200. 1895. (Mycetophila).

Male. Length 4 mm. Black, the thorax and abdomen subshining, not pollinose; halteres, femora, tibiæ and base of metatarsi dusky yellow. Antennæ twice as long as head and thorax united, densely short, white pubescent. Thorax and scutellum sparse, coarse, golden yellow pilose, abdomen fine yellowish white pilose. Front tibiæ destitute of stout bristles except at the tip, the middle and hind ones bearing numerous black bristles. Wings gray, unmarked; Sc_1 ending in the costa slightly beyond the base of Rs; media forks the length of the crossvein beyond the latter; cubitus forks opposite the proximal end of the crossvein; anal vein scarcely reaching beyond the middle of Cu_2; costal vein reaches the first third of distance between tips of Rs and M_1. "Morgantown, W. Va."

A single male specimen from Hampton, N. H. (S. A. Shaw) which may be this species or else an abberant specimen of *B. obscura* has Sc_2 very indistinct, proximad of the middle of Sc_1, the petiole of the media but little longer than the crossvein and the fork of the cubitus slightly distad of the proximal end of the crossvein.

13. *Boletina sobria* n. sp.

Female. Head, thorax and abdomen brownish black, slightly pruinose; lamellæ of ovipositor, palpi and flagellum of antennæ brown, the intermediate joints of the latter not twice as long as wide; body hairs yellowish. Coxae and legs yellow; trochanters blackish, tarsi brown; spurs pale yellow; claws each with 4 or 5 basal teeth, those of hind claws more minute. Wings grayish hyaline, veins dusky yellow (Fig. 186). Halteres yellow. Longmire's Springs, Mt. Rainier, Wash. August. (J.M.A.)

14. *Boletina arctica* Holmgren.

Oefv. Vetensk. Akad. Forh. 105. 1872.

Male and female. Length 4-5 mm. Blackish, subopaque; thorax cinereous with 3 black stripes, the middle one geminate; furrow below the humeri pale; antennæ wholly blackish; palpi fuscous, yellowish apically; abdomen blackish. Wings hyaline, anterior veins dusky; fork of the cubitus more retracted than that of the media. Halteres and legs yellowish, coxæ cinereous, tarsi fuscous. "Greenland."

Rübsaamen (in Bibliotheca Zool. XX. 104, '98) describing a specimen which he identifies with the above adds that the flagellar joints are distinctly longer than broad, the tarsal claws each have a basal tooth, and gives a figure of the wing in which Sc_1 ends proximad of the base of R_1; Sc_2 is distad of the middle of Sc_1; petiole of M slightly longer than the crossvein; costa produced far beyond tip of Rs, and cubitus forks under the petiole of the media. Hypopygium as figured (Fig. 154).

15. *Boletina tricincta* Loew.

Berlin. Ent. Zeitschr. XIII. 143. 1869.

Male and female. Length 3.2 mm., wing 3.2 mm. Head black, antennæ fuscous black, scape and base of the flagellum testaceous or subfuscous; palpi yellow. Thorax and abdomen shining black; abdominal sclerites 2-4 with yellow posterior fascia; venter except last 3 segments, yellow. Hairs yellow. Hypopygium small, similar to that of *B. dispecta* Dzied. but terminal appendages with 10 apical rays, and forceps differ (Fig. 157); lamellæ of ovipositor pale. Coxæ and legs yellowish, trochanters with fuscous spot, tibial spurs dusky yellow or pale; tarsi except the base fuscous; fore tarsi of the female tumid. Wings grayish hyaline, heavier veins fuscous. Halteres yellow. "Wis., Md."

The intermediate antennal joints not twice as long as broad; in the male one claw of the fore and middle feet, modified scoop-like, fluted and with serrate margin, the other claws sharp but with a serrate and scoop-like basal tooth; in the female each claw has a serrate basal tooth. Venation as figured (Fig. 187). Selkirk Mts., B. C. (J.C.B.); Me. and Mass. (C.W.J.); R. I. (J.B.); Wis. (W.M.W.); Ithaca, N. Y.; Brookside, N. J., (Weidt), July-Sept.

16. *Boletina sciarina* Stæger.

Kröger. Ent. Tidskr. 236. 1840.

Male and female. Length 3-4 mm. Wholly blackish brown; coxæ, femora, spurs and halteres yellow; tibiæ darker, tarsi brown; hind coxæ and sometimes the others also more or less brown. Antennæ of the male from 1.5-2 times as long as head and thorax taken together; the fore tarsi about 1.75 times as long as the tibia, the fore tibia about 1.5 times as long as the metatarsi. Wings grayish hyaline with brown veins; costa produced far beyond the tip of Rs; petiole of the media about twice as long as the crossvein; Sc_2 distad of the middle of Sc_1; Sc_1 ends opposite the base of Rs; cubitus forks under the crossvein or sometimes opposite its proximal end. "Greenland and N. H."

According to Rübsaamen one claw of each foot is modified scoop-shape, fluted and with serrate margin. I have female specimens from Maine and New York which appear to belong here. According to a figure given by Dziedzicki the hypopygium resembles that of *B. obscura* but the forceps are differently formed (Fig. 156).

Some female specimens from California and Wyoming resemble this species but differ in having longer fore tarsi.

17. *Boletina delicata* n. sp.

Male. Length 3 mm. Head, including mouth parts, basal antennal joint black (flagellum broken). Thorax and abdomen black, subopaque, with yellow hairs. Hypopygium black, resembling that of *obscura* but with different forceps (Figs. 159, 160) and terminal appendages (Fig. 158). Coxæ, femora, tibiæ and tibial spurs yellow, tarsi brownish; claws broad, digitate, digits contiguous, outer digit shorter and free. Wings grayish hyaline, veins dusky yellow (Fig. 188). Halteres yellow. Jackson Lake, Wyo., Sept., (W.M.W.)

18. *Boletina obesula* n. sp.

Female. Length 5.5 mm. Head, including mouth parts, and antennæ, black; intermediate antennal joints about twice as long as broad. Thorax black; abdomen dark brown with posterior margins of both dorsal and ventral sclerites of segments 3 and 4, and lamellæ of ovipositor, yellow. Immediate base of fore, basal 2-3 of middle and hind coxæ, and trochanters dark brown; femora and tibiæ yellow, tarsi brown; tarsal claws all similar, with basal teeth. Wings grayish hyaline, anterior veins strong, dark. (Fig. 189). Head of Tsirku River, Alaska, July-Aug., (O. M. Leland).

19. *Boletina inops* Coquillett.

Proc. Washington Acad. Sc. II. 391. 1900.

Male and female. Length 4.5 mm. Black, the second joint of antennæ and base of the third, the palpi, halteres, coxæ, femora and male hypopygium yellow, tibiæ brownish yellow; hairs of body yellow; thorax subopaque, thickly gray pruinose; abdomen subopaque; bristles of inner side of middle tibiæ slightly shorter than the diameter of each tibia; wings hyaline, tip of the subcosta slightly before the base of the radial sector, subcostal crossvein wanting; media forking slightly beyond, the cubitus about opposite to base of radial sector; third joint of antennæ twice as long as wide; hypopygium of male at least 1-2 longer than the longest segment of the abdomen preceding it. "Yakutat and Orca, Alaska."

Var. a. A single female specimen from Moores Lake, Idaho, differs in having brownish hind coxæ and abdominal segments except the first with yellow posterior margins. Wing venation as figured (Fig. 190). The leg measurements given on page 324 are of this specimen.

20. *Boletina sedula* n. sp.

Male and female. Length 3.5 mm. Head black, gray pollinose, antennæ dark, 3 basal joints yellow, intermediate joints over twice as long as wide, palpi yellowish. Thorax and abdomen black, gray pollinose, the abdomen subshining, hairs yellow. Hypopygium black, resembling that of *B. gracilis*. Coxæ and legs yellow, tarsi infuscated, spurs black; claws unmodified, each with strong tooth near the base. Wings 4 mm. long 3.6 times as long as the fore tibia; hyaline, veins yellowish brown; venation as figured (Fig. 191). Halteres yellow. Longmire's S, rings, Mt. Rainier, Wash., August (J.M.A.). In the female the fork of the cubitus is a little proximad of fork of the media.

21. *Boletina nacta* n. sp.

Male and female. Length 3.5 mm; wings 4 mm. Head and its parts black, intermediate antennal joints about 3 times as long as wide. Thorax and abdomen black subopaque, hairs yellow; hypopygium black, similar to that of *B. gracilis* but forceps differ. (Fig. 155). Coxæ and legs yellow, the bases of hind coxæ and the trochanters black; tarsi infuscated; spurs yellow; claws unmodified, each toothed near the base. Wings 3.75 times as long as the fore tibia; hyaline, veins yellowish brown; venation as figured (Fig. 192). Halteres yellow. Two-gwatee-e Pass, Wyo., Sept. (W.M.W.). In one specimen from Black Rock Creek, Wyo., the subcosta ends opposite the base of Rs.

11. *Genus Leia* Meigen.

System. Beschr. I. 258. 1818.

Lejomya Rondani, Prodr. 1, 195. 1856.

Glaphyroptera Winn. Verh. Zool.-bot. Ges. XIII. 781. 1863.

Neoglaphyroptera. O. S. Catl. Dipt. N. A. 10. 1878.

Eyes oval, ocelli 3, the laterals large, rather close though not contiguous to the eye margin, the middle one rarely absent. Legs moderately strong, setæ of fore legs rather delicate; those on the extensor surface of middle and hind legs stout. Wings elongate oval; subcosta ends in the costa at one-fourth or one-third the wing length from the base and is connected with R_1 by Sc_2 near its apex; the basal cell R is very long, extending beyond the middle of the wing; the media usually forks noticeably before the base of the radial sector; the cubitus forks proximad of the proximal end of the R-M crossvein, its anterior branch is sometimes slightly disconnected at the base; anal vein stout, incomplete. The larvæ live in mushrooms.

Table of species.

a. Thorax largely black, not vittate, humeri and anterior margin may be yellow, wing fasciate.
  b. Fore part of thorax yellow, head black between the eyes, wings with preapical fascia and a dash behind Cu_2 but no discal mark. 1. *varia.*
  bb. Thorax not yellow anteriorly except sometimes the humeri.
    c. Scutellum, vertex, and occiput yellow; Mexican. 2. *punctata.*
    cc. Scutellum black.
      d. Halteres wholly yellow.
        e. Costa produced about 1-10 of distance from Rs to M_1. 3. *melaena.*
        ee. Costa not produced.
          f. Preapical wing band lies beyond the middle of cell Rs and nearly fills apex of the wing. 4. *nigra* n. sp.
          ff. Preapical wing band nearly reaches the base of cell M_1. 4a. *nigra* var. *ε*

dd. Knob of halteres blackish.

e. Brown spot on wing at origin of the crossvein; proximal abdominal segments yellow anteriorly; pleura yellow anteriorly. St. Vincent Isl. 5. *nitens.*

ee. No brown spot at origin of the crossvein; proximal abdominal segments wholly black; Eastern U. S. 6. *ventralis.*

aa. Thorax largely yellow, or if not then at least distinctly yellow between the dorsal vittæ.

b. Mesonotum shining black except humeri and two slender converging yellow lines on each side of a wedge-shaped black median vitta.

c. Venter yellow, dorsum mainly black. 7. *cuneola.*

cc. Abdomen almost wholly black; female; Mexico. 8. *amabilis.*

bb. Mesonotum not so marked.

c. Thorax with 3 distinct dark brown, longitudinal vittæ, middle one sometimes divided; wing with fasciæ or spots.

d. A brown cloud near apex of wing distad of the preapical fascia. 9. *Winthemii.*

dd. No cloud on wing distad of the preapical fascia.

e. Hind coxæ and femora yellow. 10. *striata.*

ee. Hind coxæ and femora largely black. 11. *lineola.*

cc. Mesonotum spotless, or with only 3 reddish stripes, or with black spots on each side at base of wing.

d. Without conspicuous black spot on each side at base of wing.

e. Wing unmarked.

f. Abdomen yellow. 12. *unicolor.*

ff. Abdomen fasciate.

g. Thorax with 3 reddish brown vittæ; fore metatarsus shorter than the tibia. 13. *plebeja* n. sp.

gg. Thorax yellow; fore metatarsus as long as the tibia. 14. *hyalina.*

ee. Wing fasciate.

f. Wing with brown spot at base of crossvein.

g. Hairs of thorax yellow, setæ darker; species from the United States.

h. Crossvein shorter or not longer than the apical part of R_1. 15. *oblectabilis.*

hh. Crossvein longer than apical part of R_1. 15a. var. of *oblectabilis.*

gg. Hairs and thoracic setæ black; species from West Indies. 16. *concinna.*

ff. Wing without brown spot at base of crossvein. 17. *dryas* n. sp.

dd. Mesonotum yellow with shining black spot, large or small, on each side in front of the base of the wing.

e. Wing unmarked, hyaline.

f. Pleura and metanotum black. 8. *amabilis.*

ff. Anterior part of pleura and center of metanotum yellow. 18. *cincta.*

ee. Wing with preapical fascia.

f. Middle ocellus wanting; no cloud at proximal end of the crossvein. 19. *decora.*

ff. Middle ocellus present and frequently surrounded by black.

g. Wing with a distinct brown cloud at the proximal end of the crossvein; lateral thoracic spots large. 20. *opima.*

gg. Wing without distinct cloud at proximal end of the crossvein.

h. Thoracic spot at base of wing, small, punctiform, not extending down over the metapleural lobes; abdominal fasciæ usually produced forward on the middle line. 21. *sublunata.*

hh. Thoracic spot at base of wing large, produced over the metapleural lobes; abdominal fasciæ usually emarginate, sometimes divided, rarely produced. 22. *bivittata.*

Leia miocenica Cockerell (Bul. Am. Mus. N. Hist. 76. 1911) is a fossil from the Miocene shales of Florissant, Colorado.

1. *Leia varia* Walker.

List of Diptera, Brit. Museum. I. 93. 1848.

Length 3.5 mm; of wings 8 mm. Body yellow; head black between the eyes, which, and the feelers are also black; the latter are yellow at the base; chest except the fore part, black; segments of the abdomen bordered with black, which color extends partially along the sides of the segments; legs yellow; hips and thighs much paler than the shanks and feet; wings colorless, each with a broad, brown irregular and interrupted band near its tip; veins brown.

To the above may be added that the upper half of the pleura, the scutellum, metanotum and last abdominal segment are brownish to black, the halteres are yellow and wings as figured (Fig. 193). "Canada;" Wis., and Wyo., (W.M.W.).

2. *Leia punctata* Bellardi.

Saggio di Ditterol. Messicana, Append. 202. 1861.

Male. Length 4 mm. Black, shining. Lateral ocelli large, black; median small, black; vertex and occiput yellowish, shining; antennæ black; the first two joints and the under side of the third and fourth, yellow, the tip white; face and palpi yellow. Thorax wholly blackish, bare, shining; pleura black, each with yellow median spot; scutellum yellow; metathorax shining black. Abdomen black; genitalia yellow; venter yellow, blackish toward the base. Coxæ yellow, bare, at apex bipunctate; femora yellow each with black spot at base, blackish above; tibia yellow; tarsi fuscous; first joint yellow toward the base. Wing iridescent; with preapical spot. The figure shows the wing spot extending back into the base of the fork of the media.

"Tuxpango, near Orizaba, Mexico."

3. *Leia melæna* Loew.

Berlin. Entomol. Zeitschr. XIII. 144. 1869.

Male. Length 3 mm; wing 3.8 mm. Black, shining, with yellowish pile. Head black, face yellow; palpi pale yellow, antennæ black, 3 basal joints yellow. Thorax black, humeral triangle whitish. Abdomen black, pile yellow, hypopygium black (Fig. 162), black pilose. Coxæ and legs pale yellow, tip of each posterior femur blackish, apical joints of hind tarsi infuscated, hind tarsi a little shorter than the tibiæ. Wing proportionately long, hyaline; with wide preapical fascia which is more dilute toward posterior margin; a brown cloud behind Cu_2 (Fig. 194). Costa slightly produced beyond the tip of Rs. Halteres yellow.

"New York;" R. I., (J.B.).

4. *Leia nigra* n. sp.

Male. Length 4 mm. Head shining black, face pruinose, antennæ black, scape and palpi yellow. Thorax shining black, faintly pruinose in oblique view, setæ black, fine hairs yellowish. Abdomen shining black, hairs yellowish; intermediate ventral sclerites narrowly margined with yellowish, hypopygium black (Fig. 163). Coxæ, femora and tibial spurs yellow, tibiæ and metatarsi dusky yellow, remaining tarsal joints brown; setæ of tibiæ and tarsi and of apex of coxæ black. Wing white hyaline, preapical fascia does not cover the basal half of cells R_1 and M_1 (Fig. 195). Halteres yellow. Pullman, Wash., (J.M.A.).

Female. Differs in having black pile on thorax and abdomen; yellow fasciæ of ventral abdominal sclerites less extended, and tibiæ more brownish. Midvale, Montana (C. E. Brown).

Var. a. Female. Length 3.5 mm. Hairs of thorax and abdomen yellowish. Wing fascia is produced proximad in cell M_1 nearly reaching the fork. Little Wind River, Wyo., (W.M.W.), Sept. Represented by but a single specimen. It may be a distinct species.

5. *Leia nitens* Williston.

Trans. Ent. Soc. London. 259. 1896.

Male and female. Length 4 mm. Mesonotum shining black; wings infuscated. Front black or blackish, yellowish on the lower part; face yellow; antennæ blackish, the basal joints yellowish, about as long as the thorax. Mesonotum, scutellum, and metanotum shining black, the bristles of the same color; pleura yellow in front; reddish-brown behind. Abdomen slender; shining black or deep brown, the proximal segments in front yellow or yellowish; venter yellow. Tuberculum of halteres black. Coxæ yellow; femora nearly the same color; hind femora at the tip blackish; tibiæ brownish yellow; tarsi brown; front tibiæ shorter than the metatarsi; middle tarsi nearly a half longer than their tibiæ; hind tibiæ and tarsi of nearly equal length. Wings infuscated, the apex tinged with blackish; a brown spot at the origin of the crossvein. Middle and hind tibiæ with stout spurs. In some specimens the face is brown, the front wholly black, the posterior part of the pleura and greater part of abdomen, black. "St. Vincent Isl."

6. *Leia ventralis* Say.

Long's Exped. to St. Peter's River. App. 364.

Male and female. Length 3.5 mm. Head black; antennæ brown, 3 basal joints and the palpi yellow. Thorax and abdomen shining black, venter with segments 3 and 4 largely yellow; hairs pale. Coxæ, femora, tibiæ, and metatarsi yellow; remainder of tarsi brown; tip of each hind femur blackish; tibial spurs yellow. Wings whitish hyaline, the broad preapical band nearly reaches the base of the fork of the media. (Fig. 196). Halteres yellow with black knob. "North West

Terr.;" Mt. Ascutney, Vt., (C.W.J.); Traveler's Mt., Me., (J. A. Cushman), July.

7. *Leia cuneola* Adams.

Kansas Univ. Science Bul. II. 25. 1903 (Neoglaphyroptera).

Female. Length 4 mm. Yellow, shining; vertex with a transverse black line, occiput with a reddish cast and sparse yellow pile, antennæ, except base, dark brown; mesonotum with 3 shining black stripes, the 2 lateral ones nearly as broad as long, the middle one wedge-shaped, scarcely reaching the middle of the dorsum, pile yellow, scutellum yellow, with 2 long yellow bristles; pleura black, yellow above anterior coxæ, metanotum black, halteres yellow; abdomen shining black, except narrow lateral margins, apex and venter, which are yellowish, pile very short and yellow; legs yellow, a small spot on trochanter, extreme tip of posterior femora, of tibiæ, and tarsi in large part, fuscous; wings hyaline, a brownish fascia traversing the wing, starting about midway between tip of first vein and apex of wing. (Fig. 197). "Colo., August." Pollock, Ida. (J.M.A.) July.

8. *Leia amabilis* Williston.

Biolog. Centr. Amer. I. Suppl. 219. 1900 (Neoglaphyroptera).

Male. Length 4 mm. Head yellow. Antennæ longer than the head and thorax together; black, the scape and first 3 or 4 joints of the flagellum yellow. Thorax yellow, mesonotum with a large, deep, shining black spot on each side, leaving a narrow median stripe and front part yellow. Metanotum and mesopleura shining black; immediately subjacent to the root of the wings the color is blackish. Abdomen brownish-black, with the anterior margin of each segment and the venter yellow. Legs yellow; the tip of the hind tibiæ and the tarsi brownish; front tarsi nearly 2.5 times the length of the tibiæ; the tibiæ hardly longer than the metatarsi. Wings lightly tinged with brownish; Cu_1 separated at its origin from the vein.

Female. Head above black. The yellow of the mesonotum has an elongated black spot or stripe in the middle, narrowed to a point, and separated from the same color of the sides by a slender, curved, yellow stripe, posterior half of the pleura black. Wings with a brownish crossband distally. Abdomen almost wholly black. "Mexico."

In one male (from Medellin) the abdomen is yellow, with large black spot on each side of the segments, except the sixth; hypopygium is also black. In one female (from Orizaba) the median spot of mesonotum is absent and the fascia of the wing is obsolete.

9. *Leia winthemii* Lehmann.

Ins. Spec. in agro Hamb. captæ. 39. 1822.

Male and female. Length 4.5 mm. Head dusky yellow, face and palpi pale yellow, 3 basal joints and under side of joints 4 and 5 reddish yellow. Thorax yellow, with 3 stripes on mesonotum of which the middle one is geminate, the center of the scutellum, the middle of the metanotum, and posterior margin of metapleural lobes, brownish black; hairs pale; setæ brownish. Tergites brown, bases of all but the first broadly yellow, the brown produced forward on the middle line; venter and hairs yellow; hypopygium yellow, the ventral appendages black (Fig. 164). Coxæ and legs yellow, apices of trochanters, of hind femora, black, tarsi infuscated; spurs dusky yellow. Wings hyaline with brown markings as figured (Fig. 198). Halteres yellow. Maine; N. Y.; Wis., (W.M.W.); Oregon and Washington (J.M.A.); "Canada; N. H."

10. *Leia striata* Williston.

Kansas Univ. Quart. II. 60. 1893. (Neoglaphyroptera).

Male. Length 5 mm. Head yellow, the occiput somewhat brownish; antennæ brown, the basal joints yellow. Thorax yellow; mesonotum with 4 brown stripes, the median ones narrower, narrowed posteriorly and separated by a slender line, the lateral ones abbreviated in front; metanotum brown; bristles of the mesonotum well developed, as are also those of the trichostical row. Abdomen black, the anterior part of the segments yellow or brown. Legs yellow, tip of the hind femora and tibiæ and all the tarsi brown; front metatarsi as long as the tibiæ. Wings yellowish hyaline; an irregular brown band across the outer part, and brown spots on the crossvein and on Cu_2; anal vein incomplete; the subcosta terminates about opposite the furcation of the cubitus, and the subcostal crossvein is situated beyond its middle; the R-M crossvein longer than the last section of R_1. "Washington."

Var. a. A number of specimens resemble both the above and the following species (*L. lineola*) in most particulars, differing from the former and resembling the latter in the pleural marking; but differ from the latter in having hind coxæ and femora as in the former. In some specimens the head is marked as in the former while others are marked as in the latter. The forceps limb of a Wyoming specimen is shown in figure 165. The last section of R_1 is at least as long as the R-M crossvein (Fig. 199). The preapical wing band is broad except in the Carolina specimen. Sanford Univ. (J.M.A.); Marin Co. (Hy Edwards), Calif.; Little Wind River, Wyo., (W.M.W.); and N. C.

11. *Leia lineola* Adams.

Kansas Univ. Science Bul. II. 25. 1903. (Neoglaphyroptera).

Female. Length 4 mm. Differs from *L. striata* in the following particulars: The brown of the occiput is sharply defined, the center and sides being yellow; pleura with a brown spot anterior to and above the middle coxæ, metapleura above hind coxæ brown; the last 2 abdominal segments almost wholly yellow; all trochanters, the posterior coxæ and femora black, the latter with a narrow longitudinal line on the inner and outer sides, yellow; the brown crossband on outer part of wing is much broader. "Karn Co., Calif."

12. *Leia unicolor* Walker.

List of Diptera, Brit. Museum I. 93. 1848.

Body tawny; head reddish brown above; feelers and eyes black; the former tawny at the base; palpi yellow; hips and thighs yellow, shanks and feet dull tawny; wings colorless; veins brown; poisers yellow. Length of the body 5 mm., of the wing 10 mm. St. Martin's Falls, Albany River, Hudson's Bay.

Whether the species belongs to this genus cannot be determined from the description.

13. *Leia plebeja*, n. sp.

Male and female. Length 3.5 mm. Length of wing 3 mm. Pale reddish yellow; antennæ robust, longer than the head and thorax, six or seven apical joints somewhat infuscated; face and palpi pale; ocelli narrowly margined with black; thorax with a rufous tinge, its dorsum shining, covered with yellowish hairs interspersed with a few black ones and crossed by 4 longitudinal pale rufous bands, the 2 median of which are approximated and extend from the anterior almost to the posterior edge, while the 2 latter are broader and abbreviated before and behind. Scutellum broad and short, pale yellow, with 4 long pale bristles inserted on the posterior margin. Metanotum fuscous; pleura reddish yellow, slightly tinged with fuscous at the insertions of the posterior coxæ. Abdomen pale reddish yellow; the posterior third or half of each segment deep fuscous, or black; hypopygium yellow with blackish appendages (Fig. 166). Legs pale yellow throughout, tarsi but very slightly infuscated toward their tips. Spurs yellow. Halteres pale yellow. Wings grayish hyaline, immaculate, yellowish towards their bases and along their costal margins; veins yellowish (Fig. 200). Lawrence, Kas. (J.M.A.). Also a single specimen from Wisconsin with the MS name *plebeja* (W.M.W.).

14. *Leia hyalina* Coquillett.

Journal N. Y. Ent. Society XIII. 68. 1905. (*Lejomya*).

Length 4 mm. Yellow, the antennæ except at base, a spot on the front, 3 spots on the pleura, middle of metanotum, hind margins of abdominal segments, also apices of tarsi, black. Body polished, the short hairs yellow, the longer hairs and bristles of mesonotum and scutellum chiefly brown. First joint of front tarsi as long as the tibiæ. Wings hyaline, upper branch of cubitus usually interrupted at the base. "Las Vegas Hot Springs, N. M."

15. *Leia oblectabilis* Loew.

Berlin. Ent. Zeitschr. XIII. 146. 1869. (*Glaphyroptera*).

Female. Length 2.9 mm; wing 3 mm. Head yellow, palpi and antennæ paler, the latter darker toward the tip; ocelli black. Thorax wholly yellow, pile yellow, the setæ darker. Abdomen yellow, tergites with black posterior fasciæ which are produced triangularly along the middle line, usually reaching the anterior margin in all but the first segment, sixth segment nearly wholly blackish; seventh short, tipped with yellow; venter yellow, sixth segment black or blackish. Legs pale yellow, tips of hind femora black, spurs and tibiæ yellow, tarsi toward their apices subfuscous. Wings yellowish, tinged with cinereous, along the costa more yellow; preapical fascia wide, entire, slightly arcuate, fuscous spot at the proximal end of the crossvein and another below Cu_2 near its tip. Halteres yellow. "Middle States."

Male. Similar to female in coloring, but three thoracic stripes are feebly indicated. Hypopygium yellow (Fig. 167). Wing venation as shown (Fig. 201). Both sexes from N. C. (C.U.), Wis. (W.M.W.), Ohio and Ithaca, N. Y. July-Sept.

Var. a. Female. Differs from the foregoing in having the crossvein longer than the apical section of R_1, and in having narrower abdominal fasciæ which are not produced along the middle line. This specimen may represent a distinct species. Longmire's Springs, Mt. Rainier, Wash. (J.M.A.)

16. *Leia concinna* Williston.

Trans. Ent. Soc. London 259. 1896. (*Neoglaphyroptera*).

Female. Length 4 mm. Differs from *oblectabilis* as follows: Antennæ brown or blackish, the basal joints yellow; bristles and very short hair of the thorax black. Leg proportions as far as given by Williston are the same as for *oblectabilis*. "St. Vincent Isl., W. I."

17. *Leia dryas* n. sp.

Male and female. Length 3.5 to 4 mm. Pale yellow; each of the black ocelli surrounded by a narrow black border; antennæ scarcely as long as the head and thorax, growing fuscous on their apical half. Thoracic dorsum with sparse yellowish hairs among which are scattered a few black ones. There are traces of 3 or 4 longitudinal reddish bands. Scutellum concolorous with the thoracic dorsum; metathorax and postalar tubercle inclining to fuscous; a small black dot back of the insertion of each wing. Abdomen rather thickly covered with pale yellow hairs; the posterior fourth or third of each segment fuscous. Genitalia of male pale yellow. (Fig. 168). In the female the apical half of the abdomen, above and below, is fuscous. Legs paler than the thorax and abdomen; fore tibiæ less than half the length of the fore tarsi; apices of hind femora black; tarsi fuscous. Halteres pale yellow. Wings yellowish gray, the yellow tint being very noticeable at the base and along the costal margin; veins pale yellow. A slightly crescentic fuscous band passes over the wing before the apex, growing paler as it nears the posterior margin. There is no fuscous margin to the anal veins (Fig. 202). Southeastern Wisconsin. Specimens bearing MS name *dryas* (W.M.W.).

18. *Leia cincta* Coquillett.

Proc. Acad. Nat. Sc. Phil. 308. 1895. (*Neoglaphyroptera*).

Male. Length 4.5 mm. Head, including the mouth parts, yellow, each ocellus situated on a black spot, the median very small; antennæ yellow on the 6 basal joints, the remainder blackish. Thorax, pleura and scutellum yellow, a large black vitta at base of each wing extending across the metanotum. Abdomen shining black, base of each segment and the whole of the sixth and seventh, yellow. Legs yellow, bristles of front tibiæ minute, those of the others large. Wings yellowish hyaline, unmarked; base of the radial sector slightly distad of the forking of the media. "Tick Isl. Florida."

A male specimen from Opelansas, La., and another from Wisconsin (W.M.W.) which I identify as this species have the center of the metanotum, and the venter of the abdomen, yellow. The hypopygium and the wing of the Louisiana specimen are shown in the figures. (Figs. 98, 203).

19. *Leia decora* Loew.

Berl. Ent. Zeitschr. XIII. 144. 1869. (*Glaphyroptera*).

Female. Length 3.5 mm; wing 3.3 mm. Head yellow; antennæ except the base subfuscous or fuscous; lateral ocelli margined with black, middle ocellus wanting. Thorax yellow, on each side near the base of the wing with a blackish spot; the setæ blackish, the pile yellowish; disk of the scutellum fuscous; metanotum with median fuscous vitta; lateral tubercles blackish. Abdomen yellow, the tergites widely and sharply margined with black, the last two segments dorsally and ventrally wholly black. Coxæ and legs pale yellow, apex of hind femora black, tibiæ and spurs yellow, tarsi nearly wholly blackish. Wings yellowish tinged with gray, toward the costa and base more yellowish, stronger veins fuscous; preapical fascia perpendicular, paler posteriorly, Cu_2 accompanied by a subfuscous cloud. "Georgia."

Specimens of both sexes taken June-September at Ithaca, N. Y., do not differ from the type in the museum at Cambridge. Hypopygium and wing as figured. (Figs. 99, 204).

20. *Leia opima* Loew.

Berlin. Ent. Zeitschr. XIII. 145. 1869. (*Glaphyroptera*).

Male and female. Length 3.8 mm.; wing 4.1 mm. Head yellow, vertex and upper half of occiput fuscous; antennæ fuscous, scape, first flagellar joint and palpi yellow. Thorax including scutellum yellow; dorsum shining, on each side with large, black, oval spot which is produced forward to the anterior third of thorax leaving only a narrow yellow vitta in the center; the metathoracic tubercles and the metanotum black. Pile yellow, on the darker parts, dusky. Abdomen largely black, the base of the second tergite and the anterior angles of the following ones, the hypopygium (Fig. 100) and the venter, yellow. Coxæ and legs pale yellow, extreme apices of hind femora black, tarsi except their bases, fuscous black. Wings dilutely cinereous, veins fuscous; the preapical fascia paler toward the posterior margin; a fuscous spot covers the base of the cross-vein and the petiole of the media; another spot is behind Cu_2 (Fig. 205). Halteres yellow. "Connecticut;" Wis. and Wyo. (W.M.W.); R. I. (J.B.); N. C. (W.B.); Mass. (C.W.J.); Maine; N. H.; N. J., (Weidt).

21. *Leia sublunata* Loew.

Berlin. Ent. Zeitschr. XIII. 145. 1869. (*Glaphyroptera*).

Female. Length 4.3 mm; wing 4.5 mm. Head yellow, ocelli margined with black, middle one minute; antennæ subfuscous toward the tip; palpi pale yellow. Thorax yellow; mesonotum on each side near the base of the wing and in front of it, with a small black spot, metathoracic lobes sometimes margined with subfuscous. Abdomen yellow, first and sixth tergite with narrow black margin; the 4 intermediate with wide fasciæ which are suddenly narrowed at the lateral margins; seventh wholly yellow; venter yellow. Coxæ and femora pale yellow; extreme tip of hind femur black; tibiæ and spurs yellow; tarsi except their bases, fuscous black. Wings yellowish, veins fuscous, toward the base in part yellowish; near the tip with a slender arcuate fascia; Cu_2 with a fuscous cloud behind it. "N. Y."

Male. Like the female in color characters. Wing and hypopygium figured (Fig. 101, 206). Ithaca, N. Y.; Brookside, N. J., (Weidt).

A female specimen from Pennsylvania has narrower abdominal fasciæ; one from B. C. has broader wing faciæ; one from N. C. (W.B.) has a faint cloud upon the crossvein and petiole of the media, and less distinct abdominal fasciæ.

22. *Leia bivittata* Say.

Jr. Acad. Nat. Sc. Phil. VI. 152. 1829.

Length 3.75 mm. Honey yellow; trunk bilineate, and tergum with 2 series of black punctures. Body rather pale honey-yellow; antennæ black at tip; stemmatæ very distinct, in a curved line; thorax a little hairy, on each side a dilated black vittæ; wings fasciate near the tip; tergum on each side with a series of oval black spots; coxæ white. "Indiana."

To the above may be added the following: Ocelli are margined with black; the lateral spots on the mesonotum are large, oval, shining black, connected posteriorly with a broad, sometimes somewhat interrupted, black stripe passing under the wing and covering the lateral lobes of the metathorax, sometimes the metanotum is also black. The tergites each usually have a broad transverse fascia which is deeply emarginate in front, sometimes wholly broken giving rise to the condition described by Mr. Say. Male and female are similar in coloring. (Fig. 207). Conn.; R. I. (C.W.J.); N. C. (F. Sherman and W.B.); Wis.; Ill. (W.M.W.); Kas.; Minn.; Iowa; Mich. (J.M.A.); Ithaca, N. Y.

12. *Genus Phthinia* Winnertz.

Verh. Zool.-bot. Ges. Wien. XIII. 779. 1863.

Ocelli 3, laterals widely remote from the eye margin. Thorax small, highly arched; abdomen long, filiform in the male, a little broader in the female. Legs very long and slender. Wings shorter than the abdomen; costa extends beyond the tip of the radial sector; subcosta ends in the subcosta; subcostal crossvein (Sc_2) present; petiole of the media very short; cubitus forks distad of the fork of the media and its branches are widely divergent. (Figs. 208, 209).

Table of species.

a. Fore metatarsus shorter than its tibia; moderately slender species with moderate or strong tibial spurs.

b. Subcostal crossvein (according to the figure) distad of the base of the radial sector (St. Vincent Is.). *Megalopalma.* 1. *fraudulenta.*

bb. Subcostal crossvein situated slightly distad of the middle of the basal cell; subcosta ends about opposite the base of the radial sector. 2. *curta* n. sp.

aa. Fore metatarsus over twice as long as its tibia; very slender and delicate species with weak tibial spurs. 3. *tanypus.*

1. *Phthinia fraudulenta* Williston.

Trans. Ent. Soc. London. 263. 1896.

Male. Length 2½-3 mm. Antennæ brown or blackish, the basal joints somewhat yellowish; the joints of the flagellum closely set together, somewhat compressed; front and face blackish. Mesonotum reddish-brown, shining, with black hair; pleura and coxæ yellow. Abdomen reddish brown or blackish, black at tip, venter yellow. Legs yellow, the tarsi brownish, becoming black at the tip, spurs of tibia stout; hind tibiæ with 2 rows of spines; front metatarsi distinctly shorter than their tibiæ; hind tarsi longer than their tibiæ. Wings tinged with blackish, due to the easily perceptible pubescence. "St. Vincent Isl." Williston. Judging from the figure this species belongs to Enderlein's new genus, *Megalopelma.*

2. *Phthinia curta* n. sp.

Male and female. Length 3 mm. Head black, mouth parts and basal joint of antenna yellow; the flagellum, two large spots on each pleuron, 3 stripes on mesonotum, the metanotum, abdomen, and tarsi pale brown, other parts yellow. The median thoracic stripe is wedge shape, contiguous to anterior margin, abbreviated posteriorly, the laterals are abbreviated anteriorly, converge posteriorly, nearly meeting at the scutellum. Fore metatarsus is about .8 as long as its tibia; tibial spurs of moderate size, those of the hind legs about as long as the 4th tarsal joint. Wings hyaline, grayish, veins brown, venation as figured (Fig. 208). Hypopygium (Fig. 102). Halteres yellow. Ithaca, N. Y.

3. *Phthinia tanypus* Loew.

Berlin. Ent. Zeitschr. XIII. 143. 1869.

Male and female. Length 6-6½ mm. Very slender, legs very delicate, much elongated. Head yellowish to subfuscous; antennæ fuscous, immediate base and scape, yellow; palpi yellow, dusky toward the tips. Thorax opaque, ferruginous to fuscous, pleura paler, dorsum not vittate; humeri and lateral line from the humerus to the base of the wing white pollinose. Abdomen slender, much elongated, fuscous black, each segment paler toward the base. Genitalia pale; hypopygium small. Coxæ and legs yellowish, apical half of each femur, the tibia and tarsi more dusky. Fore metatarsus about 2.4 times its tibia in length. Halteres yellow with dusky knobs. Wings saturate cinereous or fuscous cinereous tinged, veins fuscous black, in the female the wing membrane tinged along the course of the veins. (Fig. 209). "N. Y.," Montpelier, Vt. (C.W.J.); Old Forge, N. Y., (J.G.N.).

13. Genus *Sackenia* Scudder.

Bul. U. S. Geol. Survey. Terr. III. 753. 1877.

This fossil genus resembles *Boletina* from which it differs mainly in the wing venation. The subcostal crossvein is wanting, the radial sector is much curved, nearly reaching the apex of the wing and the anal vein appears to reach the margin. It is represented by *S. arcuata* Scudder (l. c.) and *S. gibbosa* Cockerell. The latter species has a shortened anal vein and may be therefore better included with Boletina.

14. Genus *Cœlosia* Winnertz.

Verh. Zool.-bot. Ges. Wien. XIII. 796. 1863.

Ocelli 3, laterals remote of the eye margin. Antennæ of the male elongate, the intermediate joints from 3 to 6 times as long as broad. Abdomen 6-segmented; slender and compressed in the male, clavate and somewhat depressed in the female; hypopygium large (Figs. 103, 104). Wings elongate oval; costa far produced beyond tip of the radial sector; subcostal vein ends in the costa at or beyond 1-3 the length of the wing; subcostal crossvein (Sc_2) wanting; media with short petiole; cubitus forks distad of the fork of the media. (Figs. 210-212).

Table of species.

a. Thorax yellow; not vittate; abdomen of the male with narrow dorsal, ventral and lateral longitudinal stripes; abdomen of the female, brown. 1. *flava.*

aa. Thorax dark. or else with dark stripes.

  b. Thorax dark, not vittate, abdomen unicolored.

    c. Third vein strongly bowed forward toward its apex; costal vein extends slightly over 1-2 way from apex of Rs to that of M_1; the media forking nearly 1-2 way between the cross-vein and the fork of the cubitus; male. 2. *pygophora.*

    cc. Costal vein but slightly produced. See *Boletina nacta.*

  bb. Thorax yellowish or with distinct vittæ.

    c. Abdominal segments with yellow posterior margins in the female, or with lateral spots in the male. 3. *flavicauda.*

    cc. Abdomen unicolored.

      d. Costa produced scarcely half way from the tip of Rs to that of M_1; wing hyaline. 4. *gracilis* n. sp.

      dd. Costa produced fully half way from the tip of Rs to that of M_1; wing more or less cinereous.

        e. Subcosta ends in the costa about opposite middle of R-M crossvein; veins margined with cinereous; female. 5. *lepida* n. sp.

        ee. Subcosta ends noticeably distad of middle of the R-M crossvein; apex of wing more or less cinereous. 6. *modesta* n. sp.

1. *Coelosia flava* Stæger.

Kroyer's Tidsskr. Ent. 237. 1840. (Boletina).

Male and female. Length 4-4½ mm. Yellow, antennæ and tarsi darker, abdomen of the male with a slender dorsal, ventral and 2 lateral blackish lines; sixth segment wholly blackish; abdomen of the female sordidly brown. An European species said to occur also in the United States.

2. *Coclosia pygophora* Coquillett.

Proc. Entomol. Soc. Wash. VI. 170. 1904.

Male. Length 3 mm. Black, the first 2 joints of the antennæ, a large humeral spot, the hypopygium, halteres, coxæ, femora, tibiæ and bases of tarsi, yellow. Body thinly grayish pruinose, the hairs yellowish, the bristles on sides of thorax and the hairs of the hypopygium chiefly brown; hypopygium very large. Wings grayish hyaline, subcosta terminating in the costa slightly before the base of the radial sector; the radial sector strongly bowed forward toward its apex; costal vein extending slightly over half way from apex of Rs to that of M_1, the latter vein forking midway between the small crossvein and fork of the cubitus. "San Mateo Co., Cal."

3. *Coelosia flavicauda* Winnertz.

Verh. Zool.-bot. Ges. Wien. XIII. 798. 1863.

Male and female. Length 3.5 mm. Thorax yellow, with 3 confluent blackish vittæ; flagellum of the antenna, head, abdomen, and tarsi blackish, the basal antennal joints, palpi, lateral spots on segments, 2, 3 and 4 of the abdomen, and hypopygium in the male and posterior margins of the segments in the female, yellow. Wings hyaline scarcely tinged, veins brown, the radial sector slightly undulate. San Jose and Pacific Grove, Cal. (Aldrich).

4. *Coelosia gracilis* n. sp.

Male and female. Length 3.5 mm. Head black, mouth parts and basal antennal joints, yellow; flagellum fuscous. Thorax reddish yellow, with 3 black dorsal vittæ, the middle one geminate and wedge shaped, metanotum dusky. Abdomen fuscous; hairs yellow, hypopygium yellow. Legs yellow, tarsi darker, fore metatarsus about 3-4 as long as its tibia. Wings hyaline, veins dusky yellow, venation as figured (Fig. 210). Cal. (Bradley), Col. (W.M.W.).

5. *Coelosia lepida* n. sp.

Male and female. Length 3.5 mm. Head black, mouth parts and basal antennal joints yellow; flagellum fuscous. Thorax reddish yellow, with 3 black dorsal vittæ, the middle one geminate and wedge shaped; metanotum dusky. Abdomen pale fuscous; hairs yellow; hypopygium as figured (Fig. 103). See also plate 7, fig. 7 in Fasc. 93, Genera Insectorum. Legs yellow, tarsi darker, fore metatarsus about 3-4 as long as the tibia. Wings cinereous hyaline, the veins margined with cinereous. Halteres yellow. This species differs from *C. gracilis* in its wing venation; the costa being more produced, the subcosta shorter, and the veins more prominent (Fig. 211). Los Angeles (W.M.W.) and Palo Alta, Cal. (Aldrich).

6. *Coelosia modesta* n. sp.

Male and female. Length 3 mm. Head black, mouth parts and basal antennal joints yellow, flagellum fuscous. Thorax reddish yellow, with 3 vittæ, spots on pleura and the metanotum black. Hairs yellow. Abdomen blackish; hypopygium (Fig. 104.) Legs yellow, tarsi dusky, fore metatarsus about 4-5 as long as the tibia. Wings hyaline with faint gray cloud on apex of wing extending to the cubitus, less marked in the female; venation as figured. (Fig. 212). This species differs from *C. gracilis* in having the costa more produced and in its apical wing cloud. Palo Alta (Aldrich), Berkeley, Cal., (W.M.W.).

15. Genus *Syntemna* Winnertz.

Verh. Zool.-bot. Ges. Wien. XIII. 767. 1863.

Ocelli 3 in number, subequal in size, laterals remote from the eye margin. Abdomen 7-segmented, cylindrical. Legs stout, of moderate length. Wings large; costa extends beyond the tip of the radial sector; subcosta either ends free, in which case the subcostal crossvein is present near the tip, or ends in R_1 beyond the middle of the basal cell; the media forks distad of the base of the radial sector; the cubitus forks proximad of the fork of the media (Figs. 213-215). The position of the ocelli will distinguish this genus from *Trichonta*. The position of the ocelli and the oblique position of the crossvein distinguishes it from *Docosia*.

Table of species.

a. Males.
 b. Antennæ long, third joint over twice as long as broad.
  c. Cubitus forks slightly distad of the crossvein; anal vein not much produced beyond the fork of the cubitus. 1. *rejecta* n. sp.
  cc. Cubitus forks far proximad of the crossvein. 2. *longicornis*.
 bb. Antennæ rather short, third joint but little longer than broad; cubitus forks proximad of the crossvein.
  c. Posterior margins of abdominal segments yellow.
   d. Anal vein extends at least a fourth of its length distad of the fork of the cubitus.
    e. Abdomen brown. 3. *vittata*.
    ee. Abdomen fasciate with yellow. 3a. *vittata* var. *fasciata* n. var.
   dd. Anal vein scarcely extends beyond fork of the cubitus; head black, cubitus forks only slightly proximad of the crossvein; fore metatarsus nearly 7-8 as long as its tibia. 4. *separata* n. sp.
  cc. Posterior margins of abdominal segments black; head yellow, cubitus forks far proximad of the crossvein. 5. *polyzona*.

aa. Females. Antenna short, third joint but little longer than broad; cubitus forks far proximad of the crossvein; anal vein extends far distad of the forks of the cubitus. 3. *vittata.*

Syntemna mutor Adams is identical with *Docosia dichroa* Lw.

1. *Syntemna rejecta* n. sp.

Male. Length 4 mm. Head black, face, palpi and basal joints of the antennæ, yellow; antennæ about twice as long as the thorax. Thorax yellow, two oval spots on the mesonotum over the base of the wing, dark brown, setæ, yellow. Abdomen yellow, the whole of the first segment except a spot on each side, and a fascia covering the basal 1-3 to 1-2 of each of the following segments, brown; hypopygium (Fig. 105); setæ and the finer hairs pale. Legs yellow, tarsi darker, setæ of hind tibiæ scarcely longer than the diameter of the tibia, fore metatarsus nearly 3-4 as long as the tibia. Wings hyaline, veins brown, venation as figured (Fig. 213). Halteres yellow. Blue Hills, Mass. July (C.W.J.).

2. *Syntemna longicornis* Coquillett.

Proc. U. S. Nat. Museum. XXIII. 597. 1901. (*Docosia*).

Male. Length 5 mm. Yellow, the front, vertex, antennæ except the 2 basal joints, 3 vittæ on mesonotum, dorsum of first abdominal segment except a spot on each side, a fascia at base of remaining segments and the genitalia, black; tarsi becoming brown toward their apices; antennæ more than twice as long as the head and thorax, the third joint over twice as long as wide; body polished, its hairs and those of the coxæ and femora yellow; wings hyaline, the subcosta ends slightly beyond middle of the basal cell, the R-M crossvein less than twice as long as first section of radial sector, cubitus forking before the crossvein. "N. H." (Coq.); Brookline, Mass., August (C.W.J.). In the Massachusetts specimen the median vitta is obsolete.

3. *Syntemna vittata* Coquillett.

Proc. U. S. Nat. Museum. XXIII. 597. 1901. (*Docosia*).

Male. Length 4 mm. Head black, mouth parts, and broad base of antennæ yellow, third joint of antennæ only slightly longer than broad; body polished, brown, a median vitta on the mesonotum, expanded at the front end and crossing the pleura, also middle of breast yellow, middle of metanotum reddish yellow; hairs of thorax black; halteres and legs yellow, changing into brown at apices of the tarsi; bristles of hind tibiæ longer than the greatest diameter of the tibiæ; wings grayish hyaline, the cubitus forks far proximad of the forking of the media; anal vein reaching over 1-4 of its length beyond the forking of the cubitus. "N. H." (Coq.). The type of *vittata* has more or less yellow on the sides of the intermediate segments of the abdomen.

Female. A specimen from Friday Harbor, Wash. (Aldrich, Col.) has the thorax largely yellow, the pleura and large oval spots on the mesonotum above the base of the wings, brown. The other parts as described for the male. Venation as figured (Fig. 214). This may be a distinct species but until a male from the same locality is found it better be left here.

3a. *Syntemna vittata* var. *fasciata* n. var.

Male. Differs from *vittata* in having abdomen yellow, the whole of the first segment and the basal 1-3 of 1-2 of each of the following, dark brown; hypopygium (Fig. 106). Venation similar to that shown in Fig. 214. Eastport, Maine.

4. *Syntemna separata* n. sp.

Male. Length 3.5 mm. Head black; face, palpi and 5 basal joints of each antenna yellow; antennæ but little longer than the head and thorax. Thorax yellow, the pleura largely and 2 oval spots on the mesonotum over the base of the wing, dark brown, setæ black. Abdomen yellow, the whole of the first segment and a large fascia like spot nearly covering the basal half of each of the following segments, brown; setæ black, the finer hairs pale. Legs yellow, tarsi darker, setæ of the hind tibiæ longer than the diameter of the tibia, fore metatarsus nearly 7-8 as long as the tibia. Wings hyaline, venation as figured. (Fig. 215). Halteres yellow. St. Johnsbury, Vt., June, (C.W.J.).

5. *Syntemna polyzona* Loew.

Berlin. Ent. Zeitschr. XIII. 142. 1869.

Male. Length 3.8 mm. Head and its parts yellow, antennæ darker apically; ocellar spot black. Thorax and abdomen yellow, the segments of the latter posteriorly fasciate with black;

pile yellow. Legs yellow, tarsi darker. Wings tinged with yellow, the anterior veins darker. Halteres yellow, the knob dusky at base.

An examination of the type shows that the antennæ are short, the intermediate joints being but little longer than wide; that the cubitus forks far proximad of the crossvein and that the anal vein ends slightly distad of the R-M crossvein. "Middle states" (Loew); Brookside, N. J., (Weidt), Aug.

16. Genus *Megophthalmidia* Dziedzicki.

Horae Soc. Ent. Ross. XXIII. 525. 1889.

Ocelli 3, all large, the laterals widely remote from the eye margin. Thorax short, highly arched. Abdomen short, 6-segmented; hypopygium inflected under the abdomen. Legs stout, fore legs short. Wing oblong-oval; costa produced far beyond the tip of the radial sector; subcosta rather short, ending in R_1; the radial sector arises near the middle of the wing; petiole of the media long; cubitus forks proximad of the proximal end of the R-M crossvein which is nearly longitudinal in position; anal veins vestigial. (Fig. 216). Resembles *Docosia* but differs in the position of the lateral ocelli.

Megophthalmidia occidentalis Johannsen.

Genera Insectorum, Fasc. 93. 89. 1909.

Male and female. Length 2.5 mm. Head black; antennæ and proboscis brown; palpi yellow; the antennæ robust, about as long as the thorax, the intermediate joints cylindrical, shorter than broad, pilose; face setose. Thorax brownish yellow, including pleura, sternum, and scutellum; the metanotum more brownish, especially anteriorly. Setæ of the lateral and anterior margins of the thorax rather conspicuous; about 5 pairs of scutellar setæ, the longest about as long as the tibial spurs. Abdomen brownish yellow, appearing darker than the thorax because of the presence of black setulæ; apically somewhat darker; hypopygium as figured on Plate 7, Fig. 5 in Genera Insectorum, Fasc. 93; ovipositor yellow, conical, somewhat laterally compressed, the apices of the pointed lateral plates, with tuft of setæ. Legs, including coxæ, pale yellow, hind pair slightly darker; fore femora about as long as the coxæ, hind femora about twice as long; fore metatarsus over 1-2 as long as the tibia; the black tibial spurs about 1-2 as long as the corresponding metatarsus; coxæ and femora with black setæ which are longer and more conspicuous on the outside near the tip; tibial setæ small; empodium very distinct; tarsal claws each with large tooth near base. Wings extend beyond tip of abdomen; hyaline, veins yellow; venation as shown (Fig. 216). Halteres yellow. Friday Harbor, Mt. Rainier, Wash., July and August. (Aldrich).

17. Genus *Docosia* Winnertz.

Verh. Zool.-bot. Ges. Wien. XIII. 802. 1863.

Ocelli 3, the middle one smaller, the laterals close to the eye margin. Thorax large, short; abdomen short. Legs strong, particularly the hind pair. Wings large, broad, longer than the abdomen; costa produced beyond the radial sector. Subcosta ends in R_1 or ends free; basal section of the radial sector nearly perpendicular in position, the second section in the same right line with the R-M crossvein which is longitudinal in position; base of fork of cubitus under or proximad of the fork of the media (Fig. 218).

Table of species.

a. Abdomen reddish yellow, thorax shining black. 1. *dichroa.*
aa. Abdomen black.
  b. Subcosta ends in R_1.
    c. Media and cubitus fork about opposite the base of the radial sector; third antennal joint only slightly longer than broad. 2. *obscura.*
    cc. Media and cubitus fork noticeably proximad of the base of the radial sector; third antennal joint about twice as long as wide. 3. *nigella* n. sp.
  bb. Subcosta ends free, its basal section strong, apically much attenuated; legs mainly dark brown. 4. *nitida* n. sp.

For *D. longicornis* and *vittata* see *Syntemna.*

1. *Docosia dichroa* Loew.

Berlin. Ent. Zeitschr. XIII. 148. 1869.

mutor, Adams; Science Bul. Kas. Univ. II. 24. 1903. (*Syntemna*).

Male and female. Length 3-3.5 mm. Head and antennæ black, palpi fuscous or subfuscous. Thorax wholly black, shining. Abdomen reddish yellow in the male, the last two segments and the hypopygium (pl. 7, fig. 11, Genera Insectorum, Fasc. 93) fuscous or black. Terminal appendage of lateral sclerite (Fig. 108). Legs including coxæ reddish yellow; tarsi largely infuscated; fore metatarsus over 1-2 as long as the tibia. Wings hyaline, anterior veins dusky; venation as shown (Fig. 218). "D. C.;" "N. J.;" (C.W.J.); "Mo." (*mutor*, Adams); Kas. (J.M.A.); Wis.; Mich.; Ithaca, N. Y.

2. *Docosia obscura* Coquillett.

Proc. U. S. Nat. Museum XXIII. 597. 1901.

Male. Length 3-3.5 mm. Black, the halteres and legs yellow, bases of coxæ, femora on base of under side, and the tarsi brown; third joint of antennæ only slightly longer than broad; body polished, the hairs yellow; bristles of hind tibiæ shorter than greatest diameter of the tibiæ; wings hyaline, veins brownish, subcosta ends in R_1, R-M crossvein at least 4 times as long as the base of the radial sector, media and cubitus fork opposite the base of the radial sector, anal vein almost reaching the fork of the cubitus. "White Mts., N. H." (Coq.). A defective specimen from Muir Woods, California, collected by Dr. J. C. Bradley probably also belongs here.

3. *Docosia nigella* n. sp.

Male. Length 4 mm. Black, the halteres, palpi, third antennal joint, and legs yellow, bases of the coxæ, under side and apices of the femora, and the tarsi brown; third antennal joint twice, the following joints about 3 times as long as broad; body polished, the hairs pale; bristles of hind tibiæ not longer than greatest diameter of tibia. One claw of each fore foot sickle shaped, with tooth proximad of the bend, the other claw smaller and with two teeth; fifth tarsal joint of fore foot enlarged. Wings hyaline, veins brownish, venation as figured (Fig. 219). Hypopygium (Fig. 109). Differs from *D. obscura* mainly in wing venation. Head of Tsirku River, Alaska, July-August, (Prof. O. M. Leland).

4. *Docosia nitida* n. sp.

Male and female. Length 2 mm. Black; the halteres and tibial spurs pale yellow, the fore femora, fore tibiæ and knees sometimes, brownish yellow; the tarsi and the other legs dark brown, wings hyaline, anterior veins brownish; posterior veins pale, all other parts black; body shining, hairs pale, sparse. Antennæ short, intermediate joints not longer than broad. Setæ of hind tarsi shorter than diameter of tibia. Venation as figured (Fig. 220). Hypopygium (Fig. 110). Brookings, S. D. (J.M.A.)

18. Genus *Anatella* Winnertz.

Verh. Zool.-bot. Ges. Wien. XIII. 854. 1863.

Ocelli 3, the middle one smaller than the laterals, the latter continguous to the eye margin. Abdomen slender, compressed, constricted at the base. Legs long, spurs unequal. Wings elongate oval, anal lobe small; costa produced far beyond the tip of the radial sector; subcostal vein very short, ending in R_1; fork of the cubitus may be proximad, under or distad of the fork of the media; anal stout but incomplete (Fig. 217). Very small species.

A. tacita is a fossil species from Colorado.

Anatella silvestris Johannsen.

Genera Insectorum. Fasc. 93. 91. 1909

Male and female. Length 2.5 mm. Head brown, eyes black, antennæ yellowish brown, the 3 basal joints and the palpi pale yellow; antennæ about twice as long as the thorax. Thorax pale brown, with indications of 3 darker stripes; hairs pale, setæ black. Abdomen pale brown (venter yellowish in the female), apical margin of each of the four posterior segments dark brown; hypopygium yellowish (Fig. 107). Coxæ and legs pale yellow, tarsi infuscated; fore metatarsus and tibia subequal in length; tarsal claw elbowed, apical part slightly sinuous, curved at the tip; basal tooth very small. Wings hyaline, veins dusky yellow; venation as shown (Fig. 217). Halteres yellow. Ithaca, N. Y. March and August.

19. Genus *Trichonta* Winnertz.

Verh. Zool.-bot. Ges. Wien. XIII. 847. 1863.

Ocelli 3, the laterals large, close to the eye margin. Abdomen constricted at the base, compressed; hypopygium large. Wings large; costa scarcely noticeably produced beyond the tip of the radial sector; subcosta long, ending in R_1 beyond the middle of the basal cell R; the cubitus forks proximad of the fork of the media (Figs. 221 to 223). Distinguished from *Syntemna* by the position of the lateral ocelli, in having the costa less produced beyond the tip of the radial sector, and in the arrangement of the setulæ of the wing in parallel rows.

Table of species.

a. Length 6 mm; thoracic stripes subobsolete. 1. *perspicua.*

aa. Length less than 5 mm.

b. Cubitus forks noticeably proximad of the proximal end of the crossvein; species over 3 mm. in length.

c. Fore metatarsus less than .8 of tibia in length; abdomen dark brown, hind margins of the segments broadly yellow; female. 2. *cincta* n. sp.

cc. Fore metatarsus over .8 of the tibia in length; abdomen yellow, each segment with a large sub-triangular spot; male. 3. *triangularis* n. sp.

bb. Cubitus forks at or distad of the proximal end of the crossvein.

c. Species over 3 mm. in length.

d. Cubitus forks at the proximal end of the crossvein; abdomen dark brown, each segment except the first with yellow margins. 4. *vulgaris.*

dd. Cubitus forks distad of the proximal end of the crossvein.

e. Thorax brown, humeri yellow; abdomen yellow, each segment with a large triangular brown spot; hind tarsi slightly shorter than its tibia. 5. *obesa.*

ee. Thorax yellowish, with 3 vittæ sometimes subcoalescent.

f. Abdomen largely brown, apical margin and large posterior lateral triangles, yellow; hind tarsi longer than tibia; Cu_2 somewhat sinuate. 6. *bellula* n. sp.

ff. Abdomen brown, segments yellowish at base. 7. *foeda.*

cc. Species less than 3 mm. in length.

d. Cubitus forks under the proximal end of the crossvein; hypopygium with slender clasper, each with about 10 strong setæ (Fig. 113). 8. *diffissa* n. sp.

dd. Cubitus forks only slightly proximad of fork of media; each clasper with a clavate basal lobe (Fig. 114); ventral aspect of hypopygium, apically, densely setose. 9. *patens* n. sp.

Trichonta Dawsoni is a fossil from British Columbia.

1. *Trichonta perspicua* Van der Wulp.

Tijdschr. v. Ent. XXIV. 142. 1881.

Male. Length 6 mm. Reddish yellow; antennæ 1.5 times as long as head and thorax, scape and basal joints yellow, remainder of flagellum fuscous. Thorax yellowish, with indications of 3 vittæ of which the median is geminate and most distinct. Abdomen slender, with a fuscous spot on each of the segments, that of the sixth nearly covering entire segment except the venter; hypopygium yellowish. Legs yellowish; coxæ each with black spot at apex; tibiæ a little darker, tarsi brown; fore metatarsus a fifth shorter than the tibia. Halteres yellow. Wings with yellowish gray tint; subcosta ends in R_1 beyond the middle of the basal cell; cubitus forks somewhat proximad of the fork of the media. "Quebec" (V.d.W.). "N. J."

2. *Trichonta cincta* n. sp.

Female. Length 3.25 mm. Head and antennæ fuscous, the face, palpi and scape yellow; antennæ about a third longer than head and thorax. Thorax yellow; dorsum with 3 wide brown stripes; scutellum, metanotum, and pleura largely brown; hairs pale. Abdomen black, shining, hind margin of each segment yellow. Legs and coxæ yellow, tarsi brown; a brown dash on under side of each femur; fore metatarsus over .75 as long as the tibia; hind tarsus slightly longer than its tibia. Wings hyaline, yellowish tinged, anterior veins brown; media forks slightly distad of the base of the radial sector; cubitus forks proximad of the proximal end of the crossvein, anal vein faint. Halteres yellow. Eastport, Me. (C.W.J.).

3. *Trichonta triangularis* n. sp.

Male. Length 4 mm. Head brownish yellow; face, palpi and basal joints of antennæ yellow, larger part of flagellum dark brown with whitish pubescence; antennæ about 2-3 longer than head and thorax. Thorax including pleura, scutellum, and metanotum yellow, mesonotum with 3 brown stripes; hairs yellow, setæ brown. Abdomen yellow, each segment with a large brown triangular spot, leaving the sides and narrow posterior margin yellow. Hypopygium brownish (Fig. 10, pl. 7 Genera Insectorum, Fasc. 93). Forceps (Fig. 111). Coxæ and legs yellow, tibiæ a little darker than femora, tarsi brownish, fore metatarsus about .95 as long as the tibia. Wings hyaline, yellow tinged. Venation as figured (Fig. 221). Halteres yellow. (Aug.) Ithaca, N. Y.

Var. a. Male. Differs only in having the fore metatarsus about 7-8 as long as the tibia. Ithaca, N. Y.

4. *Trichonta vulgaris* Loew.

Berlin. Ent. Zeitschr. XIII. 149. 1869.

Male and female. Length 3.2-3.5 mm. Head and antennæ fuscous, basal joints of the latter and palpi yellow. Dorsum of the thorax yellow with 3 fuscous stripes which are sometimes confluent; scutellum, metanotum and the pleura except between the fore coxæ and the humeri, fuscous. Abdomen fuscous, each segment except the first with a posterior fascia. Hypopygium black. Coxæ and legs yellow, tarsi darker; in the female the last 4 joints slightly tumid below. Wings cinereous, toward the costa yellowish; cubitus forks under the proximal end of the crossvein. "Md., D. C."

5. *Trichonta obesa* Winnertz.

Verh. Zool.-bot. Ges. Wien. XIII. 854. 1863.

Female. Length 4.5 mm. Fuscous; basal joints of the antennæ, palpi, humeri, legs and halteres yellow. Tarsi dark; femora with brown dash on the underside near the base; hind tarsi slightly shorter than the tibia. Abdomen yellow, with a triangular spot, covering the larger part of each segment. Wings grayish hyaline, the media forks under the base of the radial sector, the cubitus under the center of the crossvein. The male hypopygium is described and figured by Mik in Verh. Zool.-bot. Ges. Wien. XXX. 607. 1880. "Europe and Greenland."

6. *Trichonta bellula* n. sp.

Male. Length 3.5 mm. Head black, face, palpi and 4 basal joints of antennæ yellow, remainder of flagellum brown; antennæ about a third longer than the head and thorax. Dorsum of the thorax yellow with 3 brown stripes; pleura, scutellum and metanotum largely dark brown; hairs yellow, setæ brown. Abdomen dark brown, posterior margin of each segment produced anteriorly on the sides and anterior part of the venter, yellow; hypopygium dark (Fig. 112). Coxæ and legs yellow, tarsi darkened, each femur with a brown spot on the underside near the base; hind metatarsus slightly less than half as long as its tibia. Wings hyaline, grayish tinged, anterior veins brown; subcosta ends in R_1 beyond the middle of the basal cell; the media forks slightly distad of base of Rs; the cubitus forks under the middle of the crossvein; Cu_2 somewhat sinuate; the anal vein and the petiole of the cubitus subequal in length. Halteres yellow. Mt. Ascutney, Vt., July (C.W.J.).

7. *Trichonta foeda* Loew.

Berlin. Ent. Zeitschr. XIII. 150. 1869.

Female. Length 3.7 mm. Head and antennæ fuscous black, face and 3 basal joints of antennæ, yellow; palpi mainly yellow. Dorsum of thorax yellow, with 3 blackish stripes; metanotum, scutellum and pleura more or less fuscous; hairs of thorax pale, setæ black. Abdomen fuscous, each segment more or less yellow at the base. Coxæ and legs yellow, tarsi darker. Wings cinereous, yellowish toward the costa, the stronger veins fuscous; cubitus forks under or but very slightly proximad of the fork of the media. Halteres yellow. "Middle States."

8. *Trichonta diffissa* n. sp.

Male. Length 2.2 mm. Head brownish yellow; face, palpi and base of antennæ yellow; antennæ 1.5 as long as head and thorax. Dorsum of thorax yellow with 3 brown stripes which coalesce posteriorly; scutellum, metanotum, and hinder part of pleura, brown; hairs yellow, setæ brownish. Abdomen brown; the venter and both front and hind margins of the segments and the hypopygium (Fig. 113) yellow; larger part of fifth and sixth segments dark brown. Coxæ and legs yellow, tibiæ slightly darker, apex of each hind femur, and the whole of the tarsi brown. Wings hyaline with a yellowish tinge; venation as figured. Halteres yellow. Ithaca, N. Y., and Brookline, Mass., August (C.W.J.).

9. *Trichonta patens* n. sp.

Male and female. Length 2.2-2.5 mm. In color similar to the foregoing. In the type specimen, the thorax is largely yellow, thoracic stripes pale brown, and the apex of the hind femur is not brown. In other specimens the darker color predominates. Differs from *T. diffissa* in wing venation, the cubitus forking distad of the proximal end of the crossvein (Fig. 223). The hypopygium differs in having a clavate lobe about 1-2 as long as the clasper articulated near the base of each clasper; and in having the apex of the ventral sclerite densely setose (Fig. 114). Ithaca, N. Y., May and August.

20. Genus *Cordyla* Meigen.

Illiger's Magazine II. 262. 1803; Klass. 1. 93. 1804.

Polyxena. Nouv. Class. Mouches. 16. 1800. (Without type).

Front broad; eyes oval, ocelli small, 2 in number; contiguous to the eye margin; antennæ projecting forward, 2+9, 2+10, 2+12, 2+13, or 2+14 jointed, very short, but little longer than the height of the head, the joints shorter than broad, disk-like, closely sessile in dried specimens; palpi 4-jointed, basal joint small, second much enlarged, thickened (Fig. 54 Part I), third and fourth slender, almost filiform. Abdomen compressed, hypopygium of male small and inconspicuous. Legs slender, lateral setæ of hind tibiæ shorter than the diameter of the tibia at the widest part; posterior basal seta of hind coxa wanting. Costa of the wing does not extend beyond the tip of Rs; subcosta very short, curved toward R_1; media forks distad of the basal section of Rs; its posterior branch usually not reaching the wing margin (Figs. 224-228). The larvæ live in decaying wood and in fungi.

Table of species.

a. Males.
- b. Antennæ 2+13 jointed.
  - c. Yellowish species, dorsum of thorax and end of abdomen darker; cubitus forks distad of the middle of petiole of media. 1. *manca* n. sp.
  - cc. Fuscous species; cubitus forks proximad of middle of petiole of media. 2. *scita* n. sp.
- bb. Antennæ 2+12 or 2+10 jointed.
  - c. Antennæ 2+12 jointed; abdomen wholly fuscous. 3. *volucris.*
  - cc. Antennæ 2+10 jointed.
    - d. Humeri yellow; hypopygium as figured (Fig. 118); eastern species. 4. *recens* n. sp.
    - dd. Humeri dusky; hypopygium as figured (Fig. 119); western species. 5. *neglecta* n. sp.

aa. Females; antennæ 2+9 and 2+10 jointed.
- b. Antennæ 2+10 jointed; thorax and abdomen fuscous. 3. *volucris.*
- bb. Antennæ 2+9 jointed.
  - c. Cubitus forks about opposite proximal end of the crossvein; thorax and abdomen shining dark reddish brown. 6. *C. sp.*
  - cc. Cubitus forks at or distad of middle of petiole of the media.
    - d. Wing over 5.5 times as long as the fore tibia. 7. *C. sp.*
    - dd. Wing less than 5 times as long as the fore tibia.

e. Cubitus forks about opposite middle of petiole of media.
1. *manca* n. sp.
ee. Cubitus forks distad of middle of petiole of media.
4. *recens* n. sp.

1. *Cordyla manca* n. sp.

Male and female. Length 3 mm. Head and antennæ brown, base of the latter and last 2 joints of palpi yellow, large palpal joint dark brown; antennæ of male 2+13, of female 2+9 jointed. Thorax, abdomen and legs yellow, the mesonotum more dusky with indications of 3 stripes; posterior tergites dusky yellow to brown, posterior margins yellow; tibial spurs and tarsi brown; setæ black; hypopygium small (Fig. 115). Wings grayish hyaline, costal cell brown (Fig. 224). Halteres yellow. Ithaca, N. Y.

2. *Cordyla scita* n. sp.

Male. Length 2.5 mm. Fuscous; last 2 joints of palpi, coxæ, femora, tibiæ and halteres yellow; wings grayish hyaline, costa cell dusky yellow (Fig. 225); tibial spurs and tarsi brown. Antennæ 2+13 jointed; hypopygium small (Fig. 116). Friday Harbor, Washington (J.M.A.), July.

3. *Cordyla volucris* Johannsen.

Genera Insectorum; Fasc. 93. 101. 1909.

Male and female. Length 2.5 mm. Fuscous; base of each antenna, last 2 palpal joints, coxæ, femora, tibiæ and halteres yellow; wings grayish hyaline, costal cell more grayish (Fig. 226); tibial spurs and tarsi brown. Antennæ of male 2+12, of female 2+10 jointed; hypopygium small (Fig. 20, pl. 7 Genera Insectorum, Fasc. 93). (Fig. 117). Bred from larvæ found in fungi. Ithaca, N. Y., Sept.

4. *Cordyla recens* n. sp.

Male and female. Length 2.5 mm. Fuscous; base of antennæ, last 2 palpal joints, humeri, ventral segments 2, 3 and part of 4 of abdomen, coxæ, femora except tip of hind pair, tibiæ and halteres yellow; tibial spurs and tarsi brown; wings grayish hyaline, costal cell dusky yellow to grayish (Fig. 227). Antennæ of male 2+10, of female 2+9 jointed; hypopygium small (Fig. 118). Ithaca and Caroline, N. Y., June, July.

5. *Cordyla neglecta* n. sp.

Male. Length 2.5 mm. Coloring as in the foregoing (*C. recens*) but humeri only indistinctly yellow; venation and hypopygium as figured (Figs. 228, 119). Antennæ 2+10 jointed. Felton, Cal. (J.C.B.) May. A defective female specimen from Los Angeles, Cal., may belong here also.

6. *Cordyla* sp.

Female. Length 3 mm. Fuscous; the base of the antennæ, last 2 palpi joints, coxæ, femora, tibiæ and halteres yellow; tibial spurs and tarsi brown; venter and incisures dusky yellow; wings grayish hyaline, costal cell dusky yellow. Antennæ 2+9 jointed. Dubois, Wyo., 7000 ft. (W.M.W.), Sept.

7. *Cordyla* sp.

Female. Like *C. volucris* but antennæ 2+9 jointed. Orono, Me.; Washington, D. C. October and December. The Maine specimen was bred from a fungus (*Collybia* sp?).

21. Genus *Brachypeza* Winnertz.

Verh. Zool.-bot. Ges. Wien. XIII. 806. 1863.

Front broad, ocelli 3, laterals contiguous to eye margin, the middle one small; second palpal joint slightly swollen, the antennæ rather short, the flagellar joints closely sessile, annular. Abdomen constricted at the base, compressed; hypopygium of the male small. Legs stout, femora all broad, flattened; tibiæ strong, somewhat enlarged at the ends, with long spurs and moderately long lateral setæ; posterior basal seta of hind coxa present. Subcosta short, ending in R_1; costa not produced beyond Rs; the fork of the media under or proximad of the base of Rs; fork of cubitus far proximad of the proximal end of the crossvein; anal fold strong, anal vein short and delicate (Fig. 229).

Brachypeza bisignata Winnertz.

Verh. Zool.-bot. Ges. Wien. XIII. 807. 1863.

Male. Length 5 mm. Robust. Antennæ shorter than the thorax, brown, 2 or 3 basal joints yellow; palpi, proboscis and face yellow, front and vertex dark brown, pruinose; with yellow hairs. Mesonotum with 3 wide blackish vittæ; the laterals abbreviated anteriorly, the middle one wedge shaped; hairs yellow; lateral and scutellar setæ strong, black; pleura yellow or brownish yellow, metanotum brown. Abdomen with blackish hair; first segment brown with yellow posterior margin, segments, 2, 3, 4 yellow, 5 and 6 brown; hypopygium brown, small. Coxæ, femora and tibiæ yellow, the apices of the hind femora, and of hind tibiæ and of all the tarsi brown; setæ of coxæ and tibiæ black. Each wing with a spot on the disk and another at the apex of Rs. Halteres yellow.

Female. Described by Lundström ('07 and '09). Abdomen wholly yellow except the first and sometimes a part of the sixth is brown.

Var. *divergens* n. var.

Male. Differs from Winnertz's description as follows: Front between middle ocellus and the base of the antennæ yellow; tips of trochanters, of middle femora and of middle tibiæ black; abdomen with a narrow black median dorsal stripe, 6 or 8 subconfluent black spots on sides of segments 2, 3, 4, and the greater part of sides of 5 and 6 except narrow posterior margin, black. Wing spots somewhat larger than in the European form. Hypopygium and wing as figured (Figs. 120, 229). The spurs are about 3-4 as long as the corresponding metatarsi; the hind femur is about 1-4 as wide as long; the hind tibia about 1-8 as wide as long. A single specimen was bred from a fungus (Collybia sp.?), Nov. 2, Orono, Me.; male and female specimens from St. Johnsbury, Vt., and Hanover, N. H., (C.W.J.), June, July.

22. *Rhymosia* Winnertz.

Verh. Zool.-bot. Ges. Wien. XIII. 810. 1863.

Head oval, front broad, ocelli 3, laterals large, closely contiguous to the eye margin, the middle one minute, placed in a groove on the front, sometimes almost concealed. Legs long and slender; lateral setæ of tibiæ delicate and little if any longer than the diameter of the tibiæ at the widest part. Posterior basal setæ of hind coxæ present. Costa meets the radial sector before the tip of the wing; subcosta very short, ending free or in R_1; fork of media proximad or under base of Rs; cubitus usually forks under or proximad of the proximal end of the R-M crossvein, its elongate fork narrow at the base then suddenly divergent; anal vein very stout, rather long though not reaching wing margin; last anal long, incomplete, slender (Fig. 233). Larvæ live in fungi (*Armillaria,* etc.).

The elongate fork of the cubitus with its divergent branches, and the strong anal vein will distinguish this genus from its nearest relatives.

Table of species.

a. Cubitus forks nearly under the proximal end of the crossvein; fore metatarsus little if any longer than the tibia; anal vein ends distad of the fork of the cubitus; female. 1. Sp. a.

aa. Cubitus forks proximad of the proximal end of the crossvein.

b. Fore tibia and metatarsus subequal in length; anal vein slender, produced slightly beyond the fork of the cubitus; subcosta ends in R_1; female. 2. Sp. b.

bb. Fore tibia shorter than metatarsus, or otherwise distinct.

c. Third and fourth tarsal joints of the male with a series of curved spines below; fore metatarsus 1.6 times the tibia in length; anal vein produced beyond fork of the cubitus; hypopygium small (Fig. 121). 3. *serripes* n. sp.

cc. Tarsal joints without curved spines in the male.

d. Anal vein ends distad of the base of the fork of the cubitus.

e. Petiole of media shorter than the crossvein.

f. Head and thorax largely fuscous, hypopygium of male much longer than the last visible abdominal segment. 4. *inflata* n. sp.

ff. Head and thorax largely yellowish; hypopygium shorter than last abdominal segment. 5. *filipes.*

ee. Petiole of media and crossvein subequal in length; hypopygium small (Fig. 123). 6. *imitator* n. sp.

dd. Anal vein ends at or proximad of the base of the fork of the cubitus.

e. Two basal setæ on each hind coxa. 7. *akeleyi* n. sp.

ee. One basal seta on hind coxa.

f. Fore tarsi about 3.5 times fore tibia in length in the male; 4 scutellar setæ. 8. *captiosa* n. sp.

ff. Fore tarsi about 3 times fore tibia in length in the male; 2 scutellar setæ. (Calif.) 9. *diffissa* n. sp.

Note. *Mycetophila plebeja* Walker and *M. sericea* Say. may belong here.

1. *Rhymosia* sp. a.

Female. Length 3 mm. Head and thorax fuscous, the scape, palpi, humeral spot and thoracic hairs yellow. Abdomen fuscous, the venter largely yellowish. Coxæ and legs yellow, tarsi and tibial spurs brown. Two scutellar setæ, one basal hind coxal seta. Wings yellowish hyaline, subcosta short, ending free (Fig. 230). Halteres yellow. Los Angeles Co., Cal., Feb. (W.M.W.)

2. *Rhymosia* sp. b.

Female. Length 4.5 mm. Head fuscous, the scape, basal joints of flagellum, and palpi yellow. Thorax yellow, the dorsum of the mesonotum, the lower margin of the pleura, the scutellum except the margin, and the metanotum, fuscous; hairs yellow, of the dorsum dense, depressed, brownish; 4 scutellar setæ. Tergites of abdomen fuscous, sternites yellow. Coxæ and legs yellow, tarsi and tibial spurs brown; one basal hind coxal seta. Wing yellowish hyaline, subcosta ends in R_1 (Fig. 231). Halteres yellow. Selkirk Mts., B. C. (J.C.B.).

3. *Rhymosia serripes* n. sp.

Male. Length 3 mm. Head fuscous, the scape and palpi yellow; antennæ half longer than the thorax. Thorax yellow, the 3 stripes of the mesonotum, the scutellum and metanotum fuscous; hairs yellow, those of the mesonotum darker, setæ black; 2 scutellar setæ. Dorsum of abdomen brownish, venter yellow; hypopygium yellow, small (Fig. 121). Coxæ and legs yellow, tarsi and tibial spurs brown; one posterior basal hind coxal seta; third and fourth fore tarsal joints each with 7 or 8 short, stout, curved, claw-like spines, those of the third joint situated distad of the middle and more blunt. Wing yellowish hyaline, subcosta short, ends free (Fig. 232). Halteres yellow. Ithaca, N. Y. Aug.

4. *Rhymosia inflata* n. sp.

Male. Length 5 mm. Head fuscous; antennæ less than twice as long as the thorax, fuscous, the immediate base of the flagellum, the scape, and the palpi yellowish. Setæ of thorax and the 2 of the scutellum black; the hairs appressed, silvery. Mesonotum with 3 sometimes wholly confluent fuscous stripes, the disk of the scutellum, metanotum and the pleura in large part fuscous. Abdomen yellow, the first segment, the last segment in large part, the dorsum of each intermediate segment, the tip of the large hypopygium (Fig. 122), and sometimes an interrupted longitudinal ventral line, fuscous. Coxæ and legs yellow, tarsi and tibial spurs brown; usually 2 posterior basal hind coxal setæ. Wing yellowish hyaline, subcosta ends free (Fig. 233). Halteres yellow.

Female. Like the male, but the exposed part of the ovipositor when retracted is slightly shorter than the last abdominal segment and there is usually but one basal hind coxal seta.

Ithaca, N. Y. Oct.-Nov. Bred from *Armillaria mellea.*

5. *Rhymosia filipes* Loew.

Berl. Ent. Zeitschr. XIII. 149. 1869.

Length 5.5 mm., wing 4.3 mm. Opaque ochraceous testaceous. Head similarly colored, antennæ long, slender, fuscous, the scape, the immediate base of the flagellum, and the palpi yellowish. Setæ of thorax and scutellum black. The first and last abdominal segments and a dilated posterior fascia on each of the intermediate tergites, fuscous. Hypopygium yellow, a little shorter than the last abdominal segment, black pilose. Coxæ dusky yellow, with short black setæ. Legs slender, long, dusky yellow, tibiæ more subfuscous, tibial spurs and tarsi blackish. Wing cinereous yellow, more dusky yellow toward the costal margin. "Connecticut."

In the type specimen the petiole of the media is about half as long as the R-M crossvein, and the fork of the cubitus is far proximad of the proximal end of the crossvein.

6. *Rhymosia imitator* n. sp.

Male and female. Length 4.5 mm. Resembles *R. inflata* (4) in coloring, but the brown of the abdomen is more extended, each intermediate sclerite having the yellow confined to the anterior 1-2 of the sides. The 2 scutellar setæ and one posterior basal hind coxal seta, black. Wings yellowish hyaline, subcosta ends free (Fig. 234). Halteres yellow. Hypopygium (Fig. 123) small. Black Rock Creek, Wyo., Sept.; Austin, Texas (W.M.W.) June; San Pablo, Cal. (J.C.B.) Nov.

7. *Rhymosia akeleyi* n. sp.

Akeleyi Wheeler, MS.

Male. Length 4.5 mm. Resembles *R. inflata* (4) in coloring, but the face, the pleura except the lower margin in part and the wide margin of the scutellum yellow. Abdomen yellow, the dorsum of each sclerite except narrow hind margin, the entire last segment, and the tip of the large hypopygium (Fig. 124) black. Two scutellar and 2 posterior basal hind coxal setæ. Legs colored as in *inflata*. Wing yellowish gray hyaline, subcosta ends in R_1 (Fig. 235). Halteres yellow. Wis. (W.M.W.) and Cornish, N. H. (C.W.J.) July.

8. *Rhymosia captiosa* n. sp.

Male. Length 5.5 mm. Head fuscous, face, palpi, scape and base of flagellum yellow; antennæ about a third longer than the thorax. Thorax yellow, the dorsum of mesothorax, the disk of the scutellum, the center of the metathorax, and the lower margin of the pleura, fuscous. The hairs of the head and thorax appressed, pale, the setæ black; 4 prominent scutellar setæ. Abdomen yellow, the dorsum of each of the first four segments brown except toward the posterior margin, the whole of the fifth and sixth brown; hypopygium large, about as long as the last two abdominal segments taken together; yellow, tipped with black. (Fig. 125). Coxæ and legs yellowish, tarsi and tibial spurs brown. Wings yellowish gray hyaline, subcosta ends in R_1 (Fig. 236). Brattleboro, Vt., and N. H. (C.W.J.).

Female. Like the male in coloring except that the fifth and sixth abdominal segments are marked like those preceding. Hanover, N. H.; Brattleboro, Vt.; and North Adams, Mass. (C.W.J.). June and July.

9. *Rhymosia diffissa* n. sp.

Male. Length 4.5 mm. Head fuscous, face dusky yellow, palpi and scape yellow; antennæ over twice as long as the thorax. Thorax fuscous, the humeri and a narrow line to the base of the wing yellow, hairs appressed, pale, setæ black, 2 scutellar setæ. First and last segment of the abdomen largely black, the intermediate segments yellow, each with a very large triangular saddle which nearly reaches the posterior margin, broadest anteriorly where it nearly reaches the sternite; hairs dusky; hypopygium large, yellow, tipped with black (Fig. 126). Coxæ and legs yellowish, tarsi and tibial spurs brown. Wings yellowish gray hyaline, subcosta ends in R_1 (Fig. 237). Halteres yellow. Stanford Univ., Cal., Feb.; Mt. Constitution, Orcas, Id. (J.M.A.) July.

23. *Allodia* Winnertz.

Verh. Zool.-bot. Ges. Wien. XIII. 826. 1863.

Brachycampta, Winnertz, ibidem. 833. 1863.

Lateral ocelli contiguous to the eye margin, the middle one very minute, in a groove, or wanting. Scutellum large, with 2 to 8 marginal setæ. Legs slender, hind coxæ with 1 to 3 posterior basal setæ. Costa ends at the tip of Rs; subcosta short, ending free or in R_1; petiole of media short; cubitus forks proximad of the fork of the media, and often even proximad of the base of the petiole of the media; first anal delicate, short, incomplete (*Allodia* Winnertz) or entirely wanting (*Brachycampta* Winnertz), second anal delicate and incomplete.

As both the structure of the anal vein and the position of the fork of the cubitus are slightly variable even within a species these characters cannot be used to distinguish the two Winnertzian genera.

Table of species.

a. Hind coxæ each with a vertical black dash near the apex on outer side; under side of hind femora each with a brown mark; 6 scutellar setæ. 1. *crassicornis* and varieties.

aa. Not so marked.

 b. Fore metatarsus equal or longer than the tibia and at least 1-4 of its length longer than the coxa.

  c. Four scutellar bristles, 2 hind coxal setæ, fore metatarsus nearly twice as long as the fore coxa. 2. *bulbosa* n. sp.

  cc. With 2 scutellar bristles, or otherwise different.

   d. Cubitus forks proximad of the proximal end of the cross-vein.

    e. Pleura fuscous; anal vein moderately strong (Fig. 237); length 4.5 mm; western species; page 313. *Rhymosia diffissa* n. sp.

    ee. With other characters.

     f. Claspers as figured (Fig. 130); eastern species. 3. *actuaria* n. sp.

     ff. Claspers otherwise; Wyoming species. 4. *Allodia* sp.

   dd. Cubitus forks under or distad of the proximal end of the crossvein; end of clasper broadly truncate. 5. *falcata* n. sp.

bb. Fore metatarsus shorter than the tibia and not 1-10 longer than fore coxa.
  c. Scutellum with 4 marginal setæ.
    d. Cubitus forks proximad of the proximal end of the R-M crossvein.
      e. Superior and inferior forceps lanceolate. (Fig. 132); a row of 4 to 6 setæ over the fore coxa; Mass. 6. *elata* n. sp.
      ee. One pair of forceps curved; (Fig. 133); lower margin of trochanter with 2 setæ; B. C. 7. *bella* n. sp.
    dd. Cubitus forks distad of proximal end of crossvein; female. 8. *Allodia* sp.
  cc. Scutellum with 2 marginal setæ.
    d. Cubitus forks at least slightly proximad of proximal end of crossvein; or if directly under, then thorax largely yellow.
      e. Yellowish species.
        f. One pair of forceps clavate, much longer than the other pair (Fig. 134); N. Y. 9. *beata* n. sp.
        ff. Both pairs of forceps more or less elongate (Fig. 135); Western species. 10. *callida* n. sp.
      ee. Dusky species; fore metatarsus less than .8 as long as the tibia; female. Western species. 11. *Allodia* sp.
    dd. Cubitus forks under or distad of base of the crossvein; thorax mainly brown or fuscous. 12. *delita* n. sp.

Allodia (Brachycampta) *unicolor* Lundb. from Greenland is omitted from the above table. Its thorax and abdomen are uniformly brown; fork of the cubitus is retracted and the fore metatarsus is shorter than the tibia.

The species *despecta, nubila, obscura, plebeja,* and *sericea* described under *Mycetophila* may possibly belong to this genus.

1. *Allodia crassicornis* Stannius.

Observ. de Mycetophila. 22. 1831.

Male. Length 4 to 5 mm. Face and mouth parts yellowish; head brownish; antennæ as long as head and thorax united, brown, basal joints yellow. Thorax brown to yellowish, mesonotum with 3 broad blackish stripes which may be wholly confluent; hairs yellowish gray, appressed, setæ at the sides and the 6 upon the scutellum, black; pleura brown to yellowish. The first abdominal segment fuscous with yellow hind margin, the second, third and fourth yellow, each with a large quadrangular fuscous spot, or sometimes only with rather smaller triangular spot, fifth and sixth fuscous usually with yellow posterior margins; hypopygium yellow. Coxæ yellow, hairs yellow, setæ at tip of fore pair black; posterior pair with vertical black dash at tip on outer side, and with 2 posterior basal setæ, trochanters each with black spot below; femora yellow with brown spot on the under side of each, and brown spot at apex; tibiæ pale brown, spurs and tarsi brown, fore tibia about 1-16 shorter than the metatarsus. Wing yellowish tinged, media forks at or slightly distad of the base of Rs, cubitus forks distad of the proximal end of the crossvein; anal furrow delicate ending before the base of the fork of the cubitus; anal vein stronger and longer; halteres yellow.

Female. Antennæ shorter than head and thorax united, conical, 5 basal joints of flagellum swollen, twice as wide as long, fuscous, with yellowish basal joints. Abdomen fuscous, segments with yellow posterior margins and venter. "Europe, N. A., Pa., N. J."

Var. a. Male and female. With vertical black dash upon middle coxa also but no brown spot under fore femora; hypopygium as figured (Fig. 127), cubitus forks at or very slightly proximad of the proximal end of the crossvein; otherwise like the foregoing. Burlington, Vt. (C.W.J.); Ithaca, N. Y. May-July.

Var. b. Female. Like var. a but with cylindrical antennæ. Burlington, Vt. (C.W.J.). June, July.

Var. c. Male. Like var. a but with less yellow upon thorax and abdomen, and with fore metatarsus 1-16 shorter than the tibia. Ithaca, N. Y.

Var. d. Female. Like var. c with conical antennæ but with fore metatarsus about .2 shorter than the tibia. Torrey's Lake, Wyoming, (W.M.W.). September.

2. *Allodia bulbosa* n. sp.

Male. Length 4.5 mm. Yellow; apical half of antennæ, the 3 thoracic stripes, center of scutellum, the lower margin of the metapleura, the metanotum light brown, the anterior 2-3 of each tergite of abdomen, a spot at tip of each hind femur, the tibial spurs and tarsi darker brown; hairs pale, setæ black; hypopygium small, yellow (Fig. 129). Hind coxæ each with 2 posterior basal setæ; fore metatarsus 1.38 times the tibia in length. Wings tinged with yellow, subcosta curved down but not ending in R_1 (Fig. 239); anal furrow strong, anal vein weak. N. H.; Ithaca, N. Y. (June); Forest Hill, N. J., (Weidt).

3. *Allodia actuaria* n. sp.

Male. Length 2.5 mm. Head fuscous, palpi and scape yellow. Thorax yellow, the center of the mesonotum, the scutellum, metanotum and margin of the metapleura dark brown, hairs pale, setæ black; 2 scutellar setæ. Abdomen yellow, posterior 2-3 of the first 4 dorsally, and the whole of the fifth segment dark brown; hypopygium yellow (Fig. 130). Coxæ and legs yellow, tibial spurs and tarsi brown; fore metatarsus about 1-8 longer than the tibia. Wings hyaline, yellow tinged, fork of cubitus retracted, anal vein indistinct (Fig. 240). Halteres yellow. Ithaca, N. Y. (Aug.)

Female. A single female specimen from Woods Hole, Mass., (C.W.J.) has wholly yellow pleura, and the mesonotum with 2 indistinct brown stripes which meet in front of the dark scutellum.

4. *Allodia* sp.

Male. Length 3 mm. Similar to the foregoing in coloring but the brown on the mesonotum is more extended, and the hypopygium differs. Fore metatarsus about .2 longer than the tibia. Wings hyaline, yellow tinged, fork of cubitus retracted far proximad of the base of the petiole of the media. A single specimen from Buck Creek, Wyo. (W.M.W.) Aug.

5. *Allodia falcata* n. sp.

Male. Length 3.5 mm. Fuscous; the palpi, scape, the apical 1-3 or 1-4 of the intermediate ventral sclerites of the abdomen, the hypopygium, coxæ, tibiæ and halteres yellow, tibial spurs and tarsi brownish; wings yellowish hyaline. Antennæ about 1.5 times as long as the head and thorax united. Hairs of body pale, setæ black; 2 setæ on scutellum; hypopygium longer than the sixth abdominal segment (Fig. 131); fore metatarsus and tibia subequal. Subcosta bent towards but not reaching R_1; cubitus forks about opposite or slightly distad of the proximal end of the crossvein.

Female. Yellow of abdomen more extended, and humeri sometimes also yellow. Cape May, N. J. and Ithaca, N. Y. (Sept.).

Var. a. Male and female. Length 3 mm. Humeri, pleura largely, venter and sides of the second to fifth abdominal segments, and sometimes hind margins of dorsal sclerites also, yellow. Prince Co. Wis., Chicago, Ill., (W.M.W.), Longmire's Springs, Wash. (J.M.A.) May to Aug.

6. *Allodia elata* n. sp.

Male. Length 2.5 mm. Head dusky yellow; basal joints of antennæ, palpi, and face yellow, apical half of antennæ subfuscous, hairs pale. Thorax yellow, scutellum, metanotum and 2 narrow converging stripes on mesonotum, brown; hairs pale, setæ black; 4 marginal setæ on scutellum. Abdomen yellow, a longitudinal dorsal stripe and the greater part of the fifth and sixth segments, dark brown; hypopygium (Fig. 132) yellow. A row of 4 to 6 fine blackish setæ just over the base of the fore coxæ. Coxæ and legs yellow, tibial spurs and tarsi brown; fore metatarsus about 7-8 of tibia in length; one posterior basal hind coxal seta. Wings yellowish hyaline; subcosta curved toward but not reaching R_1, cubitus forks proximad of the proximal end of the crossvein. Halteres yellow. Fall River, Mass., (N. S. Easton) May.

Female. One specimen from Hampton, N. H. (S. A. Shaw) differs in being paler, abdominal markings pale brown, setæ over fore coxæ paler.

Var. a. Female. Mesonotum subfuscous, tergites fuscous except hind margins. Blue Hills, Mass. (C.W.J.) July. One specimen.

Var. b. Female. Head, flagellum, thorax and abdomen fuscous, venter and narrow hind margins of tergites yellow. St. Johnsbury, Vt. (C.W.J.) June. One specimen. Var. a and b may possibly be distinct species.

7. *Allodia bella* n. sp.

Male. Length 2.5 mm. Head and antennæ brown; face, palpi, scape and base of flagellum yellow; antennæ about 1-4 longer than the head and thorax united. Thorax reddish yellow, mesonotum with 3 brown stripes more or less confluent; scutellum reddish, with 4 setæ, metanotum and margin of metapleura, brown; 2 setæ over the base of the fore coxæ. Abdomen dark brown, the venter of the first 4 segments yellow;

hypopygium (Fig. 133), yellow. Coxæ and legs yellow, tibial spurs and tarsi brown; fore metatarsus slightly shorter than the tibia. Wings yellowish hyaline; subcosta bends toward but apparently does not reach R_1; cubitus forks slightly proximad of the proximal end of the crossvein. Halteres yellow. Downie Creek, Selkirk Mts., B. C. (J.C.B.) August.

A defective specimen from Stanford Univ., Calif. (J.M.A.) taken in February may belong here.

8. *Allodia* sp.

Female. Length 3 mm. Brown; the scape, palpi, coxæ, femora, tibiæ, venter of intermediate segments in large part, ovipositor, and halteres yellow. Antennæ shorter than the thorax; fore metatarsus shorter than the tibia; cubitus forks distad of the proximal end of the crossvein. Dubois, Wyo. (W.M.W.) Sept.

9. *Allodia beata* n. sp.

Male and female. Length 3 mm. Head brown, basal joints of antennæ, and palpi yellow; antennæ about 1.5 times as long as the head. Thorax dusky yellow, 3 more or less confluent stripes of the mesonotum, scutellum and metanotum dark brown; scutellum with 2 marginal setæ. The tergites of the abdomen brown, the venter yellow; hypopygium (Fig. 134) yellow. (See also Pl. 7, fig. 14, Genera Insectorum, Fasc. 93). Coxæ and legs yellow, the tibial spurs, the tarsi and the extreme tips of the hind femora brown, fore metatarsus shorter than tibia. Wings yellowish hyaline; cubitus forks proximad of the proximal end of the crossvein. Halteres yellow. Ellis, and Ithaca, N. Y.

In some specimens the thoracic marks are obsolete and the abdomen is also much paler. In one the fifth and sixth segments are dark brown.

10. *Allodia callida* n. sp.

Male. Length 3 mm. Similar to the preceding but fifth and sixth abdominal segments are dark brown. Leg proportions also similar. Cubitus forks under the proximal end of the crossvein. Hypopygium with both pairs of forceps more or less lanceolate (Fig. 135). Keyport, Wash. (J.M.A.) Aug.; Littlewind River, Wyo. Sept.

11. *Allodia* sp.

Female. Length 3.5 mm. Fuscous; scape, palpi, spot below humerus, hind margins of the posterior tergites and the venter especially toward the tip, coxæ, tibia, and halteres yellow. Antennæ slightly enlarged at the base, about as long as head and thorax. Fore metatarsus about .8 as long as the tibia. Cubitus forks proximad of base of crossvein. Mt. Constitution, Orcas, Id., Wash. (J.M.A.) July.

12. *Allodia delita* n. sp.

Male. Length 3.5 mm. Fuscous, scape, palpi, humeri, anterior part of the venter, coxæ, femora, tibiæ, and halteres yellow. Antennæ more than half again as long as the head and thorax united. Scutellum with 2 marginal setæ; setæ over fore coxæ blackish. Fore metatarsus slightly shorter than the tibia. Wing yellowish hyaline; subcosta curved toward but does not reach R_1; cubitus forks about opposite the fork of the media. Hypopygium large (Fig. 136). Mt. Constitution, Orcas, Id.; Wash. (J.M.A.) July.

Female. A specimen from Berkeley, Calif. (W.M.W.) has dark humeri, pale brown hairs over fore coxæ, and shorter antennæ.

Var. a. Male. Length 3 mm. Like the foregoing in coloring and structure but the setæ above the fore coxæ are pale brown and the hypopygium differs slightly. Wis. (W.M.W.). This may possibly be a distinct species.

Addenda.

Dr. H. Dziedzicki of Warsaw, Russia, recently informed me that the hypopygium of *Platyura diluta* Lw. is identical with that of *P. unicolor* Winn., and that of *P. subterminalis* is like that of *P. infuscata* Winn. As the last two also resemble each other in other particulars they may be identical. *Platyura parva* belongs to Enderlein's new genus *Paraplatyura,* R_{2+3} ending in R_1.

Prof. T. D. A. Cockerell called my attention to an error in Part II (p. 131). *Tetragoneura peritula* should have been recorded from near Rifle, Colorado, an Eocene locality.

On page 136 in the description the hypopygium of *S. galbana* for *inferior* read *superior,* for *dorsal* read *ventral,* and vice versa. Similar corrections must be made under explanation of figure 122, page 192. For *glabana* read *galbana.* (Part II).

In the tables of leg measures on pages 323-325 the letters ct or t following a name signify that the measurements were made upon the cotype or the type specimen.

Since the publication of my previous papers on the *Mycetophilidae* in Bulletins 172 and 180 of this Station and in Genera Insectorum, Fasc. 93 there have appeared two papers by Dr. Enderlein (Trans. Linn. Soc. London, 1910, and Stettin Ent. Zeit. 1911) on this family of flies in which some additional genera have been proposed. As some of these genera occur in America it is desirable to give a brief synopsis of each with such differential characters as may be necessary to distinguish them from the older genera as characterized in the synoptic tables published in the previous papers of this series and in Genera Insectorum.

Mycetobiinae.

Mesochria is related to *Mycetobia* but differs in having contiguous eyes, and a coalescence of the tips R_1 and R_{2+3}. *Scotella* I consider a *Sciophiline*. See below.

Ceroplatinae.

Placoceratias differs from *Ceratelion* in possessing but 2 ocelli. In *Paraplatyura* R_{2+3} ends in R_1 in this respect differing from *Platyura. P. parva* from the St. Vincent Isl. should be placed here.

Sciophilinae.

Ectrepesthoneura was erected to contain *Tetragoneura hirta.* In this genus the subcosta ends in R_1 and the petiole of the cubitus is very short, thus distinguishing it from *Tetragoneura.* *Scotella* was referred to the *Mycetobiinae* by Dr. Enderlein but I am inclined to interpret the homology of the wing veins differently. In the figure given by him (Tran. Linn. Soc. p. 61) the veins marked cu and ax I consider to be M and cu respectively. This genus may be separated from *Paratinia* by the elongate petiole of the radial sector, and the presence of scales on thorax and abdomen. *Pleonazoneura* and *Neurocompsa* are both related to *Neoempheria* from which they differ in having a distinct vein between R and M instead of merely a fold. The second genus is distinguished further in having an accessory crossvein.

Mycetophilinae.

Aphanizophleps is an aberrant form with defective venation probably related to the *Sciarinae,* resembling *Manota* from which it is distinguished by the position of the lateral ocelli close to the eye margin. *Leiella* closely resembles *Rondaniella,* but it has only 2 ocelli, and the basal section of Rs is lacking. *Megalopelma,* a genus split off from *Phthinia,* differs in having the subcostal crossvein placed distad of the base of Rs. The American species *P. fraudulenta* no doubt belongs here. *Platurocypta* has but 2 ocelli, and a depressed instead of a compressed abdomen, differing in these respects from *Epicypta.* *Plastacephala* may be distinguished from *Mycetophila* by the form of the abdomen which is depressed instead of compressed. *Platyprosthiogyne* resembles *Zygomyia* but it has its costa produced, the ocelli but 2 in number, and a depressed abdomen.

LEG MEASUREMENTS.

These tables give the relative measurements of the joints of the legs, the fore tibia (T) being taken as 100.

Name.	Fore Leg.							Middle Leg.							Hind Leg.						
	F	T	1	2	3	4	5	F	T	1	2	3	4	5	F	T	1	2	3	4	5
Gnoriste megarrhina, male	80	100	89	51	29	18	11	90	132	102	52	31	18	13	105	162	102	42	28	15	10
Gnoriste megarrhina, female	83	100	88	49	29	17	–	90	132	97	44	34	–	–	118	180	110	43	29	19	12
Gnoriste macra, male, t	–	100	84	44	35	21	16	98	150	84	49	32	21	16	128	–	–	–	–	–	–
Acnemia flaveola, female	–	100	85	44	35	25	21	118	118	76	38	27	21	15	148	170	82	36	27	18	12
Acnemia psylla, male	106	100	90	52	35	23	19	132	142	100	42	26	19	13	158	171	103	37	24	18	14
Rondaniella abbreviata, male	118	100	71	44	32	22	19	148	159	100	48	40	26	20	–	–	–	–	–	–	–
Neuratelia silvatica, male, t	81	100	144	71	53	28	19	–	–	–	–	–	–	–	125	180	116	53	33	19	15
Neuratelia scitula, male, t	78	100	143	71	50	–	–	–	–	–	–	–	–	–	112	156	104	50	33	19	15
Neuratelia eminens, female, t	95	100	95	55	42	27	18	90	118	87	53	32	21	16	136	175	106	49	36	22	16
Neuratelia desidiosa, female, t	93	100	104	–	–	–	–	93	132	108	54	40	24	18	131	181	113	55	33	21	18
Neuratelia nemoralis, male	85	100	102	67	45	25	16	97	127	104	60	36	20	16	120	181	116	57	33	25	18
Leptomorphus ypsilon, female, t	73	100	163	75	61	42	25	85	146	131	62	49	29	22	124	193	122	58	42	25	20
Phthinia tanypus, female	73	100	238	88	46	23	15	85	143	203	88	38	–	–	126	162	124	62	31	9	6
Phthinia tanypus, male	70	100	235	95	52	30	17	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Phthinia curta, male t	82	100	82	80	53	40	27	82	126	100	63	37	23	17	133	163	120	60	30	20	13
Coelosia modesta, male, t	96	100	78	49	31	19	13	–	–	–	–	–	–	–	144	200	100	38	27	18	13
Coelosia lepida, male, t	78	100	75	48	33	22	13	118	140	87	43	28	20	15	120	196	93	37	26	20	15
Coelosia gracilis, male, t	95	100	74	52	43	26	17	131	156	100	48	33	22	15	156	210	108	43	26	22	15
Syntemna separata, male, t	102	100	85	64	51	–	–	142	140	111	51	38	30	21	–	200	115	43	34	25	21
Syntemna rejecta, male, t	100	100	72	46	35	27	21	137	150	96	46	33	25	21	167	208	117	46	33	25	21
Syntemna longicornis, male	97	100	63	44	37	30	20	115	130	85	45	33	26	22	157	189	100	46	30	22	18
Syntemna vittata, var. fasciata, male, t	113	100	67	52	47	31	22	131	131	100	47	36	25	19	172	185	103	39	28	22	19
Syntemna vittata? female	118	100	78	54	45	32	23	132	132	97	43	36	–	–	157	200	107	47	36	25	20
Megophthalmidia occidentalis, male, t	103	100	56	33	30	23	20	135	131	83	45	36	28	19	167	183	90	45	31	26	21
Anatella sylvestris, male, t	93	100	98	81	54	39	32	110	132	107	58	39	32	27	136	171	117	49	29	24	22
Docosia nigella, male, t	123	100	63	27	18	11	41	159	141	79	36	25	18	36	177	208	105	50	–	–	–
Docosia nitida, male, t	119	100	71	33	28	22	22	150	131	90	47	36	26	22	174	187	122	53	39	30	22
Docosia dichroa, male	119	100	57	19	16	12	19	148	126	78	31	24	19	24	166	176	100	43	36	24	19
Trichonta triangularis, male, var. a. t	114	100	95	57	47	29	22	136	146	107	57	43	–	–	161	205	116	50	36	–	–
Trichonta triangularis, male, t	106	100	88	53	39	27	25	131	140	97	49	38	28	25	156	200	107	44	33	25	22

LEG MEASUREMENTS.

These tables give the relative measurements of the joints of the legs, the fore tibia (T) being taken as 100—Continued.

Name.	Fore Leg.							Middle Leg.							Hind Leg.						
	F	T	1	2	3	4	5	F	T	1	2	3	4	5	F	T	1	2	3	4	5
Trichonta diffissa, male, c. t	125	100	78	44	30	22	18	136	130	86	40	30	22	19	160	195	100	37	27	21	19
Trichonta patens, female, t	122	100	78	45	36	22	19	122	140	88	45	36	22	19	156	200	98	40	33	25	19
Trichonta bellula, male, t	112	100	79	54	37	21	–	138	142	92	46	31	25	21	146	196	92	42	29	23	19
Trichonta cincta, female, t	111	100	77	–	–	–	–	140	140	93	47	34	25	21	148	205	115	42	34	25	21
Boletina sedula, male, t	90	100	85	52	28	18	16	107	153	97	43	27	18	15	–	–	–	–	–	–	–
Boletina sedula, female, c. t	94	100	78	47	29	19	17	122	148	87	39	27	18	16	138	188	94	31	23	16	13
Boletina inops, female	93	100	72	40	25	19	15	106	134	82	35	25	16	14	130	183	98	31	25	16	14
Boletina nacta, male, t	90	100	90	61	47	27	20	114	145	100	58	40	23	20	131	189	122	52	37	23	16
Boletina obscura, male, t	100	100	70	36	28	16	20	120	128	76	40	30	16	20	152	180	97	46	32	16	20
Boletina imitator, male, t	80	100	91	52	35	22	15	98	131	95	39	30	17	14	124	170	106	35	28	17	–
Boletina longicornis, male, t	85	100	80	49	32	19	13	100	135	90	40	27	20	12	–	–	–	–	–	–	–
Boletina tricincta, male	108	100	–	–	–	–	–	–	–	–	–	–	–	–	168	200	108	43	35	27	22
Boletina tricincta, female	95	100	70	40	30	18	14	114	117	70	37	30	17	15	139	161	74	35	28	22	15
Boletina notescens, male, t	91	100	88	51	33	21	15	112	127	98	40	30	21	15	136	172	100	36	17	21	15
Boletina notescens, var. a., female	92	100	81	47	33	21	16	119	139	95	45	33	19	17	142	189	111	–	–	–	–
Boletina hopkinsii? female	98	100	67	35	27	17	19	118	130	82	40	31	20	18	149	183	98	43	31	–	–
Boletina gracilis, male, t	87	100	80	54	38	24	17	–	–	–	–	–	–	–	132	169	104	44	31	19	17
Boletina delicata, male, t	92	100	84	52	34	–	–	116	132	90	46	32	16	14	144	190	96	44	32	20	14
Boletina cincta, male, t	93	100	62	45	38	24	21	117	114	80	41	28	21	17	138	173	–	–	–	–	–
Boletina melancholica, male, t	–	100	76	42	18	15	14	–	121	83	41	28	15	15	124	182	97	38	28	19	17
Boletina sobria, female	100	100	64	41	32	23	18	132	132	82	40	34	23	18	154	191	102	41	34	23	23
Boletina obesula, female, t	97	100	70	34	25	17	15	116	133	78	39	28	19	17	144	187	106	44	31	22	17
Leia nigra, male, t	112	100	80	40	27	20	20	162	154	106	58	41	29	23	182	212	110	56	41	30	23
Leia dryas, male, t	112	100	104	57	43	27	23	160	160	106	50	37	27	20	160	220	100	47	30	27	20
Leia plebeja, male, t	106	100	87	47	40	27	23	166	166	114	57	43	27	20	200	240	110	60	40	30	23
Leia opima	110	100	110	66	47	28	23	156	172	112	53	37	24	22	184	236	110	50	35	24	20
Leia striata, var. a., male	114	100	123	78	57	39	25	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Leia winthemii, male	103	100	110	60	43	26	19	144	165	103	48	38	24	19	162	220	107	46	31	24	19
Leia cincta, male	120	100	–	–	–	–	–	165	165	105	55	40	27	17	–	–	–	–	–	–	–
Leia decora, male	118	100	84	49	47	30	24	172	160	–	–	–	–	–	182	226	111	–	–	–	–

LEG MEASUREMENTS.

These tables give the relative measurements of the joints of the legs, the fore tibia (T) being taken as 100—Concluded.

Name.	Fore Leg.							Middle Leg.							Hind Leg.						
	F	T	1	2	3	4	5	F	T	1	2	3	4	5	F	T	1	2	3	4	5
Leia sublunata, male	112	100	96	53	44	26	20	158	160	112	53	35	22	16	170	250	104	48	33	22	18
Leia varia, female	98	100	–	–	–	–	–	140	162	115	57	38	27	23	166	217	–	–	–	–	–
Leia ventralis, female	102	100	84	40	32	22	22	148	152	94	42	32	24	24	184	220	96	40	32	22	22
Leia cuneola, female	120	100	104	50	35	26	20	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Leia bivittata, female	104	100	83	43	35	23	17	143	143	97	47	37	23	18	162	204	95	45	38	27	18
Leia oblectabilis, male	118	100	114	63	54	38	25	159	173	114	50	36	27	23	191	246	107	41	34	27	23
Brachypeza bisignata var. divergens, male, t	114	100	84	68	47	36	32	159	146	136	77	57	41	34	191	191	136	59	45	36	32
Cordyla manca, female, c. t	144	100	72	60	56	40	40	208	189	144	92	64	–	–	232	248	168	68	56	48	40
Cordyla recens, male	137	100	100	73	64	–	–	168	182	164	82	73	50	36	227	236	164	68	59	36	27
Cordyla scita, male, t	–	100	83	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cordyla neglecta, male, t	154	100	91	68	63	41	36	182	191	154	82	68	41	32	218	236	154	63	59	36	27
Cordyla volucris, male, c. t	142	100	92	67	62	46	37	150	175	158	–	–	–	–	208	200	168	75	62	46	37
Cordyla volucris, female	130	100	71	58	46	37	33	166	150	124	75	58	46	37	208	192	142	66	58	42	33
Rhymosia captiosa, male, t.	100	100	129	84	64	48	32	122	132	138	71	55	39	29	152	188	142	62	45	32	23
Rhymosia imitator, male, t	100	100	117	74	52	39	30	117	126	133	74	–	–	–	133	178	144	–	–	–	–
Rhymosia akeleyi, male, c t	96	100	111	82	59	41	30	119	122	126	66	44	33	26	141	165	132	51	41	26	18
Rhymosia akeleyi, male, t	100	100	120	83	60	43	30	120	140	133	70	50	33	27	147	183	132	57	37	27	20
Rhymosia inflata, male, t	100	100	114	74	58	39	26	116	123	119	68	51	32	26	136	168	130	55	36	26	19
Rhymosia serripes, male, t	90	100	160	85	60	30	25	–	–	–	–	–	–	–	140	185	135	65	–	–	–
Rhymosia diffissa, male, t	96	100	122	77	48	30	22	119	137	141	63	44	30	22	136	185	137	–	–	–	–
Allodia crassicornis, var. a., male	100	100	107	77	60	43	33	133	133	133	70	53	40	27	156	196	127	57	–	–	–
Allodia bulbosa, male, t	90	100	133	57	40	30	23	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Allodia falcata, male, t	86	100	109	72	57	38	28	102	124	124	59	48	33	28	138	166	131	48	38	28	19
Allodia actuaria, male, t	100	100	112	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Allodia beata, male, t	121	100	88	64	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Allodia delita, male, t	–	100	89	74	52	40	34	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Allodia callida, male, t	100	100	91	64	54	36	27	136	136	114	63	50	32	23	–	–	–	–	–	–	–
Allodia bella, male, t	106	100	87	73	53	40	33	–	–	–	–	–	–	–	166	207	140	60	40	27	20
Allodia elata, male, t	100	100	83	72	56	39	31	139	139	125	69	55	33	28	166	195	134	61	45	33	22

Explanation of Plates.

Abbreviations used in the explanation of the plates of the hypopygia. da = dorsal aspect, va = ventral aspect, ma = mesal aspect, la = lateral aspect, a = median ventral plate, s = superior forceps, i = inferior forceps.

Plate.

Hypopygia. Magnification x 60 unless otherwise noted.

98. *Leia cincta,* median ventral process, c, limb of forceps.
99. *L. decora,* la a, median sclerite, x 35.
100. *L. opima,* x 35.
101. *L. sublunata,* x 35.
102. *Phthinia curta,* x 35.
103. *Coelosia lepida,* ma of limb.
104. *C. modesta,* c and b, limbs.
105. *Syntemna rejecta,* x 35.
106. *S. vittata, var fasciata,* b is la of c.
107. *Anatella silvestris,* la.
108. *Docosia dichroa,* terminal appendage of lateral sclerite.
109. *D. nigella,* x 20.
110. *D. nitida.*
111. *Trichonta triangularis,* forceps limb, x 35.
112. *T. bellula,* forceps.
113. *T. diffissa,* forceps.
114. *T. patens,* forceps.
115. *Cordyla manca,* b', ma of b.
116. *C. scita.*
117. *C. volucris,* ma. Forceps.
118. *C. recens.* Forceps.
119. *C. neglecta.* Forceps.
120. *Brachypeza bisignata var. divergens,* latero-dorsal aspect, x 20.
121. *Rhymosia serripes,* x 35.
122. *R. inflata,* x 20.
123. *R. imitator,* x 35. Forceps.
124. *R. akeleyi,* x 35. Apex of hypopygium.
125. *R. captiosa,* x 20.
126. *R. diffissa,* b = va-la, b' = da of b, x 35. Forceps.
127. *Allodia crassicornis,* var a, x 35. Forceps.
128. *A. crassicornis,* var c, x 35. Forceps.
129. *A. bulbosa.* Forceps.
130. *A. actuaria.* Forceps.
131. *A. falcata.* Forceps.
132. *A. elata.* Forceps.
133. *A. bella.* Forceps.
134. *A. beata,* x 40. Forceps.
135. *A. callida,* x 40. Forceps.
136. *A. delita,* x 45. Forceps.

Plate.

Hypopygia. Magnification x 35 unless otherwise noted.

137. *Gnoriste megarrhina,* da.
138. *G. macra,* forceps, ma.
139. *G. megarrhina,* forceps, ma.
140. *Acnemia psylla,* var. da. Forceps.
141. *A. psylla,* da, x 45.
142. *Rondaniella abbreviata.*
143. *Neuratelia silvatica,* da, x 45.
144. *N. scitula,* da.
145. *N. nemoralis,* inner appendage of s, da x 60.
146. *Boletina obscura.*
147. *B. cincta.*
148. *B. melancholicus,* median ventral lobe, x 60.
149. *B. melancholicus,* forceps, x 60.
150. *B. imitator,* x 20.
151. *B. gracilis,* forceps.
152. *B. longicornis,* x 25.
153. *B. notescens,* forceps, x 60.
154. *B. arctica,* after Rübsaamen.
155. *B. nacta,* apex of forceps, x 60.
156. *B. sciarina,* forceps, after Dziedzicki.
157. *B. tricincta,* forceps.
158. *B. delicata,* va, median ventral lobe.
159. *B. delicata,* da, upper lateral lobe.
160. *B. delicata,* va. lower lateral lobe.
161. *B. notescens,* var. a, ovipositor.
162. *Leia melæna.*
163. *L. nigra.*
164. *L. winthemii.*
165. *L. striata,* var. a, forceps la, x 60.
166. *L. plebeja,* forceps, la, x 60.
167. *L. oblectabilis,* forceps, la, x 60.
168. *L. dryas.*

Plate.

169. *Gnoriste megarrhina.*
170. *G. macra.*
171. *Acnemia psylla.*
172. *A. flaveola.*
173. *Rondaniella abbreviata.*
174. *Neuratelia silvatica.*
175. *N. eminens.*
176. *N. nemoralis.*
177. *Leptomorphus ypsilon.*
178. *Allocotocera parvula.*
179. *Boletina obscura.*
180. *B. cincta.*
181. *B. melancholica.*
182. *B. imitator.*
183. *B. gracilis.*
184. *B. longicornis.*
185. *B. notescens.*
186. *B. sobria.*
187. *B. tricincta.*
188. *B. delicata.*
189. *B. obesula.*
190. *B. inops,* var. a.
191. *B. sedula.*
192. *B. nacta.*

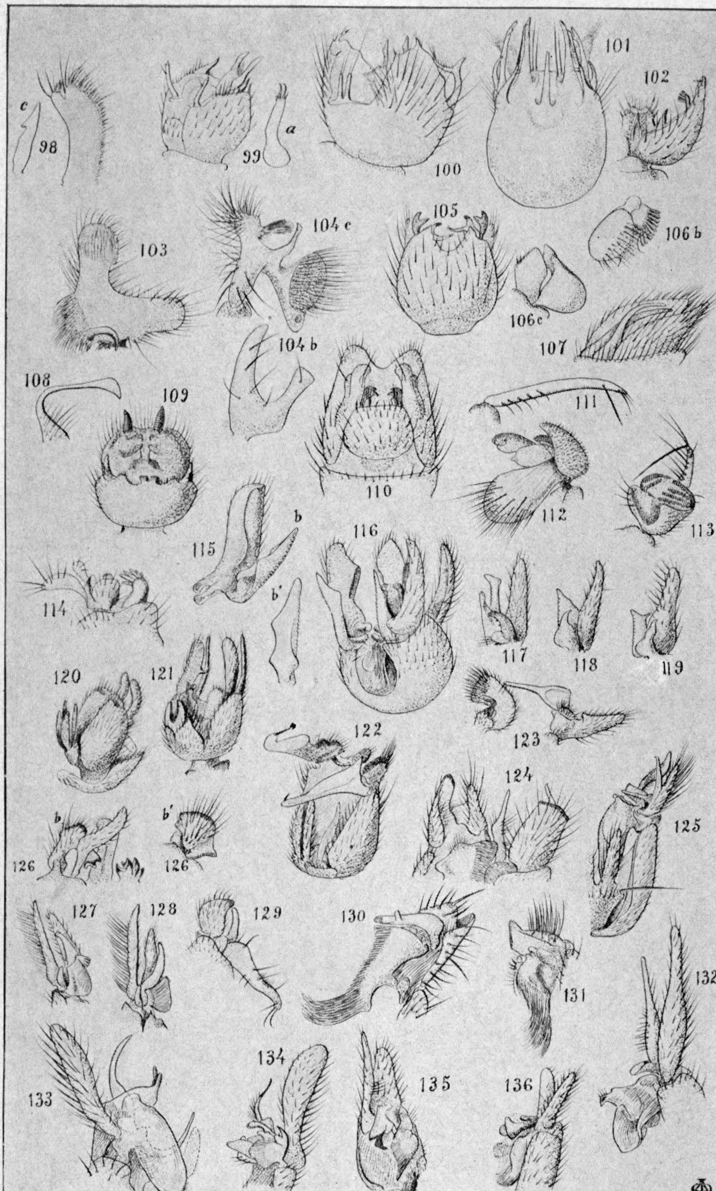
193. *Leia varia.*
194. *L. melæna.*
195. *L. nigra.*
196. *L. ventralis.*
197. *L. cuneola.*
198. *L. winthemii.*
199. *L. striata,* var. a.
200. *L. plebeja.*
201. *L. oblectabilis.*
202. *L. dryas.*
203. *L. cincta.*
204. *L. decora.*

Plate.

205. *Leia opima.*
206. *L. sublunata.*
207. *L. bivittata.*
208. *Phthinia curta.*
209. *P. tanypus.*
210. *Coelosia gracilis.*
211. *C. lepida.*
212. *C. modesta.*
213. *Syntemna rejecta.*
214. *S. vittata.*
215. *S. separata.*
216. *Megophthalmidia occidentalis.*
217. *Anatella silvestris.*
218. *Docosia dichroa.*
219. *D. nigella.*
220. *D. nitida.*
221. *Trichonta triangularis.*
222. *T. diffissa.*
223. *T. patens.*
224. *Cordyla manca.*
225. *C. scita.*
226. *C. volucris.*
227. *C. recens.*
228. *C. neglecta.*
229. *Brachypeza bisignata,* var divergens.
230. *Rhymosia* sp a.
231. *R.* sp. b.
232. *R. serripes.*
233. *R. inflata.*
234. *R. imitator.*
235. *R. akeleyi.*
236. *R. captiosa.*
237. *R. diffissa.*
238. *Allodia crassicornis,* var. a.
239. *A. bulbosa.*
240. *A. actuaria.*

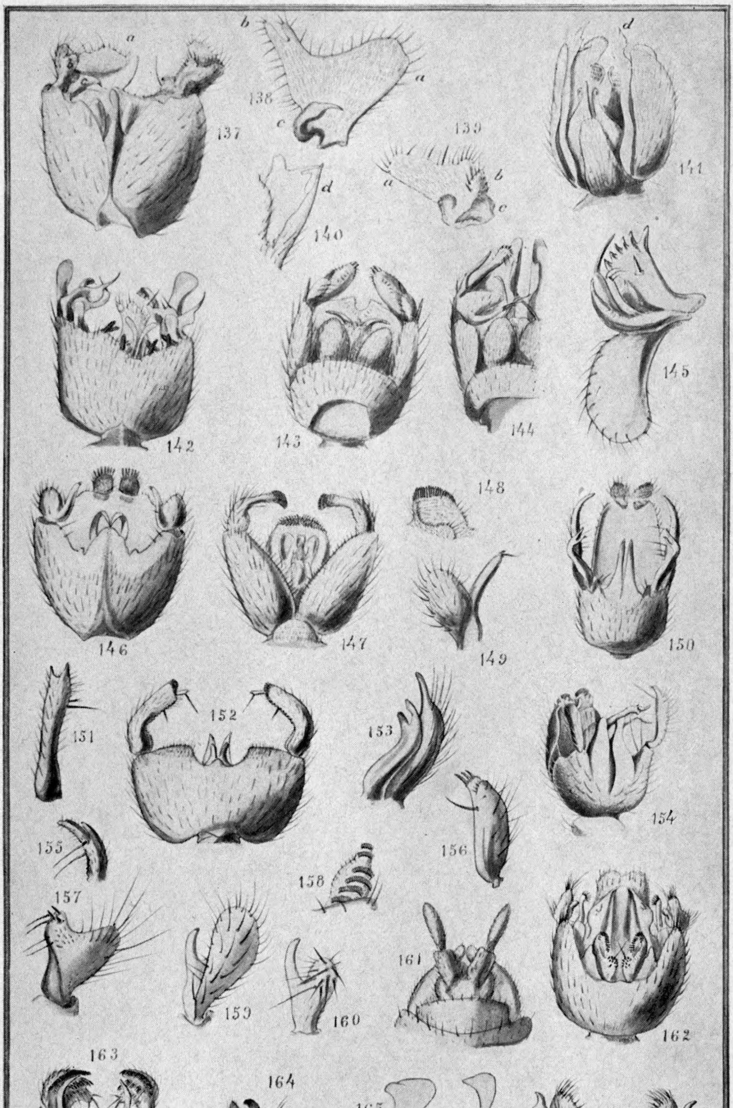
Plate.

241. *Docosia dichroa.*
242. *Exechia.*
243. *Boletina vittata* (Europe).
244. *Leia winthemii.*
245. *Mycetophila punctata.*

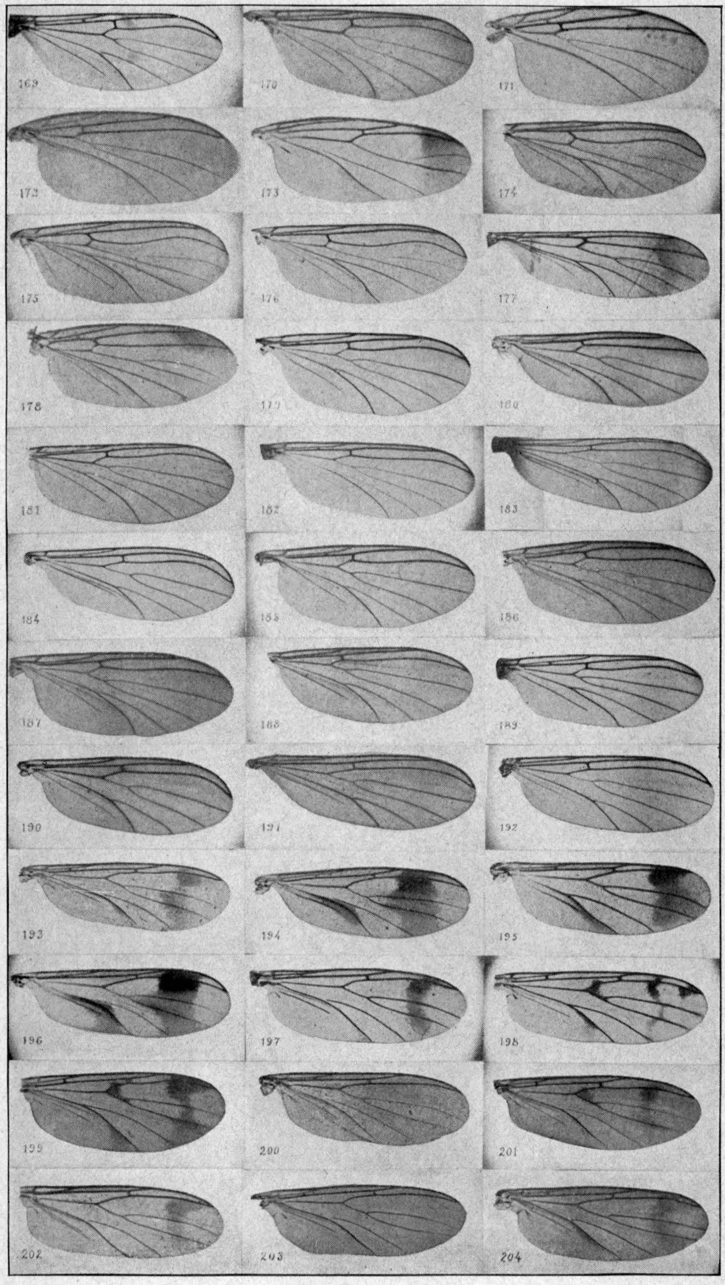


Figs. 98 to 136. Details of hypopygia.

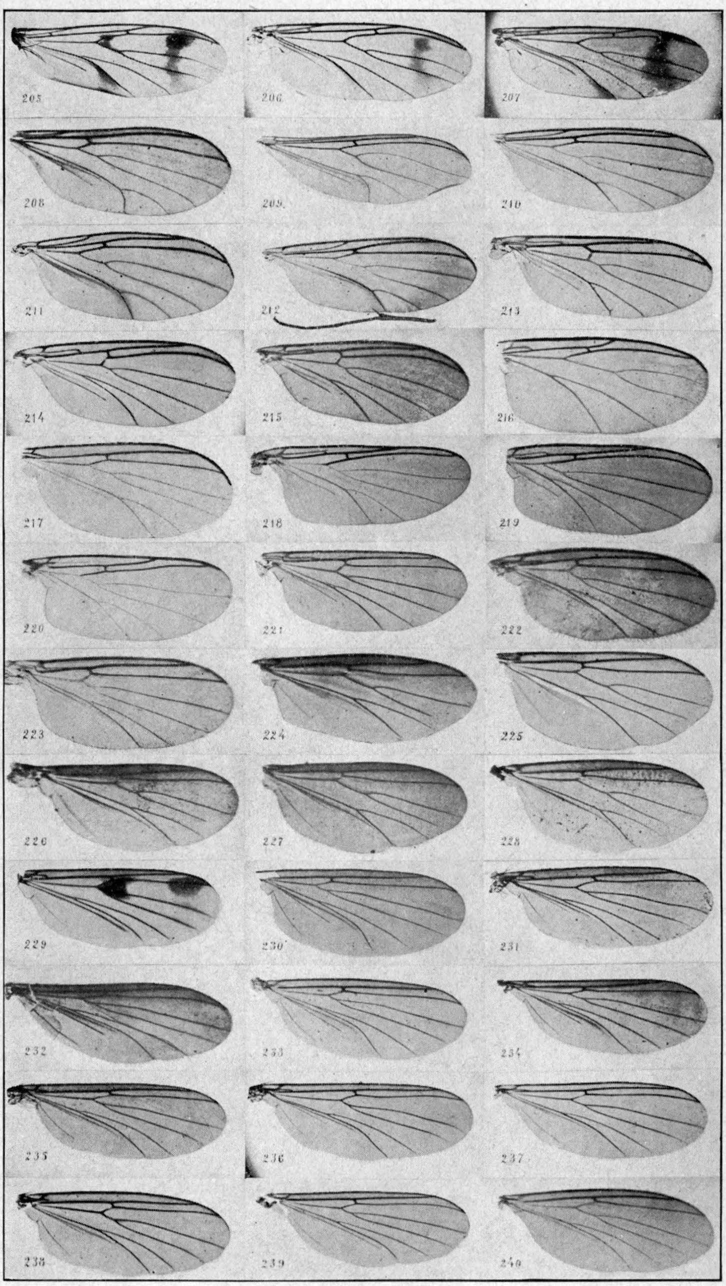
98-101, Leia. 102, Phthinia. 103-104, Coelosia. 105-106, Syntemna. 107, Anatella. 108-110, Docosia. 111-114, Trichonta. 115-119, Cordyla. 120, Brachypeza. 121-126, Rhymosia. 127-136, Allodia.



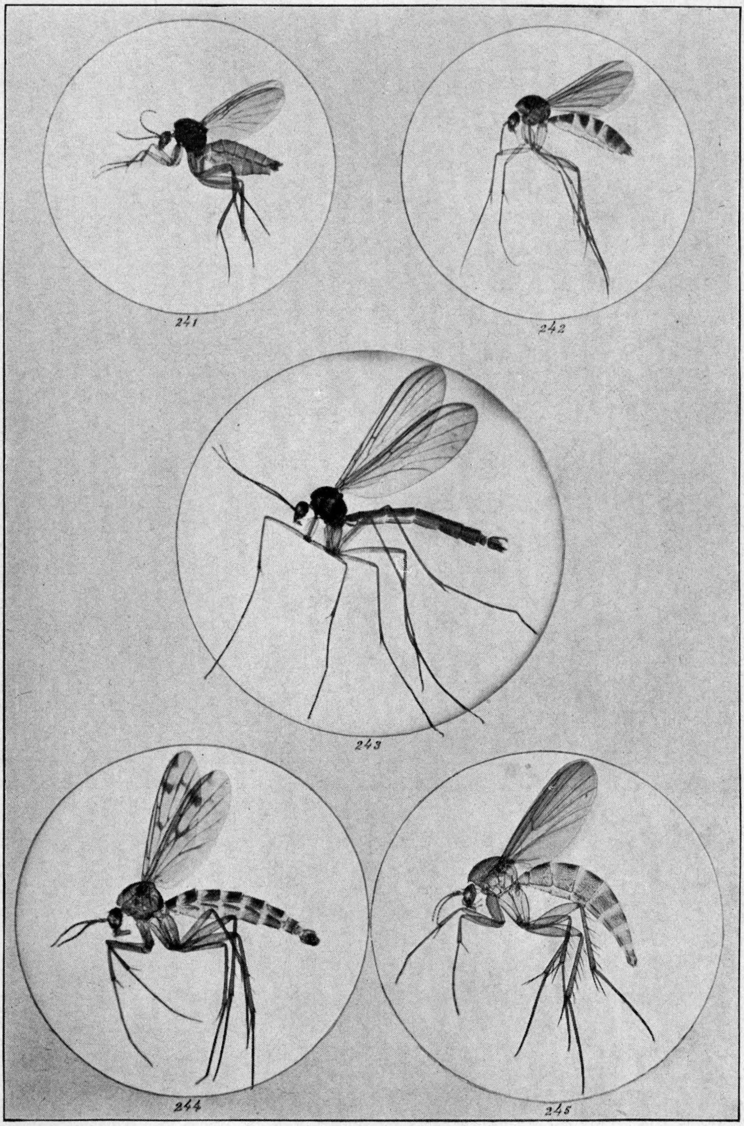
Figs. 137 to 168. Details of hypopygia.
137-139, Gnoriste. 140-141, Acnemia. 142, Rondaniella. 143-145, Neuratelia. 146-160, Boletina. 161, Boletina (*ovipositor*). 162-168, Leia.



Figs. 169-170, Gnoriste. 171-172, Acnemia. 173, Rondaniella. 174-176, Neuratelia. 177, Leptomorphus. 178, Allocotocera. 179-192, Boletina. 193-204, Leia (*Neoglaphyroptera*).



Figs. 205-207, Leia (*Neoglaphyroptera*). 208-209, Phthinia. 210-212, Coelosia. 213-215, Syntemna. 216, Megophthalmidia. 217, Anatella. 218-220, Docosia. 221-223, Trichonta. 224-228, Cordyla. 229, Brachypeza. 230-237, Rhymosia. 238-240, Allodia (+ *Brachycampta*).



241, Docosia. 242, Exechia. 243, Boletina. 244, Leia (*Neoglaphyroptera*)
245, Mycetophila. Photographed from balsam mounts.

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.

January 1, 1911 to May 31, 1911, the instruments used were at Lat. 44° 54′ 2″ N. Lon. 68° 40′ 11″ W. Elevation 150 feet. From June 1, 1911, to December 31, 1911, 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-three years.

METEOROLOGICAL SUMMARY FOR 1911.

Observations Made at the Maine Experimental Station.

1911.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Mean.	Total.
Highest temperature	48.0	45.0	53.0	85.0	96.0	85.0	96.0	88.0	81.0	73.0	63.0	58.0		
Lowest temperature	–20.0	–22.0	–12.0	9.0	26.0	38.0	48.0	40.0	25.0	22.0	7.0	–4.0		
Mean temperature	18.15	14.56	25.2	40.9	59.25	62.30	71.2	66.2	57.2	46.10	34.40	28.00	43.62	
Mean temperature in 43 years	16.39	18.82	28.43	40.82	52.64	61.97	67.20	65.10	57.55	45.25	34.36	20.75	42.39	
Total precipitation in inches	3.21	2.78	3.97	1.18	0.75	4.60	4.45	2.94	3.05	1.94	3.28	3.91	....	36.06
Mean precipitation in 43 years	4.23	3.83	4.20	2.88	3.38	3.48	3.25	3.43	3.49	3.77	3.62	3.69	....	43.30
Number of days with precipitation of .01 inches or more	11	8	11	7	5	11	10	6	12	8	10	7	....	106
Snow fall in inches	19.75	24.5	24	6	....	....	....	....	....	Trace..	Trace..	8.00	....	76.25
Mean snow fall in 43 years	22.63	21.8	16.1	5.5	0.2	....	....	....	....	0.76	7.5	16.6	....	91.11
Number of clear days	9	12	14	13	11	4	3	5	2	13	18	9	....	113
Number of fair days	8	6	2	8	6	16	22	14	15	9	4	9	....	119
Number of cloudy days	14	10	15	9	14	10	6	12	13	9	8	13	....	133
Total movement of wind in miles	5987	5246	5876	5423	5551	2687	3132	3271	3641	3830	5874	4008	....	54526

Monthly and Annual Precipitation (as rain) for the Year 1911.

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Bar Harbor	4.55	4.14	4.35	1.70	T	3.51	4.41	1.90	5.15	2.10	6.65	4.30	42.76
Cornish	2.94	3.46	4.29	1.16	1.00	3.04	3.84	3.13	5.34	2.99	3.78	3.34	38.31
Eastport	2.98	2.47	3.68	2.55	0.13	5.07	3.50	2.53	2.67	1.57	3.83	2.80	33.78
Fairfield	1.98	2.19	4.03	0.58	1.34	2.21	2.75	2.38	2.28	1.68	2.81	3.12	27.35
Farmington	1.96	2.06	5.54	......	1.20	......	2.68	3.90	3.22	3.08	3.40	3.07	30.11
Gardiner	2.73	2.51	4.60	0.78	1.10	3.57	5.43	2.59	4.85	2.35	3.76	2.19	36.46
Greenville	2.91	2.68	4.95	1.24	0.40	3.85	4.04	4.06	3.89	2.63	3.86	4.27	38.78
Houlton	1.25	0.85	1.65	0.95	0.03	1.95	2.11	2.80	3.85	1.80	2.65	1.85	21.74
Lewiston	2.75	2.69	5.04	1.00	0.56	3.88	5.64	2.34	3.88	2.38	3.42	3.14	36.72
Madison	2.28	1.77	5.71	0.93	0.59	5.33	4.91	7.01	3.86	3.44	3.67	3.24	42.74
Millinocket	2.87	1.96	4.26	1.08	0.51	5.06	......	3.90	2.73	1.77	4.36	4.29	32.79
North Bridgton	2.75	2.56	4.31	0.91	1.35	2.88	3.89	2.82	3.63	2.82	3.21	2.97	34.10
Orono	3.21	2.78	3.97	1.18	0.75	4.60	4.45	2.94	3.05	1.94	3.28	3.91	36.06
Patten	3.13	1.47	3.65	1.02	2.58	4.46	3.73	4.55	6.75	1.54	4.02	3.10	40.00
Portland	2.58	5.02	5.60	2.25	1.37	2.74	4.71	2.56	2.84	1.85	3.51	4.49	39.52
Presque Isle	2.68	1.02	1.81	1.03	0.34	......	......	2.87	3.29	......	......	2.78	15.82
Rumford Falls	1.97	2.58	4.16	0.76	0.88	2.75	2.46	4.85	3.20	3.23	2.88	2.74	32.46
Winslow	2.24	1.40	3.83	0.59	0.61	4.17	4.43	2.63	3.60	2.13	3.04	3.00	31.67

No reports were printed from the stations in the months where blanks occur.

REPORT OF TREASURER FOR FISCAL YEAR ENDING JUNE 30, 1911.

RECEIPTS.	Hatch fund.	Adams fund.	General account.	Inspections.
Balance July 1, 1910	....	....	$764 19	$46 79
Treasurer of United States	$15,000 00	$15,000 00		
State	....	....	....	†9,688 26
Sales, etc	....	....	1,894 74	
Analysis fees	....	....	....	1,837 43
Total	$15,000 00	$15,000 00	$2,658 93	$11,572 48
*Deficit	....	....	....	123 52
				$11,696 00
DISBURSEMENTS.				
Salaries	$5,609 83	$13,927 11	$1,157 92	$8,622 96
Labor	1,980 51	98 05	9 38	
Publications	158 25			
Postage and stationery	454 51	....	13 75	442 75
Freight and express	416 05	31 89	3 30	247 48
Heat, light and power	551 02	....	....	141 84
Chemical supplies	194 01	....	....	534 91
Seeds, plants and sundry supplies	641 56	258 98	41 43	55 23
Fertilizers	678 09			
Feeding stuffs	1,401 48	23 17		
Library	809 18	58 12		
Tools, implements and machinery	484 63	12 88	2 25	
Furniture and fixtures	287 59			
Scientific apparatus	293 86	336 45	....	445 76
Live stock	125 21	51 00	9 30	
Traveling expenses	250 27	158 52	....	1,103 45
Contingent expenses	56 25	....	57 50	101 62
Buildings	607 70	43 83		
Balance, June 30, 1910	....	....	1,364 10	
Total	$15,000 00	$15,000 00	$2,658 93	$11,696 00

* This is only an apparent deficit as the inspection year ends with the State year December 31.

† Due but not paid July 1, 1911.

The classified report does not include $1,000.00 paid for services and feeding stuffs in poultry investigations by the U. S. Department of Agriculture, an appropriation of $5,200 from the State for printing Station publications nor the receipts and expenditures for food packed under inspection.

INDEX.

APPENDIX

Official Inspections

29 to 35

POULTRY DISEASES AND THEIR TREATMENT.
SUGGESTIONS FOR WOODLOT OWNERS IN MAINE.

CONTENTS

January, 1911

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

Analysts
James M. Bartlett — Herman H. Hanson
Albert G. Durgin — Royden L. Hammond
Alfred K. Burke

Official Inspections.

29

FERTILIZER INSPECTION.

The law regulating the sale of commercial fertilizers in this State formerly called for the publication of two bulletins each year. The first of these, issued in the early spring, contained the analysis of the samples received from the manufacturer guaranteed to represent within reasonable limits the goods to be later placed upon the market. The second bulletin contained the analysis of the samples collected in the open market by a representative of the Station.

It has been found by long experience that the results of the analysis of samples collected by representatives of the Station are a safer guide in the purchase of fertilizers than those of the manufacturers' samples. The Legislature of 1909 changed the law relative to publication so that hereafter only one fertilizer bulletin will be published each year. This will contain the reports of the analysis of the samples collected by the Station representatives of fertilizers sold in Maine during the year.

Chief Requirements of the Law.

The law applies to "any material used for fertilizing purposes, the price of which exceeds ten dollars a ton." For many years the sale of materials other than mixed goods was so small that no notice was taken of it. As time went on, however, with the propagation of the ideas of home mixing, the demand for chemicals increased. For the last few years the most common chemicals such as acid phosphate, ground bone, nitrate of soda and the various potash salts are regularly licensed by the companies handling them. In the case chiefly of companies manufacturing in the State it happens that other fertilizing constituents are sold in small amounts and primarily for experimental purposes. While the law is explicit there will until further notice, be no prosecutions made by the Director of the Maine Agricultural Experiment Station for the sale without license of small amounts of these more unusual fertilizing constituents, provided the company can show that these goods were sold in good faith for experimental purposes. As a part of the indication that the goods were thus sold it should be explained to the customer exactly under what conditions the goods are sold; that they are unlicensed; that they have not been or are not likely to be analyzed by the Director of the Maine Experiment Station and that the Director holds himself in no way responsible for the quality of these unlicensed goods sold for experimental purposes. Their sale is allowed because the Director does not regard it as the purposes of the law to either hamper ordinary business or hinder experiments on the part of the farmer. Whenever any goods thus offered experimentally come to be sold in considerable amount they must be licensed the same as other fertilizing materials.

The Brand. Each package shall bear, conspicuously printed, the following statements:

The number of net pounds contained in each package.
The name or trade mark under which it is sold.
The name of the manufacturer or shipper.
The place of manufacture.
The place of business of manufacturer or shipper.
The percentage of nitrogen or its equivalent in ammonia.
The percentage of potash soluble in water.
The percentage of phosphoric acid in available form.

The percentage of total phosphoric acid.

The Certificate. There shall be filed annually between Nov. 15 and Dec. 15 with the Director of the Station a certificate containing an accurate statement of the brand. This certificate applies to the next succeeding calendar year.

Analysis Fee. For each brand of fertilizer sold or offered for sale in the State there shall be paid annually "an analysis fee as follows: Ten dollars for the phosphoric acid and five dollars each for the nitrogen and potash contained or said to be contained in the fertilizer."

The License. Upon the payment of the fee and receipt of the certificate the Director of the Station "shall issue a certificate of compliance."

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."

Executive. The Director of the Station is directed to collect and analyze samples of all fertilizers sold 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.

The full text of the law is printed in Official Inspections 12. A copy will be sent on request made to the Director of the Experiment Station, Orono, Maine.

Fertility and Plant Food.

To produce profitable crops and at the same time to maintain and even to increase the productive capacity of the soil may rightly be termed "good farming." Many farmers are able to do this, and the knowledge of how to do it has been largely acquired through years of experience, during which the character of the soil, its adaptability for crops, and the methods of its management and manuring have been made the subjects of careful study, without, however, any definite and accurate knowledge concerning manures and their functions in relation to soils and crops. Those who desire to study these questions, are invited to write to the Superintendent of the Extension Department of the College of Agriculture, University of Maine, Orono, Maine, who will gladly send a list of suitable books and give full information relative to correspondence courses on this subject.*

Soils vary greatly in their capabilities of supplying food to crops. Different ingredients are deficient in different soils. The way to learn what materials are proper in a given case is by observation and experiment. The rational method for determining what ingredients of plant-food a soil fails to furnish in abundance, and how these lacking materials can be most economically supplied, is to put the questions to the soil with different fertilizing materials and get the reply in the crops produced. How to make these experiments is explained in Circular No. 8 of the Office of Experiment Stations of the U. S. Department of Agriculture. A copy of this circular can be had by applying to the Secretary of Agriculture, Washington, D. C.

The chief use of fertilizers is to supply plant-food. It is good farming to make the most of the natural resources of the soil and of the manures produced on the farm, and to depend upon artificial fertilizers only to furnish what more is needed. It is not good economy to pay high prices for materials which the soil may itself yield, but it is good economy to supply the lacking ones in the cheapest way. The rule in the purchase of costly commercial fertilizers should be to select those that supply, in the best forms and at the lowest cost, the plant-food which the crop needs and the soil fails to furnish.

Plants differ widely with respect to their capacities for gathering their food from soil and air; hence the proper fertilizer in a given case depends upon the crop as well as upon the soil. The fertility of the soil would remain practically unchanged if all the ingredients removed in the various farm products were restored to the land. This may be accomplished by feeding the crops grown on the farm to animals, carefully saving the manure and returning it to the soil. If it is practicable to pursue a system of stock feeding in which those products of the farm which are comparatively poor in fertilizing constituents are

*This Station has a circular on Home Mixed Fertilizers that may be had on request to Director Chas. D. Woods, Orono. Farmers' Bulletin 44 of the U. S. Department of Agriculture discussing commercial fertilizers will be sent to any address on application to the Secretary of Agriculture, Washington, D. C. The Maine Bulletin, Vol. XI, No. 5, discusses The Restoration of Fertility and Commercial Fertilizers. This can be obtained by writing the College of Agriculture, Orono, Maine.

exchanged in the market for feeding stuffs of high fertilizing value, the loss of soil fertility may be reduced to a minimum, or there may be an actual gain in fertility.

Constituents of Fertilizers.

The only ingredients of plant-food which we ordinarily need to consider in fertilizers are potash, lime, phosphoric acid, and nitrogen. The available supply of lime is often insufficient; hence one reason for the good effect so often observed from the application of lime, and of plaster, which is a compound of lime and sulphuric acid. The remaining substances, nitrogen, phosphoric acid and potash, are the most important ingredients of our common commercial fertilizers, both because of their scarcity in the soil and their high cost. It is in supplying these that phosphates, bone manures, potash-salts, guano, nitrate of soda, and most other commercial fertilizers are chiefly useful.

The term "form" as applied to a fertilizing constituent has reference to its combination or association with other constituents which may be useful, though not necessarily so. The form of the constituent, too, has an important bearing upon its availability, and hence upon its usefulness as plant food. Many materials containing the essential elements are practically worthless as sources of plant-food because the form is not right; the plants are unable to extract them from their combinations; they are "unavailable." In many of these materials the forms may be changed by proper treatment, in which case they become valuable not because the element itself is changed, but because it then exists in such form as readily to feed the plant.

Nitrogen is the most expensive of the three essential fertilizing elements. It exists in three different forms, organic nitrogen, ammonia and nitrate.

Organic nitrogen exists in combination with other elements either as vegetable or animal matter. All materials containing organic nitrogen are valuable in proportion to their rapidity of decay, because change of form must take place before the nitrogen can serve as plant food. Organic nitrogen differs in availability not only according to the kind of material which supplies it, but according to the treatment it receives.

Nitrogen as ammonia usually exists in commercial manures in the form of sulphate of ammonia and is more readily available than organic nitrogen. While nitrogen in the form of ammonia is extremely soluble in water, it is not readily removed from the soil by leaching, as it is held by the organic compounds of the soil.

Nitrogen as nitrate exists in commercial products chiefly as nitrate of soda. Nitrogen in this form is directly and immediately available, no further changes being necessary. It is completely soluble in water, and diffuses readily throughout the soil. It differs from the ammonia compounds in forming no insoluble compounds with soil constituents and may be lost by leaching.

Phosphoric acid is derived from materials called phosphates, in which it may exist in combination with lime, iron, or alumina as phosphates of lime, iron or alumina. Phosphate of lime is the form most largely used as a source of phosphoric acid. Phosphoric acid occurs in fertilizers in three forms: That soluble in water and readily taken up by plants; that insoluble in water but still readily used by plants and known as "reverted"; and that soluble only in strong acids and consequently very slowly used by the plant. The "soluble" and "reverted" together constitute the "available" phosphoric acid. The phosphoric acid in natural or untreated phosphates is insoluble in water, and not readily available to plants. If it is combined with organic substances as in animal bone, the rate of decay is more rapid than if with purely mineral substances. The insoluble phosphates may be converted into soluble forms by treatment with strong acids. Such phosphates are known as acid phosphates or superphosphates. The "insoluble phosphoric acid" of a high cost commercial fertilizer has little or no value to the purchaser because at the usual rate of application the quantity is too small to make any perceptible effect upon the crop, and because its presence in the fertilizer excludes an equal amount of more needful and valuable constituents.

Potash in commercial fertilizers exists chiefly as muriates and sulphates. With potash the form does not exert so great an influence upon availability as is the case with nitrogen and phosphoric acid. All ordinary forms are freely soluble in water, and are believed to be nearly if not quite equally available as food. The form of the potash has an important influence upon the quality of certain crops. For example, the results of experiments seem to indicate that the quality of tobacco, and certain other crops, is unfavorably influenced by the use of muriate of potash, while the same crops show a superior quality if materials free from chlorides have been used as the source of potash.

VALUATION OF FERTILIZERS.

The agricultural value of any fertilizing constituent is measured by the value of the increase of the crop produced by its use, and is, of course, a variable factor, depending upon the availability of the constituent, and the value of the crop produced. The form of the materials used must be carefully considered in the use of manures. Slow-acting materials cannot be expected to give profitable returns upon quick-growing crops, nor expensive materials profitable returns when used for crops of relatively low value.

The agricultural value is distinct from what is termed "commercial value," or cost in market. This last is determined by market and trade conditions, as cost of production of the crude material, methods of manipulation required, etc. Since there is no strict relation between agricultural and commercial or market value, it may happen that an element in its most available form, and under ordinary conditions of high agricultural value, costs less in market than the same element in less available forms and of a lower agricultural value. The commercial value has reference to the material as an article of commerce, hence commercial ratings of various fertilizers have reference to their relative cost and are used largely as a means by which the different materials may be compared.

The commercial valuation of a fertilizer consists in calculating the retail trade-value or cash-cost at freight centers (in raw materials of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer. Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates, and similar articles, for which $20 to $75 per ton are paid, depend for their trade value exclusively on the substances, nitrogen, phosphoric acid and potash, which are comparatively costly and steady in price. The trade-value per pound of the ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce. The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the trade-value of the above-named ingredients a suitable margin for the expenses of manufacturer, etc., and for the convenience or other advantage incidental to their use.

For many years this Station has not printed an estimate of the commercial value of the different brands licensed in the State. If anyone wishes to calculate the commercial value he can do so by using the trade values adopted for 1910 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, 1910, 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 1910.

	Cents per pound
Nitrogen in nitrates	16
in ammonia salts	16
Organic nitrogen in dry and fine ground fish, meat and blood, and in mixed fertilizers	20
in fine bone and tankage	20
in coarse bone and tankage	15
Phosphoric acid, water-soluble	4½
citrate-soluble	4
in fine ground bone and tankage	4
in coarse bone and tankage	3½
in cotton seed meal, castor pomace and ashes	3½
in mixed fertilizers, if insoluble in ammonium citrate	2
Potash as high grade sulphate and in forms free from muriate or chlorides	5
as muriate	4¼

RULES FOR CALCULATING VALUATION OF FERTILIZERS.

The commercial valuation will be accurate enough as a means of comparison if the following rule is adopted:

Multiply 4.0 by the percentage of nitrogen.

Multiply 0.8 by the percentage of available phosphoric acid.

Multiply 0.4 by the percentage of insoluble phosphoric acid.

Multiply 1.0 by the percentage of potash.

The sum of these 4 products will be the commercial valuation per ton on the basis taken.

Illustration. The table of analyses shows a certain fertilizer to have the following composition: Nitrogen 3.30 per cent; Available phosphoric acid 8.00 per cent; Insoluble phosphoric acid 1.00 per cent; Potash 6.00 per cent. The valuation in this case will be computed thus:

Nitrogen,	4.0 × 3.30,	$13 20
Available phosphoric acid,	0.8 × 8.00,	6 40
Insoluble phosphoric acid,	0.4 × 1.00,	40
Potash,	1.0 × 6.00,	6 00
		$26 00

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.

WOOD ASHES.

Wood ashes while quite extensively sold in Maine as a fertilizer are not sold at a price that puts them into the class of materials that come under the inspection laws. Most every farmer and particularly those who are engaged in producing hay on rather heavy or clay loam lands, know the value of these materials for fertilizing purposes and there is no question but they are a valuable addition to the stock of substances used as manures.

While ashes are valuable and we would not wish to discourage their use in any way we would caution the farmer against purchasing promiscuous lots, of which he has no knowledge of the manner in which they were produced, unless they carry a guaranteed analysis from a reliable party. Their greatest money value depends upon the potash they contain and this element varies greatly depending on the wood from which they were made, manner of burning and whether protected from rains after burning. Potash is volatile at high temperatures and consequently when ashes are burned hard as they sometimes are in furnaces a part of the potash is lost. For this reason, particularly when they are bought for their potash content, the farmer should have a guaranteed analysis of water soluble potash content. In estimating the agricultural value, however, one should not lose sight of the fact that ashes contain quite an amount of phosphoric acid and a large amount of lime. To these two latter constituents the beneficial action of ashes is probably often due as much as to the potash they contain. The Station has no funds for making free analyses of ashes but will make them at cost of the chemist's time. The necessity of such analysis is shown by the variations given in the following table.

Highest, Lowest and Average Amounts of Phosphoric Acid, Potash and Lime in 100 Pounds of Ashes.

Kinds of ashes.		Phosphoric acid.	Potash Soluble in water	Lime.
Unleached ashes.		%	%	%
Hard wood	highest	6.0	10.4	39.0
	lowest	2.0	5.2	31.7
	average	3.3	8.0	36.5
Mill furnace ashes.				
Soft wood	highest	2.7	4.7	46.2
	lowest	1.3	0.9	35.9
	average	1.7	3.5	42.8
Canada ashes car lots.				
	highest	-	6.6	-
	lowest	-	3.3	-
	average	-	5.0	-
Leached ashes.				
	average.	1.7	0.7	26.5

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 ingenuously 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, 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."

Under date of December 7 the company sent a copy of a letter claimed to have been written by the president of the Emerson Piano Company of Boston, in which he gives an account of a good yield of corn obtained by the following treatment: A coating of manure was placed over the land before plowing. On planting a small amount of Mineral Fertilizer was placed in each hill. The season was dry and cultivation was carried throughout the season. Many of the stalks bore four and some five perfectly developed ears. This is another instance in which Mineral Fertilizer did not prevent the growing of a crop with good cultivation when the land had been treated with farm manure. If this corn, and corn that will produce four and five perfectly developed ears to the stalk would have been sure of winning a prize, was exhibited at the New England Corn Show at Worcester it has not come to the writer's attention.

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.

It is only fair to the New England Fertilizer Company that people should not confuse the New England Fertilizer Company which manufactures chemicals of high quality with this New England Mineral Fertilizer and Chemical Company which puts upon the market a brand of so-called fertilizer that is destitute of plant food as ordinarily considered.

Results of Inspection.

There has been little reason for thinking at any time during the past 15 years that commercial fertilizers have been offered in Maine with fraudulent intent. The companies that have been doing business for many years have learned to manufacture commercial fertilizers so that they correspond for the most part quite closely to their professed analysis. A study of the analyses here reported will show that such companies as well as some of the newer companies are able to manufacture their goods so that the samples found by the Station representatives agree very closely with their professed analysis. It is perhaps not clearly understood by the user of commercial fertilizers what this means in the way of care on the part of the manufacturer.

Usually the sample by the Station representatives is taken at the warehouse from 10 packages. The samples thus taken are carefully mixed and a pint jar filled from the mixture. When the jar is received at the laboratory the goods are again sampled. The amount which is actually used by the chemist is only a small fraction of an ounce. Thus it happens that the very small amount analyzed by the chemist represents many tons. That there is substantial agreement is high testimony not only to the honesty of the fertilizer manufacturer but to the care with which his goods are manufactured.

The increase of home mixing in the State has brought it about that there are some people now engaged in making fertilizers for commercial purposes who are not as efficiently equipped either in their knowledge of the business or in their facilities as are the older manufacturers. It is perfectly possible to accurately compound fertilizers with a minimum of machinery so that the goods will be evenly mixed and in good mechanical condition. In order to do this, however, the person manufacturing the goods must understand what he is about and know accurately the analysis of the materials that are entering into the make-up.

The user of fertilizers should carefully study the results of the analyses given in this bulletin. The failure of a single sample to conform to its analysis may be no serious fault of the manufacturer as it may happen that for some reason the sample which was examined by the Station did not fairly represent the goods. While only experienced men draw the Station samples, long experience has taught us that even exercising the greatest care possible there may be mistakes on our part as well as on the part of the manufacturer. If the brand of goods that a consumer has used or thinks of using is found to be deficient as shown by the analysis reported in this bulletin, the analysis for the preceding year should be looked into. If many of the different brands made by the company whose fertilizer a man has been using do not conform within reasonable limits to their guaranteed analysis he should carefully consider the advisability of getting goods from other manufacturers.

While on the whole the analyses here reported are satisfactory, there are a few instances that seem to demand special comment.

The Atlantic Fertilizer Company of Baltimore, Maryland, came into the State this year for the first time and licensed a brand called Rawson & Hodges Peerless Brand Fertilizer. The Station inspectors found this goods only at one place, in Presque Isle. Consequently only one sample was obtained. While this was up in potash and considerably above in phosphoric acid, it was materially below in nitrogen. It may have been that these goods were not thoroughly mixed and the shortage may be thus accounted for.

In 1909 the goods of the Buffalo Fertilizer Company, Buffalo, New York, (the goods as sold in Maine being manufactured at Houlton) were practically in accord with their guarantees. The samples reported this year were taken at the factory and in the presence of the assistant manager. It will be noted that all of the high grade goods are materially deficient in nitrogen, and that one brand is very low in potash. After the results of the analyses were reported to the company the manager brought to the Experiment Station many reports of analyses, made by competent chemists, of the raw materials which entered into the goods. He also brought with him the books kept by the man who actually manages the mixing. The records seem to show a careful system of keeping track of the various lots of goods put up. In regard to the low grade goods here reported several facts are to be remembered. The factory was completely burned on February 23. The company had to rebuild and in the meantime had to mix by hand. A great deal of their goods was put out immediately upon mixing. Because of the bad showing of these goods it is greatly regretted that only one sample was obtained of each brand. The goods are largely sold directly from the factory to the consumer and it was only at their place of business at Houlton that these goods were found by the inspectors. Because of the trying circumstances under which these goods were made the present year, the cases are passed without prosecution.

The Coe-Mortimer Company, who handle the E. Frank Coe's brands, manufactured goods which ran for the most part better than in the preceding year. A sample of their Blood, Bone and Potash was considerably below in nitrogen. It was correspondingly high in potash and phosphoric acid. After the regular samples were drawn, at the request of the company two more samples were obtained and the results are inserted in the table. The uniformly high potash and low nitrogen would seem to indicate a mistake in the formulæ. The money value is practically the same.

The deficiency of the Deep Cove Manufacturing Company's Fish and Potash in total phosphoric acid is not important. It is to be noted that the goods were practically up in nitrogen, potash and in available phosphoric acid.

The Blood, Bone and Potash brand of the Martin & White Company did not conform very well to its guaranty. Two samples of these goods were obtained and they were both faulty. This is the first year that this company has been doing business in Maine. Their so-called Potato Grower analyzed practically in accordance with the guaranty.

The P. & P. Potato Phosphate of the Parmenter & Polsey Fertilizer Company was deficient in both nitrogen and potash. Only one sample of these goods was obtained. As the other goods of the company ran fairly well in accord with their guarantees this was doubtless due to accident of some kind.

The Provincial Chemical Fertilizer Company of St. John, N. B., agreed in 1909 that they would not solicit new business in Maine in 1910. It will be noted that their goods are, as in the past, below their claim. One of their selling agents in Maine will doubtless be prosecuted the present year in order to convince the company that they must either live up to their guarantees or keep their goods out of the State.

The goods of the F. W. Tunnell Company run this year fairly in accord with their guarantees, with the exception that their High Grade Fish Guano was low in nitrogen. The goods were only found in one place in the State and only one sample of each was obtained. The general character of the analysis indicates that the company endeavors to give goods up to their guarantees.

The Whitman & Pratt Company's goods would seem to indicate somewhat faulty mixing. Apparently it is the intention of the company to put in all the plant food that they claim. Their Potato Plowman is seriously below in nitrogen, but unusually high in phosphoric acid and somewhat above in potash. The same general statements apply to their Animal Brand. All of which seems to indicate unsatisfactory and faulty mixing.

In the tables that follow, the analyses of the samples of commercial fertilizers collected in the open market in the spring of 1910 by the Station representatives are given. The samples were drawn by experienced men and every precaution was taken to make sure that they fairly represented the goods sampled. So far as possible the samples were taken in the large warehouses where a large amount of the goods were stored as received from the factory. They were taken in almost every instance from at least 10 packages and where possible in the presence of a representative of the manufacturers.

Descriptive List of Station Samples, 1910.

Station number.	Manufacturer, place of business and brand.
	AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y.
1679	A. A. C. Co's Aroostook Complete Manure
1749	A. A. C. Co.'s Aroostook Complete Manure
1561	A. A. C. Co.'s Aroostook High Grade
1676	A. A. C. Co.'s Aroostook High Grade
1753	A. A. C. Co.'s Aroostook High Grade
1573	A. A. C. Co.'s Grass and Oats Fertilizer
1746	A. A. C. Co.'s Grass and Oats Fertilizer
1614	A. A. C. Co.'s Northern Maine Potato Special
1756	A. A. C. Co.'s Northern Maine Potato Special
1535	A. A. C. Co.'s Peerless Potato Manure
1687	A. A. C. Co.'s Peerless Potato Manure
1735	A. A. C. Co.'s Peerless Potato Manure
1766	A. A. Potato Grower
1605	Bradley's Alkaline Bone with Potash
1596	Bradley's Complete Manure for Potatoes and Vegetables
1632	Bradley's Complete Manure for Potatoes and Vegetables
1633	Bradley's Complete Manure with 10% Potash
1736	Bradley's Complete Manure with 10% Potash
1592	Bradley's Corn Phosphate
1634	Bradley's Corn Phosphate
1793	Bradley's Corn Phosphate
1593	Bradley's Eureka Fertilizer
1791	Bradley's Eureka Fertilizer
1591	Bradley's Niagara Phosphate
1759	Bradley's Niagara Phosphate
1603	Bradley's Potato Fertilizer
1647	Bradley's Potato Fertilizer
1595	Bradley's Potato Manure
1588	Bradley's X L Super-Phosphate of Lime
1688	Bradley's X L Super-Phosphate of Lime
1559	Clark's Cove Bay State Fertilizer
1638	Clark's Cove Bay State Fertilizer for Seeding Down
1564	Clark's Cove Bay State Fertilizer G. G
1648	Clark's Cove Bay State Fertilizer G. G
1852	Clark's Cove Defiance Complete Manure
1546	Clark's Cove Great Planet Manure A. A
1557	Clark's Cove King Philip Alkaline Guano for all Crops
1635	Clark's Cove King Philip Alkaline Guano for all Crops
1558	Clark's Cove Potato Fertilizer
1639	Clark's Cove Potato Fertilizer
1571	Clark's Cove Potato Manure
1656	Clark's Cove Potato Manure
1534	Cleveland Fertilizer for All Crops
1563	Cleveland High Grade Complete Manure
1560	Cleveland Potato Phosphate
1547	Cleveland Super-Phosphate
1604	Complete Manure with 10% Potash

Analysis of Station Samples, 1910.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
	As Nitrates.	As Ammonia.	Total. Found.	Total. Guaranteed.	Soluble.	Reverted.	Insoluble.	Available. Found.	Available. Guaranteed.	Total. Found.	Total. Guaranteed.	Found.	Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
1679	1.46	0.12	2.40	2.47	3.75	2.81	2.31	6.56	6.00	8.87	......	10.41	10.00
1749	0.44	0.84	2.42	2.47	5.93	0.42	1.53	6.35	6.00	7.88	......	10.49	10.00
1561	0.92	0.50	4.24	4.12	6.59	0.95	2.19	7.54	7.00	9.73	......	7.20	7.00
1676	1.22	0.62	3.88	4.12	5.44	2.25	2.21	7.69	7.00	9.90	......	6.82	7.00
1753	1.24	0.90	3.92	4.12	5.01	2.14	2.04	7.15	7.00	9.19	......	7.62	7.00
1573	......	......	......	.....	8.66	2.50	2.21	11.16	11.00	13.37	......	1.99	2.00
1746	......	......	......	......	7.02	3.32	1.91	10.34	11.00	12.25	......	2.22	2.00
1614	1.84	0.10	3.74	3.70	5.26	3.32	1.44	8.58	7.00	10.02	......	9.66	10.00
1756	1.54	0.64	3.92	3.70	4.19	2.47	1.12	6.66	7.00	7.78	......	10.47	10.00
1535	0.76	0.30	3.36	3.29	6.70	1.41	2.13	8.11	8.00	10.24	......	6.93	7.00
1687	1.60	0.34	3.04	3.29	6.54	1.68	2.07	8.22	8.00	10.29	......	7.06	7.00
1735	1.68	0.78	3.13	3.29	5.74	2.27	2.04	8.01	8.00	10.05	......	7.55	7.00
1766	1.52	0.60	3.88	3.70	4.51	2.12	1.15	6.63	7.00	7.78	8.00	10.28	10.00
1605	......	......	......	......	8.42	2.40	2.13	10.82	11.00	12.95	12.00	2.07	2.00
1596	0.92	0.38	3 20	3.29	7.13	0.85	2.13	7.98	8.00	10.11	9.00	6.99	7.00
1632	1.56	0.66	3.30	3.29	6.70	1.96	1.90	8.66	8.00	10.56	9.00	7.77	7.00
1633	0.74	0.98	3.24	3.29	5.12	1.54	1.81	6.66	6.00	8.47	7.00	9.76	10.00
1736	1.46	0.82	3.24	3.29	3.96	2.29	1.33	6.25	6.00	7.58	7.00	10.12	10.00
1592	0.00	0.42	1.95	2.06	6.25	1.95	2.17	8.20	8.00	10.37	9.00	1.51	1.50
1634	0.00	0.82	2.44	2.06	4.31	2.58	1.80	6.89	8.00	8.69	9.00	2.52	1.50
1793	0.16	0.46	1.94	2.06	7.40	1.78	2.27	9.18	8.00	11.45	9.00	1.81	1.50
1593	0.00	0.58	1.04	1. 3	6.06	2.77	2.11	8.83	8.00	10.94	9.00	2.21	2.00
1791	0.00	0.52	1.06	1.03	6.94	1.96	2.11	8.90	8.00	11.01	9.00	2.10	2.00
1591	0.00	0.58	1.04	0.82	6.08	2.73	2.04	8.81	7.00	10.85	8.00	2.19	1.00
1759	0.00	0.52	1.28	0.82	5.44	2.03	1.17	7.47	7.00	8.64	8.00	2.46	1.00
1603	0.00	0.50	2.00	2.03	7.21	1.99	2.83	9.20	8.00	12.03	9.00	3.30	3.00
1647	0.00	0.92	2.26	2.06	7.19	1.30	2.40	8.49	8.00	10.89	9.00	3.57	3.00
1595	0.68	0.50	2.60	2.47	5.55	1.73	2.16	7.28	6.00	9.44	7.00	5.19	5.00
1588	0.72	0.52	2.44	2.47	6.44	2.60	2.78	9.04	9.00	11.82	10.00	2.29	2.00
1688	0.74	0.62	2.46	2.47	7.75	1.60	2.17	9.35	9.00	11.52	10.00	2.34	2.00
1559	0.54	0.84	2.32	2.47	7.80	1.65	2.56	9.45	9.00	12.01	10.00	2.22	2.00
1638	0.00	0.54	1 22	1.03	6.67	1.90	1.11	8.57	8.00	9.68	9.00	1.92	2.0
1564	0.00	0.56	2.12	2.06	8.01	1.63	2.55	9.64	8.00	12.19	9.00	1.76	1.50
1648	0.00	0.76	2.28	2.06	7.34	0.81	2.11	8.15	8.00	10.26	9.00	1.74	1.50
1852	0.12	0.40	1.10	0.82	6.86	1.76	2.16	8.62	7.00	10.78	8.00	2.33	1.00
1546	1.02	0.30	3.42	3.29	6.78	1.33	2.21	8.11	8.00	10.32	9.00	7.12	7.00
1557	0.00	0.54	1.16	1.03	6.46	2.50	2.48	8.96	8.00	11 44	9.00	2 05	2.00
1635	0.00	0.46	1.38	1.03	6.46	2.03	1.40	8.49	8.00	9.89	9.00	2.05	2.00
1558	0.38	0.36	2 00	2.06	8.39	1.25	1.68	9.64	8.00	11.32	9.00	2.97	3.00
1639	0.08	0.64	1.92	2.06	6.84	2.09	1.28	8.93	8.00	10.21	9.00	3.37	3.00
1571	0.38	0.70	2.52	2.47	6.41	1.49	1.99	7.90	6.00	9.89	7.00	6.66	5.00
1656	0.60	1.04	2.82	2.47	5.15	0.87	2.00	6.02	6.00	8.02	7.00	6.30	5.00
1534	0.00	0.48	1.12	1.03	6.81	2.05	2.30	8.86	8.00	11.16	9.00	2.07	2.00
1563	0.94	0.40	3.36	3.29	7.02	1.21	2.14	8.23	8.00	10.37	9.00	6.90	7.00
1560	0 20	0.32	2.22	2.06	6.54	1.99	3.32	8.53	8.00	11.85	9.00	2.87	3.00
1547	0.18	0.54	2.12	2.06	7.53	1.67	2.33	9.20	8.00	11.53	9.00	2.28	1.50
1604	1.40	0.56	3.26	3.29	4.23	2.40	1.81	6.63	6.00	8.44	7.00	9.78	10.00

Descriptive List of Station Samples, 1910.

Station number.	Manufacturer, place of business and brand.
1734	Complete Manure with 10% Potash
1540	Crocker's Ammoniated Corn Phosphate
1752	Crocker's Ammoniated Corn Phosphate
1544	Crocker's Aroostook Potato Special
1673	Crocker's Aroostook Potato Special
1565	Crocker's New Rival Ammoniated Super-Phosphate
1675	Crocker's New Rival Ammoniated Super-Phosphate
1758	Crocker's New Rival Ammoniated Super-Phosphate
1541	Crocker's Potato, Hop & Tobacco
1674	Crocker's Potato, Hop & Tobacco
1751	Crocker's Potato, Hop & Tobacco
1545	Crocker's Special Potato Manure
1678	Crocker's Special Potato Manure
1798	Crocker's Special Potato Manure
1590	Cumberland Potato Fertilizer
1655	Cumberland Potato Fertilizer
1601	Cumberland Super-Phosphate
1651	Cumberland Super-Phosphate
1598	Darling's Blood, Bone & Potash
1754	Darling's Blood, Bone & Potash
1789	Fine Ground Bone
1790	Grass & Lawn Top Dressing
1537	Great Eastern General Fertilizer
1671	Great Eastern General Fertilizer
1594	Great Eastern High Grade Potato Manure
1669	Great Eastern High Grade Potato Manure
1792	Great Eastern High Grade Potato Manure
1672	Great Eastern Northern Corn Special
1794	Great Eastern Northern Corn Special
1666	Great Eastern Potato Manure
1750	Great Eastern Potato Manure
1589	High Grade Fertilizer with 10% Potash
1643	High Grade Fertilizer with 10% Potash
1532	Lazaretto Aroostook Potato Guano
1663	Lazaretto Aroostook Potato Guano
1551	Lazaretto Corn Guano
1574	Lazaretto High Grade Potato Guano
1552	Lazaretto Propeller Potato Guano
1843	Otis Potato Fertilizer
1844	Otis Super-Phosphate
1553	Pacific Dissolved Bone & Potash
1762	Pacific Dissolved Bone & Potash
1554	Pacific Grass & Grain Fertilizer
1770	Pacific Grass & Grain Fertilizer
1549	Pacific High Grade General Fertilizer
1548	Pacific Nobsque Guano for All Crops
1772	Pacific Nobsque Guano for All Crops

Analysis of Station Samples, 1910.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
	As Nitrates.	As Ammonia.	Total.		Soluble.	Reverted.	Insoluble.	Available.		Total.		Found.	Guaranteed.
			Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.		
	%	%	%	%	%	%	%	%	%	%	%	%	%
1734	1.22	0.96	3.36	3.29	3.91	1.79	1.54	5.70	6.00	7.24	7.00	10.42	10.00
1540	0.00	0.70	2.20	2.06	7.38	1.79	2.55	9.17	8.00	11.72	......	1.95	1.50
1752	0.00	0.88	2.02	2.06	7.08	1.80	1.79	8.88	8.00	10.67	......	1.65	1.50
1544	0.52	0.74	2.18	2.06	7.30	2.06	1.76	9.36	8.00	11.12	......	7.60	6.00
1673	0.64	0.70	2.04	2.06	5.97	1.75	1.45	7.72	8.00	9.17	......	6.30	6.00
1565	0.00	0.50	1.16	1.03	6.78	2.23	2.41	9.01	8.00	11.42	.....	2.13	2.00
1675	0.00	0.44	1.30	1.03	6.68	2.86	2.02	9.54	8.00	11.56	......	2.52	2.00
1758	0.00	0.62	1.20	1.03	5.50	2.29	0.98	7.79	8.00	8.77	......	2.51	2.00
1541	0.16	0.30	2.10	2.06	6.11	2.54	3.06	8.65	8.00	11.71	.....	3.00	3.00
1674	0.10	0.60	2.04	2.06	6.84	2.68	1.93	9.52	8.00	11.45	.....	3.45	3.00
1751	0.10	0.36	2.00	2.06	6.03	2.35	2.82	8.38	8.00	11.20	......	2.85	3.00
1545	0.46	1.18	3.20	3.29	5.14	1.63	1.43	6.77	6.00	8.20	......	9.27	10.00
1678	1.00	0.50	2.58	3.29	4.75	1.88	1.28	6.63	6.00	7.91	......	10.76	10.00
1798	0.98	0.78	3.04	3.29	4.91	1.82	1.40	6.73	6.00	8.13	......	9.86	10.00
1590	0.06	0.48	2.22	2.06	7.02	1.92	2.86	8.94	8.00	11.80	9.00	3.18	3.00
1655	0.16	0.52	2.06	2.06	7.37	1.19	2.17	8.56	8.00	10.73	9.00	3.22	3.00
1601	0.00	0.48	2.02	2.06	6.68	1.45	2.32	8.13	8.00	10.45	9.00	2.05	1.50
1651	0.00	0.80	2.20	2.06	6.86	0.85	2.39	7.71	8.00	10.10	9.00	1.76	1.50
1598	1.10	0.24	4.10	4.11	6.00	1.30	1.89	7.30	7.00	9.19	8.00	7.03	7.00
1754	1.04	0.84	4.12	4.11	4.98	2.03	2.00	7.01	7.00	9.01	8.00	7.30	7.00
1789	.....	......	2.48	2.47	......	......	......	......	......	26.96	22.88	....	......
1790	0.00	0.46	3.86	3.91	2.90	3.48	1.16	6.38	5.00	7.54	6.00	3.12	2.00
1537	0.00	0.56	1.06	0.82	6.43	2.11	2.03	8.54	8.00	10.57	......	4.95	4.00
1671	0.00	0.52	1.46	0.82	6.78	1.81	1.59	8.59	8.00	10.18	......	4.64	4.00
1594	1.30	0.60	3.80	3.29	3.99	2.66	1.74	6.65	6.00	8.39	......	9.72	10.00
1669	1.16	1.16	3.30	3.29	3.11	2.37	1.38	5.48	6.00	6.86	......	9.90	10.00
1792	0.82	0.68	3.02	3.29	7.45	0.03	1.29	7.48	6.00	8.77	......	10.18	10.00
1672	0.06	1.02	2.16	2.06	6.75	1.37	1.53	8.12	8.00	9.65	......	1.75	1.50
1794	0.20	0.46	1.94	2.06	7.61	1.52	2.13	9.13	8.00	11.26	......	1.83	1.50
1666	0.64	0.84	2.00	2.06	7.37	1.74	2.21	9.11	8.00	11.32	......	3.52	3.00
1750	0.20	0.30	2.14	2.06	6.43	2.13	2.88	8.56	8.00	11.44	.....	3.05	3.00
1589	0.08	1.22	2.36	2.47	3.03	3.34	2.13	6.37	6.00	8.50	7.00	10.13	10.00
1643	1.08	0.44	2.28	2.47	4.04	2.50	1.85	6.54	6.00	8.39	7.00	10.22	10.00
1532	0.04	0.46	1.18	0.82	6.30	2.08	2.39	8.38	8.00	10.77	......	4.38	4.00
1663	0.08	0.62	1.18	0.82	6.09	2.60	1.28	8.69	8.00	9.97	......	4.34	4.00
1551	0.10	0.52	1.68	1.64	7.21	1.84	2.39	9.05	8.00	11.44	......	2.64	2.00
1574	0.20	1.38	2.97	3.29	5.71	0.89	1.21	6.60	6.00	7.81	......	9.68	10.00
1552	0.34	0.86	2.14	2.06	7.53	1.86	1.79	9.39	8.00	11.18	......	6.17	6.00
1843	0.84	0.82	2.32	2.06	6.99	1.32	1.53	8.31	8.00	9.84	9.00	3.39	3.00
1844	0.56	0.54	2.18	2.06	7.53	1.96	2.30	9.49	8.00	11.79	9.00	1.92	1.50
1553	......	......	......	......	9.20	1.91	1.76	11.11	10.00	12.87	11.00	1.96	2.00
1762	......	......	......	.....	8.64	2.15	2.21	10.79	10.00	13.00	11.00	2.03	2.00
1554	0.00	0.54	1.10	0.82	6.91	2.14	2.13	9.05	7.00	11.18	8.00	2.07	1.00
1770	0.00	0.52	1.28	0.82	6.81	2.24	1.88	9.05	7.00	10.93	8.00	2.44	1.00
1549	0.80	0.30	3.52	3.29	6.49	1.89	2.27	8.38	8.00	10.65	9.00	7.01	7.00
1548	0.00	0.52	1.22	1.03	6.49	2.25	2.58	8.74	8.00	11.32	9.00	2.14	2.00
1772	0.00	0.60	1.22	1.03	6.38	1.17	2.81	7.55	8.00	10.36	9.00	2.47	2.00

Descriptive List of Station Samples, 1910.

Station number.	Manufacturer, place o business and brand.
1555	Pacific Potato Special
1652	Pacific Potato Special
1562	Packer's Union Animal Corn Fertilizer
1670	Packer's Union Animal Corn Fertilizer
1538	Packer's Union Gardener's Complete Manure
1748	Packer's Union Gardener's Complete Manure
1539	Packer's Union Potato Manure
1668	Packer's Union Potato Manure
1747	Packer's Union Potato Manure
1542	Packer's Union Universal Fertilizer
1667	Packer's Union Universal Fertilizer
1757	Packer's Union Universal Fertilizer
1797	Quinnipiac Climax Phosphate for All Crops
1795	Quinnipiac Corn Manure
1864	Quinnipiac Corn Manure
1863	Quinnipiac Market Garden Manure
1536	Read's Farmers' Friend Super-Phosphate
1645	Read's Farmers' Friend Super-Phosphate
1765	Read's Farmers' Friend Super-Phosphate
1531	Read's High Grade Farmers' Friend Super-Phosphate
1646	Read's High Grade Farmers' Friend Super-Phosphate
1769	Read's High Grade Farmers' Friend Super-Phosphate
1530	Read's Potato Manure
1661	Read's Potato Manure
1767	Read's Potato Manure
1533	Read's Practical Potato Special
1636	Read's Practical Potato Special
1763	Read's Practical Potato Special
1567	Read's Standard Super-Phosphate
1644	Read's Standard Super-Phosphate
1764	Read's Standard Super Phosphate
1550	Read's Sure Catch Fertilizer
1640	Read's Sure Catch Fertilizer
1568	Read's Vegetable & Vine Fertilizer
1768	Read's Vegetable & Vine Fertilizer
1649	Soluble Pacific Guano
1760	Soluble Pacific Guano
1658	Standard A Brand
1773	Standard A Brand
1543	Standard Bone & Potash
1641	Standard Bone & Potash
1570	Standard Complete Manure
1650	Standard Complete Manure
1799	Standard Complete Manure
1642	Standard Fertilizer
1755	Standard Fertilizer

Analysis of Station Samples, 1910.

Station number.	Nitrogen. As Nitrates.	Nitrogen. As Ammonia.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
1555	0.30	0.44	2.20	2.06	8.13	1.22	1.66	9.35	8.00	11.01	9.00	2.98	3.00
1652	0.06	0.54	2.10	2.06	7.34	0.81	2.22	8.15	8.00	10.37	9.00	3.18	3.00
1562	0.52	1.22	2.30	2.47	7.72	1.96	2.04	9.69	9.00	11.72	......	2.84	2.00
1670	0.66	0.72	2.52	2.47	7.89	1.32	1.24	9.21	9.00	10.45	......	2.39	2.00
1538	0.00	1.22	2.18	2.47	4.78	2.03	1.40	6.81	6.00	8.21	7.00	9.77	10.00
1748	0.46	0.92	2.30	2.47	3.99	2.50	1.48	6.49	6.00	7.97	......	10.27	10.00
1539	0.42	1.04	1.96	2.06	6.99	1.54	2.00	8.53	8.00	10.53	......	7.49	6.00
1668	0.46	0.84	1.94	2.06	5.71	1.88	1.53	7.59	8.00	9.12	......	6.15	6.00
1747	0.48	0.82	2.24	2.06	6.59	1.73	1.79	8.32	8.00	10.11	......	7.19	6.00
1542	0.00	0.56	1.10	0.82	6.51	1.93	2.09	8.44	8.00	10.53	......	3.93	4.00
1667	0.00	0.48	1.20	0.82	4.94	4.15	1.20	9.09	8.00	10.29	......	3.87	4.00
1757	0.00	0.56	1.16	0.82	5.28	2.05	1.17	7.33	8.00	8.50	......	4.64	4.00
1797	0.00	0.34	1.30	1.03	7.35	1.32	2.30	8.67	8.00	10.97	9.00	2.66	2.00
1795	0.32	0.52	2.16	2.06	7.26	3.33	1.90	8.69	8.00	10.59	9.00	2.07	1.50
1864	1.04	0.42	2.36	2.06	6.49	1.93	1.99	8.42	8.00	10.41	9.00	1.90	1.50
1863	1.74	0.70	3.30	3.29	5.18	2.85	2.02	8.03	8.00	10.05	9.00	5.94	7.00
1536	0.16	0.32	1.96	2.06	6.62	1.68	3.20	8.30	8.00	11.50	9.00	3.03	3.00
1645	0.00	0.42	1.98	2.06	7.02	1.88	1.47	8.90	8.00	10.37	9.00	3.11	3.00
1765	0.26	0.34	2.10	2.06	6.78	1.93	2.58	8.71	8.00	11.29	9.00	2.96	3.00
1531	0.76	0.94	3.07	3.29	4.74	1.68	1.47	6.42	6.00	7.89	7.00	9.80	10.00
1646	1.26	1.26	3.28	3.29	3.89	1.27	1.67	5.16	6.00	6.83	7.00	9.88	10.00
1769	1.30	1.10	3.20	3.29	3.08	2.09	1.45	5.17	6.00	6.62	7.00	9.88	10.00
1530	0.56	1.18	2.20	2.47	4.78	1.80	1.15	6.58	6.00	7.73	7.00	10.23	10.00
1661	0.62	1.06	2.46	2.47	4.43	1.68	1.34	6.11	6.00	7.45	7.00	9.71	10.00
1767	0.58	1.18	2.46	2.47	4.00	1.93	1.28	5.93	6.00	7.21	7.00	9.92	10.00
1533	0.00	0.32	1.08	0.82	5.73	1.93	2.42	7.66	4.00	10.08	5.00	7.84	8.00
1636	0.20	0.70	1.56	0.82	5.53	2.72	1.16	8.25	4.00	9.41	5.00	7.92	8.00
1763	0.10	0.48	1.14	0.82	4.47	2.14	1.05	6.61	4.00	7.66	5.00	8.55	8.00
1567	0.00	0.38	1.14	0.82	5.92	1.82	2.45	7.74	8.00	10.19	9.00	5.87	4.00
1644	0.00	0.44	1.20	0.82	6.27	3.14	1.28	9.41	8.00	10.69	9.00	2.00	4.00
1764	0.00	0.52	1.28	0.82	5.47	2.08	0.97	7.55	8.00	8.52	9.00	4.94	4.00
1550	......	......	......	......	8.13	2.73	2.30	10.86	10.00	13.16	11.00	2.01	2.00
1640	......	......	......	......	3.84	6.71	2.72	10.55	10.00	13.27	11.00	2.37	2.00
1568	0.48	0.82	2.20	2.06	7.34	1.61	1.86	8.95	8.00	10.81	9.00	3.63	6.00
1768	0.60	0.80	2.18	2.06	7.11	1.80	1.82	8.91	8.00	10.73	9.00	6.94	6.00
1649	0.04	0.78	2.26	2.06	6.99	1.50	1.88	8.49	8.00	10.37	9.00	1.80	1.50
1760	0.04	0.82	2.16	2.06	6.73	1.60	1.85	8.33	8.00	10.18	9.00	1.75	1.50
1658	0.00	0.50	1.34	0.82	6.65	1.15	2.31	7.80	7.00	10.11	8.00	2.07	1.00
1773	0.00	0.48	1.20	0.82	5.39	2.30	1.43	7.69	7.00	9.12	8.00	2.56	1.00
1543	......	......	......	......	8.37	2.73	2.11	11.10	10.00	13.21	11.00	1.95	2.00
1641	......	......	......	......	4.39	5.94	2.51	10.33	10.00	12.84	11.00	2.35	2.00
1570	0.92	0.26	3.38	3.29	6.94	1.31	2.04	8.25	8.00	10.29	9.00	7.05	7.00
1650	1.56	0.86	3.12	3.29	5.69	2.46	1.34	8.15	8.00	9.49	9.00	6.39	7.00
1799	1.42	0.84	3.06	3.29	5.82	2.12	2.11	7.94	8.00	10.05	9.00	7.32	7.00
1642	0.00	0.80	2.26	2.06	6.64	2.52	1.53	9.16	8.00	10.69	9.00	1.96	1.50
1755	0.00	0.64	2.06	2.06	6.19	2.10	2.04	8.29	8.00	10.33	9.00	1.49	1.50

Descriptive List of Station Samples, 1910.

Station number.	Manufacturer, place of business and brand.
1566	Standard Guano for All Crops
1660	Standard Guano for All Crops
1774	Standard Guano for All Crops
1653	Standard Special for Potatoes
1771	Standard Special for Potatoes
1851	Williams & Clark Americus Ammoniated Bone Super-Phosphate
1664	Williams & Clark Americus Corn Phosphate
1659	Williams & Clark Americus High Grade Special for Potatoes and Vegetables
1665	Williams & Clark Americus Potato Manure
1657	Williams & Clark Royal Bone Phosphate for All Crops
	ARMOUR FERTILIZER COMPANY, BALTIMORE, MARYLAND.
1717	All Soluble
1720	Bone, Blood and Potash
1819	Bone, Blood and Potash
1721	Complete Potato
1818	Complete Potato
1716	Corn Grower
1718	Fruit & Root Crop Special
1715	High Grade Potato
1714	Wheat, Corn & Oats Special
1719	Wheat, Corn & Oats Special
	ATLANTIC FERTILIZER COMPANY, BALTIMORE, MARYLAND.
1812	Rawson & Hodges' Peerless Brand Fertilizer
	BOWKER FERTILIZER COMPANY, BOSTON, MASS.
1786	Bowker's Blood, Bone and Potash
1813	Bowker's Blood, Bone and Potash
1692	Bowker's Bone and Potash Square Brand
1784	Bowker's Bone and Potash Square Brand
1815	Bowker's Complete Manure for Potatoes and Vegetables
1689	Bowker's Corn Phosphate
1776	Bowker's Corn Phosphate
1581	Bowker's Early Potato Manure
1780	Bowker's Early Potato Manure
1695	Bowker's Farm and Garden Phosphate
1696	Bowker's Fresh Ground Bone
1690	Bowker's Hill and Drill Phosphate
1785	Bowker's Hill and Drill Phosphate
1579	Bowker's Market Garden Fertilizer
1778	Bowker's Market Garden Fertilizer
1698	Bowker's Potash Bone
1569	Bowker's Potash or Staple Phosphate
1779	Bowker's Potash or Staple Phosphate
1578	Bowker's Potato and Vegetable Fertilizer
1691	Bowker's Potato and Vegetable Fertilizer
1781	Bowker's Potato and Vegetable Fertilizer
1583	Bowker's Potato and Vegetable Phosphate
1694	Bowker's Potato and Vegetable Phosphate

Analysis of Station Samples, 1910.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
	As Nitrates.	As Ammonia.	Total. Found.	Total. Guaranteed.	Soluble.	Reverted.	Insoluble.	Available. Found.	Available. Guaranteed.	Total. Found.	Total. Guaranteed.	Found.	Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
1566	0.00	0.60	1.24	1.03	7.19	1.56	2.40	8.75	8.00	11.15	9.00	2.09	2.00
1660	0.00	0.46	1.26	1.03	6.28	3.43	1.42	9.71	8.00	11.13	9.00	1.95	2.00
1774	0.00	0.48	1.16	1.03	5.23	2.43	1.45	7.66	8.00	9.11	9.00	2.34	2.00
1653	0.00	0.60	2.12	2.06	7.34	0.95	2.17	8.29	8.00	10.46	9.00	3.26	3.00
1771	0.24	0.22	2.00	2.06	5.38	4.76	1.28	10.14	8.00	11.42	9.00	3.13	3.00
1851	0.70	0.52	2.66	2.47	7.70	1.88	1.90	9.58	9.00	11.48	10.00	2.59	2.00
1664	0.00	0.76	2.38	2.06	3.56	3.20	1.85	6.76	8.00	8.61	9.00	2.51	1.50
1659	1.10	1.00	3.28	3.29	5.98	1.99	1.17	7.97	8.00	9.14	9.00	6.62	7.00
1665	0.08	0.74	2.02	2.06	7.35	1.59	2.00	8.94	8.00	10.94	9.00	3.44	3.00
1657	0.00	0.50	1.23	1.03	6.65	1.34	1.98	7.99	8.00	9.97	9.00	2.07	2.00
1717	1.60	0.30	2.96	2.88	6.86	1.77	1.02	8.63	8.00	9.65	8.50	4.24	4.00
1720	1.50	0.62	3.98	4.11	6.54	1.85	0.80	8.39	8.00	9.19	8.50	7.30	7.00
1819	0.26	1.38	4.02	4.11	6.52	1.81	1.24	8.33	8.00	9.57	8.50	7.09	7.00
1721	1.52	0.10	3.18	3.29	4.15	2.46	1.08	6.61	6.00	7.69	6.50	11.01	10.00
1818	1.74	0.36	3.10	3.29	3.67	2.57	1.02	6.24	6.00	7.26	6.50	10.39	10.00
1716	0.76	0.22	1.74	1.65	6.62	2.03	0.89	8.70	8.00	9.59	8.50	3.45	2.00
1718	0.58	0.26	1.66	1.65	6.30	1.99	0.93	8.29	8.00	9.22	8.50	5.83	5.00
1715	0.70	0.26	1.72	1.65	6.97	1.51	0.98	8.48	8.00	9.46	8.50	10.33	10.00
1714	0.18	0.06	1.10	0.82	5.14	1.93	1.24	7.07	7.00	8.31	7.50	1.56	1.00
1719	0.08	0.12	0.86	0.82	4.67	2.15	1.11	6.82	7.00	7.93	7.50	1.22	1.00
1812	0.72	1.04	3.06	3.70	8.09	1.22	0.34	9.31	7.00	9.65	8.00	10.29	10.00
1786	1.58	0.10	3.36	4.11	5.47	2.55	1.66	8.02	7.00	9.68	8.00	6.59	7.00
1813	1.36	0.04	4.02	4.11	4.56	2.97	2.25	7.53	7.00	9.78	8.00	7.39	7.00
1692	0.32	0.14	1.70	1.65	3.80	3.40	3.28	7.20	6.00	10.48	7.00	1.94	2.00
1784	0.30	0.14	1.68	1.65	3.24	3.58	2.78	6.82	6.00	9.60	7.00	2.20	2.00
1815	1.42	0.12	3.34	3.29	3.46	2.92	1.85	6.38	6.00	8.23	7.00	9.97	10.00
1689	0.52	0.14	1.76	1.65	4.42	3.87	2.49	8.29	8.00	10.78	9.00	2.25	2.00
1776	0.40	0.80	2.28	1.65	7.43	1.78	1.67	9.21	8.00	10.88	9.00	2.82	2.00
1581	1.22	0.06	3.22	3.29	5.42	2.62	2.49	8.04	8.00	10.53	9.00	7.21	7.00
1780	1.60	0.48	3.32	3.29	8.37	0.51	1.65	8.88	8.00	10.53	9.00	7.83	7.00
1695	0.56	0.16	1.64	1.65	4.42	3.94	2.63	8.36	8.00	10.99	9.00	2.10	2.00
1696	.....	.....	2.70	2.47	.....	.....	.....	.....	.....	23.30	22.88	.....	.....
1690	0.80	0.20	2.34	2.47	4.05	5.22	3.39	9.27	9.00	12.66	10.00	2.16	2.00
1785	0.86	0.08	2.12	2.47	3.91	5.01	2.72	8.92	9.00	11.64	10.00	2.41	2.00
1579	0.50	1.08	2.10	2.47	4.55	1.54	1.76	6.09	6.00	7.85	7.00	9.92	10.00
1778	0.70	0.52	2.30	2.47	6.78	0.44	1.58	7.22	6.00	8.80	7.00	10.19	10.00
1698	0.04	0.10	0.96	0.82	4.55	1.96	1.62	6.51	6.00	8.13	7.00	2.36	2.00
1569	0.08	0.16	1.26	0.82	3.96	4.27	3.06	8.23	8.00	11.29	9.00	3.33	3.00
1779	0.12	0.28	1.02	0.82	6.08	2.23	1.82	8.31	8.00	10.13	9.00	3.63	3.00
1578	0.58	0.90	2.56	2.47	6.89	1.46	2.02	8.35	8.00	10.37	9.00	5.58	4.00
1691	0.84	0.04	2.14	2.47	5.23	4.21	2.83	9.44	8.00	12.27	9.00	3.80	4.00
1781	1.16	0.06	2.80	2.47	5.52	3.14	2.46	8.66	8.00	11.12	9.00	4.96	4.00
1583	0.52	0.16	1.74	1.65	5.15	2.97	2.39	8.12	8.00	10.51	9.00	2.28	2.00
1694	0.58	0.14	1.70	1.65	4.51	3.79	2.45	8.30	8.00	10.75	9.00	2.12	2.00

Descriptive List of Station Samples, 1910.

Station number.	Manufacturer, place of business and brand.
1878	Bowker's 6% Potato Fertilizer
1620	Bowker's Superphosphate with Potash
1783	Bowker's Superphosphate with Potash
1582	Bowker's Sure Crop Phosphate
1702	Bowker's Sure Crop Phosphate
1787	Bowker's Sure Crop Phosphate
1580	Stockbridge Manure "A" for Potatoes
1697	Stockbridge Manure "A" for Potatoes
1703	Stockbridge Manure "A" for Potatoes
1586	Stockbridge Special Complete Manure for Corn and All Grain Crops
1584	Stockbridge Special Complete Manure for Potatoes and Vegetables
1775	Stockbridge Special Complete Manure for Potatoes and Vegetables
1693	Stockbridge Special Complete Manure for Seeding Down, Permanent Dressing and Legumes
1883	Stockbridge Special Complete Manure for Top Dressing and for Forcing
	BUFFALO FERTILIZER COMPANY, HOULTON, MAINE.
1834	Buffalo Farmers' Choice
1832	Buffalo 5-8-7
1833	Buffalo 5-8-9
1831	Buffalo Four-Six-Ten
1830	Buffalo Top Dresser
	E. D. CHITTENDEN COMPANY, BRIDGEPORT, CONNECTICUT.
1817	Chittenden's High Grade Potato
	COE-MORTIMER COMPANY, NEW YORK CITY, N. Y.
1803	E. Frank Coe's Blood, Bone and Potash
1825	E. Frank Coe's Blood, Bone and Potash
1887	E. Frank Coe's Blood, Bone and Potash
1888	E. Frank Coe's Blood, Bone and Potash
1608	E. Frank Coe's Celebrated Special Potato Fertilizer
1610	E. Frank Coe's Columbian Corn Fertilizer
1609	E. Frank Coe's Columbian Potato Fertilizer
1805	E. Frank Coe's Complete Manure with 10% Potash
1599	E. Frank Coe's Double Strength Potato Manure
1600	E. Frank Coe's Excelsior Potato Fertilizer
1602	E. Frank Coe's Famous Prize Brand Grain and Grass Fertilizer
1804	E. Frank Coe's Famous Prize Brand Grain and Grass Fertilizer
1612	E. Frank Coe's Grass and Grain Special
1613	E. Frank Coe's High Grade Ammoniated Bone Superphosphate
1880	E. Frank Coe's New Englander Corn and Potato Fertilizer
1881	E. Frank Coe's New Englander Corn and Potato Fertilizer
1611	E. Frank Coe's Red Brand Excelsior Guano
1597	E. Frank Coe's Standard Potato Fertilizer
1806	E. Frank Coe's Standard Potato Fertilizer
	DEEP COVE MANUFACTURING COMPANY, EASTPORT, MAINE.
1814	Fish and Potash

Analysis of Station Samples, 1910.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
	As Nitrates.	As Ammonia.	Total. Found.	Total. Guaranteed.	Soluble.	Reverted.	Insoluble.	Available. Found.	Available. Guaranteed.	Total. Found.	Total. Guaranteed.	Found.	Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
1878	0.10	0.10	1.02	0.82	3.24	2.86	1.89	6.10	6.00	7.99	7 00	6.44	6.00
1620	.....	.....	.....	.....	4.71	5.44	2.64	10.15	10.00	12.79	11.00	2.38	2.00
1783	.....	.....	.....	.....	9.06	2.44	1.58	11.50	10.00	13.08	11.00	2.26	2.00
1582	0.04	0.16	1.00	0.82	5.68	2.12	1.80	7.80	8.00	9.60	9.00	2.27	2.00
1702	0.02	0.12	1.04	0.82	5.60	2.66	2.03	8.26	8.00	10.29	9.00	2.18	2.00
1787	0.04	0.14	0.90	0.82	5.55	2.70	1.67	8.25	8.00	9.92	9.00	2.63	2.00
1580	1.84	0.10	3.70	4.11	5.18	1.99	1.63	7.17	7.00	8.80	8.00	10.81	10.00
1697	2.04	0.12	3.76	4.11	2.98	4.32	2.03	7.30	7.00	9.33	8.00	8.48	10.00
1703	1.88	0.12	4.30	4.11	3.59	3.47	1.79	7.06	7.00	8.85	8.00	10.17	10.00
1586	1.16	0.04	3.06	3.29	5.26	4.85	2.97	10.11	10.00	13.08	11.00	6.42	7.00
1584	0.84	1.40	3.06	3.29	5.14	0.99	2.32	6.13	6.00	8.45	7.00	10.21	10.00
1775	1.46	0.50	3.02	3.29	4.07	2.44	1.16	6.51	6.00	7.67	7.00	9.62	10.00
1693	0.86	1.00	2.45	2.47	2.27	2.72	2.67	4.99	6.00	7.66	9.00	10.73	10.00
1883	2.50	0.12	4.44	4.94	3.67	3.24	1.38	6.91	4.00	8.29	6.00	6.63	6.00
1834	0.12	0.04	1.26	0.82	6.46	2.08	0.79	8.54	8.00	9.33	9.00	6.49	5.00
1832	1.70	0.58	3.00	4.10	6.16	2.30	0.76	8.46	8.00	9.22	9.00	8.29	7.00
1833	1.82	0.44	3.54	4.10	6.67	2.47	0.70	9.14	8.00	9.84	9.00	5.71	9.00
1831	1.20	0.42	2.68	3.28	4.15	1.97	1.26	6.12	6.00	7.38	7.00	10.41	10.00
1830	3.68	0.14	5.04	5.75	4.16	1.88	0.55	6.04	6.00	6.59	7.00	6.72	5.00
1817	0.14	3.06	4.02	4.10	6.36	1.23	2.04	7.59	8.00	9.63	10.00	7.64	7.00
1803	1.78	0.62	3.94	4.11	6.44	2.34	2.07	8.78	8.00	10.85	9.00	8.72	7.00
1825	3.25	0.00	3.27	4.11	5.42	3.46	1.12	8.88	8.00	10.00	9.00	8.47	7.00
1887	0.13	0.68	3.84	4.11	5.58	1.84	1.59	7.42	8.00	9.01	9.00	8.61	7.00
1888	1.44	0.65	3.81	4.11	5.12	2.33	1.48	7.45	8.00	8.93	9.00	8.30	7.00
1608	0.00	0.14	1.52	1.65	5.10	2.82	1.86	7.92	8.00	9.78	9.00	3.49	4.00
1610	0.00	0.10	1.22	1.23	6.32	2.27	0.87	8.59	8.50	9.46	9.50	2.52	2.50
1609	0.00	0.08	1.70	1.23	6.43	2.37	1.12	8.80	8.50	9.92	9.50	2.41	2.50
1805	0.14	0.42	2.36	2.47	2.68	3.74	2.99	6.42	6.00	9.41	7.00	9.84	10.00
1599	0.00	0.96	3.10	3.70	5.18	1.51	1.81	6.69	7.00	8.50	8.50	10.05	10.00
1600	0.02	0.56	2.46	2.47	4.15	2.13	2.14	6.28	7.00	8.42	8.00	7.93	8.00
1602	.....	.....	.....	.....	6.40	2.65	0.76	9.05	10.00	9.81	11.00	2.54	2.00
1804	.....	.....	.....	.....	6.22	4.55	0.55	10.77	10.00	11.32	11.00	2.36	2.00
1612	0.00	0.08	0.84	0.80	5.58	3.30	0.80	8.88	8 50	9.68	9.50	1.44	1.50
1613	0.00	0.10	1.78	1.85	5.47	2.81	1.94	8.28	8.00	10.22	9.00	2.80	3.00
1880	0.00	0.38	0.78	0.80	3.86	3.41	1.02	7.27	7.50	8.29	8.50	2.76	3.00
1881	0.00	0.46	0.87	0.80	4.88	2.76	1.31	7.64	7.50	8.95	8.50	3.11	3.00
1611	0.12	0.46	3.48	3.30	6.25	1.90	1.59	8.15	8.00	9.74	9.00	6.89	7.00
1597	0.06	0.82	3.48	3.30	3.67	2.05	2.17	5.72	6.00	7.89	7.00	9.61	10.00
1806	0.22	0.46	3.22	3.30	3.30	3.90	3.96	7.20	6.00	11.16	7.00	10.11	10.00
1814	2.46	0.00	3.25	3.30	3.99	2.17	0.68	6.16	6.00	6.84	8.00	10.01	10.00

Descriptive List of Station Samples, 1910.

Station number.	Manufacturer, place of business and brand.
	ESSEX FERTILIZER COMPANY, BOSTON, MASS.
1860	Essex Complete Manure for Corn, Grain and Grass
1502	Essex Complete Manure for Potatoes, Roots and Vegetables
1529	Essex Complete Manure for Potatoes, Roots and Vegetables
1861	Essex Complete Manure for Potatoes, Roots and Vegetables
1858	Essex Grain and Grass Fertilizer
1859	Essex Market Garden and Potato Manure
1508	Essex Peerless Potato Manure
1837	Essex Peerless Potato Manure
1862	Essex Fish and Potash
	HUBBARD FERTILIZER COMPANY, BALTIMORE, MARYLAND.
1838	Hubbard's Aroostook Special Fertilizer
1701	Hubbard's Blood, Bone and Potash Fertilizer
1708	Hubbard's Blood, Bone and Potash Fertilizer
1706	Hubbard's Bone and Potash
1699	Hubbard's Farmers' I. X. L.
1707	Hubbard's Farmers' I. X. L.
1829	Hubbard's Maine Potato Grower Fertilizer
1835	Hubbard's Maine Potato Grower Fertilizer
1700	Hubbard's Special Potato Fertilizer
1705	Hubbard's Special Potato Fertilizer
	LISTER'S AGRICULTURAL CHEMICAL CO., NEWARK, NEW JERSEY.
1662	Lister's Bone Meal
1615	Lister's Grain and Grass Fertilizer
1683	Lister's Grain and Grass Fertilizer
1619	Lister's High Grade Special for Spring Crops
1685	Lister's High Grade Special for Spring Crops
1618	Lister's Potato Manure
1681	Lister's Potato Manure
1577	Lister's Special Corn Fertilizer
1682	Lister's Special Corn Fertilizer
1585	Lister's Special Potato Fertilizer
1684	Lister's Special Potato Fertilizer
1616	Lister's Success Fertilizer
1680	Lister's Success Fertilizer
1617	Lister's 10% Potato Grower
1686	Lister's 10% Potato Grower
	MARTIN & WHITE COMPANY, BALTIMORE, MARYLAND.
1816	Bone, Blood and Potash
1822	Bone, Blood and Potash
1823	Maine Potato Grower
	MERROW BROS. & COMPANY, AUBURN, MAINE.
1713	Merrow's Bone Meal
	MORISON BROTHERS, BANGOR, MAINE.
1628	Acid Phosphate
1624	Morison Brothers "A" Brand Potato Fertilizer
1626	Morison Brothers "C" Brand Fertilizer for All Crops
1627	Morison Brothers 3-8-10 Fertilizer

Analysis of Station Samples, 1910.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
	As Nitrates.	As Ammonia.	Total.		Soluble.	Reverted.	Insoluble.	Available.		Total.		Found.	Guaranteed.
			Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.		
	%	%	%	%	%	%	%	%	%	%	%	%	%
1860	1.08	0.06	3.14	3.28	4.00	1.90	1.01	5.90	6.0	6.91	7.00	9.94	10.00
1502	0.00	0.46	2.91	3.25	4.47	2.38	0.96	6.85	6.0	7.81	7.00	9.95	10.00
1529	0.00	0.38	2.96	3.25	4.34	2.10	1.22	6.44	6.0	7.66	7.00	10.19	10.00
1861	0.00	0.60	3.96	3.25	4.32	2.00	0.75	6.32	6.00	7.07	7.00	9.27	10.00
1858	0.04	0.04	0.98	0.82	6.06	1.88	2.30	7.94	8.00	10.24	9.00	3.21	4.00
1859	0.00	0.36	2.20	2.00	6.44	1.65	0.92	8.09	8.00	9.01	9.00	4.89	5.00
1508	0.00	0.66	3.66	4.10	5.02	3.67	1.66	8.69	7.00	10.35	8.00	8.54	8.00
1837	0.00	0.66	3.78	4.10	5.30	1.91	1.40	7.21	7.00	8.61	8.00	8.20	8.00
1862	0.12	0.04	2.16	2.00	5.74	2.56	1.72	8.30	8.00	10.02	9.00	3.23	3.00
1838	0.84	2.12	3.72	3.83	4.91	2.03	1.07	6.94	7.00	8.01	9.00	10.49	10.00
1701	1.22	0.08	2.76	3.32	5.33	3.72	1.17	9.05	8.00	10.22	10.00	8.12	7.00
1708	1.20	1.42	3.08	3.32	6.38	1.73	1.24	8.11	8.00	9.35	10.00	7.19	7.00
1706	......	......	......	......	3.43	7.74	1.21	11.17	10.00	12.38	12.00	2.47	2.00
1699	0.66	0.08	1.82	1.65	1.37	5.58	1.63	6.95	8.00	8.58	10.00	2.45	2.00
1707	0.64	0.00	1.70	1.65	1.24	6.20	1.63	7.76	8.00	9.44	10.00	2.80	2.00
1829	0.50	2.34	3.62	4.15	6.81	1.95	0.76	8.76	8.00	9.52	10.00	6.82	7.00
1835	0.90	2.64	3.76	4.15	4.08	4.24	1.15	8.32	8.00	9.47	10.00	7.11	7.00
1700	1.50	0.06	2.88	3.28	4.15	3.15	1.22	7.30	6.00	8.52	8.00	10.23	10.00
1705	0.62	1.80	3.24	3.28	4.43	2.34	0.96	6.77	6.00	7.73	8.00	10.32	10.00
1662	......	......	3.49	2.67	......	......	......	......	......	23.84	22.88	......	......
1615	......	......	....	......	3.43	6.55	1.57	9.98	10.00	11.55	11.00	1.97	2.00
1683	......	......	......	......	7.97	1.97	0.83	9.94	10.00	10.77	11.00	2.21	2.00
1619	0.00	0.20	1.76	1.65	6.57	2.01	1.95	8.58	8.00	10.53	9.00	10.85	10.00
1685	0.00	0.16	1.68	1.65	6.54	1.79	1.35	8.33	8.00	9.63	9.00	10.27	10.00
1618	0.00	1.92	3.46	3.29	6.16	1.79	1.59	7.95	8.00	9.54	9.00	7.46	7.00
1631	0.00	1.78	3.30	3.29	6.65	1.90	1.34	8.55	8.00	9.89	9.00	7.49	7.00
1577	0.00	0.16	1.46	1.23	5.87	2.16	2.14	8.03	8.00	10.17	9.00	3.26	3.00
1682	0.00	0.20	1.30	1.23	6.17	1.83	2.05	8.00	8.00	10.05	9.00	3.42	3.00
1585	0.00	0.18	1.78	1.65	5.90	2.22	1.53	8.12	8.00	9.70	9.00	3.21	3.00
1684	0.00	0.18	1.86	1.65	6.09	1.81	2.23	7.90	8.00	10.13	9.00	3.67	3.00
1616	0.00	0.16	1.30	1.23	6.70	2.43	2.19	9.13	9.00	11.32	10.00	2.10	2.00
1680	0.00	0.10	1.32	1.23	6.49	2.12	2.28	8.61	9.00	10.89	10.00	2.39	2.00
1617	0.00	1.72	3.42	3.29	4.07	1.94	1.65	6.01	6.00	7.66	7.00	10.87	10.00
1686	0.00	1.62	3.16	3.29	4.12	1.82	1.81	5.94	6.00	7.75	7.00	10.69	10.00
1816	0.00	2.42	3.40	4.10	5.55	0.64	1.70	6.19	8.00	7.89	9.50	7.09	7.00
1822	0.00	2.52	3.70	4.10	4.23	2.25	1.62	6.48	8.00	8.10	9.50	6.92	7.00
1823	0.32	2.26	3.22	3.28	3.94	1.92	1.76	5.86	6.00	7.62	7.00	10.00	10.00
1713	......	......	1.52	1.25	......	......	......	......	......	30.31	31.00	......	......
1628	......	......	......	.....	13.45	3.25	0.45	16.70	16.00	17.15	......	......	.....
1624	2.40	0.04	2.90	3.00	5.58	2.57	1.34	8.15	8.00	9.49	......	10.89	10.00
1626	1.14	0.06	2.94	2.20	7.18	2.89	1.14	10.07	10.00	11.21	......	6.29	6.00
1627	1.82	0.08	3.16	2.47	5.90	2.96	1.28	8.86	8.00	10.14	......	10.23	10.00

Descriptive List of Station Samples, 1910.

Station number.	Manufacturer, place of business and brand.
1625	Morison Brothers "Xtra" High Grade Potato Fertilizer
1630	Muriate of Potash
1629	Nitrate of Soda
1631	Sulphate of Potash
	NATIONAL FERTILIZER COMPANY, BOSTON, MASS.
1841	Chittenden's Ammoniated Bone Phosphate
1809	Chittenden's Aroostook Special
1820	Chittenden's Aroostook Special
1842	Chittenden's Complete Corn and Grain Fertilizer
1848	Chittenden's Complete Grass Fertilizer
1827	Chittenden's Complete Root Fertilizer
1849	Chittenden's Eureka Potato Fertilizer
1811	Chittenden's Excelsior Potato Fertilizer
1821	Chittenden's Excelsior Potato Fertilizer
1810	Chittenden's Market Garden Fertilizer
1850	Chittenden's Universal Phosphate
	NEW ENGLAND FERTILIZER COMPANY, BOSTON, MASS.
1518	New England Complete Manure
1737	New England Complete Manure
1505	New England Corn and Grain Fertilizer
1504	New England Corn Phosphate
1512	New England High Grade Potato Fertilizer
1740	New England High Grade Special with 10% Potash
1517	New England High Grade Special with 10% Potash
1828	New England Market Garden Manure
1511	New England Potato Fertilizer
1802	New England Potato Fertilizer
1513	New England Potato Grower
1745	New England Potato Grower
1525	New England Superphosphate
1738	New England Superphosphate
	PARMENTER & POLSEY FERTILIZER COMPANY, BOSTON, MASS.
1519	P. & P. "A. A." Brand
1514	P. & P. Aroostook Special
1524	P. & P. Grain Grower
1854	P. & P. Grain Grower
1526	P. & P. Maine Potato Fertilizer
1521	P. & P. Plymouth Rock Brand
1853	P. & P. Potato Grower
1528	P. & P. Potato Phosphate
1520	P. & P. Special Potato Fertilizer
1527	Star Brand Superphosphate
	E. W. PENLEY, AUBURN, MAINE.
1712	Penley's Auburn Fertilizer
1710	Penley's Best Potato Fertilizer
1711	Penley's 4-6-10
1709	Penley's Seeding Down

Analysis of Station Samples, 1910.

Station number.	Nitrogen. As nitrates.	Nitrogen. As ammonia.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
1625	2.78	0.08	4.22	4.12	5.02	2.61	1.68	7.63	7.00	9.31	......	10.11	10.00
1630	......	......	......	......	......	......	......	......	......	......	......	53.20	50.00
1629	15.92	0.00	15.92	15.00	......	......	......	......	......	.....	......	......	......
1631	......	......	......	......	......	......	......	......	......	.....	.....	48.40	48.00
1841	0.22	0.78	2.38	1.65	4.40	2.65	1.85	7.05	8.00	8.90	9.00	2.76	2.00
1809	2.24	0.10	4.04	4.11	4.04	3.34	0.85	7.38	7.00	8.23	8.00	7.08	7.00
1820	0.00	0.68	4.12	4.11	4.72	2.29	1.28	7.01	7.00	8.29	8.00	7.04	7.00
1842	1.52	0.76	3.26	3.29	6.78	1.83	1.47	8.61	8.00	10.08	9.00	7.54	6.00
1848	2.20	0.86	3.84	4.11	5.93	1.73	1.96	7.66	6.00	9.62	7.00	6.77	5.00
1827	1.56	0.44	3.24	3.29	6.09	2.30	2.04	8.39	8.00	10.43	9.00	7.61	6.00
1849	0.48	0.68	2.76	2.47	6.22	0.35	1.44	6.57	6.00	8.01	7.00	9.74	10.00
1811	1.14	0.60	3,24	3.29	4.48	1.96	1.12	6.44	6.00	7.56	7.00	10.00	10.00
1821	......	0.86	3.24	3.29	4.37	1.67	1.06	6.04	6.00	7.10	7.00	10.15	10.00
1810	1.38	0.72	2.88	2.47	5.77	2.17	1.79	7.94	6.00	9.73	7.00	5.14	5.00
1850	0.00	0.80	1.22	0.82	6.14	2.47	1.44	8.61	8.00	10.05	9.00	2.26	1.00
1518	0.00	0.66	2.98	3.28	4.83	2.40	0.74	7.23	6.00	7.97	7.00	10.10	10.00
1737	0.·0	0.72	3.28	3.28	4.39	2.19	1.20	6.58	6.00	7.78	7.00	10.04	10.00
1505	0.00	0.06	1.22	1.22	4.80	2.20	1.28	7.00	7.00	8.28	8.00	2.34	2.00
1504	0.00	0.42	1.62	1.64	6.06	1.92	1.19	7.98	8.00	9.17	9.00	3.01	3.00
1512	0.00	0.54	2.32	2.46	6.48	2.08	0.66	8.56	8.00	9.22	9.00	6.06	6.00
1740	0.00	0.60	3.28	3.69	5.23	1.86	1.14	7.09	7.00	8.23	8.00	10.36	10.00
1517	0.00	0.60	3.50	3.69	5.55	2.29	1.14	7.84	7.00	8.98	8.00	10.45	10.00
1828	0.18	0.62	4.32	4.10	4.74	2.47	1.28	7.21	7.00	8.49	8.00	6.76	7.00
1511	0.00	0.40	1.52	1.64	5.74	1.55	0.51	7.29	7.00	7.80	8.00	3.75	4.00
1802	0.00	0.42	1.68	1.64	5.25	1.63	0.70	6.88	7.00	7.58	8.00	3.73	4.00
1513	0.00	0.08	2.32	2.46	3.51	3.08	1.37	6.59	6.00	7.96	7.00	10.02	10.00
1745	0.00	0.06	2.22	2.46	4.23	1.82	1.11	6.05	6.00	7.16	7.00	10.15	10.00
1525	0.00	0.56	2.36	2.46	4.32	3.76	1.14	8.08	8.00	9.22	10.00	4.02	4.00
1738	0.00	0.42	2.34	2.46	6.49	2.18	0.79	8.67	8.00	9.46	10.00	4.25	4.00
1519	0.00	0.66	3.98	4.10	4.91	2.84	2.11	7.75	7.00	9.86	8.00	8.34	8.00
1514	0.00	0.70	3.52	3.69	5.10	2.09	1.06	7.19	7.00	8.25	8.00	10.62	10.00
1524	0.00	0.06	1.18	1.23	4.39	2.56	1.34	6.95	7.00	8.29	8.00	2.01	2.00
1854	0.00	0.06	1.40	1.23	5.42	2.12	0.61	7.54	7.00	8.15	8.00	1.79	2.00
1526	0.00	0.56	2.98	3.28	4.48	2.52	0.89	7.00	6.00	7.89	7.00	10.23	10.00
1521	0.04	0.20	2.30	2.46	6.03	2.00	1.86	8.03	8.00	9.89	9.00	4.09	4.00
1853	0.00	0.20	2.32	2.46	4.07	2.48	1.34	6.55	6.00	7.89	7.00	8.60	10.00
1528	0.00	0.36	2.10	2.46	6.11	1.75	1.15	7.86	8.00	9.01	9.00	5.21	6.00
1520	0.00	0.70	3.20	3.28	6.19	2.81	1.21	9.00	8.00	10.21	9.00	7.60	7.00
1527	0.00	0.40	1.56	1.64	5.39	1.64	0.70	7.03	7.00	7.73	8.00	3.95	4.00
1712	1.76	0.08	2.78	2.47	0.83	6.70	2.36	7.53	8.00	9.89	9.00	4.60	4.00
1710	1.78	0.06	2.82	2.47	0.88	6.12	1.96	7.00	6.00	8.96	7.00	9.63	10.00
1711	2.48	0.12	3.30	3.29	0.88	4.34	2.42	5.22	6.00	7.64	7.00	10.35	10.00
1709	0.46	0.10	1.44	1.03	0.91	6.29	2.58	7.20	8.00	9.78	9.00	2.34	2.00

Descriptive List of Station Samples, 1910.

Station number.	Manufacturer, place of business and brand.
	PORTLAND RENDERING COMPANY, PORTLAND, MAINE.
1501	Bone Dust Tankage
1704	Bone Dust Tankage
	R. T. PRENTISS COMPANY, PRESQUE ISLE, MAINE.
1808	Prentiss 5-8-7
1807	Prentiss 4-6-10
	PROVINCIAL CHEMICAL FERTILIZER CO., ST. JOHN, NEW BRUNSWICK.
1839	10% Complete Aroostook Potato
	ROGERS & HUBBARD COMPANY, MIDDLETOWN, CONNECTICUT.
1857	Hubbard's Bone Base Grass and Grain Fertilizer
1855	Hubbard's Bone Base Soluble Corn and General Crops Manure
1856	Hubbard's Bone Base Soluble Potato Manure
	SAGADAHOC FERTILIZER COMPANY, BOWDOINHAM, MAINE.
1732	Acid Phosphate
1727	Aroostook Potato Manure
1725	Dirigo Fertilizer
1728	4-6 and 10 Fertilizer
1884	4-6 and 10 Fertilizer
1733	Muriate of Potash
1731	Nitrate of Soda
1726	Sagadahoc High Grade Superphosphate
1722	Sagadahoc Special Potato Fertilizer
1730	6, 6 and 6 Fertilizer
1723	3-6 and 10 Fertilizer
1724	XX Chemical Fertilizer
1729	Yankee Fertilizer
	SWIFT'S LOWELL FERTILIZER COMPANY, BOSTON, MASS.
1870	Acid Phosphate
1871	Muriate of Potash
1872	Nitrate of Soda
1509	Swift's Lowell Animal Brand
1741	Swift's Lowell Animal Brand
1503	Swift's Lowell Bone Fertilizer for Corn and Grain
1523	Swift's Lowell Dissolved Bone and Potash
1879	Swift's Lowell Empress Brand
1840	Swifl's Lowell Ground Bone
1515	Swift's Lowell Potato Grower
1743	Swift's Lowell Potato Grower
1507	Swift's Lowell Potato Manure
1510	Swfft's Lowell Potato Phosphate
1742	Swift's Lowell Potato Phosphate
1506	Swift's Special Corn and Vegetable Manure
1522	Swift's Special Potato Fertilizer
1744	Swift's Special Potato Fertilizer
1516	Swift's Superior Fertilizer with 10% Potash
1739	Swift's Superior Fertilizer with 10% Potash

Analysis of Station Samples, 1910.

Station number.	Nitrogen. As nitrates.	Nitrogen. As ammonia.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
1501	0.00	0.08	6.14	5.75	0.27	7.57	7.76	7.84	......	15.60	14.50	......	......
1704	0.00	0.12	5.90	5.75	0.29	9.68	6.81	9.97	......	16.78	14.50	......	......
1808	2.80	0.44	3.72	4.12	4.02	3.14	0.75	7.16	8.00	7.91	10.00	7.50	7.00
1807	0.14	2.42	3.24	3.29	3.43	2.26	1.81	5.69	6.00	7.50	8.00	9.98	10.00
1839	0.00	1.06	2.54	3.29	4.94	1.34	3.00	6.28	8.00	9.28	......	8.80	10.00
1857	0.18	0.04	2.34	2.20	0.51	7.84	7.60	8.35	6.50	15.95	16.00	13.56	12.00
1855	1.18	0.04	2.34	2.50	2.84	4.44	2.53	7.28	6.00	9.81	8.00	8.63	8.00
1856	2.12	0.20	4.78	5.00	1.12	6.25	3.67	7.37	7.00	11.04	10.00	5.88	5.00
1732	......	......	......	......	12.23	2.61	1.21	14.84	15.00	16.05	......	......	......
1727	0.18	0.10	0.94	1.05	5.77	1.44	0.94	7.21	6.00	8.15	7.00	4.98	4.00
1725	0.00	0.04	1.56	1.00	2.07	3.88	2.18	5.95	4.00	8.13	6.00	6.34	2.00
1728	1.92	0.92	3.40	3.29	6.03	2.46	0.51	8.49	6.00	9.00	7.00	9.84	10.00
1884	1.44	0.74	3.20	3.29	5.74	2.57	0.70	8.31	6.00	9.01	7.00	7.04	10.00
1733	......	......	......	......	......	......	......	......	......	......	......	50.96	50.00
1731	14.76	......	14.76	14.00	......	......	......	......	......	......	......	......	......
1726	0.96	0.00	2.30	1.85	6.33	1.22	0.78	7.55	7.00	8.33	8.00	4.56	3.00
1722	0.98	0.34	1.98	2 00	8.02	2.08	0.71	10.10	7.00	10.81	8.00	7.77	8.00
1730	1.88	1.16	4.32	4.96	5.53	3.72	1.85	9.25	6.00	11.10	8.00	7.12	6.00
1723	1.50	0.66	2.54	2.47	4.31	2.13	0.64	6.44	6.00	7.08	7.00	11.23	10.00
1724	6.80	0.04	7.26	7.00	1.08	5.14	2.27	6.22	3.00	8.49	7.00	8.43	8.00
1729	0.60	0.00	0.60	0.40	7.45	2.02	0.56	9.47	7.00	10.03	8.00	4.94	2.00
1870	......	......	......	......	10.13	3.17	1.66	13.30	12.00	14.96	13.00	......	......
1871	......	......	......	......	......	......	......	......	......	......	......	47.16	50.00
1872	14.72	......	14.72	15.00	......	......	......	......	......	......	......	......	......
1509	0.00	0.10	2.38	2.46	4.58	3.21	2.53	7.79	8.00	10.32	10.00	4.36	4.00
1741	0.00	0.54	2.34	2.46	6.59	1.89	0.69	8.48	8.00	9.17	10.00	4.19	4.00
1503	0.00	0.36	1.56	1.64	5.90	2.03	1.15	8.18	8.00	9.33	9.00	3.00	3.00
1523	0.00	0.12	1.90	1.64	6.03	2.74	2.55	8.77	9.00	11.32	10.00	2.34	2.00
1879	0.00	0.02	1.20	1.25	4.34	2.80	1.31	7.14	7.00	8.45	8.00	2.26	2.00
1840	......	......	2.30	2.46	......	......	......	......	......	26.27	23.00	......	......
1515	0.00	0.62	3.30	3.28	4.23	2.24	1.34	6.47	6.00	7.81	7.00	9.52	10.00
1743	0.00	0.58	3.18	3.28	4.55	1.79	1.35	6.34	6.00	7.69	7.00	9.88	10.00
1507	0.00	0.10	1.86	1.64	4.86	2.29	1.02	7.15	7.00	8.17	8.00	4.09	4.00
1510	0.00	0.24	2.32	2.46	5.55	2.61	1.17	8.16	8.00	9.33	9.00	6.15	6.00
1742	0.00	0.54	2.38	2.46	6.17	2.24	0.79	8.41	8.00	9.20	9.00	6.15	6.00
1506	0.00	0.66	3.16	3.28	6.09	2.54	1.21	8.63	8.00	9.84	9.00	7.31	7.00
1522	0.00	0.08	2.26	2.46	3.25	2.67	1.42	5.92	6.00	7.34	7.00	9.74	10.00
1744	0.00	0.08	2.20	2.46	4.08	2.13	1.02	6.21	6.00	7.23	7.00	10.20	10.00
1516	0.00	0.58	3.26	3.69	5.49	2.80	0.91	8.29	7.00	9.20	8.00	10.75	10.00
1739	0.00	0.68	3.48	3.69	5.55	2.25	0.97	7.80	7.00	8.77	8.00	10.59	10.00

Descriptive List of Station Samples, 1910.

Station number.	Manufacturer, place of business and brand
	F. W. TUNNELL & COMPANY, PHILADELPHIA, PA.
1867	All Crop Mixture
1868	Champion Phosphate
1866	Trucker's High Grade Fish Guano
1865	Wizard Potato Manure
	TUSCARORA FERTILIZER COMPANY, BALTIMORE, MARYLAND.
1847	Aroostook Special
1845	Complete Potato
1382	Fruit and Potato
1824	Tuscarora Trucker
1846	Tuscarora Trucker
	JOHN WATSON & COMPANY, HOULTON, MAINE.
1836	Watson's Improved Potato Fertilizer
	WHITMAN & PRATT RENDERING COMPANY, LOWELL, MASS.
1876	Whitman & Pratt's Animal Brand
1869	Whitman & Pratt's Potash Special
1873	Whitman & Pratt's Potash Special
1875	Whitman & Pratt's Potato Plowman
1874	Whitman & Pratt's Seeding Down
1877	Whitman & Pratt's Vegetable Grower

Analysis of Station Samples, 1910.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
			Total.					Available.		Total.			
	As nitrates.	As ammonia.	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
1867	0.08	1.02	2.74	2.46	7.38	1.93	1.33	9.31	8.00	10.61	9.00	4.01	4.00
1868	0.00	1.16	2.70	1.64	7.34	1.90	1.37	9.24	8.00	10.61	9.00	3.94	3.00
1866	0.26	1.74	3.48	4.12	4.85	1.49	1.24	6.34	5.00	7.58	7.00	2.24	1.75
1835	0.08	1.76	3.06	3.30	7.89	0.94	0.47	8.83	8.00	9.30	9.00	10.07	10.00
1847	1.32	0.00	2.76	2.47	5.93	1.91	1.00	7.84	7.00	8.84	7.50	8.16	8.00
1845	1.48	0.16	3.38	3.29	3.99	2.53	1.21	6.52	6.00	7.73	6.50	10.40	10.00
1882	0.74	0.04	2.00	1.65	5.49	2.46	0.69	7.95	8.00	8.64	8.50	10.14	10.00
1824	2.20	0.20	4.14	4.11	5.82	2.41	0.70	8.23	8.00	8.93	8.50	7.85	7.00
1846	2.20	0.20	4.44	4.11	4.19	3.96	0.64	8.15	8.00	8.79	8.50	7.88	7.00
1836	2.66	0.84	3.92	4.12	6.11	1.41	0.65	7.52	8.00	8.17	9.50	7.48	7.00
1876	0.00	1.52	2.80	3.69	4.67	3.89	2.68	8.56	7.00	11.24	9.00	10.84	10.00
1869	0.00	1.26	2.92	2.88	0.46	5.50	2.68	5.96	6.00	8.64	8.00	11.43	10.00
1873	0.24	1.30	3.53	2.88	1.99	4.75	2.11	6.74	6.00	8.85	8.00	9.73	10.00
1875	0.12	0.76	2.56	3.29	4.58	4.12	3.25	8.70	7.00	11.95	9.00	6.44	6.00
1874	0.24	0.04	2.40	2.05	0.10	22.04	0.38	22.14	......	22.52	20.00	4.63	5.00
1877	0.24	1.34	3.28	3.29	1.44	5.79	3.87	7.23	8.00	11.10	10.00	8.14	7.00

Classification of Lime for Agricultural Purposes.

Agreement between the Directors of the New England and New Jersey Experiment Stations and the Special Committee of the National Lime Manufacturers' Association.

LIME	(1) High Calcium	(1) Hydrate	(1) Spraying	Must contain 93% combined oxides and hydrates and all pass a standard 100 mesh sieve.
			(2) Land....	Must contain not less than 90% combined oxides, hydrates and carbonates of which not over 25% shall be carbonates.
		(2) Caustic	(1) Lump..... (2) Fines..... (3) Ground...	Must contain 90% combined oxides and carbonates of which not more than 10% shall be carbonates, excepting Ground, which may contain 20% carbonates.
	(2) Dolomitic or High Magnesium	(3) Ground Limestone....		Must contain 90% combined carbonates and pass 50 mesh sieve.
		(4) Kiln Slaked............		Not guaranteed, contains core, ashes and refuse.

All shipments except *Kiln Slacked* shall be accompanied by a statement showing (1 proper class name and (2) guaranteed analysis in which the respective percentages of calcium and magnesium oxides are given.

Package shipments to show class and analysis on each package.

Bulk shipments to have class and analysis statement attached either to invoice or inner side of car.

All lime to be sold by weight, hundred weight or ton.

Analyses to be those at kiln and guaranteed.

March, 1911

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

Analysts
James M. Bartlett — Herman H. Hanson
Albert G. Durgin — Royden L. Hammond
Alfred K. Burke

Official Inspections.

30

OYSTERS.

In the fall of 1907 many samples of oysters were obtained from different places in the State and most of them were found to be preserved with borax or some form of boric acid. These cases were thoroughly investigated by hearings and correspondence and while no prosecutions were made the effect of the investigation was apparant a year later when samples of oysters were again collected in about a dozen of the cities and large towns and no preservatives of any kind detected.

Until recently, however, it has been the custom to float oysters in fresh or slightly brackish water in order to give them a fat, plump appearance. The procedure simply bloated the oysters and the customer purchased a good percentage of water at the price of oysters, the water being invisible because inside the oysters. This bloated condition was also obtained by the use of ice in contact with the oysters, because when the ice melted it produced a similar condition. This practice of adding ice is particularly reprehensible because the oysters may become polluted from the use of impure ice.

The floating of oysters is now regulated under the national law, which forbids floating in water of less saline content than that in which they can live and mature, and the addition of ice directly to the oysters, either for shipping or displaying purposes, is prohibited by both the national and state laws.

In October 1909 the following standard was published for Maine:—"Opened oysters sold in bulk shall not contain ice, or added water; nor more than 17 per cent. by weight of free liquid; nor less than 10 per cent. by weight of total dry solids."

This standard was adopted after careful examination of both solid pack and adulterated goods when it was found that the free liquid which would drain from the pure oysters would not exceed 15 per cent. and usually ran much under that figure while the free liquid from the iced oysters ran sometimes as high as 65 per cent. It was found further that the oysters themselves after being freed from the liquid had taken in water so that the actual meat of the watered stock was only 8.6 per cent, whereas the meat of the solid pack was 13.4 per cent.

During the fall of 1910 over 50 samples of oysters were purchased by the deputy without being known to the dealer and the results of the examination of these samples follow. The situation was found on the whole to be better than was anticipated. Some of the samples were excellent, most of them were at least fair, and only a very few gave results which seemed to indicate adulteration. These were investigated with the results given in the table. Sometimes a second sample showed marked improvement over the first, seeming to indicate more careful handling or correction of fault. In only one case were oysters found actually in contact with ice and this apparently occurred during the illness and absence of the proprietor. No preservatives were found in any of the oysters.

Almost all oysters shipped into the state at present come in sanitary, sealed packages with ice packed around the receptacle in such a way that it cannot come in contact with the oysters themselves and the same or similar packages are used in which the goods are exposed for sale. While this careful handling is necessarily more expensive than the careless manner in which they were formerly sold, the added cost seems to be more than made up by the greater value received.

In the following table the figures in the column headed "free liquid" indicate the amount of liquid which would run from the oysters through a colander in 10 minutes. The dry solids were obtained by drying down a weighed amount of the drained oysters to constant weight at 100° C., and the loss on boiling is the loss in weight of 100 grams of the drained oysters after boiling for 20 minutes with 400 cubic centimeters of distilled water.

Table Showing the Results of Examination of Oysters Purchased and Examined in the Fall of 1910, arranged alphabetically by towns.

Station number.	Town and Dealer.	Price per pint.	Weight as purchased.	Weight drained oysters.	Free liquid.	Dry solids.	Loss on boiling.	Remarks.
		cts.	ozs.	ozs.	%	%	%	
9456	Auburn, Dunn & Ross	18	18.3	17.0	6.4	20.4	55	
9454	Auburn, Jerry Murphy	20	17.0	16.0	6.6	19.7	62	
9452	Auburn, New Auburn Fish Market	18	16.3	13.4	13.7	15.2	66	
9635	Augusta, W. H. Bruce Concern	19	17.8	14.2	20.6	14.4	58	Liquids high, passed.
9636	Augusta, Geo. G. Haskell & Son	18	17 2	15.1	12.5	14.2	62	
9634	Augusta, John F. Turner	25	19.8	17.1	13.7	18.0	58	
9631	Augusta, Wm. Young	25	17.6	16.3	7.2	18.1	47	
9423	Bangor, W. L. Clark	25	18.6	16.7	10.6	19.4	41	
9649	Bangor, Frank F. Foster	20	27.5	26.5	3.5	21.0	45	
9424	Bangor, Chas. S. Jones&Co.	25	17.8	15.8	12.3	18.0	45	
9425	Bangor, Chas. S. Jones&Co.	25	17.9	16.3	8.9	21.3	34	
9422	Bangor, D. J. McGrath	25	17.6	10.3	41.6	10.6	53	Adulterated by addition of ice. Hearing appointed. Explanation accepted.
9650	Bangor, Thompson & Waldron	25	18.6	13.9	25.5	19.2	48	Too much liquids. Passed because of high solids.
9420	Bangor, Wentworth's Market	25	18.6	16.1	9.8	18.9	45	
9421	Bangor, Wentworth's Market	25	17.1	16.2	7.8	17.8	43	
9426	Bangor, Hartley E. Wentworth	25	18.3	17.2	5.6	22.6	35	
9437	Brewer, N. H. Hall	25	16.6	14.8	10.8	19.1	59	
9646	Brewer, N. H. Hall	25	17.9	14.4	19.3	18.3	56	Too much liquids, passed.
9439	Brewer. Harlow Bros	25	16.8	15.9	5.4	23.6	52	
9647	Brewer, S. S. Herrick	25	19.0	17.9	5.9	19.0	51	
9442	Brewer. Kenney & McMahon	25	17.8	15.7	11.8	20.7	51	
9441	Brewer, A. C. Moore	24	16.4	14.1	14.2	19.4	59	
9648	Brewer, South, F. W. Wentworth	25	17.8	16.6	6.7	18.2	51	
9615	Fairfield, Frank Coffell	20	16.4	12.3	25.1	17.1	54	Too much liquid. Case investigated.
9617	Fairfield, W. W. Nye & Co.	23	17.0	11.1	34.4	13.5	51	Adulterated with water. Explanation accepted.
9625	Gardiner, Cash Market Co.	23	18.4	14.2	22.8	14.3	66	Too much liquid. Adulterated.
9627	Gardiner, Manson's Market	23	18.3	17.6	3.7	20.4	48	
9623	Gardiner, H. H. Ring & Son	23	18.3	14.6	20.4	17.1	64	Too much liquid. Solids fair. passed.
9629	Hallowell, Shea's Fish Market	25	17.9	17.0	5.5	22.1	45	

Table Showing the Results of Examination of Oysters Purchased and Examined in the Fall of 1910, arranged alphabetically by towns.—Concluded.

Station number.	Town and Dealer.	Price per pint.	Weight as purchased.	Weight drained oysters.	Free liquid.	Dry solids.	Loss on boiling.	Remarks.
		cts.	ozs.	ozs.	%	%	%	
9464	Lewiston, Palmers's Market	20	18.1	13.0	28.5	19.7	55	Liquids far too high. Passed because of high solids.
9471	Lewiston, Atwood's Market	23	16.9	16.3	3.6	20.8	52	
9460	Lewiston, Harvey's Fish Market	20	16.3	15.2	7.9	19.0	61	
9466	Lewiston, Linney Bros.	18	16.5	13.7	16.6	17.9	65	
9468	Lewiston, R. Stewart	22	18.3	10.6	41.8	14.3	68	First sample adulterated with water. Second sample passed.
9681	Lewiston, R. Stewart	23	17.0	14.6	14.2	14.8	62	
9462	Lewiston, Walker's Fish and Oyster Market	20	17.9	15.9	11.2	19.9	50	
9616	Oakland, Sanford's Market	20	16.7	12.4	25.5	15.3	64	Too much liquid. Case investigated.
9662	Portland, Portland Public Market	23	16.8	13.1	22.5	17.0	54	Too much liquid. Passed because of fair solids.
9673	Portland, Capitol Lunch	25	19.7	18.5	5.9	19.4	53	
9663	Portland, Cobb & Trefethen	20	17.9	12.1	27.2	17.2	53	First sample adulterated. Hearing appointed. Second sample passed.
9688	Portland, Cobb & Trefethen	23	18.4	17.2	6.9	20.5	47	
9671	Portland, W. L. Daggett & Co.	22	18.8	16.9	10.0	19.8	49	
9669	Portland, Doughty & Jewett	20	17.2	15.0	12.7	16.8	60	
9667	Portland, H. W. Gordon	20	17.1	15.4	9.9	16.8	56	
9665	Portland, Gribbin Bros.	23	17.6	16.3	7.0	20.4	54	
9659	Portland, Hamilton Bros.	23	17.0	14 5	14.0	13.0	53	Solids rather low, passed.
9657	Portland, C. W. Lombard	23	17.9	13.9	22.0	17.9	58	High liquid. Passed because of fair solids.
9661	Portland, Munjoy Fish Market	23	17.3	16.2	6.5	19.5	48	
9656	Portland, Geo. C. Shaw Co.	25	17.4	16.4	6.1	21.2	52	
9655	Portland, F. H. Verrill	23	18.0	15.6	13.3	18.4	53	
9654	Portland, W. L. Wilson & Co.	25	18.6	14.5	21.9	21.1	53	Too high liquid. Passed because of high solids.
9610	Waterville, Geo. L. Cannon	23	17.7	16.4	7.3	19.0	51	
9614	Waterville, E. F. Cote	23	16.8	10.9	35.4	14.4	64	Adulterated with water. Case investigated.
9608	Waterville, McCallum's Meat and Fish Market	23	17.3	15.8	8.9	19.8	55	
9618	Waterville, Edw. McLaughlin	23	17.1	14.8	13.4	20.2	45	
9612	Waterville, Whitcomb & Crosby	20	17.6	16.7	5.2	20.5	44	

PORK SAUSAGE.

Sausage made from pork and spices alone and sold for what it actually is need not be labeled, but if cereal is added its presence must be stated upon a label accompanying each package sold.

From the examination of samples of pork sausage purchased during the last few months it would appear that most of the goods sold under that name are properly labeled if they contain cereal and that much less sausage is now made with cereal than a short time ago.

There would seem to be two reasons for this latter fact. To be sure that a label accompanies each package which goes out from a busy store is an added care and at times a nuisance, from the standpoint of the dealer; and again, most retailers are averse to acknowledging that their goods are cheapened by any adulteration.

The markets listed in the following table represent only a small part of the places visited by the inspector. In some places signs were displayed declaring that the sausage contained cereal and in these cases no samples were purchased; in other places when the goods called for were wrapped up tags bearing the same statement were included and in such instances the goods were not taken.

The figures and statements in the table of pork sausage analyses are self explanatory. In the 3 cases where cereal was found one sample had a label inside the package clearly stating that fact. Another carried no label because of a misunderstanding. Tags were displayed but the statements upon them were not explicit and new tags were printed. The other case has been temporarily passed pending examination of further samples.

Since the above was sent to the printer a sample of pork sausage has been purchased from Mr. Nelson McFadden, 124 Maine St., Brunswick, and found to be adulterated by the addition of cereal starch. The case is a particularly aggravated one because of a previous offence of the same kind, noted in Official Inspections 22, and will probably be prosecuted.

Table showing the results of the examination of goods that were delivered to the station inspector when he bought pork sausage from the retailer.

Station number.	Town and Dealer.	Price per pound.	Dry matter.	Fat.	Protein.	Cereal.	Remarks.
		cts.	%	%	%		
9494	Auburn, C. L. Damon	18	56.7	36.7	13.5	Present..	Declared on label.
9637	Augusta, Merrill Bros	16	56.1	41.6	10.8	Absent ..	
9638	Augusta, Webber & Hewett	16	63.8	51.4	6.7	Absent ..	
9651	Bangor, Oscar A. Fickett	20	....	....	....	Absent ..	
9626	Gardiner, Cash Market Co., Inc	15	61.7	46.9	8.8	Present..	
9628	Gardiner, A. W. Cunningham & Co.	16	56.3	42.1	11.1	Absent ..	
9474	Lewiston, E. W. Beaumont & Co.	16	65.2	44.6	9.3	Absent ..	
9485	Lewiston, O. Roger	15	55.7	36.9	11.2	Present..	
9476	Lewiston, Tanguay & Ouellette	16	66.2	44.6	9.3	Absent ..	
9479	Lewiston, Fred I. Wills	15	64.9	45.0	9.3	Absent ..	
9675	Portland, John W. Deering & Son	20	68.7	53.0	13.0	Absent ..	
9674	Portland, Littlefield & Co	18	65.7	53.2	9.3	Absent ..	
9676	Portland, Mercier's Meat Market	18	62.2	51.1	9.4	Absent ..	
9653	Portland, Manhattan Market	18	60.2	46.4	9.9	Absent ..	
9652	Portland, Portland Public Market	18	61.3	47.7	10.0	Absent ..	

CLAMS.

With regard to clams the situation is similar to that of oysters somewhat over a year ago. The same standard cannot, apparently, be applied to both, and, as at present sold, opened clams oftentimes contain far too much liquid. Of the samples collected along with the oysters last fall 55 per cent carried what seemed to be an unnecessary amount of liquid. No prosecutions were attempted but in the worst cases the dealers were warned and it is hoped that the publicity given to the results will have an effect on future sales.

The same determinations were made as upon oysters and the results are given in the following table.

Table Showing the Results of Clams Purchased and Examined in the Fall of 1910. Arranged alphabetically by towns.

Station number.	Town and Dealer.	Price per pint.	Weight as purchased.	Weight drained clams.	Free liquid.	Dry solids.	Loss on boiling.	Remarks.
		cts.	ozs.	ozs.	%	%	%	
9457	Auburn, Dunn & Ross	13	18.0	12.0	33.1	13.4	72	Too much liquid.
9455	Auburn, Jerry Murphy	13	14.4	10.5	27.1	14.4	71	Too much liquid.
9453	Auburn, New Auburn Fish Market	13	16.0	10.5	35.3	13.9	74	Too much liquid.
9633	Augusta, C. E. Daggett	13	17.2	15.2	11.1	21.4	61	
9632	Augusta, Wm. Young	13	16.7	10.8	35.6	13.4	70	Too much liquid.
9438	Brewer, N. H. Hall	13	16.0	10.7	33.1	19.2	69	Too much liquid.
9440	Brewer, Harlow Bros	15	17.3	13.2	24.0	20.1	67	
9444	Brewer, Kenney & McMahon	13	17.6	12.7	27.7	15.6	69	Too much liquid.
9442	Brewer, A. C. Moore	15	13.8	9.5	31.0	17.8	67	Short measure explained at time of purchase. Too much liquid.
9624	Gardiner, Metropolitan Market, H. H. Ring & Son	15	18.3	14.2	22.2	16.6	68	
9630	Hallowell, Shae's Fish Market	13	14.6	13.3	9.4	19.4	63	
9461	Lewiston, Harvey's Fish Market	13	17.3	12.3	29.5	13.9	76	Too much liquid.
9470	Lewiston, F. Lagarre	13	17.2	11.9	30.9	13.5	67	Too much liquid.
9467	Lewiston, Linney Bros	13	16.4	11.6	29.7	15.1	66	Too much liquid.
9465	Lewiston, Palmer's Market	10	18.0	13.3	26.1	12.9	74	
9469	Lewiston, R. Stewart	13	17.1	9.5	44.5	12.7	72	Far too much liquid.
9463	Lewiston, Walker's Fish & Oyster Market	13	17.0	10.2	39.7	13.2	72	Too much liquid.
9664	Portland, Cobb & Trefethen	10	18.1	13.4	26.0	13.5	70	
9672	Portland, W. L. Daggett & Co.	10	18.5	15.0	18.7	19.2	62	
9670	Portland, Doughty & Jewett	10	15.2	12.2	20.1	17.8	66	
9668	Portland, B. W. Gordon	10	16.9	13.1	22.6	20.8	60	
9666	Portland, Gribbin Bros	10	15.9	11.7	26.8	14.3	67	
9660	Portland, Hamilton Bros.	10	19.3	14.7	23.7	17.8	58	
9658	Portland, C. W. Lombard	10	17.2	10.2	40.9	12.9	69	Far too much liquid.
9611	Waterville, Geo. L. Cannon	13	18.1	12.3	32.2	11.6	71	Too much liquid.
9613	Waterville, Robinson's Market	10	18.5	13.6	26.4	15.8	66	
9607	Waterville, Elmwood Market	13	15.7	11.5	26.5	12.0	72	
9609	Waterville, McCallum's Market	11	17.2	12.2	29.0	15.6	70	Too much liquid.

IMITATION BEER.

In the desire to avoid breaking the prohibitory law, which does not allow the sale of a malt beverage, and at the same time make the consumer think that he is getting the real thing or something similar, certain bottlers in the State are violating the Maine Food and Drug Law in labeling bottled goods. Imitation beer carrying about three per cent alcohol is being imported into the State in conformity with the National Food and Drug Law under a label "fermented liquor" or something equivalent. These are fermented goods, and are made without the use of malt. They are bottled in Maine and sometimes have put upon them labels which are exceedingly misleading, so much so that the goods are misbranded. It is unlawful to brand these goods in any way so as to deceive the purchaser as to their character. They cannot without some defining word be called "beer" as beer is a malt beverage. They cannot be called "lager beer" even though they may have been aged in the wood. They could be lawfully labeled "Imitation" in some such way as "Regal Brand Imitation Lager Beer."

Put up as these goods are in bottles of the general style used for Budweiser Beer, aritifically colored so as to resemble such goods, and labeled "lager beer" or something similar, they are calculated to deceive and doubtless do deceive many who use them.

This is a warning to the purchaser of these spurious articles as well as a caution to the bottlers thereof.

Fictitious and Incorrect Firm Names. It is an altogether too common practice for bottlers of carbonated beverages to use bottles bearing blown in the glass the names of other manufacturers. This is misbranding under the law and the practice must cease. It is a great injustice to a manufacturer of high grade goods to have his bottles filled by makers of low grade, artificially sweetened and flavored sodas.

April, 1911

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

Analysts

James M. Bartlett — Herman H. Hanson
Albert G. Durgin — Royden L. Hammond
Alfred K. Burke

Official Inspections.

31

FEEDING STUFF INSPECTION.

CHIEF REQUIREMENTS OF THE LAW.

The points of the law of most interest both to the dealer and consumer concisely stated, follow:

Kinds of Feed Exempt Under the Law. The law applies to all feeding stuffs *except* the following: hays and straws; whole seeds, meals, brans and middlings of wheat, rye, barley, oats, Indian corn, buckwheat and broom corn, sold separately; wheat bran and middlings mixed together and pure grains ground together.

Kinds of Feed Coming Within the Law. The principal feeds coming under the provisions of the law are linseed meals, cottonseed meals, cottonseed feeds, pea meals, cocoanut meals, gluten meals, gluten feeds, maize feeds, starch feeds, sugar feeds, dried brewer's grains, dried distiller's grains, malt sprouts, hominy feeds, cerealine feeds, rice meals, oat feeds, corn and oat chops, corn and oat feeds, corn bran, ground beef or fish scraps, foods, poultry foods, stock foods, patented, proprietary and trademark stock and poultry foods, mixed feeds other than those composed solely of wheat bran and middlings mixed together or pure grains ground together, and all other materials of similar nature.

The Brand. Each package of feeding stuffs coming within the law shall bear, conspicuously printed, the following statements:

The number of net pounds contained in the package.
The name or trade-mark under which it is sold.
The name of the manufacturer or shipper.
The place of manufacture.
The place of business of manufacturer or shipper.
The percentage of crude protein.
The percentage of crude fat.

The Adulteration of Feeding Stuffs. If any foreign substances are added to whole or ground grain or wheat offals, the true mixture must be plainly marked upon the packages.

Penalties. The sale or offering for sale of feeding stuffs not properly branded, or containing a smaller percentage of protein and fat than are guaranteed, or of adulterated feeding stuffs, is punishable by a fine not exceeding $100 for the first, and $200 for each subsequent offense.

THE GUARANTY.

No prosecution will be made against any handler of feeding stuffs within the State provided he obtain at the time of purchase a *written guaranty* that the goods are in conformity with the law regulating their sale. Failure to obtain such a guaranty on the part of the dealer will be presumptive evidence that he is not sufficiently interested in the purity of the goods which he handles, and unless there are especially extenuating circumstances, the Director will feel it his duty to begin prosecution for a violation of the laws regulating the sale of concentrated commercial feeding stuffs.

Any form of guaranty covering the facts may be used. The *printed matter on the bag or the tags* accompanying the feeding stuff *will not be considered as a guaranty.* The guaranty to be valid must be signed in ink. The guaranty should identify and may be attached to the bill of sale, invoice, bill of lading or other schedule giving the name and amount of feed stuff. In case of car load lots, the car number should appear.

In case the dealer cannot obtain a written guaranty from the parties from whom he purchases, the only safe thing is to take a sample from the car immediately on its arrival and before it is accepted, and send to the Experiment Station, together with the name of feed and manufacturer and the guarantees. A prompt free analysis will be made and results reported.

INSPECTION FOR 1910-11.

In the tables which follow are given the results of the examination of the samples of feeding stuffs received from dealers and collected by the inspector from April, 1910, to March, 1911.

THE RESULTS OF INSPECTION OF FEEDING STUFFS.

The improvement in the feeding stuffs situation noted in the last Official Inspections of feeding stuffs, No. 23, has continued through the last year and the results of the inspection just completed show that a still better class of feeds is being handled and used than last season.

This improvement is probably in a measure due to the continued interest and practice of the dealers in submitting samples of the goods, about which they had any doubt, to the Station for analysis before putting them on the market, and we believe that if the farmers were only as much alive to the situation and as much interested in the composition of the goods they buy a still more improved condition would be brought about.

The *cottonseed meals* for the most part have run well up to the guarantees, particularly early in the season it was noticeable that a better class of goods was being shipped into the State than had been coming in recent years. One brand, however, later in the season fell considerably below the guaranty in protein in several official samples taken by the inspector. These are under investigation and some of them have already been referred to the United States Board of Food and Drug Inspection for prosecution.

Linseed oil meal does not appear to be in very much demand,

(Discussion continued on page 58.)

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
MEAT SCRAP.						
Meat Scrap ..... Armour & Co.	D	63.75	55.00	-	12.00	2556
Meat Scrap—Blue Ribbon Brand ..... Park & Pollard, Boston, Mass.	D	63.81	60.00	-	-	2487
Meat Scrap..... Portland Rendering Co., Portland, Maine.	D	43.69	40.00	-	8.00	2486
COTTON SEED MEAL.						
Anchor Brand Choice Cotton Seed Meal..........	D	43.94	41.00	-	7.50	2530
Kemper Mill & Elevator Co..... Kansas City, Mo.	D	40.75	41.00	-	7.50	2561
Buckeye Prime Cotton Seed Meal.....	D	41.25	39.00	-	6.50	2446
Buckeye Cotton Oil Co..... Cincinnati, Ohio.	D	41.06	39.00	-	6.50	2459
	D	42.25	39.00	-	6.50	2460
	D	38.94	39.00	-	6.50	2493
	D	40.25	39.00	-	6.50	2494
	D	41.31	39.00	-	6.50	2508
	D	42.62	39.00	-	6.50	2509
	D	38.56	39.00	-	6.50	2515
	D	37.06	39.00	-	6.50	2518
	D	39.01	39.00	-	6.50	2521
	D	39.06	39.00	-	6.50	2538
	D	40.50	39.00	-	6.50	2539
	D	38.12	39.00	-	6.50	2540
	D	42.37	39.00	-	6.50	2542
	D	39.12	39.00	-	6.50	2547
	D	38.50	39.00	-	6.50	2553
	D	40.87	39.00	-	6.50	2557
	O	34.21	39.00	6.40	6.50	2565
	D	39.62	39.00	-	6.50	2590
	D	38.00	39.00	-	6.50	2595
	O	35.37	39.00	-	6.50	2608
	O	42.37	39.00	-	6.50	2615
	D	37.62	39.00	-	6.50	2616
	D	38.50	39.00	-	6.50	2629
	D	40.12	39.00	-	6.50	2658
	D	37.25	39.00	-	6.50	2674
	O	40.31	39.00	7.89	6.50	2688
	D	38.81	39.00	-	6.50	2703
	D	35.87	39.00	-	6.50	2705
	D	39.12	39.00	-	6.50	2707
	D	38.68	39.00	-	6.50	2708
	D	38.75	39.00	-	6.50	2709
	D	40.06	39.00	-	6.50	2712
	D	38.37	39.00	-	6.50	2716
	O	38.68	39.00	-	6.50	2727
	O	34.88	39.00	7.20	6.50	2730
	O	35.43	39.00	-	6.50	2735
	D	37.50	39.00	-	6.50	2747
	O	38.31	39.00	-	6.50	2770
	O	38.68	39.00	-	6.50	2771
	O	37.18	39.00	-	6.50	2787
	D	33.68	39.00	8.98	6.50	2800
	D	39.12	39.00	6.50	6.50	2802
	D	40.25	39.00	-	6.50	2830

ANALYSES OF SAMPLES OF FEEDING STUFFS—CONTINUED.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
Choice Cotton Seed Meal American Cotton Oil Co.	D	36.56	41.00	–	9.00	2478
Choice Cotton Seed Meal	O	40.50	41.00	7.64	7.50	2597
Kemper Mill & Elevator Co	O	38.81	41.00	–	7.50	2753
Cotton Seed Meal H. E. Bridges & Co., Memphis, Tenn.	D	39.69	38.00	–	7.00	2504
	D	41.68	38.00	–	7.00	2510
	D	39.69	38.00	–	7.00	2520
	D	40.12	38.00	–	7 00	2524
	D	38.68	38.00	–	7.00	2525
	C	38.25	38.00	–	7.00	2560
	D	40.12	41.00	–	9.00	2593
	D	37.94	41.00	–	9.00	2623
	O	39.50	41.00	8.07	9.00	2665
	O	40.50	38.00	7.60	7.00	2685
	O	38.25	41.00	–	9.00	2766
	O	38.25	41.00	–	9.00	2768
	D	37.93	41.00	9.70	9.00	2807
	O	41.31	41.00	–	9.00	2816
Cotton Seed Meal Memphis Cotton Seed Products Co.	D	42.25	41.00	–	–	2591
Dirigo Brand Cotton Seed Meal	D	42.50	41.00	–	7.00	2549
W. Newton Smith, Baltimore, Md	D	41.12	41.00	–	7.00	2594
Dixie Brand Cotton Seed Meal	D	37.25	38.50	–	7.00	2436
Humphreys, Godwin Co	D	38.06	38.50	–	7.00	2437
Memphis, Tenn.	D	41.93	38.50	–	7.00	2438
	D	38.06	38.50	–	7.00	2439
	D	40.12	38.50	–	7.00	2440
	D	39.32	38.50	–	7.00	2442
	D	38.50	41.00	–	7.00	2443
	D	43.00	41.00	–	7.00	2445
	D	40.75	38.50	–	7.00	2447
	D	39.87	38.50	–	7.00	2453
	D	44.69	38.50	–	7.00	2456
	D	41.37	41.00	–	7.00	2457
	D	44.13	41.00	–	7.00	2458
	D	42.69	41.00	–	7.00	2463
	D	41.94	41.00	–	7.00	2466
	D	40.13	38.62	–	6.00	2488
	D	38.94	38.62	–	6.00	2490
	D	39.75	38.62	–	6.00	2505
	D	42.59	38.50	–	7 00	2511
	D	40.87	38.62	–	6.00	2566
	O	42.06	38.62	–	6.00	2570
	O	41.25	38.62	9.53	6.00	2586
	O	41.00	38.62	–	6.00	2589
	D	38.50	38.62	–	6.00	2624
	O	38.87	38.62	–	6.00	2643
	D	35.43	38.62	–	6.00	2646
	O	41.68	38.62	–	6.00	2648
	O	39.12	38.62	–	6.00	2650
	D	40.62	38.62	–	6.00	2655
	D	40.37	38.62	–	6.00	2656
	O	41.81	38.62	–	6.00	2701
	D	41.87	38.62	–	6.00	2715
	D	41.75	38.62	–	6.00	2718
	D	40.50	38.62	–	6.00	2744
	D	41.75	41.00	–	7.00	2745
	O	41.75	38.50	–	7.00	2748

ANALYSES OF SAMPLES OF FEEDING STUFFS—CONTINUED.

NAME OF FEED AND MANUFACTURER OR SHIPPER.	Source of sample.	PROTEIN. Found—per cent.	PROTEIN. Guaranteed—per cent.	FAT. Found—per cent.	FAT. Guaranteed—per cent.	Station number.
Dixie Brand Cotton Seed Meal—Continued	O	42.25	38.62	-	6.00	2757
	O	41.87	38.62	-	6.00	2762
	D	41.75	38.62	-	6.00	2776
	D	40.75	38.62	-	6.00	2809
	O	40.25	38.62	-	6.00	2820
Dove Brand Cotton Seed Meal	D	37.25	38.00	-	7.00	2435
F. W. Brode & Co.	D	42.06	38.00	-	7.00	2441
	D	42.06	38.00	-	7.00	2514
	D	38.25	38.00	-	7.00	2531
	D	41.62	38.00	-	7.00	2536
	D	40.00	38.00	-	7.00	2537
	D	39.62	38.00	-	7.00	2670
	D	39.00	38.00	-	7.00	2672
	D	40.50	38.00	-	7.00	2673
	O	39.75	38.00	8.35	7.00	2719
	O	39.25	38.00	-	7.00	2726
	O	40.18	38.00	-	7.00	2738
	O	40.56	38.00	-	7.00	2794
	D	40.00	38.00	-	7.00	2826
Good Luck Brand Cotton Seed Meal	D	39.75	41.00	-	7.00	2448
S. P. Davis, Little Rock, Ark.	D	41.81	41.00	-	7.00	2455
	D	48.09	41.00	-	7.00	2545
	D	42.75	41.00	-	7.00	2555
	D	38.12	41.00	-	7.00	2627
	O	42.68	41.00	7.26	7.00	2662
	O	38.06	41.00	6.37	7.00	2697
	O	39.18	41.00	-	7.00	2737
	D	39.37	41.00	-	7.00	2772
	D	41.56	41.00	-	7.00	2779
Green Diamond Brand Cotton Seed Meal	D	42.50	41.00	-	9.00	2559
Chapin & Co.	O	43.31	41.00	-	9.00	2564
	D	44.37	41.00	-	9.00	2580
	D	42.75	41.00	-	9.00	2581
	D	42.37	41.00	-	9.00	2620
	D	42.62	41.00	-	9.00	2622
	O	42.00	41.00	7.90	9.00	2720
	O	40.62	41.00	-	9.00	2796
Owl Brand Cotton Seed Meal	D	42.60	41.00	-	6.00	2483
F. W. Brode & Co.	D	42.39	41.00	-	6.00	2484
	D	39.82	41.00	-	6.00	2489
	D	40.00	41.00	-	6.00	2491
	D	42.69	41.00	-	6.00	2523
	D	39.12	41.00	-	6.00	2533
	D	41.25	41.00	-	6.00	2541
	D	39.75	41.00	-	6.00	2552
	D	40.50	41.00	-	6.00	2567
	D	42.62	41.00	-	6.00	2568
	D	43.00	41.00	-	6.00	2569
	D	41.75	41.00	-	6.00	2619
	D	41.25	41.00	-	6.00	2625
	O	40.12	41.00	-	6.00	2631
	O	39.31	41.00	-	6.00	2636
	D	41.12	41.00	-	6.00	2653
	O	41.87	41.00	8.02	6.00	2659
	O	42.18	41.00	-	6.00	2661
	O	39.81	41.00	-	6.00	2677
	D	41.87	41.00	-	6.00	2706

ANALYSES OF SAMPLES OF FEEDING STUFFS—CONTINUED.

NAME OF FEED AND MANUFACTURER OR SHIPPER.	Source of sample.	PROTEIN. Found—per cent.	PROTEIN. Guaranteed—per cent.	FAT. Found—per cent.	FAT. Guaranteed—per cent.	Station number.
Owl Brand Cotton Seed Meal—Concluded	D	44.25	41.00	-	6.00	2711
	D	36.44	41.00	-	6.00	2717
	D	39.81	41.00	-	6.00	2743
	O	40.69	41.00	-	6.00	2754
	D	42.00	41.00	-	6.00	2777
	O	40.69	41.00	-	6.00	2791
	D	39.06	41.00	-	6.00	2801
	D	43.31	41.00	-	6.00	2803
	D	43.00	41.00	-	6.00	2804
	D	41.00	41.00	-	6.00	2805
	O	43.25	41.00	-	6.00	2812
	O	41.43	41.00	7.86	6.00	2822
	D	40.37	41.00	-	6.00	2825
	O	41.31	41.00	-	6.00	2828
	D	42.75	41.00	-	6.00	2831
Prime Cotton Seed Meal	D	37.06	38.61	-	8.00	2529
American Cotton Oil Co	D	44.31	38.61	-	8.00	2534
	D	38.87	38.61	-	8.00	2546
	D	40.00	38.61	-	8.00	2578
	D	40.56	38.61	-	8.00	2669
	D	39.18	38.61	-	8.00	2676
	O	38.93	38.61	8.80	8.00	2679
	O	36.31	38.61	-	8.00	2684
	D	38.62	38.61	-	8.00	2713
	D	41.87	38.61	-	8.00	2714
	O	41.31	38.61	-	8.00	2725
	O	40.50	38.61	-	8.00	2755
	O	40.62	33.61	-	8.00	2814
Prime Cotton Seed Meal	D	39.25	39.00	-	9.00	2503
McCaw Manufacturing Co., Hurtsboro, Ala.						
Soper's Choice Cotton Seed Meal	D	42.31	41.00	-	8.00	2668
J. E. Soper Co., Boston, Mass	O	40.00	41.00	-	8.00	2696
	D	42.50	41.00	-	8.00	2710
	O	40.62	41.00	7.67	8.00	2784
	D	40.50	41.00	-	8.00	2810
	O	42.18	41.00	-	8.00	2811
	O	40.50	41.00	-	8.00	2829
	D	42.75	41.00	-	8.00	2832

LINSEED OIL MEAL.

NAME OF FEED AND MANUFACTURER OR SHIPPER.	Source of sample.	PROTEIN. Found—per cent.	PROTEIN. Guaranteed—per cent.	FAT. Found—per cent.	FAT. Guaranteed—per cent.	Station number.
Old Process Oil Meal	D	36.18	32.00	-	5.00	2775
American Linseed Co............................	O	39.43	32.00	-	5.00	2799
	O	39.00	32.00	5.51	5.00	2819
	O	40.18	32.00	-	5.00	2823
Old Process Linseed Oil Meal	D	35.69	30.00	-	5.00	2548
The Guy G. Major Co., Toledo, O...............	O	33.37	30.00	6.91	5.00	2587
	D	28.56	30.00	-	5.00	2596
	D	31.75	30.00	-	5.00	2657
	O	28.56	30.00	-	5.00	2722
	O	31.44	30.00	-	5.00	2728
	O	33.81	30.00	-	5.00	2749

ANALYSES OF SAMPLES OF FEEDING STUFFS—CONTINUED.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
GLUTEN FEEDS.						
Buffalo Gluten Feed	D	24.00	24.00	-	2.50	2470
Corn Products Refining Co., New York	D	23.69	24.00	-	2.50	2499
	D	27.32	24.00	-	2.50	2501
	D	27.37	24.00	-	2.50	2512
	D	27.78	24.00	-	2.50	2513
	D	26.12	24.00	-	2.50	2516
	D	26.75	24.00	-	2.50	2517
	D	24.82	24.00	-	2.50	2519
	D	26.69	24.00	-	2.50	2526
	D	25.44	24.00	-	2.50	2535
	O	26.06	24.00	-	2.50	2563
	O	24.75	24.00	-	2.50	2585
	D	25.43	24.00	-	2.50	2617
	O	26.37	24.00	-	2.50	2686
	O	24.81	24.00	4.23	2.50	2767
Cream of Corn Gluten Feed	D	24.19	25.00	-	2.50	2451
American Maize Products Co	D	24.12	23.00	-	2.50	2464
	O	26.56	23.00	2.46	2.50	2689
Crescent Gluten Feed	D	23.06	24.00	-	2.50	2477
Corn Products Refining Co., New York	D	24.38	24.00	-	2.50	2618
	D	25.06	23.00	-	2.50	2621
	O	25.62	24.00	4.82	2.50	2663
	O	25.75	24.00	-	2.50	2764
	O	24.56	24.00	-	2.50	2783
Golden Rod Gluten Feed	D	25.56	23.00	-	3.00	2449
American Maize Products Co	O	23.75	23.25	5.00	2.50	2765
Jenks Gluten Feed	D	25.63	23.00	-	3.00	2507
Huron Milling Co., Harbor Beach, Mich	O	24.34	23.00	4.53	3.00	2600
	O	23.81	23.00	-	3.00	2678
	O	23.00	23.00	-	3.00	2682
	O	23.50	23.00	-	3.00	2729
	O	26.75	23.00	-	3.00	2732
	O	24.25	23.00	-	3.00	2817
K K K Gluten Feed	D	22.25	23.00	-	2.00	2452
J. C. Hubinger Bros. Co	D	22.44	23.00	-	2.00	2461
Union Gluten Feed	D	22.88	24.00	-	3.00	2450
Union Starch Co.						
DISTILLERS GRAINS.						
Ajax Flakes	D	29.57	30.00	-	11.00	2482
Ajax Milling and Feed Co	O	30.12	30.00	13.50	11.00	2604
	O	32.00	31.00	-	12.00	2605
	O	27.62	30.00	-	11.00	2751
	D	31.00	30.00	-	11.00	2835
Bourbon Grains R	O	31.68	29.80	9.65	9.60	2634
Climax Grains	O	32.87	30.00	14.79	10.00	2602
Deutsch & Sickert, Milwaukee, Wis.						
Continental Gluten Feed	O	29.37	33.00	15.93	14.00	2700
Continental Cereal Co., Peoria, Ill.						

ANALYSES OF SAMPLES OF FEEDING STUFFS—CONTINUED.

NAME OF FEED AND MANUFACTURER OR SHIPPER.	Source of sample.	PROTEIN. Found—per cent.	PROTEIN. Guaranteed—per cent.	FAT. Found—per cent.	FAT. Guaranteed—per cent.	Station number.
Dewey Distillers Grains Dewey Bros. Co., Blanchester, Ohio.	D	29.37	28.00	–	9.00	2626
Fourex J. W. Biles Co., Cincinnati, Ohio	D	28.87	31.00	–	12.00	2468
	D	29.56	31.00	–	12.00	2475
	D	26.98	31.00	–	12.00	2480
	D	32.25	31.00	–	12.00	2522
	O	32.50	31.00	12.91	12.00	2584
	O	32.06	31.00	–	12.00	2750
	O	32.00	31.00	–	12.00	2752
	O	33.00	31.00	–	12.00	2795
WHEAT OFFALS, FEED FLOUR.						
Pillsbury's XX Daisy Feed Flour Pillsbury, Minneapolis, Minn.	O	18.63	16.00	–	4.00	2741
Red Dog Flour Blish Milling Co., Saymore, Ind.	O	15.75	–	–	–	2761
WHEAT OFFALS, MIDDLINGS.						
Henkel's Coarse Brown Feed Commercial Milling Co., Detroit, Mich.	O	17.75	15.00	5.37	4.00	2680
Winter Wheat Middlings Wm. A. Coombs, Coldwater, Mich.	O	17.25	15.00	–	3.00	2574
WHEAT OFFALS, MIXED FEED.						
Acme Feed Acme Evans Co., Indianapolis, Ind.	O	17.38	15.50	–	4.00	2687
Brook's Fancy Mixed Feed A. H. McLeod Milling Co.	O	16.69	–	–	–	2641
Certified Mixed Feed Hunter, Robinson, Wenz Milling Co.	O	18.50	14.50	–	4.00	2758
Champion Mixed Feed Portland Milling Co., Portland, Mich.	O	17.44	14.87	–	6.00	2613
Cornish Mixed Feed (Dealer) Pendexter Bros., Cornish, Maine.	O	17.69	–	–	–	2664
Crescent Mixed Feed Kemper Mill and Elevator Co.	O	17.25	15.00	–	4.00	2637
Esmeralda Mixed Feed Ohio Cereal Co., Circleville, Ohio.	O	17.81	14.50	–	3.70	2692
Garland Mixed Feed Garland Milling Co.	O	18.63	16.00	–	4.00	2724
Gwinn's Dairy Feed Gwinn Milling Co., Columbus, Ohio.	O	17.88	16.39	–	4.50	2599

ANALYSES OF SAMPLES OF FEEDING STUFFS—CONTINUED.

NAME OF FEED AND MANUFACTURER OR SHIPPER.	Source of sample.	PROTEIN. Found—per cent.	PROTEIN. Guaranteed—per cent.	FAT. Found—per cent.	FAT. Guaranteed—per cent.	Station number.
Henkel's Mixed Feed Commercial Milling Co., Detroit, Mich.	O	15.13	14.50	-	4.50	2790
Ideal Mixed Feed Fergus Flour Mill Co., Fergus Falls, Minn.	O	17.50	-	-	-	2681
Kent Winter Wheat Mixed Feed Williams Bros. Co.	O	16.88	12.00	-	2.00	2702
King Feed R. P. Moore Milling Co., Princeton, Ind.	O	17.81	15.00	-	4.00	2698
Lexington Pure Feed Lexington Roller Mills Co., Inc.	O	16.13	-	-	-	2785
Mixed Bran and Middlings (Dealer) C. A. Whitehouse.	D	16.38	12.00	-	5.00	2780
Pine Tree Mixed Feed Chapin & Co., St. Louis, Mo.	O	16.56	14.00	-	7.55	2651
Pyramid Mixed Feed Kimball Bros., Bath, Maine.	O	15.88	14.67	-	7.55	2792
Snow Flake Mixed Feed Lawrenceburg, Roller Mills Co.	O	17.25	15.20	-	4.30	2633
Soft Winter Mixed Feed H. L. Halliday Milling Co., Cain, Ill.	O	15.00	14.50	-	4.00	2789
Stott's Honest Mixed Feed David Stott, Detroit, Mich.	O	16.75	-	-	-	2699
Superior Mixed Feed F. W. Stock & Co., Hillsdale, Mich.	O	17.25	-	-	-	2660
Tally-ho Mixed Feed Minneapolis, Minn.	O	16.94	16.00	-	4.50	2575
Trojan Mixed Feed The Allen and Wheeler Co.	O	16.25	14.50	-	4.00	2815
Try-Me Winter Mixed Feed Sparks Milling Co., Alton, Ill.	O	18.56	-	-	4.25	2821
Vermont Brand Mixed Feed Chapin & Co., St. Louis, Missouri.	O	17.00	14.00	-	4.00	2683
Voight's Pure Wheat Cow Feed Voight Milling Co.	O	16.00	-	-	-	2639
Wildfire Mixed Feed Hunter, Robinson, Wenz Co.	O	17.38	14.50	-	4.00	2610
William Tell Mixed Feed Ansted & Burke Co.	O	16.44	14.00	-	3.00	2614
Winter Wheat Mixed Feed	D	16.13	15.00	-	3.00	2497
Wm. A. Coombs Milling Co.	O	15.75	15.00	-	3.00	2638
Xtragood Mixed Feed	O	17.50	-	-	-	2576
Griswold & McKinnon St. Johnsbury, Vt.	O	16.50	-	-	-	2644

ANALYSES OF SAMPLES OF FEEDING STUFFS—CONTINUED.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
WHEAT OFFALS, BRAN.						
Bran... Western Canada Flour Mills Co., Ltd.	O	16.31	16.28	-	5.50	2598
Fancy Bran... Millbank Milling Co., Millbank, S. D.	O	15.56	13.00	-	4.50	2642
Henkel's Bran... Commercial Milling Co., Detroit, Mich.	O	16.25	14.00	-	3.00	2588
Pillsbury's Bran... Pillsbury, Minneapolis, Minn.	O	16.56	14.50	-	6.00	2647
Pure Hard Wheat Coarse Bran... Washburn, Crosby Co. Minneapolis, Minn.	O	16.25	14.50	-	4.00	2612
Pure Wheat Bran... Northwestern Consolidated Milling Co.	O	17.06	14.50	-	4.00	2742
Snow Flake Bran... Lawrenceburg Roller Mills Co.	O	15.94	14.20	-	3.80	2649
Voight's Pure Winter Wheat Bran... Voight Milling Co., Grand Rapids.	O	14.75	-	-	-	2601
ADULTERATED WHEAT OFFALS.						
Blue Grass Mixed Feed... A. Waller & Co., Henderson, Ky.	C	12.00	9.00	-	2.00	2454
Dairy Mixed Feed...	D	12.00	11.00	-	3.00	2462
Henry Jennings, Boston, Mass...	D	11.56	12.00	-	3.00	2502
	O	10.00	12.00	3.11	3.00	2571
	O	9.94	12.00	3 54	3.00	2675
Holstein Mixed Feed...	O	11.13	12.00	3.61	3.00	2572
Indiana Milling Co...	O	11.13	12.00	-	4.00	2798
Jersey Mixed Feed...	O	10.00	12.00	3.20	3.00	2607
Indiana Milling Co...	O	10.07	12.00	3.25	3.00	2788
MISCELLANEOUS COMPOUND FEEDS. Protein over 20 per cent.						
Bagraco Poultry Feed... Bath Grain Co., Bath, Maine.	M	38.62	37.00	-	6.00	2774
Blue Ribbon Feed... Quaker Oats Co.	C	24.25	25.00	-	4.00	2704
Husted Molasses Feed... Husted Milling Co.	O	22.31	18.00	-	4.00	2827
Park & Pollard's Dry Mash... Park & Pollard Co., Boston, Mass.	O	22.56	20.00	3.20	3.00	2573

ANALYSES OF SAMPLES OF FEEDING STUFFS—CONTINUED.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.	Station number.
Peerless Poultry Mash E. A. Clark & Co.	M	23.06	-	5.03	-	2543
Unicorn Dairy Ration	D	26.12	26.00	-	6.00	2444
Chapin & Co	D	24.00	26.00	-	5.50	2481
	D	26.51	26.00	-	5.50	2500
	O	26.75	26.00	7.59	5.50	2583
	O	26.26	26.00	-	6.00	2603
	O	25.53	26.00	-	5.50	2694
	O	26.00	26.00	-	7.00	2733
	O	24.96	26.00	-	5.50	2739
Union Grains (Ubiko)	D	23.96	24.00	-	7.00	2479
J. W. Biles Co., Cincinnati, O	O	25.44	24.00	-	7.00	2609
	O	24.13	24.00	7.30	7.00	2611
	O	24.69	24.00	-	7.00	2695
	O	25.68	24.00	-	7.00	2731
	O	24.69	24.00	-	7.00	2734
	O	25.18	24.00	-	7.00	2736
	O	24.81	24.00	-	7.00	2769
	D	26.18	24.00	-	7.00	2778

MISCELLANEOUS COMPOUND FEEDS. Protein 15–20 per cent.

International Sugared Feed International Sugar Feed Co., Minneapolis.	O	18.56	16.50	5.55	3.50	2635
Scribner's Growing Feed D. & C. E. Scribner, Brunswick, Maine.	O	15.38	14.00	6.79	3.00	2691
Scribner's Laying Mash D. & C. E. Scribner, Brunswick, Maine.	O	18.00	20.00	2.50	2.00	2690
Sugarota Dairy Feed	O	16.13	16.00	4.49	3.00	2640
Northwest Mills Co., Winona	O	15.69	-	-	-	2652
Yankee Dry Mash O. L. Clark, Freeport, Maine.	M	16.50	-	-	-	2465

MISCELLANEOUS COMPOUND FEEDS. Protein 10–15 per cent.

Corn Falfa Feed	D	10.44	12.00	-	4.00	2667
Haskell's Stock Feed	O	8.63	8.00	7.15	4.00	2606
W. H. Haskell & Co., Toledo, O	O	10.25	8.00	-	4.00	2740
	O	10.44	8.00	-	4.00	2797
Hominy Feed M. F. Baringer, Philadelphia, Pa.	O	11.06	9.00	8.32	6.00	2760
Park & Pollard's Screened Scratch Feed Park & Pollard Co., Boston, Mass.	O	11.19	10.00	-	3.00	2793
Peerless Scratch Feed E. A. Clark & Co., Yarmouth, Maine.	M	10.28	-	4.10	-	2544

ANALYSES OF SAMPLES OF FEEDING STUFFS—CONCLUDED.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein.		Fat.		Station number.
		Found—per cent.	Guaranteed—per cent.	Found—per cent.	Guaranteed—per cent.	
Schumacher's Stock Feed	D	11.69	10.00	-	3.50	2472
Quaker Oats Co., Chicago, Ill.	O	9.82	10.00	-	3.50	2498
	O	11.44	10.00	3.88	3.25	2592
	O	11.00	10.00	3.40	3.50	2693
	O	11.19	10.00	-	3.25	2756
	O	11.00	10.00	-	3.25	2782
	O	11.75	10.00	-	3.50	2813
Scratch Feed F. A. Waldron & Son.	M	11.25	-	3.78	-	2824
MISCELLANEOUS COMPOUND FEEDS. Protein under 10 per cent.						
Brooks' Fancy Stock Feed, Corn and Oats A. H. McLeod Milling Co.	O	9.06	7.63	-	2.97	2645
Corn and Oats Feed H. F. Bailey Co., Bangor, Me.	M	7.81	-	3.79	-	2485
Empire Feed	D	7.94	7.50	-	3.00	2434
Empire Mills, Olean, N. Y	D	8.81	7.63	-	3.97	2654
Henkel's Chop Feed Commercial Milling Co., Detroit, Mich.	O	9.38	6.00	5.43	5.00	2562
New England Stock Feed, N-E-S-F	D	7.88	9.00	-	4.00	2467
H-O Co., Buffalo, N. Y	D	7.31	9.00	-	4.00	2476
Northern Oat Feed Chas. M. Cox Co.	D	7.25	5.75	-	2.50	2495
Star Feed Toledo Elevator Co.	O	9.00	7.00	6.94	5.50	2723
Victor Feed Quaker Oats Co., Chicago, Ill.	O	8.13	7.50	4.24	3.00	2632
MISCELLANEOUS FEEDS.						
Beet Pulp, Dried Larrowe Milling Co., Detroit, Mich.	D	10.00	-	0.82	-	2808
Corn Meal, Granulated Mollett Grain Co.	D	8.00	-	-	-	2432
Corn Meal W. E. Barker, Brooks, Me.	M	8.25	-	-	-	2433
Corn Meal	D	7.88	-	-		2527
Corn Meal J. R. B. Dinsmore, Wiscasset, Me.	M	10.31	-	4.25	-	2833
Corn Meal, Western	D	7.63	-	2 09	-	2834

(Discussion of results of inspection continued from page 47.)
probably on account of its high price. Only a few samples were received from dealers and but 7 official samples obtained by the inspector. The analysis of these meals shows that the goods put out by the American Linseed Company run considerably above their guarantees, and those by the Guy G. Major Company to be above in all but 2 samples.

The samples of *gluten feeds* examined have shown them to be very satisfactory and it was seldom that a sample fell below the guaranty. An average of the results would show them to run considerably above. The practice of coloring, however, has been continued in most instances and, according to the requirements of the pure food law, this fact is stated on the package. The practice should be discouraged since it adds nothing to the value of the product and might be used in some instances to conceal inferiority. The acidity of the feeds remains about the same and although they are quite acid to the taste they contain practically no free mineral acid.

Dried distillers' grains for the most part conform very well to their guarantees. It is a more difficult matter to sample these goods than most kinds of feeds and dealers should take great care in this particular when sending samples for analysis. It seems a mistake to call some kinds of distillers' grains gluten feed, as is done in some cases, although they somewhat resemble the latter in composition.

The *wheat offals,* middlings, mixed feeds, and brans are not required by law to carry a guaranty, but most of the manufacturers have adopted the plan of guaranteeing protein or both protein and fat, and the plan is a good one. Almost every sample of this class of goods ran above its guaranty.

The *adulterated wheat offals* contained ground corn cobs and they, as far as we learned, all carried tags stating their composition with one exception and this case together with two others running below guaranty are being investigated under the National Food and Drug law. It is the fault of the feeder if he buys one of these brands containing only about two-thirds the protein of a good mixed feed because it can be purchased for 5 or 10 cents less per hundred.

No feeder would think of buying ground corn cobs, which have practically no feeding value, at $1.25 or $1.30 per 100 pounds, if put on the market in sacks by themselves, but still some feeders do continue to buy them when mixed with wheat bran, and dealers that think more of the money they are getting than the quality of their goods will continue to handle them. Their sale should be discouraged by both dealer and feeder and the goods thereby driven from the State. It is gratifying to say that the inspector found the goods on sale only in a few places.

The *miscellaneous feeds* of various kinds carry guaranties ranging all the way from 5.75 to 37.00 per cent protein, the lower grades usually having the highest sounding names. Some of these feeds are legitimate mixtures no doubt worth the price asked for them, while others are made up solely with the object of getting rid of screenings, sweepings, and the refuse from cereal breakfast food mills. Some of them contain an excess of hulls and chaff and some contain large quantities of ground-up weed seeds.

The byproducts of breakfast food mills, oat hulls, and such materials have a feeding value and the feeder of the future will no doubt use them in their proper place. They should not be forced upon him under high-sounding names, ground into a fine powder and further disguised with cheap molasses. The attention of the public is continually called to this important point by the bulletins of the various experiment stations and still the mixtures of ground corn cobs, oat hulls, and weed seeds seem to find a ready sale.

Rebates to Retailers.

There appears to be a tacit agreement between the manufacturers or shippers of cottonseed meal into the State with the retailers to give a rebate of 50 cents per unit for each unit which the goods fall below the guaranty in protein. The retailers are very active in claiming these rebates whenever opportunity offers. This fact, probably, is a great incentive to them to send samples to the Station for analysis. The allowing of such rebates is certainly very commendable and shows that the manufacturers are acting in good faith in making their guarantees and a willingness on their part to make good any loss that has occurred through the goods falling below. The question then arises, who actually suffers loss from the goods running under the guaranty. The retailer receives a rebate in proportion to the amount the goods fell below the guaranty, then does he make a corresponding reduction in price to the consumer on whom the loss actually comes? If not, and he sells goods which perhaps were guaranteed to carry 41 per cent protein but actually carry only 37 per cent without any reduction in price, then he is increasing his profits at the expense of not only the manufacturers but the consumer.

This practice, if it actually exists, can only be remedied by the farmer taking an equal interest in the composition of the goods he is buying and insisting on having a reduction in price, or the rebate, on goods falling below guaranty. He should refuse to pay full price for goods guaranteed to carry perhaps 41 per cent protein but actually carrying only 36 or 37 per cent, as shown by the tag which the law obliges the dealer to affix before he can lawfully sell such goods. As yet the consumers have shown much less interest in the composition of the goods than the dealers, and until they do, it cannot be expected that they will receive the benefits from the rebates which they should. The consumer has the same opportunity for free analysis of feeds at the Station as the dealer, but very few consumers take advantage of it. To obtain free analyses, however, the sample must be taken according to the Station's directions in order to insure us that it is fairly drawn. These directions will be sent on application to Director Chas. D. Woods, Orono.

Worm Seeds in Feeding Stuffs.

The oil meals and gluten feeds, the analyses of which precede, have never been found to contain weed seeds of any amount. The analyses of the feeding stuffs which are more or less likely to carry weed seeds, follow. In most cases the official samples have been tested for weed seeds, but rarely have the samples which have been sent in by correspondents been so tested. In no case was there an exact quantitative analysis made, nor were the weed seeds tested for vitality.

FEEDING STUFFS CONTAINING WHOLE WEED SEEDS.

Sta. No.	Name of Feed.	Kinds of Seeds.
2687	Acme Feed Acme Evans Co.	Few mustard.
2758	Certified Mixed Feed Hunter, Robinson, Wenz Co.	Few corn cockle.
2692	Esmeralda Mixed Feed The Ohio Cereal Co.	Few corn cockle.
2642	Fancy Bran Millbank Milling Co.	Some wild buckwheat and yellow foxtail.
2827	Husted Molasses Feed Husted Milling Co.	Few dock and lady's thumb.
2562	Henkels' Chop Feed Commercial Milling Co.	Some mustard, wild buckwheat and lady's thumb.
2635	International Sugared Feed International Sugar Feed Co.	Some goosefoot, green foxtail, false flax, wild buckwheat and mustard.
2698	King Feed R. P. Moore Milling Co.	Few corn cockle.
2573	Park and Pollard's Dry Mash	Some mustard.
2793	Park and Pollard's Screened Scratch Feed	Few ragweed, yellow foxtall and corn cockle.
2647	Pillsbury's Bran	Some goosefoot and few green foxtail.
2582	Schumacher Stock Feed Quaker Oats Co.	Some goosefoot.
2813	Schumacher Stock Feed Quaker Oats Co.	Few goosefoot.
2691	Scribner's Growing Feed D. &. C. E. Scribner.	Some goosefoot.
2690	Scribner's Laying Mash D. & C. E. Scribner.	Some mustard and wild buckwheat.
2789	Soft Winter Mixed Feed H. L. Halliday Milling Co.	Few corn cockle and goosefoot.
2640	Sugarata Dairy Feed Northwest Mills Co.	About 10 % yellow foxtail, green foxtail, wild buckwheat, ragweed, goosefoot, mustard, lady's thumb, barnyard grass and pepper grass.
2652	Sugarata Dairy Feed Northwest Mills Co.	About 10 % yellow foxtail, green foxtail, goosefoot, lady's thumb, wild buckwheat, mustard and false flax.
2660	Superior Mixed Feed F. W. Stock & Co.	Some mustard, wild buckwheat, goosefoot and corn cockle.
2815	Trojan Mixed Feed The Allen & Wheeler Co.	Few goosefoot.
2821	Try-Me Winter Mixed Feed Sparks Milling Co.	Few dock.
2583	Unicorn Dairy Ration Chapin & Co.	Some mustard and wild buckwheat.
2603	Unicorn Dairy Ration Chapin & Co.	Wild buckwheat and lady's thumb quite abundant.
2694	Unicorn Dairy Ration Chapin & Co.	Some mustard and wild buckwheat.

FEEDING STUFFS CONTAINING WHOLE WEED SEEDS—CONCLUDED.

Sta. No.	Name of Feed.	Kinds of Seeds.
2733	Unicorn Dairy Ration .... Chapin & Co.	Some mustard, wild buckwheat, dock and lady's thumb.
2739	Unicorn Dairy Ration .... Chapin & Co.	Some mustard, wild buckwheat and goosefoot.
2609	Union Grains .... J. W. Biles Co.	Some wild buckwheat and mustard.
2695	Union Grains .... J. W. Biles Co.	Some wild buckwheat and mustard.
2734	Union Grains .... J. W. Biles Co.	Some wild buckwheat and mustard.
2736	Union Grains .... J. W. Biles Co.	Some wild buckwheat and mustard.
2769	Union Grains .... J. W. Biles Co.	Some wild buckwheat and mustard.
2683	Vermont Brand Mixed Feed.............. Chapin & Co.	Some goosefoot.
2610	Wild Fire Mixed Feed	Few wild buckwheat, mustard and goosefoot.
2644	Xtragood Mixed Feed .... Griswold & McKinnon.	Few goosefoot.

Adulterated Corn Meal.

Several times during the year complaints have come to us that an inferior grade of corn product, made from the refuse of bolted corn meal, was being shipped into the state as corn meal and sold in unfair competition with the native ground product. Upon investigation we have with one exception been unable to find satisfactory evidence that such was the case. Frequently the alleged inferior goods ran higher in protein than native corn meal with which it was compared.

A short time ago, however, it was reported to us that a milling company with office in Massachusetts was shipping into Maine a so-called Fancy Corn Meal, which, according to their own circulars, was not made from whole corn but from degerminated corn, and which, it would seem, ought not to be sold as corn meal. A sample said to be from this meal was analyzed and found to be considerably below the analysis of a good whole corn meal in both protein and fat. As the material was coming from another state it was thought best to turn the information over to the National Board of Food and Drug Inspection for investigation under the national law. This was accordingly done and they propose to follow up the matter as thoroughly as possible.

Important Notice.

The session of the legislature just closed passed an act to amend and unify the various inspection laws, the enforcement of which is entrusted to the Director of the Experiment Station. As regards the feeding stuffs there are several changes to be carefully noted, and which have been made in order that the Maine law shall conform as far as possible to the "Uniform Feed Law adopted by the Association of Feed Control Officials of the United States" last November, such changes being in direct conformity with suggestions offered by the "American Feed Manufacturers Association."

The first important change to be noted is the requirement that feeding stuffs coming under the law shall be registered with the Director of the Experiment Station and that a registration fee of ten dollars is required for each brand. This applies to local millers as well as to interstate shippers, but in order that unfairness be avoided it is provided that any brand may be registered for the following year without the payment of the fee if it can be established that the sales on that brand did not exceed 50 tons for the year. It is expected that such registration will be made and fees paid by the manufacturers of the various brands to be sold. The list of feeding stuffs exempt from the requirements of the law now includes only hays and straws, the whole seeds, and the whole seeds ground separately. It will be noted that registration may be refused for brands bearing a misleading name, and the attention of the handlers of feeds containing such adulterations as ground corn cobs is called particularly to this point and to the fact that the name "Mixed Feed" cannot be applied to such materials if they are to be registered in Maine.

In addition to the requirement of a minimum guaranty of the amount of protein and fat present, which is required under the old law, a maximum guaranty of the amount of crude fiber present and, if the feed is a compound feed, the name of each ingredient contained therein, is, at the suggestion of the manufacturers, also required.

The new law will go into effect 90 days after the adjournment of the legislature, on June 30, 1911, and for the registration of feeds for the remainder of the year half fee will be required. This would seem to be in accord with the spirit of the law as it is designed to go into effect at once and at the same time declares that the registration of all brands shall terminate on December thirty-first of each year.

Attention is here called to the hope that the very satisfactory cooperation of most of the dealers of the state during the last two years be continued, and all dealers are urged to obtain written guarantees from the shippers to the effect that all feeds purchased conform to the requirements of the feeding stuffs law and to the food laws.

The rules and regulations deemed necessary for the proper enforcement of the law are now being prepared and will probably be received from the public printer within the next month. These will be sent to those interested upon application.

May, 1911

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

ANALYSTS

James M. Bartlett
Herman H. Hanson
Albert G. Durgin
Royden L. Hammond
Alfred K. Burke

CHIEF INSPECTOR

Harry M. Woods

Official Inspections.

32

CHANGES IN INSPECTION LAWS.

The Legislature of 1911 re-enacted and added to the laws of which the Director of the Maine Agricultural Experiment Station is the executive. With the exception of the packing of food under inspection these laws do not become effective until June 29, 1911. The laws have to do with the regulating of the manufacture, sale and distribution of agricultural seed, commercial feeding stuffs, commercial fertilizers, drugs, foods, fungicides and insecticides. The law indexed for ready reference has been printed, and also the requirements under the law and the rules and regulations for carrying out the provisions of each of the above headings have been prepared. Any or all of these will be sent on application to Director Charles D. Woods, Orono, Maine.

The object of the present publication is to concisely point out the changes in and the chief requirements of the various laws.

Agricultural Seeds.

The law applies to all of the ordinary grasses and grains. It requires that each package shall be plainly marked with the name of the seed and its minimum percentage of purity.

If a copy of the requirements under this law is desired ask for Circular 420.

Commercial Feeding Stuffs.

The law regulating the sale of commercial feeding stuffs has been considerably changed. The law now applies to all feeding stuffs with the exception of hay and straw, the whole seeds and the unmixed meals made directly from the entire grains of wheat, rye, barley, oats, Indian corn, buckwheat, flaxseed and broom corn. The offals from the milling of wheat and mixed meals which were exempt under the old law come under the provisions of the new.

The package must be plainly labeled to show: 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 minimum percentage of crude fat; the minimum percentage of crude protein; the maximum percentage of crude fiber; and, if the feeding stuff is a compound feed, the name of each ingredient contained therein. If it is artificially colored the name of the material used for that purpose is also to be stated.

Before a feeding stuff can be lawfully sold in the State it is necessary that it be registered and for that purpose there must be deposited with the Director of the Maine Agricultural Experiment Station a certified copy of the statements named above, a registration fee of $10.00, and, if the director requires, a sample of the feeding stuff.

The Director of the Experiment Station has power to refuse to register a feeding stuff 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, and, in the case of a mixed feeding stuff, if the specific names of each and all ingredients are not stated. He also has power to cancel the registration of a feeding stuff manufactured, sold or distributed in violation of any of the provisions of the law.

A feeding stuff is adulterated if:—its weight, composition, quality, strength or purity varies from its affixed guaranty; it is colored, coated or stained whereby damage or inferiority is concealed; it contains any poisonous or deleterious ingredients; or any foreign substance has been added to any whole or ground grain unless the true composition, mixture or adulteration is plainly indicated upon the package in which it is contained.

A feeding stuff is misbranded if:—the package or label bears any statement, design or device which is false or misleading in any particular; it does not carry the statements required by law; the printed statements attached to the package differ from the statements in the certificate, or the registration fee has not been paid.

If a copy of the requirements under this law is desired ask for Circular 421.

Commercial Fertilizers.

The law regulating the sale of commercial fertilizers has been changed but slightly. The fee has been changed from $20.00 for a complete fertilizer to $25.00.

The law applies to any material used for fertilizing purposes the price of which exceeds $10.00 per ton.

Every package should bear the unmber of net pounds in the package, the name or trademark under which it is sold, the principal address of the manufacturer or shipper, the minimum percentage of nitrogen or its equivalent in ammonia in available form, the minimum percentage of potash, the minimum percentage of available phosphoric acid, soluble and reverted, and the minimum percentage of total phosphoric acid.

Before a fertilizer can be lawfully sold in the State it is necessary that it be registered and for that purpose there must be deposited with the Director of the Maine Agricultural Experiment Station a certified copy of the statements named above, a registration fee of $10.00 for the nitrogen, $10.00 for the phosphoric acid and $5.00 for the potash contained or said to be contained in the fertilizer, and, if the Director requires, a sample of the fertilizer.

The Director of the Experiment Station has power to refuse to register a 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. He also has power to cancel the registration of a fertilizer manufactured, sold, distributed or transported in violation of any of the provisions of the law.

A fertilizer is adulterated if:—its weight, composition, quality, strength or purity varies from its affixed guaranty; or it contains any materials deleterious to growing plants.

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 above; the printed statements attached to the container differ from the statements contained in the certificate; or the registration fee has not been paid.

If a copy of the requirements under this law is desired ask for Circular 422.

DRUGS.

The law regulating the sale of drugs is practically the same as the National Food and Drugs Act, and drugs that can lawfully enter into interstate trade can be lawfully sold in Maine. The drug law is practically the same as the one that has been in force for the past four years.

The law applies to the sale of all medicines and preparations recognized in the United States Pharmacopoeia and National Formulary, and any substance or mixture of substances intended to be used for the cure, mitigation or prevention of disease in man or other animals.

A drug that is exactly what is indicated by its name need bear no label, except that it must show the quantity or proportion of alcohol, morphine, opium, cocaine, heroin, alpha or beta eucaine, chloroform, cannabis indica, chloral hydrate or acetanilide or any derivative or any preparation of such substances contained in the drug. A drug that differs in any way from the name applied to it, or that imitates or simulates another article should at all times be labeled so as to plainly and clearly show its true nature to the non-professional person.

A drug is adulterated if its standard of strength, quality or purity differs from that laid down in the United States Pharmacopoeia or National Formulary or fixed by the Director of the Maine Agricultural Experiment Station: Provided that no drug shall be deemed to be adulterated if its standard of strength, purity or quality is plainly stated so as to be understood by the non-professional person, although the standard may differ from that laid down in the United States Pharmacopoeia or National Formulary or fixed by the Director of the Maine Agricultural Experiment Station. It is also adulterated if its strength or purity differs from the professed standard or quality under which it is sold.

A drug is misbranded if: the package or label bears any statement, design or device which is false or misleading in any particular; in imitation of or offered for sale under the name of another article; the contents of the package as originally put up shall have been removed in whole or in part and other contents shall have been placed in such package; or, except in the case of a physician's prescription compounded by a physician or registered pharmacist, if the package fail to bear a statement giving the quantity or proportion of alcohol, morphine, etc., named above.

If a copy of the requirements under this law is desired ask for Circular 424.

FOODS.

The law in general is the same in its requirements as the National Food and Drugs Act and differs but slightly from the law which has been in force in the State for the past two years.

The term "food" includes all articles, whether simple, mixed or compound, used for food, drink, confectionery or condiment for man or other animals.

A food that is exactly what is indicated by its name need bear no label. A food that differs in any way from the name applied to it, or imitates or simulates another article, must at all times be labeled so as to plainly and clearly show its true nature to the non-professional person. A mixture or compound may be sold under its own distinctive name when not in imitation of or offered for sale under the distinctive name of another article, provided it is accompanied by the name and the place where such article has been manufactured or produced. Compounds, imitations or blends to be lawfully sold should be plainly labeled so as to indicate the fact.

Confectionery is adulterated if it contains terra alba, barytes, talc, chrome yellow, or other mineral substances or poisonous color or flavor or other ingredients deleterious or detrimental to health, or any vinous, malt, or spirituous liquor, or compound, or narcotic drug.

A food is adulterated if: any substance has been mixed or packed with it so as to reduce, lower, or injuriously affect its quality or strength; any substance has been substituted wholly or in part for the article; any valuable constituent of the article has been wholly or in part abstracted; it be mixed, colored, powdered, coated or stained in a manner whereby damage or inferiority is concealed; it contain any added poisonous or other added deleterious ingredient which may render such article injurious to health; it consists in whole or in part of a filthy, decomposed or putrid animal or vegetable substance or any portion of an animal unfit for food whether manufactured or not; it is the product of a diseased animal or one that died otherwise than by slaughter; 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 flies, dust or other contamination or other unclean, unhealthful or unsanitary conditions; it does not conform to the standards of strength, quality and purity established by statute or fixed by the Director of the Maine Agricultural Experiment Station: Provided, that no food shall be deemed to be adulterated if its standard of strength, purity or quality is plainly stated so as to be understood by the non-professional person, although the standard may differ from that fixed by statute or by said director; if its strength or purity differs from the professed standard or quality under which it is sold.

A food is misbranded if: the package or label bears any statement, design or device which is misleading in any particular; it be an imitation of or offered for sale under the name of another article; the contents of the package as originally put up have been removed in whole or in part and other contents shall have been placed in such package; it fail to bear a statement on the label of the quantity or proportion of each and any added coloring matter, preservative, chemical or drug contained therein; the package containing it or its label shall bear any statement, design or device regarding the ingredients of the substances contained therein which statement, design or device is false or misleading in any particular: Provided, that an article of food which does not contain any added poisonous or deleterious ingredients shall not be deemed to be adulterated or misbranded in the following cases:

First. In the case of mixtures or compounds sold under their own distinctive names and not an imitation of or offered for sale under the distinctive name of another article if the name be accompanied on the same label or brand with the statement of the place where such article has been manufactured or produced.

Second. In the case of articles labeled, branded or tagged so as to plainly indicate that they are compounds, imitations or blends.

If a copy of the requirements under this law is desired ask for Circular 425.

Packing Food Under the Maine Food Law.

Chapter 151, Public Laws of 1911, effective March 30, 1911, provides for inspection under the Maine Pure Food and Drug Law, of any food packed in Maine, provided the packer desires such inspection. While the law was intended primarily to allow certain sardine packers who desired it to have inspection maintained in their factories, it applies to any food packed in tin or glass, the packer of which desires the inspection. Packers whose goods are inspected under this law shall be authorized to mark the containers of such goods with a statement that the food therein contained was packed, inspected and passed under the Maine Pure Food and Drug Law.

The cost of maintaining the inspection is met by the packer of the food inspected. The permit to pack under the requirements of this law is for the calendar year, but the permit may be cancelled at any time if the requirements of this law or the Maine Food and Drug Law are not complied with by the packer. The Director of the Experiment Station shall provide adequate inspection and is given the power to make rules and regulations governing such inspection.

If a copy of this law is desired ask for Circular 416.

FUNGICIDES AND INSECTICIDES.

The scope of the law is the same as the National Law. It is very broad and includes all materials which are used for preventing, destroying, repelling or mitigating fungi and insects that infest vegetation, man and other animals, or houses, or any environment whatever.

Every lot or package shall be plainly marked with the number of net pounds in the package, the name or trademark under which the article is sold, the name and address of the manufacturer or shipper, the minimum percentage of total arsenic and the maximum percentage of water soluble arsenic.

Before a fungicide or insecticide can be lawfully sold in the State it is necessary that it be registered and for that purpose there must be deposited with the Director of the Maine Agricultural Experiment Station a certified copy of the statements named above, a registration fee of $10.00, and, if the director requires, a sample of the fungicide or insecticide.

Paris green is adulterated if:—it does not contain at least 50 per cent of arsenic oxide; it contains more than three and one-half per cent of arsenious oxide soluble in water; or any substance has been mixed or packed with it so as to reduce or lower or injuriously affect its quality or strength.

Lead arsenate is adulterated if:—it contains more than 50 per cent of water; it contains less than 12½ per cent of arsenic oxide; it contains more than .75 per cent arsenious oxide soluble in water; or any substance has been mixed or packed with it so as to reduce or lower or injuriously affect its quality or strength: Provided, however, that extra water may be added to lead arsenate if the resulting mixture is labeled "lead arsenate and water" with the percentage of extra water plainly and correctly stated on the label.

A fungicide or insecticide is adulterated if:—its strength or purity falls below the professed standard under which it is sold; any substance has been substituted wholly or in part for the article; any valuable constituent of the article has been wholly or in part extracted; or if it contains any substance or substances injurious to vegetation.

A fungicide or an insecticide is misbranded if:—the package or label bears any statement, design or device which is false or misleading in any particular; the container does not carry the statements named above; the printed statement attached to the container differs from the statements in the certificate; the registration fee has not been paid; it is in imitation of or offered for sale under the name of another article; labeled or misbranded so as to deceive the purchaser; any of the contents of the package as originally put up have been removed in whole or in part and other contents placed in such packages; it consists partially or completely of any inert substance or substances which do not prevent, destroy, repel or mitigate insects or fungi; and does not have the percentage amount of such inert substances plainly stated on the label.

If a copy of the requirements under this law is desired ask for Circular 423.

FREE ANALYSES.

The Station will, so far as circumstances permit, make free of charge analyses of agricultural seeds, commercial feeding stuffs, commercial fertilizers, drugs, foods, fungicides and insecticides on sale in Maine. As a protection to the dealers and to the Station the conditions named in the following paragraphs must be observed. Correspondents are advised to write the Station for blanks before drawing samples for analysis.

The directions for sampling call for care on the part of the correspondent and involve for opened goods considerable time. The analysis also takes time and care, and unless the sample fairly represents the goods on matter how accurate the analysis may be, it is worse than valueless.

Directions for Sampling Agricultural Seeds. The contents of the packets should be emptied out, mixed thoroughly by stirring, and small quantities taken from different parts of the mixture to make the sample. If seeds are in bulk or in large packages, take handfuls at random from the top, middle and bottom, and from these, after mixing, take the sample for testing.

Samples of seeds must be taken in the presence of a disinterested and reputable witness, who shall certify that the sample was taken in his presence according to these directions. The sample must be enclosed in an envelope or other suitable package, securely fastened and sealed in the presence of the witness. The names of the sender and witness must be written on the outside of package, which shall be sent to the station prepaid. A seed sample should weigh not less than two ounces.

The following information must accompany the sample or be sent by mail: The name under which the seed is sold, the name of the dealer, the city or town of the dealer, if in a car the initials and number of the car, an exact copy of all marks upon the package, the guaranteed percentage of purity, the name and postoffice address of the sender, the personally signed certification by the witness that the sample was taken in his presence according to the directions given above.

Directions for Sampling Commercial Feeding Stuffs. The sample should fairly represent the feeding stuff and is best obtained as follows: Open five full and unbroken packages, and mix well together the contents of each for a foot in depth, take out three cupfuls from different parts of the mixed portions of each package, pour them one over another upon a paper, intermix thoroughly and select not less than a half pint from the mixture for the sample. Samples of cotton seed meal and other oily meals should be packed in tin or waxed paper.

The following information must accompany the sample or be sent by mail: The name of the goods, the name of the manufacturer, the name of the dealer, the city or town of the dealer, the initials and number of the car, an exact copy of all marks upon the package, the guaranteed maximum percentage of crude fiber, the guaranteed minimum percentage of fat and of protein, the name of the sender, the postoffice address and county, the personally signed certification by the witness that the described sample was taken in his presence according to the directions given above.

Directions for Sampling Commercial Fertilizers. The Legislature of 1911 passed the following act to provide for the further analysis of commercial fertilizers:

Section 1. Any person within the State may send to the director of the Maine agricultural experiment station samples of commercial fertilizers sold or offered for sale within the state for the purpose of analysis under the following conditions: Said samples shall be taken in the presence of a witness from not less than five packages of properly stored commercial fertilizer in accordance with directions to be furnished by said director; a copy of all marks upon or affixed to the package, including the brand or trademark, the name of the manufacturer and the guaranteed chemical analysis, shall accompany the sample or be deposited with the secretary of the grange or the selectmen of the town where the sample is taken.

Section 2. On receipt of a sample of commercial fertilizer accompanied by (1) a certified statement signed by the witness that the sample was taken as provided in section one of this act, (2) a copy of the marks on or affixed to the package from which the sample was procured or a signed statement from the secretary of a grange or a selectman that the copy of the marks upon the package have been deposited with him, and (3) an analysis fee of ten dollars for each sample, the director of the Maine agricultural experiment station shall make or cause to be made, an analysis of the fertilizer and shall forthwith report the results of said analysis to the sender.

Section 3. If on receipt of the copy of the marks upon the package from which the sample of commercial fertilizer was taken, it shall be found that not more than one sample of the same brand has been analyzed by said director within the year, or if the actual analysis shall differ materially from the guaranteed analysis, the analysis made by said director shall be deemed to be of public importance, and the analysis fee shall be returned to the person who sent the sample. If the actual analysis agrees reasonably with the guaranteed analysis and more than one sample of the brand from which said sample was taken shall have been examined within the year, said director shall pay said analysis fee to the treasurer of the Maine agricultural experiment station and it shall be used for the enforcement of the inspection laws of which the said director is the executive. And the said director shall publish the official bulletin, giving the results of analyses that are deemed to be of public importance, annually in the month of October.—(Approved March 29).

The sample must be taken from not less than five packages of properly stored, dry and undamaged fertilizer, which have not been previously opened; put in the jar; sealed; and delivered to the express company in the presence of a witness who must be the dealer or his representative or a state, town or grange officer.

The sample may be taken by means of a sampling tube that reaches the whole length of the package or as follows: Provide a teacup, some large papers, and for each sample a clean and dry pint or quart glass fruit jar. Open at least 5 full and unbroken packages, and thoroughly mix the contents of each for a foot in depth; take out three cupfuls from different parts of the mixed portion of each package, pour them over one another upon a paper and intermix thoroughly but quickly to avoid loss or gain of moisture; fill the jar from this mixture; attach a label; and seal with wax. Send by prepaid express, to the Agricultural Experiment Station, Orono, Maine.

The following information should accompany the sample; the name of the goods; the name of the manufacturer; the name of the dealer; the city or town of the dealer; the initials and number of the car; an exact copy of all marks upon the package including the minimum percentage of nitrogen or ammonia, available phosphoric acid and the potash soluble in water; the name of the sender; the postoffice address and county; the personally signed certification by the witness that the described sample was taken in his presence according to the directions given above. If it is not desired to give this information to the experiment station these facts may be deposited with the secretary of the grange or the selectmen of the town where the sample was taken.

Directions for Sampling Drugs, Foods, Fungicides and Insecticides. Original unbroken packages will be accepted for analysis when sent prepaid and accompanied by the name and postoffice address of the sender and the dealer. Samples from opened or bulk goods must be taken, sealed and packed in the presence of a witness, preferably the dealer, and forwarded by prepaid express. Usually not less than a pound of a material should be sent as a sample. The sample must be accompanied by (1) an exact copy of the principal label or marks on the package from which the sample was taken, (2) the name and address of the dealer, (3) the signed statement of the witness that the sample was taken, sealed and packed in his presence, (4) the signed statement of the sender that in his judgment the sample fairly represents the goods and the accompanying statements are accurate.

All correspondence relative to work of inspection should be addressed to Director Chas. D. Woods, Orono, Maine.

June, 1911

**MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.**

CHAS. D. WOODS, Director

ANALYSTS

James M. Bartlett
Herman H. Hanson
Albert G. Durgin
Royden L. Hammond
Alfred K. Burke

Official Inspections.

33

FERTILIZER INSPECTION.

The reports of the analyses of the samples collected by the inspectors of the fertilizers found on sale in Maine in 1911 are here published together with such other information as seems pertinent.

Chief Requirements of the Law.

The following are the chief points of the law and the regulations. The full text of the law will be sent on application made to the Director of the Maine Agricultural Experiment Station, Orono, Maine.

1. *Kind of materials coming under the law.* The law applies to the sale, distribution, transportation, or the offering or exposing for sale, distribution or transportation, any materials used for fertilizing purposes the price of which exceeds $10 per ton.

For many years the sale of materials other than mixed goods was so small that no notice was taken of it. As time went on, however, with the propagation of the ideas of home mixing, the demand for chemicals increased. For the last few years the most common chemicals such as acid phosphate, ground bone, nitrate of soda and the various potash salts are regularly licensed by the companies handling them. In the case chiefly of companies manufacturing in the State it happens that other fertilizing constituents are sold in small amounts and primarily for experimental purposes. While the law is explicit there will until further notice, be no prosecutions made by the Director of the Maine Agricultural Experiment Station for the sale without license of small amounts of these more unusual fertilizing constituents, provided the company can show that these goods were sold in good faith for experimental purposes. As a part of the indication that the goods were thus sold it should be explained to the customer exactly under what conditions the goods are sold; that they are unlicensed; that they have not been or are not likely to be analyzed by the Director of the Maine Experiment Station and that the Director holds himself in no way responsible for the quality of these unlicensed goods sold for experimental purposes. Their sale is allowed because the Director does not regard it as the purposes of the law to either hamper ordinary business or hinder experiments on the part of the farmer. Whenever any goods thus offered experimentally come to be sold in considerable amount they must be licensed the same as other fertilizing materials.

2. *The Brand.* Every lot or package shall be plainly marked with:

The number of net pounds in the package.

The name or trademark under which it is sold.

The name and principal address of the manufacturer or shipper.

The minimum percentage of nitrogen, or its equivalent in ammonia, in available form.

The minimum percentage of potash.

The minimum percentage of available phosphoric acid (soluble and reverted).

The minimum percentage of total phosphoric acid.

If a fertilizer is sold in bulk or put up in packages belonging to the purchaser, upon the request of the purchaser he shall be furnished with a copy of the statements named above.

3. *Manufacturers' certificate.* Before manufacturing, selling or distributing a commercial fertilizer a certified copy of the statements named in 2 shall be filed with the Director of the Maine Experiment Station.

4. *Manufacturers' sample.* When the Director shall so request, the manufacturer shall furnish a sealed package containing not less than two pounds of the commercial fertilizer.

5. *Registration fee.* A registration fee is assessed on any brand offered for sale, distribution or transportation in the State as follows: $10 for the nitrogen, $10 for the phosphoric acid and $5 for the potash contained or said to be contained in the fertilizer. The filing of the certificate and the payment of the fee is required for only one person for a given brand.

6. *Registration may be refused or canceled.* The Director of the Station may refuse to register any commercial fertilizer which bears a name that is misleading or deceptive or which would tend to mislead or deceive as to the materials of which it is composed. The Director also has power to cancel the registration of a fertilizer manufactured, sold, distributed or transported in violation of any of the provisions of the law.

7. *Adulteration.* A fertilizer is adulterated if its weight, composition, quality, strength or purity varies from its fixed guaranty or if it contains any materials deleterious to growing plants.

8. *Misbranding.* A fertilizer is misbranded if: the package or label carries any statement, design or device that is false or misleading in any particular; the container does not carry the statements named in 2; the printed statements attached to the container differ from the statements in the certificate; and if the registration fee has not been paid.

9. *Analysis for correspondents.* A special law provides that the station shall analyze samples of fertilizers on sale in Maine taken in accordance with the law and the directions of the director and the payment of an anlysis 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 notified by the Director of the Maine Agricultural Experiment Station that an article of commercial fertilizer appears to be adulterated or misbranded the written guaranty will not protect further sales.

11. *Hearing.* The person who is believed to have violated the law regulating the sale of commercial fertilizer will be granted a hearing at which he may appear in person, or by attorney, or by letter. The notice of the hearing will name the time and place of the hearing and a copy of the charge. Failure to appear will not prejudice the case. The hearing will be private and every opportunity will be given for explanation and the establishment of innocence. If the time appointed is not a convenient one, postponement within reasonable limit will be granted.

12. *Penalty.* Violations of the law are punishable by a fine not exceeding one hundred dollars for the first offense and not exceeding two hundred dollars for each subsequent offense.

13. *Executive.* The Director of the Station is directed to collect and analyze samples of fertilizers on sale in the State; tc publish the results of the analyses together with additional information of public benefit; and to diligently enforce the provisions of the law.

Fertility and Plant Food.

To produce profitable crops and at the same time to maintain and even to increase the productive capacity of the soil may rightly be termed "good farming." Many farmers are able to do this, and the knowledge of how to do it has been largely acquired through years of experience, during which the character of the soil, its adaptability for crops, and the methods of its management and manuring have been made the subjects of careful study, without, however, any definite and accurate knowledge concerning manures and their functions in relation to soils and crops. Those who desire to study these questions, are invited to write to the Superintendent of the Extension Department of the College of Agriculture, University of Maine, Orono, Maine, who will gladly send a list of suitable books and give full information relative to correspondence courses on this subject.*

Soils vary greatly in their capabilities of supplying food to crops. Different ingredients are deficient in different soils. The way to learn what materials are proper in a given case is by observation and experiment. The rational method for determining what ingredients of plant-food a soil fails to furnish in abundance, and how these lacking materials can be most economically supplied, is to put the questions to the soil with different fertilizing materials and get the reply in the crops produced. How to make these experiments is explained in Circular No. 8 of the Office of Experiment Stations of the U. S. Department of Agriculture. A copy of this circular can be had by applying to the Secretary of Agriculture, Washington, D. C.

The chief use of fertilizers is to supply plant-food. It is good farming to make the most of the natural resources of the soil and of the manures produced on the farm, and to depend upon artificial fertilizers only to furnish what more is needed. It is not good economy to pay high prices for materials which the soil may itself yield, but it is good economy to supply the lacking ones in the cheapest way. The rule in the purchase of costly commercial fertilizers should be to select those that supply, in the best forms and at the lowest cost, the plant-food which the crop needs and the soil fails to furnish.

Plants differ widely with respect to their capacities for gathering their food from soil and air; hence the proper fertilizer in a given case depends upon the crop as well as upon the soil. The fertility of the soil would remain practically unchanged if all the ingredients removed in the various farm products were

---

*This Station has a circular on Home Mixed Fertilizers that may be had on request to Director Chas. D. Woods, Orono. Farmers' Bulletin 44 of the U. S. Department of Agriculture discussing commercial fertilizers will be sent to any address on application to the Secretary of Agriculture, Washington, D. C. The Maine Bulletin, Vol. XI, No. 5, discusses The Restoration of Fertility and Commercial Fertilizers. This can be obtained by writing the College of Agriculture, Orono, Maine.

restored to the land. This may be accomplished by feeding the crops grown on the farm to animals, carefully saving the manure and returning it to the soil. If it is practicable to pursue a system of stock feeding in which those products of the farm which are comparatively poor in fertilizing constituents are exchanged in the market for feeding stuffs of high fertilizing value, the loss of soil fertility may be reduced to a minimum, or there may be an actual gain in fertility.

Constituents of Fertilizers.

The only ingredients of plant-food which we ordinarily need to consider in fertilizers are potash, lime, phosphoric acid, and nitrogen. The available supply of lime is often insufficient; hence one reason for the good effect so often observed from the application of lime, and of plaster, which is a compound of lime and sulphuric acid. The remaining substances, nitrogen, phosphoric acid and potash, are the most important ingredients of our common commercial fertilizers, both because of their scarcity in the soil and their high cost. It is in supplying these that phosphates, bone manures, potash-salts, guano, nitrate of soda, and most other commercial fertilizers are chiefly useful.

The term "form" as applied to a fertilizing constituent has reference to its combination or association with other constituents which may be useful, though not necessarily so. The form of the constituent, too, has an important bearing upon its availability, and hence upon its usefulness as plant food. Many materials containing the essential elements are practically worthless as sources of plant-food because the form is not right; the plants are unable to extract them from their combinations; they are "unavailable." In many of these materials the forms may be changed by proper treatment, in which case they become valuable not because the element itself is changed, but because it then exists in such form as readily to feed the plant.

Nitrogen is the most expensive of the three essential fertilizing elements. It exists in three different forms, organic nitrogen, ammonia and nitrate.

Organic nitrogen exists in combination with other elements either as vegetable or animal matter. All materials containing organic nitrogen are valuable in proportion to their rapidity of decay, because change of form must take place before the nitrogen can serve as plant food. Organic nitrogen differs in availability not only according to the kind of material which supplies it, but according to the treatment it receives.

Nitrogen as ammonia usually exists in commercial manures in the form of sulphate of ammonia and is more readily available than organic nitrogen. While nitrogen in the form of ammonia is extremely soluble in water, it is not readily removed from the soil by leaching, as it is held by the organic compounds of the soil.

Nitrogen as nitrate exists in commercial products chiefly as nitrate of soda. Nitrogen in this form is directly and immediately available, no further changes being necessary. It is completely soluble in water, and diffuses readily throughout the soil. It differs from the ammonia compounds in forming no insoluble compounds with soil constituents and may be lost by leaching.

Phosphoric acid is derived from materials called phosphates, in which it may exist in combination with lime, iron, or alumina as phosphates of lime, iron or alumina. Phosphate of lime is the form most largely used as a source of phosphoric acid. Phosphoric acid occurs in fertilizers in three forms: That soluble in water and readily taken up by plants; that insoluble in water but still readily used by plants and known as "reverted"; and that soluble only in strong acids and consequently very slowly used by the plant. The "soluble" and "reverted" together constitute the "available" phosphoric acid. The phosphoric acid in natural or untreated phosphates is insoluble in water, and not readily available to plants. If it is combined with organic substances as in animal bone, the rate of decay is more rapid than if with purely mineral substances. The insoluble phosphates may be converted into soluble forms by treatment with strong acids. Such phosphates are known as acid phosphates or superphosphates. The "insoluble phosphoric acid" of a high cost commercial fertilizer has little or no value to the purchaser because at the usual rate of application the quantity is too small to make any perceptible effect upon the crop, and because its presence in the fertilizer excludes an equal amount of more needful and valuable constituents.

Potash in commercial fertilizers exists chiefly as muriates and sulphates. With potash the form does not exert so great an influence upon availability as is the case with nitrogen and phosphoric acid. All ordinary forms are freely soluble in water, and are believed to be nearly if not quite equally available as food. The form of the potash has an important influence upon the quality of certain crops. For example, the results of experiments seem to indicate that the quality of tobacco, and certain other crops, is unfavorably influenced by the use of muriate of potash, while the same crops show a superior quality of materials free from chlorides have been used as the source of potash.

VALUATION OF FERTILIZERS.

The agricultural value of any fertilizing constituent is measured by the value of the increase of the crop produced by its use, and is, of course, a variable factor, depending upon the availability of the constituent, and the value of the crop produced. The form of the materials used must be carefully considered in the use of manures. Slow-acting materials cannot be expected to give profitable returns upon quick-growing crops, nor expensive materials profitable returns when used for crops of relatively low value.

The agricultural value is distinct from what is termed "commercial value," or cost in market. This last is determined by market and trade conditions, as cost of production of the crude material, methods of manipulation required, etc. Since there is no strict relation between agricultural and commercial or market value, it may happen that an element in its most available form, and under ordinary conditions of high agricultural value, costs less in market than the same element in less available forms and of a lower agricultural value. The commercial value has reference to the material as an article of commerce, hence commercial ratings of various fertilizers have reference to their relative cost and are used largely as a means by which the different materials may be compared.

The commercial valuation of a fertilizer consists in calculating the retail trade-value or cash-cost at freight centers (in raw materials of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer. Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates, and similar articles, for which $20 to $75 per ton are paid, depend for their trade value exclusively on the substances, nitrogen, phosphoric acid and potash, which are comparatively costly and steady in price. The trade-value per pound of the ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce. The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the trade-value of the above-named ingredients a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use.

For many years this Station has not printed an estimate of the commercial value of the different brands licensed in the State. If any one wishes to calculate the commercial value he can do so by using the trade values adopted for 1911 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, 1911, 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 1911.

		Cents per pound.
Nitrogen	in nitrates	16
	in ammonia salts	16
Organic nitrogen	in dry and fine ground fish and blood	23
	in cottonseed meal and castor pomace	21
	in fine bone and tankage and in mixed fertilizers	20
	in coarse bone and tankage	15
Phosphoric acid,	water-soluble	4½
	citrate-soluble	4
	in fine ground bone and tankage	4
	in cottonseed meal, castor pomace	4
	in coarse bone, tankage and ashes	3½
	in mixed fertilizers, if insoluble in ammonium citrate	2

Potash as high grade sulphate and in forms free from muriate (chloride)	5
as muriate	4¼
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 4.0 by the percentage of nitrogen.

Multiply 0.8 by the percentage of available phosphoric acid.

Multiply 0.4 by the percentage of insoluble phosphoric acid.

Multiply 1.0 by the percentage of potash.

The sum of these 4 products will be the commercial valuation per ton on the basis taken.

Illustration. The table of analyses shows a certain fertilizer to have the following composition: Nitrogen 3.30 per cent; Available phosphoric acid 8.00 per cent; Insoluble phosphoric acid 1.00 per cent; Potash 6.00 per cent. The valuation in this case will be computed thus:

Nitrogen,	4.0×3.30,	$13 20
Available phosphoric acid,	0.8×8.00,	6 40
Insoluble phosphoric acid,	0.4×1.00,	40
Potash,	1.0×6.00,	6 00
		$26 00

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.

RESULTS OF INSPECTION.

The inspection of the spring of 1911 indicates that the fertilizer situation in Maine is at present better than we have ever found it before since the fertilizer trade assumed such large proportions for this State.

The inspectors who drew the samples were men of experience and the work was done very carefully. Almost without exception each sample was drawn from ten different bags of the same brand, thus insuring a representative sample. In the laboratory whenever the results obtained differed materially, either above or below, from the guaranty, the work was repeated so that the final report is often the result of several determinations.

In order that a mixed fertilizer run uniform in composition it is necessary that the work of mixing be done very exactly, and where the brands are made in large quantities the care involved is, of course, very great. Almost without exception the companies doing business at the present time in Maine exercise great care in selecting their materials and in mixing their goods, and while an occasional sample will vary somewhat in some particular from the guaranty, the fact that they run as near as they do shows that for the most part the goods on the market are well manufactured.

The goods of the following companies almost without exception ran well above the guarantees, and may be passed with few comments: American Agricultural Chemical Company, Armour Fertilizer Company, Bowker Fertilizer Co., Buffalo Fertilizer Company, E. D. Chittenden Company, Coe-Mortimer Company, Essex Fertilizer Company, German Kali Works, Lister's Agricultural Chemical Company, Merrow Brothers, Morison Brothers, National Fertilizer Company, New England Fertilizer Company, Parmentor & Polsey Fertilizer Company, E. W. Penley, Rogers & Hubbard Company, Sagadahoc Fertilizer Company, Swift's Lowell Fertilizer Company, F. W. Tunnell & Co., Tuscarora Fertilizer Company and Union Chemical Works.

While some of the above mentioned companies had a great many different brands upon the market, all of these different brands almost without exception were above the guarantees.

Others had but one or two brands on sale and these also were found to be well above.

The Buffalo brands about which there was some discussion last year were found to run very good the present season. The Top Dresser was slightly below in nitrogen but well above in the other constituents. Three samples of the 5-8-9 goods taken at different places ran about 0.3 per cent below in potash. All of the other brands were very uniform in composition as indicated by the analyses made.

The Atlantic Fertilizer Company had three different brands on sale which were sampled. Each of the three brands was somewhat below the guaranty in nitrogen, and one of the three was somewhat below in potash, as indicated by the analyses made on two samples of that brand.

The goods of the Hubbard Fertilizer Company were apparently rather unevenly mixed and none of the samples analyzed ran materially above the guarantees.

The one brand licensed by Martin and White was under its guarantees in both available and total phosphoric acid and in potash.

The Bone Dust Tankage of the Portland Rendering Company while somewhat under the guaranty in phosphoric acid more than made up for this shortage in the high nitrogen which it carried.

The Provincial Chemical Fertilizer Company of St. John, New Brunswick, did not license goods in Maine this year. As was noted in Official Inspections 29, containing the results of last year's collection of fertilizers, we have usually found their goods below the guarantees in one or more constituents, and in spite of repeated warnings the situation was not improved from year to year. Last year one of their selling agents was prosecuted and fined for selling goods below the guarantees, and as a result their brands were not licensed for the present year and our inspectors failed to find any of the goods on sale in the State.

A few brands licensed for the year were not found on sale by the inspectors. One of the principal reasons for this is the fact that as more companies come into the State to do business the competition becomes more keen, and more of the goods are shipped to individual consumers without passing through the large warehouses or through the hands of large distributors. These small lots are oftentimes used up at once upon receipt and it thus becomes very difficult to obtain a sample of every brand which may possibly be used in the State. If any reader of this report has used fertilizer not here listed he is invited to communicate with the Station and if he should have any of the goods in stock and properly stored, we will send directions for sampling the same and will be glad to make an analysis free of charge. Directions for sampling should be asked for before samples are sent.

Activity of Organic Forms of Nitrogen.

Concerning the activity of the various forms of organic nitrogen used for fertilizing purposes there has lately been much discussion, and it is realized that this is an important question both to the manufacturers and to consumers. In all of the New England States and in New York and in New Jersey the experiment stations have been working for some time to obtain a method by which comparable results could be arrived at. A method has been devised under which work of this kind is now being done by two stations. The increased funds which will next year become available to the Maine Experiment Station, owing to the increase in the fertilizer license fee, will allow for considerable work along this line and it is now planned to issue, after this year, a report in which the activity and availability of the different forms of nitrogen will be discussed.

Descriptive List of Fertilizer Samples, 1911.

Station number.	Manufacturer, place of business and brand.
	AMERICAN AGRICULTURAL CHEMICAL COMPANY
1011	A. A. C. Co.'s Aroostook Complete Manure
1177	A. A. C. Co.'s Complete Manure
1017	A. A. C. Co.'s Aroostook High Grade
1168	A. A. C. Co.'s Aroostook High Grade
1004	A. A. C. Co.'s Grass and Oats
1188	A. A. C. Co.'s Grass and Oats
1013	A. A. C. Co.'s Northern Maine Potato Special
1196	A. A. C. Co.'s Northern Maine Potato Special
1006	A. A. C. Co.'s Peerless Potato Manure
1167	A. A. C. Co.'s Peerless Potato Manure
1313	A. A. Potato Grower
1110	Bradley's Alkaline Bone with Potash
1163	Bradley's Alkaline Bone with Potash
1284	Bradley's Alkaline Bone with Potash
1092	Bradley's Complete Manure for Potatoes and Vegetables
1192	Bradley's Complete Manure for Potatoes and Vegetables
1314	Bradley's Complete Manure for Potatoes and Vegetables
1026	Bradley's Complete Manure with 10 per cent Potash
1142	Bradley's Complete Manure with 10 per cent Potash
1248	Bradley's Complete Manure with 10 per cent Potash
1024	Bradley's Corn Phosphate
1136	Bradley's Corn Phosphate
1311	Bradley's Corn Phosphate
1022	Bradley's Eureka Fertilizer
1141	Bradley's Eureka Fertilizer
1031	Bradley's Niagara Phosphate
1145	Bradley's Niagara Phosphate
1025	Bradley's Potato Fertilizer
1135	Bradley's Potato Fertilizer
1029	Bradley's Potato Manure
1137	Bradley's Potato Manure
1105	Bradley's XL Superphosphate of Lime
1191	Bradley's XL Superphosphate of Lime
1038	Clark's Cove Bay State Fertilizer
1189	Clark's Cove Bay State Fertilizer
1155	Clark's Cove Bay State Fertilizer for Seeding Down
1023	Clark's Cove Bay State Fertilizer G. G
1151	Clark's Cove Bay State Fertilizer G. G
1445	Clark's Cove Defiance Complete Manure
1086	Clark's Cove Great Planet Manure A. A
1367	Clark's Cove Great Planet Manure A. A
1035	Clark's Cove King Philip Alkaline Guano for All Crops
1160	Clark's Cove King Philip Alkaline Guano for All Crops
1089	Clark's Cove Potato Fertilizer
1165	Clark's Cove Potato Fertilizer
1041	Clark's Cove Potato Manure
1159	Clark's Cove Potato Manure
1088	Cleveland Fertilizer for all Crops

Analysis of Fertilizer Samples, 1911.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
	As Nitrates.	As Ammoniates.	Total.		Soluble.	Reverted.	Insoluble.	Available.		Total.		Found.	Guaranteed.
			Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.		
	%	%	%	%	%	%	%	%	%	%	%	%	%
1011	1.04	0.90	2.45	2.47	4.86	1.73	1.75	6.59	6.00	8.34	7.00	10.10	0.00
1177	......	1.18	2.48	2.47	3.49	2.97	2.93	6.46	6.00	9.39	7.00	10.30	10.00
1017	1.17	0.92	4.33	4.11	6.62	1.33	1.05	7.95	7.00	9.00	8.00	7.17	7.00
1168	0.34	0.68	4.36	4.11	6.33	1.67	1.02	8.00	7.00	9.02	8.00	7.39	7.00
1004	......	......	......	......	8.60	2.64	1.15	11.24	11.00	12.39	12.00	2.00	2.00
1188	......	......	......	......	8.85	1.99	1.47	10.84	11.00	12.31	12.00	2.06	2.00
1013	0.86	1.00	3.84	3.70	6.35	1.48	1.10	7.83	7.00	8.93	8.00	9.77	10.00
1196	0.26	0.74	3.71	3.70	5.41	2.04	1.91	7.45	7.00	9.36	8.00	9.35	10.00
1006	0.90	0.56	3.24	3.29	7.37	1.53	1.72	8.9[illegible]	8.00	10.62	9.00	7.27	7.00
1167	......	0.40	3.30	3.29	6.78	2.10	1.14	8.88	8.00	10.02	9.00	7.54	7.00
1313	0.90	0.26	3.78	3.70	5.68	2.22	1.19	7.90	7.00	9.09	8.00	10.62	10.00
1110	......	......	......	......	8.76	2.42	1.85	11.18	11.00	13.03	12.00	2.04	2.00
1163	......	......	......	......	9.25	1.35	1.28	10.60	11.00	11.88	12.00	2.52	2.00
1284	......	......	......	......	8.41	2.29	1.34	10.64	11.00	11.98	12.00	2.23	2.00
1092	0.96	1.64	3.48	3.29	8.68	0.26	0.92	8.94	8.00	9.86	9.00	6.94	7.00
1192	0.44	1.54	3.10	3.29	7.29	1.44	0.78	8.73	8.00	9.51	9.00	7.02	7.00
1314	0.50	1.24	3.32	3.29	6.56	2.03	1.67	8.59	8.00	10.26	9.00	7.90	7.00
1026	0.73	1.80	3.02	3.29	5.89	1.65	0.93	7.54	6.00	8.47	7.00	9.85	10.00
1142	......	1.38	3.20	3.29	5.23	1.67	1.54	6.90	6.00	8.44	7.00	10.87	10.00
1248	0.16	1.84	3.28	3.29	4.94	1.36	1.37	6.30	6.00	7.67	7.00	10.41	10.00
1024	0.66	0.18	2.00	2.06	6.62	1.92	2.62	8.54	8.00	11.16	9.00	1.74	1.50
1136	0.32	0.44	2.30	2.06	6.11	1.39	2.59	7.50	8.00	10.09	9.00	1.92	1.50
1311	0.06	1.14	2.20	2.06	6.56	1.91	2.26	8.47	8.00	10.73	9.00	1.95	1.50
1022	0.17	0.13	1.26	1.03	6.49	1.95	2.70	8.34	8.00	11.04	9.00	2.05	2.00
1141	......	0.20	1.04	1.03	6.52	2.21	1.89	8.73	8.00	10.62	9.00	2.14	2.00
1031	0.52	0.06	1.17	0.82	5.97	2.12	1.85	8.09	7.00	9.94	8.00	1.25	1.00
1145	0.34	0.08	1.40	0.82	6.20	1.12	1.61	7.32	7.00	8.93	8.00	1.68	1.00
1025	0.84	0.12	2.33	2.06	7.07	1.51	3.13	8.58	8.00	11.71	9.00	3.36	3.00
1135	......	1.20	2.14	2.06	6.03	2.16	2.27	8.19	8.00	10.46	9.00	3.74	3.00
1029	0.90	1.03	2.63	2.47	5.66	1.15	1.21	6.81	6.00	8.02	7.00	5.04	5.00
1137	0.30	1.20	2.66	2.47	5.58	1.21	1.60	6.79	6.00	8.39	7.00	6.71	5.00
1105	0.46	0.14	2.36	2.47	8.04	1.64	1.56	9.68	9.00	11.24	10.00	2.67	2.00
1191	0.06	1.08	2.56	2.47	6.35	3.96	2.48	10.31	9.00	12.79	10.00	2.17	2.00
1038	0.70	0.98	2.37	2.47	7.86	1.49	1.85	9.35	9.00	11.20	10.00	2.05	2.00
1189	.....	1.08	2.56	2.47	6.28	2.76	2.48	9.04	9.00	11.52	11.00	2.22	2.00
1155	......	0.17	1.02	1.03	6.49	2.50	1.39	8.99	8.00	10.38	9.00	2.29	2.00
1023	0.87	0.26	2.30	2.06	5.34	2.59	2.74	7.93	8.00	10.67	9.00	2.51	1.50
1151	0.48	0.18	2.36	2.06	6.70	1.92	2.42	8.62	8.00	11.04	9.00	2.29	1.50
1445	0.20	0.58	1.22	0.82	6.09	1.96	1.68	8.05	7.00	9.73	8.00	1.66	1.00
1086	0.96	0.72	3.16	3.29	7.18	2.10	1.77	9.28	8.00	11.05	9.00	6.94	7.00
1367	1.36	0.20	3.36	3.29	3.21	4.70	1.85	7.91	8.00	9.76	9.00	8.09	7.00
1035	......	0.18	1.16	1.03	6.05	2.09	2.90	8.14	8.00	11.04	9.00	2.24	2.00
1160	.....	0.84	1.00	1.03	6.46	2.23	1.39	8.69	8.00	10.08	9.00	2.28	2.00
1089	0.90	0.22	2.22	2.06	6.25	2.53	2.31	8.78	8.00	11.09	9.00	3.68	3.00
1165	......	1.14	2.12	2.06	5.73	2.82	1.88	8.55	8.00	10.43	9.00	3.30	3.00
1041	1.03	0.08	2.67	2.47	5.04	2.03	2.05	7.07	6.00	9.12	7.00	5.36	5.00
1159	1.26	0.20	2.52	2.47	5.44	1.07	1.01	6.51	6.00	7.51	7.00	4.92	5.00
1088	......	0.16	1.06	1.03	6.19	2.71	2.65	8.90	8.00	11.55	9.00	2.13	2.00

Descriptive List of Fertilizer Samples, 1911.

Station number.	Manufacturer, place of business and brand.
1079	Cleveland High Grade Complete Manure
1082	Cleveland Potato Phosphate
1081	Cleveland Superphosphate
1027	Complete Manure with 10 per cent Potash
1249	Complete Manure with 10 per cent Potash
1014	Crocker's Ammoniated Corn Phosphate
1175	Crocker's Ammoniated Corn Phosphate
1007	Crocker's Aroostook Potato Special
1169	Crocker's Aroostook Potato Special
1019	Crocker's New Rival Ammoniated Super-Phosphate
1178	Crocker's New Rival Ammoniated Super-Phosphate
1015	Crocker's Potato, Hop and Tobacco Phosphate
1172	Crocker's Potato, Hop and Tobacco Phosphate
1012	Crocker's Special Potato Manure
1195	Crocker's Special Potato Manure
1318	Crocker's Special Potato Manure
1085	Cumberland Potato Fertilizer
1149	Cumberland Potato Fertilizer
1100	Cumberland Super-Phosphate
1140	Cumberland Super-Phosphate
1090	Darling's Blood, Bone and Potash
1272	Darling's Blood, Bone and Potash
1407	Darling's Blood, Bone and Potash
1205	Fine Ground Tankage
1457	Grass and Lawn Top Dressing
1010	Great Eastern General Festilizer
1170	Great Eastern General Fertilizer
1266	Great Eastern General Fertilizer
1003	Great Eastern High Grade Potato Manure
1193	Great Eastern High Grade Potato Manure
1002	Great Eastern Northern Corn Special
1171	Great Eastern Northern Corn Special
1317	Great Eastern Northern Corn Special
1009	Great Eastern Potato Manure
1179	Great Eastern Potato Manure
1106	High Grade Fertilizer with 10 per cent Potash
1194	High Grade Fertilizer with 10 per cent Potash
1320	High Grade Fertilizer with 10 per cent Potash
1119	Lazaretto Aroostook Potato Guano
1118	Lazaretto Corn Guano
1123	Lazaretto High Grade Potato Guano
1350	Lazaretto High Grade Potato Guano
1120	Lazaretto Propeller Potato Guano
1201	Muriate of Potash
1204	Nitrate of Soda

Analysis of Fertilizer Samples, 1911.

Station number.	Nitrogen. As Nitrates.	Nitrogen. As Ammoniates.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
1079	1.00	0.78	3.40	3.29	7.05	1.58	1.59	8.63	8.00	10.22	9.00	6.80	7.00
1082	0.72	0.34	2.04	2.06	6.19	2.44	2.36	8.63	8.00	10.99	9.00	3.50	3.00
1081	0.96	0.12	2.21	2.06	5.28	2.98	3.00	8.26	8.00	11.26	9.00	1.87	1.50
1027	0.69	1.93	3.20	3.29	6.19	1.37	0.91	7.56	6.00	8.47	7.00	9.86	10.00
1249	0.24	1.78	3.36	3.29	4.86	1.75	1.25	6.61	6.00	7.86	7.00	10.46	10.00
1014	0.99	0.10	2.19	2.06	5.81	2.62	2.83	8.43	8.00	11.26	9.00	1.97	1.50
1175	0.16	0.30	2.34	2.06	5.30	2.83	3.34	8.13	8.00	11.47	9.00	1.96	1.50
1007	0.74	0.80	2.20	2.06	6.76	1.44	1.62	8.20	8.00	9.82	9.00	6.54	6.00
1169	......	1.00	2.34	2.06	6.33	2.35	2.13	8.68	8.00	10.80	9.00	6.12	6.00
1019	0.14	0.18	1.26	1.03	6.09	2.36	2.19	8.45	8.00	10.64	9.00	2.21	2.00
1178	......	0.26	1.06	1.03	6.89	1.49	1.76	8.38	8.00	10.14	9.00	2.75	2.00
1015	0.88	0.14	2.02	2.06	6.41	2.12	2.03	8.53	8.00	10.56	9.00	3.60	3.00
1172	......	1.32	2.16	2.06	6.71	1.66	0.91	8.37	8.00	9.28	9.00	3.24	3.00
1012	0.81	1.67	3.08	3.29	6.49	0.50	0.68	6.99	6.00	7.67	7.00	9.83	10.00
1195	0.26	1.44	3.34	3.29	5.04	2.04	1.44	7.08	6.00	8.52	7.00	11.04	10.00
1318	0.42	1.70	3.42	3.29	3.97	3.33	2.14	7.30	6.00	9.44	7.00	10.41	10.00
1085	1.00	0.16	2.22	2.06	6.68	2.12	2.40	8.80	8.00	11.20	9.00	3.55	3.00
1149	......	1.16	2.16	2.06	6.28	1.96	2.08	8.24	8.00	10.32	9.00	3.83	3.00
1100	0.80	0.10	2.16	2.06	5.33	3.61	2.37	8.94	8.00	11.31	9.00	1.90	1.50
1140	0.44	0.12	2.10	2.06	6.51	2.04	2.27	8.55	8.00	10.83	9.00	1.81	1.50
1090	0.84	1.48	4.30	4.11	6.57	1.95	0.83	8.52	7.00	9.35	8.00	7.03	7.00
1272	0.82	0.30	4.24	4.11	6.01	1.81	1.22	7.82	7.00	9.04	8.00	7.58	7.00
1407	1.10	1.08	4.24	4.11	4.59	2.51	2.12	7.10	7.00	9.22	8.00	7.89	7.00
1205	......	0.26	5.50	4.94	0.27	13.11	0.66	13.38	......	14.04	13.73	.....	.....
1457	1.44	1.64	3.86	3.91	2.68	3.43	0.80	6.11	5.00	6.91	6.00	2.34	2.00
1010	0.16	0.12	1.08	0.82	6.44	2.09	2.44	8.53	8.00	10.97	9.00	4.38	4.00
1170	0.20	0.14	1.40	0.82	5.23	3.28	1.52	8.51	8.00	10.03	9.00	3.80	4.00
1266	0.12	0.12	1.04	0.82	6.03	2.51	1.79	8.54	8.00	10.33	9.00	4.68	4.00
1003	0.52	1.70	3.22	3.29	5.42	1.15	1.05	6.57	6.00	7.62	7.00	10.50	10.00
1193	0.22	1.46	3.22	3.29	4.77	2.30	1.45	7.07	6.00	8.52	7.00	11.04	10.00
1002	0.96	0.08	2.18	2.06	4.66	2.93	2.97	7.59	8.00	10.56	9.00	1.94	1.50
1171	0.14	0.42	2.28	2.06	5.81	2.54	2.62	8.35	8.00	10.97	9.00	1.83	1.50
1317	0.22	0.34	2.06	2.06	6.14	2.51	2.77	8.65	8.00	11.42	9.00	1.97	1.50
1009	0.76	0.15	2.20	2.06	6.48	1.39	2.62	7.87	8.00	10.49	9.00	4.01	3.00
1179	......	1.20	2.12	2.06	6.38	1.81	1.86	8.19	8.00	10.05	9.00	3.26	3.00
1106	0.66	0.72	2.42	2.47	5.60	2.08	0.71	7.68	6.00	8.39	7.00	9.84	10.00
1194	0.36	0.76	2.40	2.47	5.25	2.06	0.79	7.31	6.00	8.10	7.00	10.23	10.00
1320	0.46	0.14	2.56	2.47	4.23	2.60	2.31	6.83	6.00	9.14	7.00	10.41	10.00
1119	......	0.44	1.00	0.82	6.40	2.08	1.06	8.48	8.00	9.54	9.00	4.77	4.00
1118	......	0.86	1.84	1.65	6.38	1.84	1.40	8.22	8.00	9.62	9.00	2.36	2.00
1123	0.20	1.46	3.28	3.29	4.32	2.03	1.38	6.35	6.00	7.73	7.00	10.75	10.00
1350	1.12	0.18	3.48	3.29	1.77	4.24	1.84	6.01	6.00	7.85	7.00	10.06	10.00
1120	.....	0.92	2.10	2.06	6.38	2.13	1.63	8.51	8.00	10.14	9.00	6.67	6.00
1201	......	......	.....	......	......	......	......	......	....	......	......	51.44	49.00
1204	......	......	15.14	15.00	......	......	......	......	......	......	......	......	......

Descriptive List of Fertilizer Samples, 1911.

Station number.	Manufacturer, place of business and brand.
1434	Otis Potato Fertilizer
1442	Otis Potato Fertilizer
1441	Otis Superphosphate
1433	Otis Superphosphate
1084	Pacific Dissolved Bone and Potash
1286	Pacific Dissolved Bone and Potash
1034	Pacific Grass and Grain Fertilizer
1280	Pacific Grass and Grain Fertilizer
1036	Pacific High Grade General Fertilizer
1288	Pacific Nobsque Guano for All Crops
1030	Pacific Potato Special
1164	Pacific Potato Special
1018	Packers' Union Animal Corn Fertilizer
1176	Packers' Union Animal Corn Fertilizer
1016	Packers' Union Gardeners Complete Manure
1174	Packers' Union Gardeners Complete Manure
1130	Packers' Union Potato Manure
1166	Packers' Union Potato Manure
1260	Packers' Union Potato Manure
1117	Packers' Union Universal Fertilizer
1173	Packers' Union Universal Fertilizer
1202	Plain Superphosphate
1435	Quinnipiac Climax Phosphate for All Crops
1436	Quinnipiac Corn Manure
1083	Read's Farmers' Friend Superphosphate
1150	Read's Farmers' Friend Superphosphate
1008	Read's High Grade Farmers' Friend Super-Phosphate
1152	Read's High Grade Farmers' Friend Super-Phosphate
1274	Read's High Grade Farmers' Friend Super-Phosphate
1001	Read's Potato Manure
1147	Read's Potato Manure
1276	Read's Potato Manure
1080	Read's Practical Potato Special Fertilizer
1158	Read's Practical Potato Special Fertilizer
1275	Read's Practical Potato Special Fertilizer
1087	Read's Standard Super-Phosphate
1143	Read's Standard Super-Phosphate
1042	Read's Sure Catch Fertilizer
1146	Read's Sure Catch Fertilizer
1005	Read's Vegetable and Vine Fertilizer
1281	Read's Vegetable and Vine Fertilizer
1091	Soluble Pacific Guano
1157	Soluble Pacific Guano
1040	Standard "A" Brand
1139	Standard "A" Brand
1037	Standard Bone and Potash
1144	Standard Bone and Potash

Analysis of Fertilizer Samples, 1911.

Station number.	Nitrogen. As Nitrates.	Nitrogen. As Ammoniates.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
1434	0.26	0.80	2.32	2.06	6.08	1.88	2.07	7.96	8.00	10.03	9.00	2.92	3.00
1442	0.04	0.96	2.08	2.06	6.43	2.33	1.51	8.76	8.00	10.27	9.00	3.26	3.00
1441	0.64	0.30	2.18	2.06	7.27	2.55	2.08	9.82	8.00	11.90	9.00	1.80	1.50
1433	0.26	0.98	2.08	2.06	6.20	2.14	2.07	8.34	8.00	10.41	9.00	1.80	1.50
1084	......	......	......	......	7.69	2.26	1.57	9.95	10.00	11.52	11.00	2.32	2.00
1286	......	......	......	......	7.56	2.28	1.37	9.84	10.00	11.21	11.00	2.60	2.00
1034	0.52	0.08	1.12	0.82	5.02	2.26	2.02	7.28	7.00	9.30	8.00	1.24	1.00
1280	......	0.12	1.13	0.82	5.57	1.90	2.27	7.47	7.00	9.74	8.00	1.48	2.00
1036	1.14	1.36	3.20	3.29	6.91	1.90	1.08	8.81	8.00	9.89	9.00	6.76	7.00
1288	......	0.14	1.08	1.03	4.96	3.23	2.13	8.19	8.00	10.32	9.00	2.54	2.00
1030	0.96	0.20	2.45	2.06	6.79	1.88	3.09	8.67	8.00	11.76	9.00	3.32	3.00
1164	......	1.18	2.12	2.06	6.36	2.04	1.86	8.40	8.00	10.26	9.00	3.53	3.00
1018	0.84	0.89	2.53	2.47	8.01	1.98	1.45	9.99	9.00	11.44	10.00	2.46	2.00
1176	......	1.12	2.48	2.47	6.38	4.40	2.51	10.78	9.00	11.29	10.00	2.32	2.00
1016	1.05	0.93	2.43	2.47	4.23	2.30	1.76	6.53	6.00	8.29	7.00	10.86	10.00
1174	......	1.16	2.48	2.47	3.73	3.24	2.23	6.97	6.00	9.20	7.00	10.21	10.00
1130	0.06	0.90	2.30	2.06	6.57	2.14	1.70	8.71	8.00	10.41	9.00	6.68	6.00
1166	0.10	0.92	2.20	2.06	6.79	2.46	1.82	9.25	8.00	11.07	9.00	5.71	6.00
1260	0.08	0.96	2.22	2.06	6.51	2.25	1.91	8.76	8.00	10.67	9.00	6.76	6.00
1117	......	0.50	0.98	0.82	6.62	1.80	1.10	8.42	8.00	9.52	9.00	4.30	4.00
1173	0.18	0.12	1.18	0.82	6.41	1.78	1.51	8.19	8.00	9.70	9.00	4.70	4.00
1202	......	......	......	......	12.38	1.74	0.63	14.12	12.00	14.75	13.00	......	......
1435	......	0.22	1.06	1.03	6.91	1.78	1.37	8.69	8.00	10.06	9.00	2.18	2.00
1436	0.36	0.40	2.16	2.06	6.44	2 42	1.95	8.86	8.00	10.81	9.00	1.86	1.50
1083	0.90	0.18	2.12	2.06	8.29	0 25	2.69	8.54	8.00	11.23	9.00	3.36	3.00
1150	....	1.18	2.12	2.06	6.01	2.05	2.04	8.06	8.00	10.10	9.00	3.27	3.00
1008	0.48	1.72	3.44	3.29	5.89	1.09	0.66	6.98	6.00	7.64	7.00	9.67	10.00
1152	0.44	1.36	3.21	3.29	4.93	2.01	1.58	6.94	6.00	8.52	7.00	11.36	10.00
1274	0.16	1.72	3.34	3.29	4.21	2.52	1.12	6.73	6.00	7.85	7.00	10.55	10.00
1001	0.78	0.70	2.33	2.47	4.72	2.68	1.02	7.40	6.00	8.42	7.00	9.71	10.00
1147	0.44	0.86	2.56	2.47	4.31	2.27	1.98	6.58	6.00	8.56	7.00	10.35	10.00
1276	0.52	0.26	2.48	2.47	4.05	3.38	1.53	7.43	6.00	8.96	7.00	10.55	10.00
1080	0.46	0.10	1.12	0.82	2.58	2.02	1.38	4.60	4.00	5.98	5.00	7.70	8.00
1158	0.38	0.10	1.22	0.82	3.62	1.24	1.17	4 86	4.00	6.03	5.00	7.74	8.00
1275	......	0.12	1.00	0.82	2.03	2.34	1.68	4.37	4.00	6.05	5.00	9.24	8.00
1087	0.12	0.12	0.98	0.82	6.68	2.34	2.16	9.02	8.00	11.18	9.00	3.90	4.00
1143	0.36	0.08	1.10	0.82	7 51	1.06	1.43	8.57	8.00	10.00	9.00	3.80	4.00
1042	......	.....	......	......	8.01	1.76	1.71	9.77	9.00	11.48	11.00	2.17	2.00
1146	......	......	......	......	8.42	1.33	1.19	9.75	10.00	10.94	11.00	2.12	2.00
1005	0.70	0.72	2.12	2.06	6.70	3.14	0.42	9.84	8.00	10.26	9.00	5.94	6.00
1281	......	0.84	2.06	2.06	6.70	2.11	2.31	8.81	8.00	11.12	9.00	5.78	6.00
1091	0.90	0.12	2.22	2.06	5.66	3.20	2.86	8.86	8.00	11.72	9.00	1.85	1.50
1157	0.78	0.10	2.08	2.06	6.83	1.76	2.19	8.59	8.00	10.78	9.00	1.94	1.50
1040	0.45	0.23	1.26	0.82	5.18	2.46	2.07	7.64	7.00	9.71	8.00	1.46	1.00
1139	0.26	0.10	1.28	0.82	6.11	1.80	1.52	7.91	7.00	9.43	8.00	1.30	1.00
1037	......	......	......	......	8.02	2.70	1 05	10.72	10.00	11.77	11.00	2.37	2.00
1144	......	......	......	......	8.88	1.22	1.10	10.10	10.00	11.20	11.00	2.28	2.00

Descriptive List of Fertilizer Samples, 1911.

Station number.	Manufacturer, place of business and brand.
1028	Standard Complete Manure
1190	Standard Complete Manure
1270	Standard Complete Manure
1103	Standard Fertilizer
1156	Standard Fertilizer
1039	Standard Guano for All Crops
1154	Standard Guano for All Crops
1290	Standard Guano for All Crops
1032	Standard Special for Potatoes
1148	Standard Special for Potatoes
1161	Williams & Clark Americus Ammoniated Bone Superphosphate
1138	Williams & Clark Americus Corn Phosphate
1456	Williams & Clark Americus High Grade Special for Potatoes and Vegetables
1162	Williams & Clark Americus Potato Manure
1153	Williams & Clark Royal Bone Phosphate for All Crops
	ARMOUR FERTILIZER WORKS, BALTIMORE, MARYLAND.
1222	All Soluble
1396	All Soluble
1228	Bone, Blood and Potash
1334	Bone, Blood and Potash
1227	Complete Potato
1343	Complete Potato
1225	Corn Grower
1395	Corn Grower
1226	Fruit and Root Crop Special
1223	High Grade Potato
1224	Wheat, Corn and Oat Special
	ATLANTIC FERTILIZER CO., BALTIMORE, MARYLAND.
1375	Rawson & Hodges Peerless Brand
1381	Rawson & Hodges Potato Fertilizer
1374	Rawson & Hodges Rival Brand
1382	Rawson & Hodges Rival Brand
	BOWKER FERTILIZER CO., BOSTON, MASS.
1415	Bowker's Acid Phosphate
1338	Bowker's Blood, Bone and Potash
1347	Bowker's Blood, Bone and Potash
1109	Bowker's Bone and Potash, Square Brand
1216	Bowker's Bone and Potash Square Brand
1337	Bowker's Complete Manure for Potatoes and Vegetables
1345	Bowker's Complete Manure for Potatoes and Vegetables
1108	Bowker's Corn Phosphate
1213	Bowker's Corn Phosphate
1112	Bowker's Early Potato Manure
1302	Bowker's Early Potato Manure
1098	Bowker's Farm and Garden Phosphate
1299	Bowker's Farm and Garden Phosphate
1219	Bowker's Fresh Ground Bone

Analysis of Fertilizer Samples, 1911.

Station number.	Nitrogen. As Nitrates.	Nitrogen. As Ammoniates.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
1028	0.87	1.23	3.36	3.29	7.10	1.64	0.91	8.74	8.00	9.65	9.00	6.95	7.00
1190	0.04	1.06	3.10	3.29	7.32	1.45	1.02	8.77	8.00	9.79	9.00	6.80	7.00
1270	0.58	0.46	3.38	3.29	7.11	1.89	1.35	9.00	8.00	10.35	9.00	7.58	7.00
1103	0.64	0.14	2.13	2.06	5.38	3.02	2.78	8.40	8.00	11.18	9.00	2.08	1.50
1156	0.60	0.26	2.16	2.06	6.17	2.27	2.12	8.44	8.00	10.56	9.00	1.87	1.50
1039	0.08	0.18	1.40	1.03	6.22	2.41	2.81	8.63	8.00	11.44	9.00	2.08	2.00
1154	......	0.14	1.00	1.03	6.49	1.41	2.59	7.90	8.00	10.49	9.00	2.14	2.00
1290	......	0.08	0.93	1.03	5.14	2.91	1.79	8.05	8.00	9.84	9.00	2.28	2.00
1032	0.90	0.16	2.34	2.06	6.76	1.88	2.99	8.54	8.00	11.53	9.00	3.43	3.00
1148	......	1.16	2.06	2.06	6.22	2.00	1.88	8.22	8.00	10.10	9.00	3.35	3.00
1161	0.08	1.12	2 48	2.47	6.48	2.36	2.12	8.84	9.00	10.96	10.00	2.60	2.00
1138	0.44	0.44	2.28	2.06	6.14	1.96	2.63	8.10	8.00	10.73	9.00	1.80	1.50
1456	0.56	1.20	3.32	3.39	7.19	2.29	1.40	9.48	8.00	10.88	9.00	7.02	7.00
1162	......	1.16	2.14	2.06	5.89	2.05	2.04	7.94	8.00	9.98	9.00	3.75	3.00
1153	......	0.16	0.96	1.03	6.38	2.03	2.55	8.41	8.00	10.96	9.00	2.12	2.00
1222	0.64	0.68	3.20	2.88	5.98	1.82	1.29	7.80	8.00	9.09	8.50	5.00	4.00
1396	1.02	0.10	3.46	2.88	6.25	1.53	0.71	7.78	8.00	8.49	8.50	5.70	4.00
1228	1.74	0.50	4.30	4.11	6.59	2.15	0.43	8.74	8.00	9.17	8.50	8.02	7.00
1334	1.64	0.10	4.48	4.11	7.18	1.44	0.20	8.62	8.00	8.82	9.00	7.58	7.00
1227	1.12	0.12	3.56	3.30	4.35	1.88	1.15	6.23	6.00	7.38	6.50	10.33	10.00
1343	1.76	0.36	3.58	3.28	4.91	1.64	0.83	6.55	6.00	7.38	8.00	10.54	10.00
1225	0.48	0.14	1.86	1.65	6.19	2.19	1.00	8.38	8.00	9.38	8.50	2.83	2.00
1395	0.40	0.12	1.83	1.65	5.82	2.04	1.44	7.86	8.00	9.30	8.50	3.09	2.00
1226	0.56	0.38	2.29	1.65	6.43	1.64	0.94	8.07	8.00	9.01	8.50	5.86	5.00
1223	0.74	0.16	2.18	1.65	6.25	1.65	1.16	7.90	8.00	9.06	8.50	9.57	10.00
1224	0.26	0.08	1.16	0.82	4.91	2.27	1.62	7.18	7.00	8.80	9.00	1.26	1.00
1375	1.48	0.22	3.28	3.70	7.18	1.59	1.28	8.77	7.00	10.05	8.00	10.22	10.00
1381	1.18	0.12	3.08	3.30	7.94	1.77	1.22	9.71	8.00	10.93	......	9.79	9.00
1374	1.46	0.14	3.12	3.30	7.80	1.64	0.94	9.44	6.00	10.38	7.00	9.63	10.00
1382	1.26	0.14	3.10	3.30	7.80	1.99	1.14	9.79	6.00	10.93	7.00	9.52	10.00
1415	......	......	......	......	13.02	4.46	1.52	17.48	14.00	19.00	15.00	......	......
1338	1.30	0.20	4.12	4.11	2.71	4.25	1.81	6.96	7.00	8.77	8.00	8.91	7.00
1347	1.74	0.16	4.20	4.11	3.40	4.21	1.72	7.61	7.00	9.33	8.00	8.67	7.00
1109	......	0.66	1.82	1.65	4.51	2.43	2.44	6.94	6.00	9.38	7.00	2.59	2.00
1216	......	0.64	1.88	1.65	4.31	2.42	1.98	6.73	6.00	8.71	7.00	2.90	2.00
1337	1.16	0.20	3.38	3.29	2.19	4.37	1.57	6.56	6.00	8.13	7.00	9.77	10.00
1345	1.28	0.20	3.45	3.29	2.17	4.23	1.49	6.40	6.00	7.89	7.00	10.17	10.00
1108	......	0.82	1.76	1.65	5.77	2.48	2.31	8.25	8.00	10.56	9.00	2.34	2.00
1213	......	0.88	1.92	1.65	6.52	2.12	1.38	8.64	8.00	10.02	9.00	2.23	2.00
1112	0.50	0.16	3.69	3.29	5.77	2.31	2.35	8.08	8.00	10.43	9.00	7.25	7.00
1302	0.94	0.22	3.56	3.29	5.89	2.81	1.43	8.70	8.00	10.13	9.00	7.81	7.00
1098	......	0.86	1.82	1.65	5.95	2.95	1.51	8.90	8.00	10.41	9.00	2.32	2.00
1299	......	0.84	1.96	1.65	6.67	2.53	1.44	9.20	8.00	10.64	9.00	2.17	2.00
1219	......	......	2.68	2.47	......	......	......	......	......	24.66	22.88	......	......

Descriptive List of Fertilizer Samples, 1911.

Station number.	Manufacturer, place of business and brand.
1122	Bowker's Hill and Drill Phosphate
1208	Bowker's Hill and Drill Phosphate
1104	Bowker's Market Garden Fertilizer
1293	Bowker's Market Garden Fertilizer
1416	Bowker's Muriate of Potash
1417	Bowker's Nitrate of Soda
1113	Bowker's Potash Bone
1215	Bowker's Potash Bone
1295	Bowker's Potash or Staple Phosphate
1094	Bowker's Potato and Vegetable Fertilizer
1211	Bowker's Potato and Vegetable Fertilizer
1107	Bowker's Potato and Vegetable Phosphate
1218	Bowker's Potato and Vegetable Phosphate
1418	Bowker's Super-Phosphate with Potash
1111	Bowker's Sure Crop Phosphate
1220	Bowker's Sure Crop Phosphate
1095	Stockbridge Manure A for Potatoes
1303	Stockbridge Manure A for Potatoes
1344	Stockbridge Manure A for Potatoes
1093	Stockbridge Special Complete Manure for Corn and All Grain Crops
1210	Stockbridge Special Complete Manure for Corn and All Grain Crops
1300	Stockbridge Special Complete Manure for Corn and All Grain Crops
1020	Stockbridge Special Complete Manure for Potatoes and Vegetables
1199	Stockbridge Special Complete Manure for Potatees and Vegetables
1294	Stockbridge Special Complete Manure for Potatoes and Vegetables
1129	Stockbridge Special Complete Manure for Seeding Down, Permanent Dressing and Legumes
1198	Stockbridge Special Complete Manure for Seeding Down, Permanent Dressing and Legumes
1307	Stockbridge Special Complete Manure for Seeding Down, Permanent Dressing and Legumes
1099	Stockbridge Special Complete Manure for Top Dressing and for Forcing
1212	Stockbridge Special Complete Manure for Top Dressing and for Forcing
	BUFFALO FERTILIZER COMPANY, HOULTON, MAINE.
1047	Buffalo 5-8-9
1384	Buffalo 5-8-9
1400	Buffalo 5-8-9
1046	Buffalo 5-8-7
1366	Buffalo 5-8-7
1383	Buffalo 5-8-7
1045	Buffalo Four-Six-Ten
1364	Buffalo Four-Six-Ten
1399	Buffalo Four-Six-Ten
1044	Buffalo Top Dresser
1386	Buffalo Top Dresser
1388	Buffalo Top Dresser

Analysis of Fertilizer Samples, 1911.

Station number.	Nitrogen. As Nitrates.	Nitrogen. As Ammoniates.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
1122	0.52	1.04	2.46	2.47	6.60	2.99	2.07	9.59	9.00	11.66	10.00	2.23	2.00
1208	......	0.40	2.60	2.47	6.27	3.13	1.68	9.40	9.00	11.28	10.00	2.17	2.00
1104	0.78	0.58	2.48	2.47	4.82	2.23	1.39	6.55	6.00	7.93	7.00	10.09	10.00
1293	0.12	1.10	2.46	2.47	4.42	2.75	1.68	7.17	6.00	8.85	7.00	10.51	10.00
1416	......	......	......	......	......	......	......	......	......	......	.....	49.36	49.00
1417	......	......	15.40	15.00	......	......	......	......	......	......	......	......	......
1113	......	0.16	1.00	0.82	6.54	2.44	1.71	8.98	6.00	10.69	7.00	2.78	2.00
1215	......	0.22	1.10	0.82	4.56	2.71	1.42	7.27	6.00	8.69	7.00	2.24	2.00
1295	..	0.34	1.07	0.82	5.23	2.86	1.67	8.09	8.00	9.76	9.00	3.72	3.00
1094	1.06	0.32	2.73	2.47	5.97	2.63	2.92	8.60	8.00	11.52	9.00	4.03	4.00
1211	0.30	0.32	2.92	2.47	6.14	2.90	2.03	9.04	8.00	11.07	9.00	4.12	4.00
1107	......	0.84	1.84	1.65	6.22	2.55	1.98	8.77	8.00	10.75	9.00	2.46	2.00
1218	......	1.00	1.96	1.65	6.57	2.15	1.49	8.72	8.00	10.21	9.00	2.30	2.00
1418	......	......	......	....	6.71	3.97	1.75	10.68	10.00	12.43	11.00	2.44	2.00
1111	......	0.17	1.10	0.82	6.32	2.07	1.98	8.39	8.00	10.37	9.00	2.82	2.00
1220	......	0.18	1.22	0.82	6.25	2.55	1.68	8.80	8.00	10.48	9.00	2.72	2.00
1095	0.70	0.14	4.52	4.11	4.12	4.33	1.71	8.45	7.00	10.46	8.00	9.55	10.00
1303	1.48	0.84	4.00	4.11	4.77	2.75	1.16	7.52	7.00	8.68	8.00	11.03	10.00
1344	1.16	0.12	4.14	4.11	3.13	4.20	1.70	7.33	7.00	8.53	8.00	10.26	10.00
1093	1.06	1.66	3.34	3.29	7.80	2.29	2.05	10.09	10.00	12.14	11.00	6.90	7.00
1210	0.66	0.12	3.74	3.29	4.13	6.08	2.12	10.21	10.00	12.33	11.00	7.30	7.00
1300	0.44	1.20	3.40	3.29	7.48	2.53	1.44	10.01	10.00	11.45	11.00	7.58	7.00
1020	0.80	1.00	3.45	3.29	4.77	1.68	1.84	6.45	6 00	8 29	7.00	9.76	10.00
1199	0.70	0.62	3.28	3.29	4.15	2.87	1.56	7.02	6.00	8.58	7.00	9.84	10.00
1294	0.34	1.54	3.64	3.29	4.82	1.94	1.90	6.76	6.00	8.66	7.00	10.27	10.00
1129	0.30	1.10	2.42	2.47	4.04	2.94	1.57	6.98	6.00	8.55	9.00	10.26	10.00
1198	0.54	0.62	2.87	2.47	4.96	1.92	1.56	6.88	6.00	8.44	9.00	9.79	10.00
1307	0.50	1.20	2.46	2.47	4.27	2.62	2.09	6.89	6.00	8.98	9.00	9.80	10.00
1099	0.74	0.24	4.60	4.94	4.86	3.12	1.94	7.98	4.00	9.92	6.00	6.97	6.00
1212	0.94	0.16	4.94	4.94	2.82	2.95	3.00	5.77	4.00	8.77	6.00	6.34	6.00
1047	2.30	0.16	4.11	4.10	6.01	2.18	0.84	8.19	8.00	9.03	9.00	8.77	9.00
1384	1.38	0.12	4.10	4.10	6.40	2.32	0.82	8.72	8.00	9.54	9.00	8.63	9.00
1400	1.48	0.18	4.40	4.10	4.59	3.70	0.88	8.29	8.00	9.17	9.00	8.69	9.00
1046	2.44	0.64	4.60	4.10	6.09	2.24	1.03	8.33	8.00	9.36	9.00	7.00	7.00
1366	1.04	0.98	4.10	4.10	6.62	1.49	0.66	8.11	8.00	8.77	9.00	7.03	7.00
1383	2.38	0.22	4.18	4.10	4.77	3.29	0.92	8.06	8.00	8.98	9.00	7.71	7.00
1045	1.44	0.32	3.60	3.28	2.63	3.61	1.34	6.24	6.00	7.58	7.00	10.14	10.00
1364	0.36	0.82	3.29	3.28	4.31	2.54	0.41	6.85	6.00	7.26	7.00	10.78	10.00
1399	1.82	0.32	4.08	3.28	2.58	4.86	0.97	7.44	6.00	8.41	7.00	10.03	10.00
1044	3.13	0.24	5.46	5.75	3.46	3.09	0.85	6.55	6.00	7.40	7.00	5.88	5.00
1386	1.94	0.28	5.74	5.76	2.86	3.87	1.29	6.73	6.00	8 02	7.00	5.44	5.00
1388	3.14	1.04	5.62	5.76	5.23	1.69	0.43	6.92	6.00	7.35	7.00	5.87	5.00

Descriptive List of Fertilizer Samples, 1911.

Station number.	Manufacturer, place of business and brand.
1043	Farmers' Choice..
1385	Farmers' Choice..
1401	Farmers' Choice..
1048	New England Special..
1391	New England Special..
	E. D. CHITTENDEN CO., BRIDGEPORT, CONN.
1351	Chittenden's High Grade Potato...................................
1355	Chittenden's High Grade Potato...................................
1354	Chittenden's 10 per cent Potato..................................
	COE-MORTIMER CO., NEW YORK.
1128	E. Frank Coe's Blood, Bone and Potash ....
1324	E. Frank Coe's Blood, Bone and Potash ....
1127	E. Frank Coe's Celebrated Special Potato Fertilizer..............
1322	E. Frank Coe's Celebrated Special Potato Fertilizer..............
1126	E. Frank Coe's Columbian Corn Fertilizer.........................
1327	E. Frank Coe's Columbian Corn Fertilizer.........................
1131	E. Frank Coe's Columbian Potato Fertilizer.......................
1329	E. Frank Coe's Columbian Potato Fertilizer.......................
1133	E. Frank Coe's Complete Manure with 10 per cent Potash ....
1323	E. Frank Coe's Complete Manure with 10 per cent Potash...........
1121	E. Frank Coe's Double Strength Potato Manure.....................
1326	E. Frank Coe's Double Strength Potato Manure.....................
1116	E. Frank Coe's Excelsior Potato Fertilizer ....
1325	E. Frank Coe's Excelsior Potato Fertilizer.......................
1124	E. Frank Coe's Famous Prize Brand Grain and Grass Fertilizer ....
1332	E. Frank Coe's Famous Prize Brand Grass and Grain Fertilizer ....
1132	E. Frank Coe's Grass and Grain Special ....
1328	E. Frank Coe's Grass and Grain Special...........................
1115	E. Frank Coe's High Grade Ammoniated Bone Superphosphate.........
1330	E. Frank Coe's High Grade Ammoniated Bone Superphosphate.........
1333	E. Frank Coe's High Grade Potato Fertilizer......................
1134	E. Frank Coe's Red Brand Excelsior Guano.........................
1331	E. Frank Coe's Red Brand Excelsior Guano.........................
1414	E. Frank Coe's Red Brand Excelsior Guano.........................
1125	E. Frank Coe's Standard Potato Fertilizer........................
1321	E. Frank Coe's Standard Potato Fertilizer. ....
	ESSEX FERTILIZER CO., BOSTON, MASS.
1439	Essex Complete Manure for Corn, Grain and Grass ....
1440	Essex Complete Manure for Corn, Grain and Grass ....
1359	Essex Complete Manure for Potatoes, Roots and Vegetables.........
1378	Essex Complete Manure for Potatoes, Roots and Vegetables.........
1411	Essex Complete Manure for Potatoes, Roots and Vegetables.........
1438	Essex Grain and Grass Fertilizer ....
1365	Essex Peerless Potato Manure ....
1379	Essex Peerless Potato Manure.....................................

Analysis of Fertilizer Samples, 1911.

Station number.	Nitrogen. As Nitrates.	Nitrogen. As Ammoniates.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
1043	0.25	0.14	1.35	0.82	5.42	2.80	0.79	8.22	8.00	9.01	9.00	5.72	5.00
1385	0.18	0.06	1.32	0.82	5.14	3.43	0.94	8.57	8.00	9.51	9.00	5.64	5.00
1401	......	0.12	1.06	0.82	4.55	3.86	0.76	8.41	8.00	9.17	9.00	5.65	5.00
1048	1.22	0.54	3.08	1.64	5.18	3.06	1.33	8.24	9.00	9.57	10.00	5.58	5.00
1391	0.82	1.20	2.06	2.00	6.59	3.07	0.76	9.66	9.00	10.37	10.00	5.79	5.00
1351	2.08	1.20	4.26	4.10	5.10	2.68	1.93	7.78	8.00	9.71	10.00	8.13	7.00
1355	2.10	0.10	4.30	4.10	4.23	3.93	1.89	8.16	8.00	10.05	10.00	7.86	7.00
1354	2.02	0.68	3.32	3.29	4.48	3.19	1.74	7.67	6.00	9.41	8.00	9.97	10.00
1128	0.80	1.48	3.93	4.11	4.18	3.83	0.79	8.01	8.00	8.80	9.00	8.20	7.00
1324	0.78	1.96	4.20	4.11	4.23	3.78	1.19	8.01	8.00	9.20	9.00	7.89	7.00
1127	0.08	1.00	1.86	1.65	3.65	4.39	0.76	8.04	8.00	8.80	9.00	4.32	4.00
1322	0.16	0.60	1.82	1.65	4.16	3.35	0.72	7.51	8.00	8.23	9.00	4.17	4.00
1126	......	0.49	1.42	1.23	4.85	3.63	0.87	8.48	8.50	9.35	9.50	2.76	2.50
1327	0.12	0.56	1.52	1.23	4.55	3.74	0.96	8.29	8.50	9.25	9.50	2.90	2.50
1131	0.12	0.52	1.57	1.23	4.78	3.92	1.03	8.70	8.50	9.73	9.50	3.50	2.50
1329	0.10	0.56	1.52	1.23	4.91	3.48	0.45	8.39	8.50	8.84	9.50	2.81	2.50
1133	0.44	1.30	2.50	2.47	2.39	4.67	0.69	7.06	6.00	7.75	7.00	10.52	10.00
1323	0.58	1.40	2.64	2.47	3.46	2.77	0.87	6.23	6.00	7.10	7.00	9.96	10.00
1121	1.20	0.98	3.57	3.70	4.35	3.76	0.82	8.11	7.00	8.93	8.50	9.87	10.00
1326	0.92	1.48	3.79	3.70	4.16	2.92	0.96	7.08	7.00	8.04	8.50	10.20	10.00
1116	0.54	1.28	2.60	2.47	2.82	4.89	1.11	7.71	7.00	8.82	8.00	9.07	8.00
1325	0.50	0.60	2.47	2.47	3.57	3.14	0.52	6.71	7.00	7.23	8.00	8.31	8.00
1124	......	......	......	......	5.55	4.34	0.27	9.89	10.00	10.22	11.00	2.29	2.00
1332	......	......	......	......	2.42	8.47	1.34	10.89	10.00	12.23	11.00	2.79	2.00
1132	0.08	0.56	1.62	0.80	5.60	3.51	0.97	9.11	8.50	10.08	9.50	1.94	1.50
1328	0.08	0.40	1.24	0.80	3.56	4.70	0.69	8.26	8.50	8.95	9.50	1.96	1.50
1115	0.18	1.14	1.90	1.85	4.35	4.03	1.57	8.38	8.00	9.95	9.00	3.72	3.00
1330	0.18	0.64	1.96	1.85	3.72	3.60	0.51	7.32	8.00	7.83	9.00	3.21	3.00
1333	0.86	0.60	2.60	2.47	4.23	3.93	0.56	8.16	8.00	8.72	9.00	6.75	6.00
1134	0.56	1.88	3.38	3.30	3.08	5.00	1.25	8.08	8.00	9.33	9.00	7.30	7.00
1331	0.70	1.58	3.48	3.30	4.19	3.69	1.21	7.72	8.00	9.09	9.00	7.76	7.00
1414	0.62	1.42	3.38	3.30	3.84	4.58	0.56	8.42	8.00	8.98	9.00	7.55	7.00
1125	0.84	1.34	3.38	3.30	1.44	4.50	1.43	5.94	6.00	7.37	7.00	10.32	10.00
1321	0.74	1.28	3.32	3.30	2.30	3.67	0.70	5.97	6.00	6.67	7.00	10.08	10.00
1439	......	1.50	3.17	3.28	5.31	1.16	0.64	6.47	6.00	7.11	7.00	10.04	10.00
1440	......	1.20	3.32	3.28	4.64	2.05	0.60	6.69	6.00	7.29	7.00	9.93	10.00
1359	......	1.38	3.18	3.28	5.39	1.29	0.47	6.68	6.00	7.15	7.00	10.17	10.00
1378	......	1.22	3.40	3.28	4.18	2.30	0.59	6.48	6.00	7.07	7.00	10.08	10.00
1411	0.06	1.48	3.20	3.28	4.88	1.73	0.57	6.61	6.00	7.18	7.00	10.73	10.00
1438	0.04	0.08	1.08	0.82	6.78	1.46	2.78	8.24	8.00	11.02	9.00	4.67	4.00
1365	0.92	0.12	4.12	4.10	6.54	0.91	1.72	7.45	7.00	9.17	8.00	8.77	8.00
1379	1.58	0.22	4.24	4.10	6.38	1.33	1.51	7.71	7.00	9.22	8.00	8.61	7.00

Descriptive List of Fertilizer Samples, 1911.

Station number.	Manufacturer, place of business and brand.
1358	Essex Potato Grower
1380	Essex Potato Grower
1437	Essex XXX Fish and Potash for All Crops
	GERMAN KALI WORKS, NEW YORK.
1206	Genuine German Kainit
1209	Muriate of Potash
1200	Sulphate of Potash
	HUBBARD FERTILIZER CO., BALTIMORE, MARYLAND.
1377	Hubbard's Aroostook Special Fertilizer
1394	Hubbard's Aroostook Special Fertilizer
1203	Hubbard's Blood, Bone and Potash
1246	Hubbard's Blood, Bone and Potash
1197	Hubbard's Farmers' IXL Fertilizer for Grain and Grass
1245	Hubbard's Farmers' IXL Fertilizer for Grain and Grass
1368	Hubbard's Maine Potato Grower Fertilizer
1393	Hubbard's Maine Potato Grower Fertilizer
1214	Hubbard's Royal Ensign Fertilizer for Corn and Grain
1242	Hubbard's Royal Ensign Fertilizer for Corn and Grain
1217	Hubbard's Special Potato Fertilizer
1243	Hubbard's Special Potato Fertilizer
1376	Hubbard's Special Potato Fertilizer
1244	Hubbard's 10 per cent Potash Guano for Potatoes
	LISTER'S AGRICULTURAL CHEMICAL CO., NEWARK, N. J.
1033	Lister's Bone Meal
1183	Lister's Bone Meal
1184	Lister's Grain and Grass Fertilizer
1101	Lister's High Grade Special sor Spring Crops
1181	Lister's High Grade Special for Spring Crops
1102	Lister's Potato Manure
1180	Lister's Potato Manure
1096	Lister's Special Corn Fertilizer
1182	Lister's Special Corn Fertilizer
1097	Lister's Special Potato Fertilizer
1186	Lister's Special Potato Fertilizer
1021	Lister's Success Fertilizer
1187	Lister's Success Fertilizer
1114	Lister's 10 per cent Potato Grower
1185	Lister's 10 per cent Potato Grower
	MARTIN & WHITE, NEW YORK CITY, N. Y.
1405	Watson's Improved Potato Fertilizer
	MERROW BROTHERS, AUBURN, ME.
1241	Merrow's Bone Meal
	MORISON BROTHERS, BANGOR, ME.
1077	Acid Phosphate
1071	Morison Bros. "A" Brand Potato Fertilizer
1078	Morison Bros. Animal Tankage

Analysis of Fertilizer Samples, 1911.

Station number.	Nitrogen. As Nitrates.	Nitrogen. As Ammoniates.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
1358	0.06	1.12	2.50	2.46	5.58	1.40	0.28	6.98	6.00	7.26	7.00	10.31	10.00
1380	......	1.10	2.40	2.46	5.15	0.99	0.42	6.14	6.00	6.56	7.00	10.03	10.00
1437	......	0.42	2.00	2.00	5.52	3.32	1.14	8.84	8.00	9.98	9.00	3.40	3.00
1206	......	......	......	......	......	......	......	......	......	......	......	13.49	12.00
1209	......	......	......	.....	......	......	......	......	......	......	......	51.76	50.00
1200	......	......	......	......	......	......	......	......	......	......	......	51.00	48.00
1377	0 76	1.24	3.52	3.83	5.15	2.01	1.25	7.16	7.00	8.41	9.00	10.18	10.00
1394	0.82	1.20	3.53	3.83	4.91	2.69	1.14	7.60	7.00	8.74	9.00	10.75	10.00
1203	0.28	1.00	3.00	3.32	6.22	2.12	1.28	8.35	8.00	9.63	10.00	6.52	7.00
1246	0.40	1.00	3.26	3.26	6.51	2.18	1.39	8.69	8.00	10.08	10.00	6.91	7.00
1197	0.06	0.74	2.00	1.64	2.71	5.63	1.63	8.34	8.00	9.97	10.00	2.34	2.00
1245	0.36	0.12	2.16	1.65	0 89	6.33	1.58	7.22	8.00	8.80	10.00	2.51	2.00
1368	1.22	1.38	3.96	4.10	6.71	1.69	0.74	8.40	8.00	9.14	10.00	7.83	7.00
1393	0.72	1.42	4.08	4.10	7.64	1.30	0.55	8.94	8.00	9.49	10.00	8.26	7.00
1214	0.54	0.56	2.40	2.46	3.24	5.03	1.49	8.27	8.00	9.76	10.00	4.35	4.00
1242	......	1.16	2.10	2.46	5.92	2.89	1.37	8.81	8.00	10.18	10.00	3.75	4.00
1217	0.28	0.94	2.70	3.32	2.15	3.94	1.72	6.09	6.00	7.81	8.00	11.66	10.00
1243	0.22	2.20	3.28	3.32	3.29	2.95	0.71	6.24	6.00	6.95	8.00	10.43	10.00
1376	0.70	1.14	3.28	3.28	2.60	4.66	1.22	7.26	6.00	8.28	8.00	10.29	10.00
1244	......	1.26	2.16	2.46	6.05	0.25	1.58	6.30	6.00	7.88	8.00	9.58	10.00
1033	......	......	4.31	2 68	......	......	......	......	......	23.27	23.00	......	.....
1183	......	......	3.60	2.67	......	......	......	......	......	26.92	22.88	......	......
1184	.....	......	......	.....	6.57	3.17	0.96	9.74	10.00	10.70	11.00	2.05	2.00
1101	......	0.24	1.90	1.65	6.01	1.87	2.44	7.88	8.00	10.32	9.00	10.24	10.00
1181	0.18	0.76	1.68	1.65	6.57	1.83	1.63	8.40	8.00	10.03	9.00	10.16	10.00
1102	0.34	1.30	3.34	3.29	6.70	1.65	1.75	8.35	8.00	10.10	9.00	7.36	7.00
1180	0.30	1.38	3.26	3.29	6.06	1.98	2.25	8.04	8.00	10.29	9.00	7.56	7.00
1096	.....	0.18	1.53	1.23	6.27	2.24	1.98	8.51	8.00	10.49	9.00	3.32	3.00
1182	0.25	0.44	1.68	1.23	5.93	2.08	2.13	8.01	8.00	10.14	9.00	3.46	3.00
1097	......	0.18	1.86	1.65	5.52	2.78	2.27	8.30	8.00	10.57	9.00	3.41	3.0C
1186	......	0.78	1.60	1.65	6.01	2.89	1.31	8.90	8.00	10.21	9.00	3.58	3.00
1021	0.15	0.15	1.52	1.23	7.24	1 42	2.22	8.66	9.00	10.88	10.00	2.28	2.00
1187	0.38	0.18	1.54	1.23	6.67	2.52	1.59	9.19	9.00	10.78	10.00	2.63	2.00
1114	0.50	1.10	3.50	3.29	4.86	1.87	1.77	6.73	6.00	8.50	7.00	10.20	10.00
1185	0.32	1.16	3.50	3.29	4.64	1.60	1.91	6.24	6.00	8.15	7.00	10.65	10.00
1405	0.12	3.65	4.27	4.12	5.79	1.86	1.66	7.65	8.00	9.31	10.00	6.47	7.00
1241	......	......	1.54	1.25	....	.....	.....	......	......	30.13	30.00	......	......
1077	......	......	......	......	15.15	1.58	0.69	16.73	16.00	17.42	......	......	......
1071	1.20	0.14	3.26	3.00	7.50	1.77	0.84	9.27	8.00	10.11	....	9.88	10.00
1078	......	.....	7.68	......	0.11	4.88	3.99	4.99	.....	8.98	......	......	......

Descriptive List of Fertilizer Samples, 1911.

Station number.	Manufacturer, place of business and brand.
1072	Morison Bros. "C" Brand for All Crops
1070	Morison Bros. 3-8-10 Fertilizer
1073	Morison Bros. Xtra High Grade Potato Fertilizer
1075	Muriate of Potash
1076	Nitrate of Soda
1074	Sulphate of Potash
	NATIONAL FERTILIZER CO., BOSTON, MASS.
1335	Chittenden's Aroostook Special
1353	Chittenden's Aroostook Special
1409	Chittenden's Complete Corn and Grain Fertilizer
1408	Chittenden's Complete Grass Fertilizer
1413	Chittenden's Complete Root Fertilizer
1356	Chittenden's Eureka Potato Fertilizer
1341	Chittenden's Excelsior Potato Fertilizer
1357	Chittenden's Excelsior Potato Fertilizer
1340	Chittenden's Extra High Grade Manure
1406	Chittenden's Extra High Grade Manure
	NEW ENGLAND FERTILIZER CO., BOSTON, MASS.
1068	New England Complete Manure
1258	New England Complete Manure
1065	New England Corn and Grain Fertilizer
1252	New England Corn and Grain Fertilizer
1051	New England Corn Phosphate
1253	New England Corn Phosphate
1059	New England High Grade Potato Fertilizer
1069	New England High Grade Special with 10 per cent Potash
1259	New England High Grade Special with 10 per cent Potash
1371	New England High Grade Special with 10 per cent Potash
1372	New England Market Garden Manure
1058	New England Potato Fertilizer
1251	New England Potato Fertilizer
1057	New England Potato Grower
1305	New England Potato and Vegetable Manure
1067	New England Superphosphate for All Crops
1304	New England Superphosphate for All Crops
	PARMENTOR & POLSEY CO., BOSTON, MASS.
1370	P. & P. A. A. Brand
1066	P. & P. Aroostook Special
1373	P. & P. Aroostook Special
1398	P. & P. Aroostook Special
1056	P. & P. Maine Potato Fertilizer
1064	P. & P. Plymouth Rock Brand
1063	P. & P. Special Potato Fertilizer
	E. W. PENLEY, AUBURN, MAINE.
1448	Penley's Auburn Fertilizer
1446	Penley's 4-6-10 Potato Fertilizer
1449	Penley's Seeding Down Fertilizer
1447	Penley's 3-6-10 Fertilizer

Analysis of Fertilizer Samples, 1911.

Station number.	Nitrogen. As Nitrates.	Nitrogen. As Ammoniates.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
1072	1.12	0.08	2.46	2.20	8.77	1.33	0.59	10.10	10.00	10.69	.....	6.52	6.00
1070	0.86	0.20	2.48	2.47	5.68	1.18	1.44	7.86	8.00	9.30	......	9.79	10.00
1073	2.10	0.10	4.24	4.12	7.91	0.61	0.89	8.52	7.00	9.41	......	10.57	10.00
1075	......	......	......	......	......	......	......	......	......	......	......	51.00	50.00
1076	......	......	15.04	15.00	......	......	......	......	......	......	......	......	......
1074	......	......	......	......	......	......	......	......	......	......	.....	50.28	48.00
1335	1.42	0.46	4.11	4.11	4.16	3.79	1.24	7.95	7.00	9.19	8.00	7.23	7.00
1353	1.36	0.22	4.30	4.11	3.19	4.35	1.66	7.54	7.00	9.20	8.00	8.45	7.00
1409	0.82	0.86	3.44	3.29	6.46	2.21	1.38	8.67	8.00	10.05	9.00	7.69	6.00
1438	1.62	1.66	4.82	4.11	4.23	2.03	1.20	6.26	6.00	7.46	7.00	4.95	5.00
1413	0.66	0.60	3.34	3.29	5.38	2.71	2.07	9.09	8.00	10.16	9.00	6.47	6.00
1356	0.98	0.20	2.90	2.47	2.30	3.79	1.68	6.09	6.00	7.77	7.00	10.46	10.00
1341	1.28	0.20	3.30	3.29	2.58	3.78	1.61	6.36	6.00	7.97	7.00	10.31	10.00
1357	1.50	0.16	3.26	3.29	2.39	3.86	1.84	6.25	6.00	8.09	7.00	10.27	10.00
1340	1.36	0.16	4.10	4.11	3.11	3.66	1.89	6.77	7.00	8.66	8.00	10.41	10.00
1406	1.40	0.20	4.30	4.11	3.14	3.83	1.56	6.97	7.00	8.53	8.00	10.36	10.00
1068	......	1.30	3.30	3.28	4.86	1.70	0.70	6.56	6.00	7.26	7.00	9.94	10.00
1258	......	1.24	3.16	3.28	4.45	2.37	0.28	6.82	6.00	7.10	7.00	10.22	10.00
1065	......	0.08	1.38	1.23	4.98	2.32	0.82	7.30	7.00	8.12	8.00	2.13	2.00
1252	......	0.12	1.27	1.23	2.98	4.21	0.80	7.19	7.00	7.99	8.00	2.32	2.00
1051	......	0.06	1.78	1.64	6.64	1.57	2.32	8.21	8.00	10.53	9.00	3.10	3.00
1253	......	0.18	1.74	1.64	0.65	7.39	0.59	8.04	8.00	8.63	9.00	3.15	3.00
1059	0.26	0.84	2.56	2.46	6.43	1.84	0.87	8.27	8.00	9.14	9.00	5.91	6.00
1069	......	1.30	3.68	3.69	5.36	1.76	0.68	7.12	7.00	7.80	8.00	10.03	10.00
1259	......	1.16	3.20	3.69	5.58	2.74	2.58	8.32	7.00	10.86	8.00	10.78	10.00
1371	0.08	1.18	3.74	3.69	5.26	1.88	0.79	7.14	7.00	7.93	8.00	9.53	10.00
1372	......	1.36	3.82	4.10	5.44	2.33	0.60	7.77	7.00	8.37	8.00	7.42	7.00
1058	......	0.44	1.66	1.64	4.47	2.99	0.40	7.46	7.00	7.86	8.00	4.03	4.00
1251	......	0.44	2.98	1.64	5.38	1.91	0.64	7.29	7.00	7.93	8.00	4.16	4.00
1057	......	1.16	2.40	2.46	5.36	1.08	0.37	6.44	6.00	6.81	7.00	10.12	10.00
1305	......	1.62	3.26	3.28	6.68	1.81	0.55	8.49	8.00	9.04	9.00	7.02	7.00
1067	......	1.24	2.42	2.46	7.26	1.00	0.64	8.26	8.00	8.90	9.00	4.18	4.00
1304	......	0.86	2.46	2.46	5.93	2.86	1.15	8.79	8.00	9.94	9.00	4.41	4.00
1370	0.12	4.50	4.12	4.10	6.94	0.38	0.88	7.32	7.00	8.20	8.00	8.21	8.00
1066	......	1.96	3.72	3.69	6.44	0.96	0.65	7.40	7.00	8.05	8.00	10.39	10.00
1378	......	1.72	3.50	3.70	6.24	1.06	0.64	7.30	7.00	7.94	8.00	11.31	10.00
1398	0.10	2.12	3.88	3.69	6.57	0.97	0.64	7.54	7.00	8.18	8.00	10.30	10.00
1056	......	1.36	3.15	3.28	6.06	0.10	0.52	6.16	6.00	6.68	7.00	10.00	10.00
1064	......	1.08	2.42	2.46	6.91	0.97	0.97	7.88	8.00	8.85	9.00	4.14	4.00
1063	......	1.58	3.22	3.28	6.67	1.62	0.80	8.29	8.00	9.09	9.00	7.30	7.00
1448	0.56	0.10	3.20	2.47	6.95	2.53	1.33	9.48	8.00	10.81	9.00	4.97	4.00
1446	1.02	0.08	3.80	3.30	5.63	3.03	1.24	8.66	6.00	9.90	7.00	10.43	10.00
1449	0.40	......	1.46	1.03	7.05	2.86	0.33	9.91	8.00	10.24	9.00	2.69	2.00
1447	0.72	0.06	2.48	2.47	5.50	3.90	0.70	9.40	6.00	10.10	7.00	9.55	10.00

Descriptive List of Fertilizer Samples, 1911.

Station number.	Manufacturer, place of business and brand.
	PORTLAND RENDERING CO., PORTLAND, ME.
1221	Bone Dust Tankage
	ROGERS & HUBBARD CO., MIDDLETOWN, CONN.
1428	Hubbard's Complete Phosphate
1453	Hubbard's Fruit or Grass and Grain Fertilizer
1422	Hubbard's New Market Garden Phosphate
1429	Hubbard's New Market Garden Phosphate
1430	Hubbard's Oats and Top Dressing
1451	Hubbard's Oats and Top Dressing
1423	Hubbard's Potato Phosphate
1450	Hubbard's Potato Phosphate
1421	Hubbard's Soluble Corn and General Crop Manure
1452	Hubbard's Soluble Corn and General Crop Manure
1420	Hubbard's Soluble Potato Manure
1427	Hubbard's Soluble Potato Manure
	SAGADAHOC FERTILIZER CO., BOWDOINHAM, ME.
1239	Acid Phosphate
1238	Aroostook Potato Manure
1233	Dirego Grass and Grain Fertilizer
1230	4-6-10 Fertilizer for Potatoes
1336	4-6-10 Fertilizer for Potatoes
1240	Nitrate of Soda
1231	Sagadahoc High Grade Superphosphate
1234	Sagadahoc 6-6-6 Fertilizer for Potatoes
1235	Sagadahoc Special Corn Fertilizer
1229	Sagadahoc Special Potato Fertilizer
1232	3-6-10 Fertilizer for Potatoes
1237	XXChemical Fertilizer Brand, Clark's Mixture
1236	Yankee Fertilizer Complete for All Crops
	SWIFT'S LOWELL FERTILIZER CO., BOSTON, MASS.
1052	Swift's Lowell Animal Brand for All Crops
1255	Swift's Lowell Animal Brand for All Crops
1062	Swift's Lowell Bone Fertilizer for Corn and Grain
1060	Swift's Lowell Dissolved Bone and Potash
1444	Swift's Lowell Ground Bone
1049	Swift's Lowell Potato Grower
1254	Swift's Lowell Potato Grower
1050	Swift's Lowell Potato Manure
1256	Swift's Lowell Potato Manure
1053	Swift's Lowell Potato Phosphate
1061	Swift's Special Corn and Vegetable Manure
1055	Swift's Special Potato Fertilizer
1250	Swift's Special Potato Fertilizer
1054	Swift's Superior Fertilizer with 10 per cent Potash
1257	Swift's Superior Fertilizer with 10 per cent Potash

Analysis of Fertilizer Samples, 1911.

Station number.	Nitrogen. As Nitrates.	Nitrogen. As Ammoniates.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
1221	......	......	8.10	5.75	0.16	7.01	4.81	7.17	......	11.98	14.50	......	......
1428	0.40	0.06	1.64	1.50	4.50	3.46	1.63	7.96	7.00	9.59	8.00	5.68	5.00
1453	0.24	0.04	2.36	2.20	0.32	7 49	8.03	7.81	6.50	15.84	16.00	11.90	12.00
1422	0.72	0.04	2.20	2 00	3.48	3.28	1.76	6.76	6.00	8.52	7.00	10.86	10.00
1429	0.48	0.10	2.02	2.00	4.10	3.15	1.31	7.25	6.00	8.56	7.00	11.08	10.00
1430	3.14	0.04	8.94	8.50	0.67	5.25	2.33	5.92	4.50	8.25	8.00	9.40	8.00
1451	3.34	0.04	8.54	8.50	0.48	6.82	1.31	7.30	4.50	8.61	8.00	8.98	8.00
1423	0 52	0.10	2.26	2.00	6.70	3.90	1.79	10.60	9.00	12.39	10.00	6.66	5.00
1450	0.70	0.08	2.00	2.00	7.75	2.82	1.82	10.57	9.00	12.39	10.00	5.86	5.00
1421	0.66	0.10	2.90	2.50	2.65	5.44	1.77	8.09	6.00	9.86	8.00	8.62	8.00
1452	0.62	0.08	2.52	2.50	2.63	4.61	1.93	7.24	6.00	9.17	8.00	9.70	8.00
1420	1.34	0.26	5.44	5.00	1.07	5.99	4.58	7.06	7.00	11.64	10.00	5.95	5.00
1427	1.26	0.22	5.06	5.00	1.08	6.40	4.45	7.48	7.00	11.93	10.00	5.29	5.00
1239	......	......	......	.. ..	12.11	3.78	1.03	15.89	15.00	16.92	......	......	......
1238	0.02	0.44	1.26	1.00	5.77	2.10	0.84	7.87	6.00	8.71	7.00	4.67	4.00
1233	0.04	0.08	1 68	1.00	4.86	3.83	3.07	8.69	6.00	11.76	8.00	4.42	3.00
1230	0.90	0.60	3.12	3.05	3.99	3.36	0.64	7.35	6.00	7.99	7.00	10.55	10.00
1336	1.06	0.62	3.28	3.05	3.67	3.05	0.41	6.72	6.00	7.13	7.00	11.44	10.00
1240	......	......	15.00	15.00	....	......	.....	......	......	......	......	......	......
1231	0.34	0.50	2.00	1.50	6.83	2.43	0.63	9.26	6.00	9.89	7.00	5.07	3.00
1234	1.64	0.08	5.42	4.40	4.80	2.39	0.43	7.19	6.00	7.62	8.00	7.56	6.00
1235	0.92	0.58	2.48	2.20	4.53	4.13	3.56	8.66	8.00	12.22	9.00	4.72	4.00
1229	0.38	0.64	2.00	2.00	5.82	3.21	0.11	9.03	7.00	9.14	8.00	7.77	8.00
1232	0.30	0.58	2.34	2.20	4.78	2.26	0.64	7.04	6.00	7.70	7.00	10.03	10.00
1237	1.64	0.24	7.50	6.00	0.30	3 85	3.97	4.15	3.00	8.12	7.00	9.92	8.00
1236	0.28	0.20	1.10	0.40	3.38	6.67	0.73	10.05	7.00	10.78	8.00	4.29	2.00
1052	......	1.22	2.54	2.46	7.15	1.20	0.63	8.35	8.00	8.98	9.00	4.13	4.00
1255	......	1.24	2.50	2.46	7.35	0.94	0.42	8.29	8.00	8.71	9.00	4.39	4.00
1062	......	0.24	1.62	1.64	5.87	2.24	0.57	8.11	8.00	8.68	9.00	3.03	3.00
1060	......	0.14	1.76	1.64	5.81	3.10	1.44	8.91	9.00	10.35	10.00	2.33	2.00
1444	......	....	2.50	2.47	......	......	......	......	......	24.85	23.00	....	......
1049	......	1.24	3.32	3.28	4.50	1.35	1.06	5.85	6.00	6.91	7 00	10.33	10.00
1254	......	1.24	3.28	3.28	4.74	2.00	0.29	6.74	6.00	7.03	7.00	10.02	10.00
1050	......	0.46	1.80	1.69	4.94	1.69	1.26	6.63	7.00	7.89	8.00	4.01	4.00
1256	......	0.44	1.70	1.64	5.30	2.12	0.31	7.42	7.00	7.73	8.00	3.75	4.00
1053	.....	1.14	2.36	2.46	7.61	1.02	0.48	8.63	8.00	9.11	9.00	5.78	6.00
1061	......	1.62	3.15	3.28	7.18	1.40	0.64	8.58	8.00	9.22	9.00	6.78	7.00
1055	......	1.00	2.38	2.46	4.35	1.82	0.83	6.17	6.00	7.00	7.00	9.94	10.00
1250	......	1.08	2.44	2.46	5.79	1.11	0.26	6.90	6.00	7.16	7.00	10.16	10.00
1054	......	1.20	3.50	3.69	5.26	1.88	0.63	7.14	7.00	7.77	8.00	10.04	10.00
1257	......	1.14	3.66	3.69	5.36	2.96	0.42	8.32	7.00	8.74	8.00	10.15	10.00

Descriptive List of Fertilizer Samples, 1911.

Station number.	Manufacturer, place of business and brand.
	F. W. TUNNELL & CO., PHILADELPHIA, PA.
1432	All Crop Mixture
1425	Champion Phosphate
1426	Market Garden Guano
1419	Pine Tree State Potato Special
1431	Pine Tree State Potato Special
	TUSCARORA FERTILIZER CO., BALTIMORE, MD.
1369	Aroostook Special
1349	Complete Potato
1443	Fruit and Potato
1348	Tuscarora Trucker
1397	Tuscarora Trucker
	UNION CHEMICAL WORKS, NORTH WALES, PA.
1455	Johnson Seed Potato Co.'s Ideal Potato Manure. Hoeing Brand
1454	Johnson Seed Potato Co.'s Ideal Potato Manure. Planting Brand

Analysis of Fertilizer Samples, 1911.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
	As Nitrates.	As Ammoniates.	Total. Found.	Total. Guaranteed.	Soluble.	Reverted.	Insoluble.	Available. Found.	Available. Guaranteed.	Total. Found.	Total. Guaranteed.	Found.	Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%	%
1432	0.28	0.62	2.62	2.47	4.43	3.17	2.11	7.60	8.00	9.71	9.00	3.97	4.00
1425	0.14	0.16	1.74	2.47	5.98	2.08	1.17	8.06	8.00	9.23	9.00	4.91	3.00
1426	0.38	1.02	3.34	3.30	5.26	1.72	0.66	6.98	8.00	7.64	9.00	8.02	7.00
1419	0.32	1.18	3.40	3.30	5.04	1.18	0.69	6.22	6.00	6.91	7.00	10.49	10.00
1431	0.38	1.06	3.18	3.30	4.71	1.59	0.64	6.30	6.00	6.94	7.00	10.94	10.00
1369	......	1.04	2.47	2.47	6.25	0.96	1.20	7.21	7.00	8.41	7.50	8.24	8.00
1349	1.48	0.10	3.96	3.28	4.50	1.48	1.28	5.98	6.00	7.26	6.50	10.98	10.00
1443	0.64	0.04	1.55	1.65	7.11	2.13	1.25	9.24	8.00	10.49	8.50	10.08	10.00
1348	2.10	0.08	4.48	4.11	5.50	2.92	0.27	8.57	8.00	8.84	9.00	8.02	7.00
1397	0.24	1.44	4.26	4.11	6.11	1.84	1.08	7.95	8.00	9.03	9.00	6.98	7.00
1455	0.88	0.74	3.52	3.30	6.22	2.41	0.46	8.63	8.00	9.09	......	10.05	10.00
1454	0.16	1.50	3.32	3.30	6.56	1.86	0.70	8.42	8.00	9.12	.....	10.68	10.00

November, 1911

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

ANALYSTS

James M. Bartlett — Herman H. Hanson
Albert G. Durgin — Royden L. Hammond
Alfred K. Burke

INSPECTORS

Elmer R. Tobey — Albert Verrill — Edgar A. White

Official Inspections

34

SPICES, PREPARED MUSTARD, HONEY AND GLUTEN FLOUR.

The analyses here reported represent goods which are, for the most part, in accord with the requirements of the Maine and the National Food Laws. Because of a shortage in the printing funds considerable interval has elapsed since the analysis of some of these goods. The results here published are believed to be of importance and interest to the dealers and consumers in the State.

All of the different brands here reported were analyzed in considerable detail. In order to economize space and cost of publication only the data necessary to an understanding of the quality of the goods as to weight and purity are here given.

Spices.

The most serious defect found with the spices examined was in the matter of weight. Very little actual adulteration was detected, although an occasional pepper contained more hulls than is found in a first class material of this kind. Some of the claims made for the spices in regard to quality also are not borne out by the results of the investigations. The shortage in net weight is not always the result of an intentional shortage on the part of the people who put up these goods. It is difficult to make an absolutely tight carton, and a large percentage of the spices when they came to the laboratory directly from the shelves of the retailer were leaking in sufficient amount to make it evident that this is a quite possible source of loss.

Prepared Mustard.

Several of the samples of prepared mustards examined were found to contain turmeric which was not declared upon the label. As these goods originally came from outside of Maine, and therefore fall under the requirements of the National Law, the reports upon these goods were turned over to the National Board of Food and Drug Inspection for further investigation.

One of the samples of prepared mustard, made by a Maine dealer, was found to be adulterated and misbranded in at least five different respects. At the time of examination it appeared to be one of the most flagrant cases of misbranding which had been found by our inspectors. The case was not carried to court because it was found that a technicality would prevent the successful prosecution of the case, and the labels were promptly corrected to read in accord with fact.

Honey.

The samples of honey examined were, with one possible exception, found to be in accord with the Maine Food Law and with the statements upon the labels. No. 9512, called "Golden Tree Pure Clover Honey" was found to consist of nothing but honey, but it was also found that honey from other than clover blossoms was present in considerable amount. This being an interstate sample, the matter was turned over to the National Board of Food and Drug Inspection, who did not find it expedient to prosecute the case and it was, therefore, dropped.

Gluten Flour.

The samples of gluten flour examined with the exception of those manufactured by Wilson Brothers were found to be in accord with the recognized standards for good gluten flour. The samples 8781 and 9290, manufactured by Wilson Brothers, Rochester, N. Y., were found in accord with the labels which claimed a four-sevenths standard flour and, therefore, these were all passed.

Tables showing results of analyses of spices and pepper purchased in packages.

Station No.	Manufacturer, Name of Dealer and Brand.	Price. Cents.	Net weight. Oz.	Remarks.
	ALLSPICE.			
9242	A. Colburn Co., Philadelphia, Pa. J. A. Rodick, Bar Harbor. "Colburn's Allspice. Full measure."	10	4.23	Passed.
9191	Benefit Co., Boston, Mass. Mrs. B. M. Young, Ellsworth. "Benefit Brand Allspice. Absolutely pure."	8	–	Passed.
9431	The Benefit Co., Boston, Mass. Direct Importing Co., Bangor. "Benefit Brand Allspice."	7	2.89	Passed.
9404	Grand Union Tea Co., Brooklyn, N. Y. Grand Union Tea Co., Portland. "Grand Union Allspice."	10	3.00	High in fiber.
9602	Importer Branch, New York. Original Importing Co., Portland. "Quality Brand Strictly Pure Allspice"	4	3.92	Not adulterated. Short wieght.
9353	Berry, Dodge Co., Newburyport, Mass. Joseph Stride, Biddeford. "Warranted Pure Allspice"	8	4.48	Passed.
9264	B. Fischer & Co., New York City. G. Soper, Bar Harbor. "Strictly Pure Allspice"	12	4.37	Passed.
9207	D. & L. Slade Co., Boston, Mass. Whiting Bros., Ellsworth. "Extra Strong Allspice"	10	5.06	Passed.
9256	D. & L. Slade Co., Boston, Mass. P. Kelley, Bar Harbor. "Absolutely Pure Allspice"	10	–	Passed.
9413	D. & L. Slade Co., Boston, Mass Thomas White, Bangor. "Slade's Absolutely Pure Allspice"	5	3.81	Not adulterated. Short weight.
9352	Dwinall Wright Co., Boston, Mass. E. T. Beauregard Co., Biddeford. "Royal Brand First Quality Pimento"	7	4.37	Passed.
9370	Geo. C. Shaw Co., Portland, Me. Geo. C. Shaw Co., Portland. "Pure Pimento. Guaranteed finest quality"	8	3.96	Passed.
9230	John Bird Co., Rockland, Me. Austin H. Joy, Ellsworth. "Pure Allspice. ¼ lb"	10	3.70	Not adulterated. Short weight.
9308	John Bird Co., Rockland, Me. H. B. Webber, Rockland. "Pure Allspice. ¼ lb"	8	3.77	Not adulterated. Short weight.
9186	Stickney & Poor Spice Co., Boston, Mass. Kearns & Cottle, Ellsworth. "Absolutely Pure Allspice"	8		Passed.
9198	Stickney & Poor Spice Co., Boston, Mass. John Kief, Ellsworth. "Absolutely Pure Allspice. ¼ lb"	8		Passed.

Tables showing results of analyses of spices and pepper purchased in packages.—Continued.

Station No.	Manufacturer, Name of Dealer and Brand.	Price. Cents.	Net weight. Oz.	Remarks.
	Allspice—Concluded.			
9210	Stickney & Poor Spice Co., Boston, Mass. Whiting Bros., Ellsworth. "Absolutely Pure Allspice. ¼ lb"	10		Passed.
9232	Stickney & Poor Spice Co., Boston, Mass. J. A. Rodick, Bar Harbor. "Pure Pimento"	10	2.29	Passed.
9260	Stickney & Poor Spice Co., Boston, Mass. E. A. Morgan, Bar Harbor. "Absolutely Pure Allspice. ¼ lb"	10	4.16	Passed.
9391	Stickney & Poor Spice Co., Boston, Mass. Patrons Cooperative Corporation, Portland. "Absolutely Pure Allspice. ¼ lb"	8	3.92	Not adulterated. Slightly short weight.
9238	Twitchell-Champlin Co., Portland, Me. J. A. Rodick, Bar Harbor. "Hatchet Brand Extra Strong Jamaica Allspice. ¼ lb"	–	3.74	Not adulterated. Short weight.
9382	Twitchell-Champlin Co., Portland, Me. "Hatchet Brand Extra Strong Allspice. ¼ lb"	8	4.00	Passed.
9384	Twitchell-Champlin Co., Portland, Me. "Hatchet Brand Extra Strong Allspice. ¼ lb"	8	4.02	Passed.
9397	W. L. Wilson & Co., Portland, Me. "White Crescent Brand Pimento"	8	3.74	Passed. No weight claimed.
	Ground Cinnamon.			
9244	A. Colburn Co., Philadelphia, Pa. J. A. Rodick, Bar Harbor. "Colburn's Cinnamon. Absolutely Pure".	15	4.30	Passed.
9190	Direct Importing Co., Boston, Mass. Mrs. B. M. Young, Ellsworth. "Benefit Brand Cinnamon. Absolutely Pure"	8	4.00	Passed.
9434	Direct Importing Co., Boston, Mass. Direct Importing Co., Bangor. "Benefit Brand Cinnamon"	8	3.14	Passed.
9355	Berry, Dodge Co., Newburyport, Mass. Joseph Stride, Biddeford. "Warranted Pure Cassia"	8	3.99	Passed.
9267	B. Fischer & Co., New York City. G. Soper, Bar Harbor. "¼ lb. Strictly Pure Cinnamon'	12	–	Batavia cassia. Not as claimed, "strictly pure cinnamon from the best grade of whole spices." Old goods.
9406	Grand Union Tea Co., Brooklyn, N. Y. Grand Union Tea Co., Portland "Grand Union Cinnamon"	10	3.10	Passed.
9599	Importer Branch, New York. Original Importing Co., Portland. "Quality Brand Strictly Pure Cinnamon"	–	4.00	Passed.

Tables showing results of analyses of spices and pepper purchased in packages.—Continued.

Station No.	Manufacturer, Name of Dealer and Brand.	Price. Cents.	Net weight. Oz.	Remarks.
	Ground Cinnamon—Concluded.			
9411	D. & L. Slade Co., Boston, Mass. Thomas White, Bangor. "Slade's Absolutely Pure Cinnamon"	8	3.42	Not adulterated. Short weight.
9372	Geo. C. Shaw Co., Portland, Me. "Absolutely Pure Cassia"	8	4.13	Passed.
9307	John Bird Co., Rockland, Me. H. B. Webber, Rockland. "¼ lb. Pure Cinnamon"	8	4.20	Passed.
9185	Stickney & Poor Spice Co., Boston, Mass. Kearns & Cottle, Ellsworth. "Absolutely Pure Cassia. ¼ lb"	–		Passed.
9199	Stickney & Poor Spice Co., Boston, Mass. John Kief, Ellsworth. "Absolutely Pure Cassia. ¼ lb."	8		Passed.
9211	Stickney & Poor Spice Co., Boston, Mass. Whiting Bros., Ellsworth. "Absolutely Pure Cassia. ¼ lb"	10		Passed.
9223	Stickney & Poor Spice Co., Boston, Mass. Austin H. Joy, Ellsworth. "Absolutely Pure Cassia. ¼ lb"	8	3.81	Not adulterated. Short weight.
9261	Stickney & Poor Spice Co., Boston, Mass. E. A. Morgan, Bar Harbor. "Absolutely Pure Cassia. ¼ lb"	10	4.06	Passed.
9390	Stickney & Poor Spice Co., Boston, Mass. Patrons Cooperative Corporation, Portland. "Absolutely Pure Cassia. ¼ lb"	8	4.02	Passed.
9239	Twitchell-Champlin Co., Portland, Me. J. A. Rodick, Bar Harbor. "Hatchet Brand Extra Strong Cassia"	10	4.02	Passed.
9400	W. L. Wilson & Co., Portland, Me. "White Crescent Brand Cassia"	8	3.81	No weight claimed. Passed.
	Ground Cloves.			
9245	A. Colburn Co., Philadelphia, Pa. J. A. Rodick, Bar Harbor. "Colburn's Cloves. Absolutely Pure"	15	3.92	No weight claimed. Passed.
9195	Benefit Co., Boston, Mass. Mrs. B. M. Young, Ellsworth. "Benefit Brand Cloves"	8		Passed.
9433	The Benefit Co., Boston, Mass. Direct Importing Co., Bangor. "Benefit Brand Cloves"	7	2.93	Passed.
9268	B. Fischer & Co., New York City. G. Soper, Bar Harbor. "¼ lb. strictly pure cloves"	12	4.27	Passed.
9405	Grand Union Tea Co., Brooklyn, N. Y. Grand Union Tea Co., Portland. "Grand Union Cloves"	–	3.25	Passed.

Tables showing results of analyses of spices and pepper purchased in packages.—Continued.

Station No.	Manufacturer, Name of Dealer and Brand.	Price. Cents.	Net weight. Oz.	Remarks.
	Ground Cloves—Concluded.			
9597	Importer Branch, New York. Original Importing Co., Portland. "Quality Brand Cloves"	7	3.76	Not adulterated. Short weight.
9415	D. & L. Slade Co., Boston, Mass. Thomas White, Bangor. "Absolutely Pure Cloves"	8	3.67	Not adulterated. Short weight.
9354	Berry, Dodge Co., Newburyport, Mass. Joseph Stride, Biddeford. "Pure Cloves"	8	4.13	Passed.
9351	Dwinall Wright Co., Boston, Mass. F. T. Beauregard Co., Biddeford. "Royal Cloves. ¼ lb"	7	4.13	Passed.
9371	Geo. C. Shaw Co., Portland, Me. "Shaw's Absolutely Pure Cloves"	8	4.20	Passed.
9306	John Bird Co., Rockland, Me. H. B. Webber, Rockland, Me. "¼ lb. Warranted Pure Cloves"	8	3.88	Short weight. High in fiber.
9183	Stickney & Poor Spice Co., Boston, Mass. Kearns & Cottle, Ellsworth. "Absolutely Pure Cloves"	8		Passed.
9212	Stickney & Poor Spice Co., Boston, Mass. Whiting Bros., Ellsworth. "Absolutely Pure Cloves. ¼ lb"	10		Passed.
9225	Stickney & Poor Spice Co., Boston, Mass. Austin H. Joy, Ellsworth. "Absolutely Pure Cloves. ¼ lb"	8	3.74	Not adulterated. Short weight.
9259	Stickney & Poor Spice Co., Boston, Mass. E. A. Morgan, Bar Harbor. "Absolutely Pure Cloves. ¼ lb"	10	4.13	High in fiber.
9387	Stickney & Poor Spice Co., Boston, Mass. Patrons Cooperative Corporation, Portland. "Absolutely Pure Cloves. ¼ lb"	8	4.27	Passed.
9237	Twitchell-Champlin Co., Portland, Me. J. A. Rodick, Bar Harbor. "Hatchet Brand Extra Strong Cloves"	10	4.09	High in fiber.
9255	Twitchell-Champlin Co., Portland, Me. P. Kelley, Bar Harbor. "Hatchet Brand Extra Strong Cloves"	10	4.09	High in fiber.
9380	Twitchell-Champlin Co., Portland, Me. "Hatchet Brand Extra Strong Cloves"	10	4.18	High in fiber.
9396	W. L. Wilson & Co., Portland, Me. "White Crescent Brand Cloves"	8	4.00	Passed.
	Whole Cloves.			
9231	John Bird Co., Rockland, Me. Austin H. Joy, Ellsworth. "Pure Whole Cloves"	5	1.90	No weight claimed. Passed.

Tables showing results of analyses of spices and pepper purchased in packages.—Continued.

Station No.	Manufacturer, Name of Dealer and Brand.	Price. Cents.	Net weight. Oz.	Remarks.
	Ground Ginger.			
9247	A. Colburn Co., Philadelphia, Pa. J. A. Rodick, Bar Harbor. "4 oz. net ginger"	15	4.30	Passed.
9194	Benefit Co., Boston, Mass. Mrs. B. M. Young, Ellsworth. "Benefit Brand Ginger"	8		Passed
9427	Benefit Co., Boston, Mass. Direct Importing Co., Bangor. "Benefit Brand Ginger"	7	3.07	High Ash.
9402	Grand Union Tea Co., Brooklyn, N. Y. Grand Union Tea Co., Portland. "Grand Union Ginger"	10	2.75	Passed.
9601	Importer Branch, New York. Original Importing Co., Portland. "Quality Brand Ginger"	4	4.09	High Ash.
9356	Berry, Dodge Co., Newburyport, Mass. Joseph Stride, Biddeford. "Pure Ginger"	8	4.16	Passed.
9265	B. Fischer & Co., New York City. G. Soper, Bar Harbor. "¼ lb. pure ginger"	12	4.23	Passed.
9206	D. & L. Slade Co., Boston, Mass. Whiting Bros., Ellsworth. "¼ lb. net ginger"	10		Passed
9727	D. & L. Slade Co., Boston, Mass. F. G. Burrell, East Madison. "¼ lb. Extra Strong Ginger"	–	3.78	Not adulterated Short weight.
9414	D. & L. Slade Co., Boston, Mass. Thomas White, Bangor. "Slade's Absolutely Pure Ginger"	5	3.77	Not adulterated. Short weight.
9350	Dwinal, Wright Co., Boston, Mass. F. T. Beauregard Co., Biddeford. "Royal Brand First Quality Ginger"	7	4.13	High in ash
9368	Geo. C. Shaw Co., Portland, Me. "Absolutely Pure Ginger"	8	4.09	High in ash.
9305	John Bird Co., Rockland, Me. H. B. Webber, Rockland. "¼ lb. Warranted Pure Ginger"	8	3.70	Not adulterated. Short weight.
9254	Haskell, Adams & Co., Boston, Mass. P. Kelley, Bar Harbor. "Rival Brand Ginger"	10	4.23	High in ash
9182	Stickney & Poor Spice Co., Boston, Mass. Kearns & Cottle, Ellsworth. "Absolutely Pure Ginger. ¼ lb"	8		Passed
9201	Stickney & Poor Spice Co., Boston, Mass. John Kief, Ellsworth. "Absolutely Pure Ginger. ¼ lb"	–	–	Passed.

Tables showing results of analyses of spices and pepper purchased in packages.—Continued.

Station No.	Manufacturer, Name of Dealer and Brand.	Price. Cents.	Net weight. Oz.	Remarks.
	Ground Ginger—Concluded.			
9224	Stickney & Poor Spice Co., Boston, Mass. Austin H. Joy, Ellsworth. "Absolutely Pure Ginger. ¼ lb"	8	3.81	Not adulterated. Short weight.
9389	Stickney & Poor Spice Co., Boston, Mass. Patrons Cooperative Corporation, Portland. "Absolutely Pure Ginger. ¼ lb"	8	3.92	Short weight. High in ash.
235	Twitchell-Champlin Co., Portland, Me. J. A. Rodick, Bar Harbor. "Hatchet Brand African Ginger"	10	2.89	Passed.
9383	Twitchell-Champlin Co., Portland, Me. "Hatchet Brand ¼ lb. African Ginger"	8	3.69	Not adulterated. Short weight.
9399	W. L. Wilson & Co., Portland, Me. "White Crescent Brand Ginger"	6	3.56	Weight not claimed. High in ash and in lime.
	Ground Mace.			
9241	A. Colburn Co., Philadelphia, Pa. J. A. Rodick, Bar Harbor. "Colburn's Mace"	15	0.92	Passed.
9197	Direct Importing Co., Boston, Mass. Mrs. B. M. Young, Ellsworth. "Benefit Brand Mace"	10		Passed.
9435	Direct Importing Co., Boston, Mass. Direct Importing Co., Bangor. "Benefit Brand Mace"	8	1.02	Passed.
9604	Importer Branch, New York. Original Importing Co., Portland. "Quality Brand Pure Mace"	8	1.46	Passed.
9216	Chas. E. Moody & Co., Boston, Mass. Whiting Bros., Ellsworth. "Moody's Matchless Brand Mace"	10		Rather high ash.
9269	B. Fischer & Co., New York City G. Soper, Bar Harbor. "¼ lb. Pure Mace"	12		Not adulterated. Short weight.
9257	D. & L. Slade Co., Boston, Mass. P. Kelley, Bar Harbor. "Extra Strong Mace. 1 oz. net"	15	1.02	Passed.
9416	D. & L. Slade Co., Boston, Mass. Thomas White, Bangor. "Absolutely Pure Mace"	15	1.13	Passed.
9373	Geo. C. Shaw Co., Portland, Me. "Shaw's Absolutely Pure Mace"	8	2.47	Passed.
9395	Stickney & Poor Spice Co., Boston, Mass. Patrons Cooperative Corporation, Portland. "Pure Mace. 1 oz"	–	1.18	Passed.
9226	Stickney & Poor Spice Co., Boston, Mass. Austin H. Joy, Ellsworth. "Pure Mace. 1 oz"	12	1.13	Rather high ash.

Tables showing results of analyses of spices and pepper purchased in packages.—Continued.

Station No.	Manufacturer, Name of Dealer and Brand.	Price. Cents.	Net weight. Oz.	Remarks.
	Ground Mace—Concluded.			
9379	Twitchell–Champlin Co., Portland. "Hatchet Brand Mace"	10	0.88	Passed.
	Marjoram.			
9215	Dwinell, Hayward & Co., Boston, Mass. Whiting Bros., Ellsworth. "Warranted Pure Marjoram"	10	–	Passed.
	Ground Mustard.			
9188	A. Colburn Co., Philadelphia, Pa. Kearns & Cottle, Ellsworth. "½ lb. Colburn's Mustard"	–		Passed.
9204	A. Colburn Co., Philadelphia, Pa. John Kief, Ellsworth. "½ lb. Colburn's Mustard"	10		Passed.
9218	A. Colburn Co., Philadelphia, Pa. Whiting Bros., Ellsworth. "Durham Superfine Mustard"	10		Passed.
9403	Grand Union Tea Co., Brooklyn, N. Y. Grand Union Tea Co., Portland. "Grand Union Mustard"	10	3.09	Weight not claimed. Passed.
9606	Importer Branch, New York. Original Importing Co., Portland. "Quality Brand Mustard"	6	3.62	Not adulterated. Short weight.
9219	Keene, England. Whiting Bros., Ellsworth. "Keen's Mustard"	10		Passed.
9418	D. & L. Slade Co., Boston, Mass. Thomas White, Bangor. "Absolutely Pure Mustard"	10	4.41	Passed.
9220	Stickney & Poor Spice Co., Boston, Mass. Whiting Bros., Ellsworth. "Extra Fine Mustard"	10		Passed.
9221	Stickney & Poor Spice Co., Boston, Mass. Austin H. Joy, Ellsworth. "Extra Fine Mustard"	10	4.23	Passed.
9393	Stickney & Poor Spice Co., Boston, Mass. Patrons Cooperative Corporation, Portland. "Extra Fine Mustard"	–	4.37	Passed.
9377	Twitchell–Champlin Co., Portland, Me. "Hatchet Brand Mustard"	10	4.02	Passed.
	Ground Nutmeg.			
9243	A. Colburn Co., Philadelphia, Pa. J. A. Rodick, Bar Harbor. "Colburn's Nutmeg"	15	1.98	Passed.
9193	Benefit Co., Boston, Mass. Mrs. B. M. Young, Ellsworth. "Benefit Brand Nutmegs"	8		Passed. No weight claimed.
9432	Direct Importing Co., Boston, Mass. Direct Importing Co., Bangor. "Benefit Brand Nutmegs"	8	2.57	Passed.

Tables showing results of analyses of spices and pepper purchased in packages.—Continued.

Station No.	Manufacturer, Name of Dealer and Brand.	Price. Cents.	Net weight. Oz.	Remarks.
	Ground Nutmeg.—Concluded.			
9603	Importer Branch, New York. Original Importing Co., Portland. "Quality Brand Nutmegs"	6	1.31	Passed.
9266	B. Fischer & Co., New York City. G. Soper, Bar Harbor. "¼ lb. Pure Nutmegs"	12	4.13	Passed.
9270	B. Fischer & Co., New York City. G. Soper, Bar Harbor. "Pure Nutmegs"	10	2.05	Passed.
9209	D. & L. Slade Co., Boston, Mass. Whiting Bros., Ellsworth. "Extra Strong Nutmeg. 2 oz"	10		Passed
9258	D. & L. Slade Co., Boston, Mass. P. Kelley, Bar Harbor. "Extra Strong Nutmeg"	15	–	Passed.
9417	D. & L. Slade Co., Boston, Mass. Thomas White, Bangor. "Absolutely Pure Nutmeg. 1 oz. net"	5	1.13	Passed.
9677	Swaine, Earle & Co., Boston, Mass. R. M. Barker, Presque Isle. "Reception Brand Nutmeg"	10	2.10	Passed.
9374	Geo. C. Shaw Co., Portland, Me. "Shaw's Absolutely Pure Nutmeg"	8	2.56	Passed.
9401	Grand Union Tea Co., Brooklyn, N. Y. Grand Union Tea Co., Portland. "Grand Union Nutmeg"	15	2.54	Passed.
9310	John Bird Co., Rockland, Me. H. B. Webber, Rockland. "Crow Brand Ground Nutmeg"	–	2.12	Passed.
9187	Stickney & Poor Spice Co., Boston, Mass. Kearns & Cottle, Ellsworth. "2 oz. Full Weight Nutmeg"	10		Passed.
9228	Stickney & Poor Spice Co., Boston, Mass. Austin H. Joy, Ellsworth. "Pure Nutmegs"	12	1.57	Passed. Old goods. No weight claimed.
9394	Stickney & Poor Spice Co., Boston, Mass. Patrons Cooperative Corporation, Portland. "2 oz. Full Weight Nutmeg"	–	2.06	Passed.
9378	Twitchell-Champlin Co., Portland. "Hatchet Brand Nutmeg"	10	0.99	Contains nutmeg shells. Some insects.
	Ground Black Pepper.			
9249	A. Colburn Co., Philadelphia, Pa. J. A. Rodick, Bar Harbor. "4 oz. net Black Pepper"	15	4.02	Passed.
9189	Direct Importing Co., Boston, Mass. Mrs. B. M. Young, Ellsworth. "Benefit Brand Black Pepper"	8		Passed.

Tables showing results of analyses of spices and pepper purchased in packages.—Continued.

Station No.	Manufacturer, Name of Dealer and Brand.	Price. Cents.	Net weight. Oz.	Remarks.
	GROUND BLACK PEPPER—Concluded.			
9428	Direct Importing Co., Boston, Mass. Direct Importing Co., Bangor. "Benefit Brand Black Pepper"	7	3.03	Passed.
9600	Importer Branch, New York. Original Importing Co., Portland. "Quality Brand Black Pepper"	5	3.99	Passed.
9349	Dwinal, Wright Co., Boston, Mass. F. T. Beauregard Co., Biddeford. "Royal Brand First Quality Black Pepper"	7	4.16	Passed.
9369	Geo. C. Shaw Co., Portland, Me. "Shaw's Absolutely Pure Black Pepper"	8	4.02	Passed.
9240	Twitchell-Champlin Co., Portland, Me. J. A. Rodick, Bar Harbor. "Hatchet Brand Extra Strong Black Pepper"	10	4.06	Passed.
	GROUND PEPPER.			
9357	Berry, Dodge Co., Newburyport, Mass. Joseph Stride, Biddeford. "Warranted Pure Pepper. ¼ lb"	8	3.88	Not adulterated. Short weight.
9409	Grand Union Tea Co., Brooklyn, N. Y. Grand Union Tea Co., Portland. "Grand Union Pepper"	10	3.14	Passed.
9208	D. & L. Slade Co., Boston, Mass. Whiting Bros., Ellsworth. "Slade's Extra Strong Pepper"	10		Passed.
9412	D. & L. Slade Co., Boston, Mass. Thomas White, Bangor, Me. "Absolutely Pure Pepper"	5	4.06	Passed.
9203	John Bird Co., Rockland, Me. John Kief, Ellsworth. "Pure Pepper. ¼ lb"	8	–	Passed.
9309	John Bird Co., Rockland, Me. H. B. Webber, Rockland. "Pure Pepper. ¼ lb"	8	3.95	High in ash. Slightly under in weight.
9184	Stickney & Poor Spice Co., Boston, Mass. Kearns & Cottle, Ellsworth. "Absolutely Pure Pepper. ¼ lb"	8		Passed.
9200	Stickney & Poor Spice Co., Boston, Mass. John Kief, Ellsworth. "Absolutely Pure Pepper. ¼ lb"	8	–	Passed.
9222	Stickney & Poor Spice Co., Boston, Mass. Austin H. Joy, Ellsworth. "Absolutely Pure Pepper. ¼ lb"	8	3.99	Passed.
9388	Stickney & Poor Spice Co., Boston, Mass. Patrons Cooperative Corporation, Portland. "Absolutely Pure Pepper. ¼ lb"	8	3.99	Passed.
9398	W. L. Wilson & Co., Portland, Me. "White Crescent Brand Pepper"	8	3.92	No weight claimed. Passed.

Tables showing results of analyses of spices and pepper purchased in packages.—Continued.

Station No.	Manufacturer, Name of Dealer and Brand.	Price. Cents.	Net weight. Oz.	Remarks.
	GROUND PEPPER—Concluded.			
9381	Twitchell-Champlin Co., Portland, Me. "Hatchet Brand Strong Pepper"	8	4.15	Passed.
	GROUND WHITE PEPPER.			
9246	A. Colburn Co., Philadelphia, Pa. J. A. Rodick, Bar Harbor. "2½ oz. White Pepper"	15	2 72	Passed.
9196	Benefit Co., Boston, Mass. Mrs. B. M. Young, Ellsworth. "Benefit Brand White Pepper"	10		Weight not claimed. Passed.
9429	Benefit Co., Boston, Mass. Direct Importing Co., Bangor. "Benefit Brand White Pepper"	8	3.14	Passed.
9407	Grand Union Tea Co., Brooklyn, N. Y. Grand Union Tea Co., Portland. "Grand Union White Pepper"	13	3.02	Passed.
9598	Importer Branch, New York. Original Importing Co., Portland. "Quality Brand White Pepper"	–	3.95	More pepper hulls than high grade white pepper usually carries. Short weight.
9348	Dwinal, Wright Co., Boston, Mass. F. T. Beauregard Co., Biddeford. "Four Ounces Royal Brand White Pepper"	10	4.27	Passed.
9367	Geo. C. Shaw Co., Portland, Me. "Shaw's Pure White Pepper"	8	1.18	Weight not claimed. Passed.
9213	Stickney & Poor Spice Co., Boston, Mass. Whiting Bros., Ellsworth. "Absolutely Pure White Pepper"	10	–	Passed.
9227	Stickney & Poor Spice Co., Boston, Mass. Austin H. Joy, Ellsworth. "Pure White Pepper. 2 oz"	10	2.01	Passed.
9386	Stickney & Poor Spice Co., Boston, Mass. Patrons Cooperative Corporation, Portland. "Absolutely Pure White Pepper. ¼ lb"	10	3.81	Not adulterated. Short weight.
9385	Twitchell-Champlin Co., Portland, Me. "Hatchet Brand Strong White Pepper"	10	3.97	Passed.
	GROUND CAYENNE PEPPER.			
9248	A. Colburn Co., Philadelphia, Pa. J. A. Rodick, Bar Harbor. "Red Pepper"	15	4.37	Passed.
9430	Benefit Co., Boston, Mass. Direct Importing Co., Bangor. "Benefit Brand Cayenne Pepper"	7	3.35	Passed.
9408	Grand Union Tea Co., Brooklyn, N. Y. Grand Union Tea Co., Portland. "Grand Union Cayenne Pepper"	13	2.70	Rather high ash.
9605	Importer Branch, New York. Original Importing Co., Portland. "Quality Brand Cayenne Pepper"	6	4.00	Rather high ash.

Tables showing results of analyses of spices and pepper purchased in packages.—Concluded.

Station No.	Manufacturer, Name of Dealer and Brand.	Price. Cents.	Net weight. Oz.	Remarks.
	GROUND CAYENNE PEPPER—Concluded.			
9263	B. Fischer & Co., New York City. G. Soper, Bar Harbor. "¼ lb. Pure Cayenne Pepper"	12	4.45	Passed.
9205	D. & L. Slade Co., Boston, Mass. Whiting Bros., Ellsworth. "Slade's Extra Strength Cayenne"	10	–	High in ash and in non-volatile extract.
9229	D. & L. Slade Co., Boston, Mass. Austin H. Joy, Ellsworth. "Slade's Extra Strong Cayenne. 2 ozs"	10	1.80	Short weight. High in total and insoluble ash.
9192	Direct Importing Co., Boston, Mass. Mrs. B. M. Young, Ellsworth. "Benefit Brand Cayenne Pepper"	8	–	High in total and insoluble ash.
9375	Geo. C. Shaw Co., Portland, Me. "Shaw's Absolutely Pure Cayenne"	8	2.82	Passed.
9202	Stickney & Poor Spice Co., Boston, Mass. John Kief, Ellsworth. "2 oz. Full Weight Cayenne"	10	–	Passed.
9392	Stickney & Poor Spice Co., Boston, Mass. Patrons Cooperative Corporation, Portland. "2 oz. Full Weight Cayenne"	–	2.35	Passed.
9234	Twitchell-Champlin Co., Portland, Me. J. A. Rodick, Bar Harbor. "Hatchet Brand Cayenne"	10	2.01	High in total and insoluble ash.
	SAVORY.			
9214	Dwinell, Hayward & Co., Boston, Mass. Whiting Bros., Ellsworth. "Warranted Pure Savory"	10	–	Passed.
	WHOLE MIXED SPICES.			
9217	Haskell, Adams & Co., Boston, Mass. Whiting Bros., Ellsworth. "Rival Brand Whole Mixed Spice"	–	–	Contains cloves, cardamon, capsicum, cinnamon, corriander, caraway, celery, pepper, pimento, mustard, ginger, bay. No foreign matter found.
9236	Twitchell-Champlin Co., Portland, Me. J. A. Rodick, Bar Harbor. "Hatchet Brand Strong Pickling Spices"	10	4.02	Contains cloves, cardamon, capsicum, cinnamon, celery, corriander mace, pepper, pimento, mustard, ginger, bay. No foreign matter found.

Table showing the analyses of prepared mustard purchased in the fall and winter of 1910.

Station No.	NAME OF MAKER, BRAND AND DEALER.	Price. Cents.	Size of jar. Ozs.	Dry matter. %	Remarks.
9513	Anchor Mills Co., Charlestown, Mass. "Prepared French Mustard. A combination of mustard and vinegar with the addition of enough spice and salt for flavoring and preservative purposes. Colored with turmeric." D. W. True & Co., Portland..........	–	7.48	–	Found in accord with label.
9546	German American Mustard Co., N. Y. "German Table Brand Mustard. Prepared with vinegar, sugar, salt, spices and selected mustard seed." Conant, Patrick Co., Portland.........	–	–	–	Found in accord with label.
9545	Chas. Gulden, New York City. "Gulden's Registered Prepared Mustard. Warranted pure. 25% mustard seed and spices, and 75% vinegar." Conant, Patrick Co., Portland.........	–	–	–	Turmeric present. Not declared.
9587	H. J. Heinz Co., Pittsburg, Pa. "Prepared Mustard." W. L. Wilson & Co., Portland.........	10	6.63	–	Passed.
9576	Jas. J. Loughery & Co., Boston, Mass. "Le Roy Extra Quality Prepared Mustard." Littlefield & Co., Portland............	10	–	–	Turmeric present. Not declared.
9550	New England Maple Syrup Co., Boston, Mass. "Golden Tree Mustard. Compound, vinegar, mustard seed, cereal, salt, spices and turmeric." Milliken-Tomlinson Co., Portland......	–	–	–	Found in accord with label.
9517	R. T. French Co., Rochester, N. Y. "French's Cream Salad Brand. Colored with turmeric. 10 parts mustard and mustard seed, 1 part spices and condiments, including turmeric, ½ part salt, 87½ parts vinegar." D. W. True & Co., Portland..........	–	12.45	–	Found in accord with label.
9535	Twitchell-Champlin Co., Portland, Me. "Superior Quality Prepared Mustard. Vinegar, mustard seed, mustard bran, maize flour, salt, cayenne, turmeric, annatto, cinnamon, cloves." Twitchell-Champlin Co., Portland....	–	10.01	–	Found in accord with label.
9549	Westmoreland Specialty Co., Grapeville, Pa. "Prepared Mustard. Contains mustard seed, vinegar, salt, spices, flavored and colored with turmeric."........	–	6.28	–	Contains cereal starch. Not declared. Adulterated.
9505	E. E. Clifford Co., Portland, Me. "Moutarde bordse Imperiale. Lambeau & Baudin. Bordeaux. Mustard 286; vinegar 700; turmeric 207; vinegar 1000." Trefethen & Sweet Co., Portland......	10	6.63	–	Benzoic acid present. Not declared. Contains added corn starch and vegetable fiber. Adulterated and misbranded.

Table showing the results of the analyses of samples of honey.

Station No.	Name of Maker, Brand and Dealer.	Water.	Ash.	Sucrose.	Remarks.
		%	%	%	
9556	J. E. Crane & Son, Middlebury, Vt. "Pure Extracted Honey." C. A. Weston Co., Portland	19.9	0.13	2.6	Passed.
9586	H. J. Manchester & Son, Middlebury, Vt. "Pure Extracted Honey." W. L. Wilson & Co., Portland	15.9	0.13	4.1	Passed.
9568	H. B. Phillips, Auburn, Me. "Pure Honey." H. S. Melcher Co., Portland	19.5	0.13	2.8	Passed.
9594	S. S. Pierce Co., Boston, Mass. "Clover Blossom Brand Honey." Geo. C. Shaw Co., Portland	19.1	0.08	4.3	Passed.
9512	New England Maple Syrup Co., Boston, Mass. "Golden Tree Pure Clover Honey." D. W. True & Co., Portland	16.4	0.05	3.5	Contains other than clover honey.
9511	C. G. Turner, Mechanic Falls, Me. "Star Honey." D. W. True & Co., Portland	19.2	0.09	2.6	Passed.
9529	Twitchell–Champlin Co., Portland, Me. "Superior Quality White California Honey." Twitchell–Champlin Co., Portland	21.6	0.07	1.7	Passed.

Table showing the results of the analyses of gluten flour.

Station No.	Name of Maker, Brand and Dealer.	Water.	Protein.	Remarks.
		%	%	
8316	Pure Gluten Food Co., New York City. "Gum Gluten Flour."	–	37.9	Passed.
9358	Pure Gluten Food Co., New York City. "Gum Gluten Flour." Andrews & Horigan Co., Biddeford	9.1	39.3	Passed.
9376	The Health Food Co., New York. "Glutosac. Whole wheat gluten flour." Geo. C. Shaw Co., Portland	8.7	36.6	Passed.
9261	Johnson Educator Food Co., New York. "Educator Gluten Flour." Ben D. Field, Belfast	8.8	40.1	Passed.
8781	Wilson Brothers, Rochester, N. Y. "Gluten. 4-7 standard." J. C. Norton, Bangor	11.1	19.9	In accord with label. Passed.
9290	Wilson Brothers, Rochester, N. Y. "Gluten Flour. 4-7 standard." A. A. Howes & Co., Belfast	9.7	19.5	In accord with label. Passed.

RULES, REGULATIONS AND STANDARDS.

The reenacted laws regulating the sale of feeds, fertilizers, drugs, foods, fungicides and insecticides became operative about July first. In order that the public might be promptly informed of the requirements under the revised laws a summary of the laws were printed in Official Inspections 32, May 1911. Pamphlets giving the detailed requirements were published soon thereafter. The following formal publications of the rules, regulations and standards under the act was delayed until after the law became operative.

As authorized and directed by Section 13 of Chapter 119 of the Public Laws of 1911, entitled "An Act to amend and unify the laws regulating the sale of Agricultural seeds, commercial feeding stuffs, commercial fertilizers, drugs, foods, fungicides and insecticides," I, Charles D. Woods, Director of the Maine Agricultural Experiment Station, hereby, on this first day of July, 1911, make and publish uniform rules and regulations for carrying out the provisions of the Act and fix the standards for purity, quality and strength for articles of agricultural seed, commercial feeding stuff, commercial fertilizer, drug, food, fungicide and insecticide as follows:—

For agricultural seed as given in Publication 420 of the Maine Agricultural Experiment Station entitled "Requirements under the Law Regulating the Sale of Agricultural Seeds."

For commercial feeding stuffs as given in Publication 421 of the Maine Agricultural Station entitled "Requirements under the Law Regulating the Sale of Commercial Feeding Stuffs."

For commercial fertilizers as given in Publication 422 of the Maine Agricultural Experiment Station entitled "Requirements under the Law Regulating the Sale of Commercial Fertilizers."

For drugs as given in Publication 424 of the Maine Agricultural Experiment Station entitled "Requirements under the Law Regulating the Sale of Drugs."

For foods as given in Publication 425 of the Maine Agricultural Experiment Station entitled "Requirements under the Law Regulating the Sale of Foods."

For fungicides and insecticides as given in Publication 423 of the Maine Agricultural Experiment Station entitled "Requirements under the Law Regulating the Sale of Fungicides and Insecticides."

CHAS. D. WOODS, *Director.*

December, 1911

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

ANALYSTS

James M. Bartlett
Albert G. Durgin
Herman H. Hanson
Royden L. Hammond
Alfred K. Burke

INSPECTORS

Elmer R. Tobey
Albert Verrill
Edgar A. White

Official Inspections

35

FOOD SANITATION.

During the year 1911 an important advance has been made in assuring purer foods and more honest values to the people of Maine. Many samples have been analyzed, as in the past, and, in addition to the laboratory work, representatives of the Station have visited hundreds of establishments where foods are manufactured or exposed for sale, and have made thorough inspections of the premises with regard to cleanliness and the general sanitary conditions. This sanitary inspection is made possible by a recently added section of the law which reads as follows: "For the purpose of this act an article shall be deemed to be adulterated in case of foods if in the manufacture, sale, distribution, transportation, or in the offering or exposing for sale, distribution or transportation, it is not at all times securely protected from filth, flies, dust or other contamination, or other unclean, unhealthful, or unsanitary conditions," and another section of the law says in part that the Director of the Station "in person or by deputy, shall have free access, ingress and egress at all reasonable hours to any place or any building wherein articles of agricultural seed, commercial feeding stuff, commercial fertilizer, drug, food, fungicide or insecticide, are manufactured, stored, transported, sold, offered or exposed for sale." Under the provisions of these two sections the inspectors have visited since the first of August, 1911, almost 600 grocery stores and markets; nearly 200 drug stores; about 240 food factories, such as corn packing plants, sardine factories, bakeries, bottling establishments and candy kitchens; about 200 confectionery and fruit stores; and over 130 hotels, restaurants and lunch rooms. This is in addition to many feeding stuffs dealers visited. Particular attention has been given to those places where foods are manufactured, stored or dispensed. In a large majority of the places visited no reasons for serious criticisms were found. In a great many cases certain points of minor importance have been noted and the conditions have been improved upon, attention being called to them. For example, general untidiness, unswept floors, occasional old goods which were made and purchased before the food law was passed, surroundings cluttered up, etc. Occasionally, however, conditions are discovered which are filthy and vile and in cases of this kind hearings have been appointed and a definite, limited amount of time has been allowed the proprietors of the premises in which to remedy the defects, or clean up. In every case of this kind it is gratifying to note that the improvement was made immediately without resorting to prosecution.

Food Factories.

There are in Maine about 75 factories where corn is packed, and many of these were visited by the inspectors while in the course of operation, during the short canning season. For the most part conditions here were fairly satisfactory, although in several instances piles of sour corn cobs and refuse were found in close proximity to the buildings where they would prove an attraction for flies, and in other cases the toilet arrangements were not satisfactory.

During the course of a special study of the sardine packing factories of this State, all of the 55 establishments of this class were visited during the summer. Contrary to the popular idea, the sanitary conditions in these places are for the most part fairly good. Exceptional conditions found in a few of the factories, however, have apparently led to the common idea that the sardine factories are at the bottom in the scale of cleanliness. Unsatisfactory toilet facilities were in a few cases observed and in one or two instances disagreeable odors from the pickling room were caused by unnecessary accumulations of fish refuse in corners and along the sides of the room.

In a few of the bottling establishments where sodas are prepared no attempts at screening were found and, during the summer months, the flies were intolerable. Indeed, in some of the samples of bottled sodas which have been taken by the inspectors dead flies have been found. In one bottling place, in a basement, there was a toilet in one corner with no attempt whatever at separation from the rest of the room. Some of the floors, also, were found very dirty and the place cluttered with empty bottles, cases and barrels in a very untidy manner.

On the other hand the manufacturers who put out the better class of sodas keep the places scrupulously clean, the finest of spring water and guaranteed colors and flavors are used, returned bottles are thoroughly washed and sterilized before being refilled, and in fact everything about the premises and the process of manufacture is as clean and sanitary as possible. Then, after the finished product is ready for distribution, labels in exact accord with fact are always used.

In Official Inspections 27, issued in November, 1910, containing the results of the investigation of sodas last year, a notice was inserted relative to the use of saccharin in this class of goods. It was there stated that in all cases when sacharin was used its presence must be stated upon the label. In spite of this warning several manufacturers were found to be using this artificial sweetener the present year and in each case of this kind prosecution was commenced and a fine was imposed and paid.

In consequence of the results obtained by a careful study of the effects of saccharin the U. S. Referee Board of Consulting Scientific Experts found that this chemical exerts a deleterious effect upon digestion and health and, therefore, its use in all food products is absolutely prohibited under both the National and State food laws after December 31, 1911.

The use of benzoate of soda in limited amount is still permitted, provided its presence and amount are plainly stated upon the labels of such goods as contain it. Syrups containing this preservative may be used at soda fountains provided its presence and amount are plainly indicated to the public by a conspicuous placard bearing the above information.

At the annual meeting of the American Bottlers Protective Association held last month in Chicago, Mr. Henry Carse, the retiring president said in his address:—

"We want legislation in every State recognizing the bottler's property rights in his branded bottles of sufficient force to enable him to enforce such rights. We want effective laws in every State to prevent the use in carbonated beverages of any ingredient that is harmful or deleterious to health, and to compel honest labeling, with proper regulations to enforce cleanliness and healthful conditions in the process of manufacture. 'The proof of the pudding is in the eating.' When a man, woman or child buys a bottle of soda which doesn't taste good, the next nickel they spend goes for something else; one or two more trials with similar results, and that individual ceases forever to be a bottled soda water consumer. If we could now have as consumers those who have been lost to us in just that way, we could all afford to ride in automobiles. Our worst enemy is within our own ranks. He is *the man who makes poor goods.* He hurts the reputable bottler by taking the retailers' trade away from him by cutting prices—but that is not the worst of it; he does most injury by producing a quality of goods that brings all carbonated drinks into disrepute and ruins the demand for them, as the public does not readily discriminate between the different brands. As an association, it seems to me that we should not admit to membership any bottler whose goods can be shown to be below a normal standard, and that our State and local associations should take the initiative in prosecuting bottlers who offend against reasonable food law regulations. Some of them have already taken action along this line, giving a commendable example for others to follow."

Bakeries.

A large number of bakeries have been visited and while for the most part these are kept as clean as could well be expected, several places were found which were positively filthy. One of these bakeries was located in a basement where little but artificial light was available and where the ventilation was extremely poor. In general, the whole place was dirty, dusty, black and uninviting. What windows there were in the place were almost impervious to light because of dirt. The floor was covered thick with layer after layer of flour, coal dust, dirt from the street and general filth, trodden in a hard layer over the entire place. Over head uncovered piping and wiring stretched across the entire room, and from the appearance of the dust and cobwebs attached there was no indication that the place had ever been brushed out. Bags of flour and salt were piled upon the floor and covered with coal dust, dirt and grime. An open toilet in one corner of the room was reeking with filthy odors. The racks upon which the bread was piled were covered thick with layers of dirt, and the sink was foul with layer after layer of a hardened paste of dough and dirt. In this case a hearing was appointed at which the proprietors of the place appeared and were given three days in which to clean up and make the conditions satisfactory. At the expiration of the three days the place was again visited and an astonishing improvement had been made in its appearance so that it was passed as quite satisfactory.

This place was in strong contrast to most of the bakeries visited where the floors and walls were clean, windows clear, no accumulations of dust, piping and wiring properly covered, well lighted and ventilated, and both supplies and finished products well protected.

Creameries.

In cooperation with the State Commissioner of Agriculture a much needed inspection of creameries has been begun and in several instances decided improvements have been made as the direct result.

It seems almost incredible that an establishment handling such an important food as milk should allow such unsanitary conditions as have been found in some instances. Milk is one of the most important and generally used food with which we have to deal and it is one of the most easily contaminated. Especially as it fills such an important place in the diet of infants and invalids the necessity for keeping it clean and pure and free from disease germs cannot be overestimated, and yet there was found in some of the creameries little or no attempt at screening, rooms swarming with flies and many flies in the strainers, refrigerator rooms so damp that water continually dropped from the ceiling into the milk, unsanitary arrangement of toilets and employees not clean in appearance and in some cases apparently not even in good health. In the particular case described above an agent of the Commissioner of Agriculture had upon more than one occasion called the attention of the proprietors to the unsanitary conditions and the danger to the public resulting from such criminal carelessness or indifference, but not having at hand any law by which he might insist that his suggestions and advice be acted upon nothing was done until a deputy acting under the food law reported the conditions. A peremptory message gave notice to the proprietors that failure to clean up would be followed by prosecution, and upon the next visit to the place a short time after a marked improvement had been made and renovations were planned to change the entire aspect of the establishment.

Not all of the creameries, however, approach the conditions described above. For instance, one which was visited in one of the largest cities of the state was in excellent condition. It was well screened, light, airy and clean, the employees were neatly dressed. One could come from a visit to the place feeling that milk or cream obtained there would be not only palatable but safe.

Groceries and Markets.

For the most part the grocery stores and markets were found in fairly good condition, although in many the protection of such foods as meat and soft fruits from dust and flies was not adequate, and often not attempted.

Several cases of dirty back rooms used for storage purposes have been found where conditions were bad. For example, a book store was crowded with various food commodities exposed to the foul odors of a poorly ventilated closet which was separated from the store room only by a loose partition which did not extend to the ceiling. Hanging within a few feet of the open door of this closet was a lot of meat, and flies had free access to both.

It has been a practice quite common in many places to have barrels, boxes and packages of such goods as pork, pickles, crackers, sugar, meal and many other things open to the inspection of customers, and incidentally to contamination from dirty hands, dust and flies. Such a practice is an insult to the public. The time has arrived when the danger of disease germs in the dust and attached to the flies is being understood. Flies breed only in filth, and next to all kinds of human food they delight most in swarming over decaying animal and vegetable matter, horse manure, human excrement, sputum of people afflicted with loathsome and contagious diseases, and everything that is connected with filth and disease. Such easily contaminated foods as meat, soft fruits, confectionery, bread, pastry, dried fruits, etc., must be well protected.

Fortunately examples of clean, sanitary groceries are not uncommon. There are many where careful protection for all perishable goods is provided, the screening is ample, windows and floors are clean, back rooms are as carefully kept as other parts of the store, and refrigerators or meat rooms are clean and sweet. Such care pays for customers appreciate cleanliness.

Hotels and Restaurants.

Several dirty kitchens and store rooms connected with eating houses have been discovered and one especially was in a filthy condition. Dust and dirt was abundant and cobwebs festooned the ceiling, lard in an open firkin was quite black with dirt, plaster from the broken ceiling covered the floor and had fallen into open packages of sugar and other supplies, and a decaying fish was found without any difficulty whatever. This place was cleaned up at once without prosecution, although a hearing was appointed.

When inspecting hotels, restaurants and lunch rooms the dining rooms, kitchens and store rooms are all visited and, in happy contrast to the example above, nearly all are found in a sanitary condition. An occasional object of criticism is, of course, discovered but for the most part it is found that wholesome food is prepared and served in an attractive manner.

Confectionery and Fruit Stores.

In many of the places where confectionery and soft fruits were sold there were often displays of these food materials, sometimes upon the sidewalk or in open windows, without suitable protection from dust and flies. In every such case the attention of the proprietor was called to the unsatisfactory condition and it is believed that in most cases they have complied with recommendations for improvement.

Drug Stores.

The sanitary condition of the drug stores is, almost without an exception, excellent. The toilet facilities of some could be improved with little expense, and in a few instances the display of confectionery could be better protected.

Marking of Compounds and Imitations.

The inspectors have endeavored to ascertain to what extent dealers were informing their customers of the presence in foods of preservatives and chemicals and as to the nature of compounds and imitations. By present rulings, a small amount of alum in pickles is legitimate if its presence is plainly declared. Retail packages of pickles containing alum sold from bulk should carry a plain statement of the presence of that chemical. Inquiries made and analysis of samples purchased indicate that this ruling is often disregarded. Several cases of this kind are now being considered and it is probable that prosecutions will follow. Similarly retail packages of compound lard should be sold as such, mixtures of glucose and molasses should never be sold as molasses, sausage containing cereal or cereal and water should never be sold as sausage and each of the above imitations or compounds should be plainly marked when sold with a statement of the exact nature of the goods. This applies not only to the above articles but also in general to all foods which are not exactly what they appear to be.

In short this regulation means that any goods of this class, containing chemicals or preservatives, or made in imitation of, or, as substitutes for other things must be plainly marked at all times so that customers may tell exactly what they are, not only when the goods come from the manufacturer or jobber, but while they are exposed for sale and when they are delivered in retail packages.

Analyses of Foods.

During the year hundreds of analyses of foods have been made, including the examination of spices, extracts, pickles, ketchups, jams, jellies, preserves, honey, salt, molasses, ice cream, bottled sodas, clams and oysters, besides occasional determinations on other miscellaneous samples. The reports on a part of these samples have already been published and others will soon follow.

It is gratifying to see the improvement in respect to adulteration and misbranding. A few years ago the cheapest possible imitations masqueraded under the names of pure fruit jams, jellies and preserves. Today one can purchase cheap substitutes if they are wished and one can also purchase the pure articles and from the labels it can be readily understood why one is so much cheaper than the other. A few years ago it was almost impossible to obtain real molasses, the unfair competition of the compounds offered in its place having driven it entirely from some of the markets. Now either pure molasses or a compound of glucose may be obtained to suit the individual need. The improvement in the oyster situation is striking, as is also the condition with regard to vinegar. When the representative of the Station first attempted to collect samples of cider vinegar, several years ago, the collection obtained was astonishing and consisted of cider vinegar ranging in strength from two to six per cent of total acid, sugar and syrup vinegars, malt vinegars, distilled colored vinegars, and even mixtures of two kinds of vinegar. At the present time but very little of the colored distilled vinegar is in the Maine market, all vinegars are, as a rule, sold for exactly what they are, and but seldom is a vinegar found which does not come up to the standard in acid strength.

There is still chance for improvement in many respects. Extracts are not always as high grade as the labels would seem to indicate; ketchups are not always made from first class stock; clams at present often carry too much water; and other foods not here mentioned could be made better than they are. Continued inspection and investigation will no doubt mean continued improvement.

Oysters and Clams.

Several years ago it was realized by pure food officials that the people were not getting full value for their money when purchasing oysters and clams. Investigations were begun and it was quickly learned that besides the very important question of the pollution of the beds from which the shell fish came and which, of course, was most important as it effected public health, that the question of watered or iced oysters and clams was also of great importance, although principally from the standpoint of honest values.

Last year this Station conducted an investigation of the oyster situation in the State and the results of the examinations were given in Official Inspections 30. It was shown in this publication that the best oysters upon the market contained but little over 3 per cent of free liquid; that is, liquid which would drain from the oysters through a colander in about 10 minutes. If oysters were iced or watered the free liquid would run up as high as over 40 per cent. No distinctions were made in price between the oysters that carried from 3 to 4 per cent free liquid and those which carried from 30 to 40 per cent. No prosecutions were made as a result of the findings of last year, but the dealers were warned in many cases that a repetition of our findings would mean a fine under the food laws. At the beginning of the present oyster season our inspectors collected in various parts of the State a considerable number of samples of oysters. It was gratifying to note that the percentage of oysters carrying the small amount of free liquid had largely increased over that of last year. A number of dealers were found, however, and among them several who had been warned the year before, who were still selling oysters that carried from 30 to 40 per cent free liquid. In all such cases hearings were appointed and prosecutions begun. In almost every instance the dealer plead guilty and paid the fine.

At the same time that the inspectors were collecting the samples of oysters, a large number of samples of opened clams were collected and from the results obtained upon these samples it is evident that at the beginning of the present season the clam situation was in about the same position as the oyster situation was two years ago. Of the scores of clam samples analyzed during the past two seasons the lowest amount of free liquid found was 9.4 per cent. The highest amount found was 44.5 per cent—almost half free liquid. By far the largest portion of the clam samples carried over 30 per cent of free liquid. Investigations into the method of digging, preparing and handling clams have been made, and it is found that the practice is in general as follows:

A large dealer will often have as many as 50 or 60 diggers who work for him alone. The clams are dug during the day time, taken to the home of the digger and during the evening the whole family enters 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, as is sometimes practiced. In the latter method the opener immerses his hands in hot water or the clams are put in hot water to make them open more easily. The clam liquor is usually thrown away. The opened clams are washed in fresh water and they are often allowed to stand in this water over night until the wagon of the dealer comes around in the morning to collect the catch of 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 in the floating of oysters. The difference between the fresh clam meat and clams which have been soaked is illustrated by two analyses recently made in our laboratory. Fresh clams opened in the laboratory gave in dry matter from the drained meat 24.9 per cent of total solids. A sample analyzed about the same time from a lot of clams which had been soaked gave 15.9 per cent total dry matter, a difference of 9 per cent. The dry matter in some of the clams which we analyzed ran as low as 12 per cent.

There is no reason why clams should not be sold in as solid a condition as oysters are sold at the present time. Clams which are properly dug, washed, opened, rinsed and drained will not carry much, if any, more free liquid than the best oysters which are found upon the market at the present time, and clams which are not soaked in any way should contain at least 20 per cent total dry matter.

As in the case of oysters, the standards for opened clams in force in this State do not contain any arbitrary figures for free liquid or total solids. The standard reads as follows: "Opened shell fish 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."

The requirements of this standard are not ambiguous and they can be easily followed by every dealer in shell fish in the State if he wishes so to do. Thus far no prosecutions have been made in regard to the clams obtained. The dealers are warned, however, that prosecutions will be made in a manner similar to the oyster prosecutions if in the future violations are found.

Written Guarantees.

Section 17 of Chapter 119 of the Public Laws of 1911, being the inspection laws of this State, reads as follows: "No person shall be prosecuted under the provisions of this act when he can establish proof of purchase and a guaranty signed by the person residing in the United States, from whom the purchase was made, to the effect that the article in question is not adulterated or misbranded within the meaning of this act."

For several years the importance of obtaining a written guaranty when goods coming under the inspection laws of this State are purchased has been emphasized by the Director of the Experiment Station in the regular publications of the Station, special circulars and publications and personal letters to dealers with whom there has been correspndence.

It is surprising to find how few of the dealers in this State are attempting to comply with this important advice. A written guaranty obtained under the conditions specified in the above section protects the dealer in the sale of unopened packages of materials coming under the inspection laws if those materials are afterwards found to be either adulterated or misbranded. A general guaranty filed under the National Food Law and indicated on the label of the goods by a serial number is equivalent to such a guaranty. Such a guaranty not only protects the retailer in case his goods are found not to be in accord with the requirements of the inspection laws, but it shows to the people from whom he purchases his supplies that he is interested in the quality of his goods, and this acts as an incentive for them to supply him with a better class of goods than otherwise might be delivered.

The importance of obtaining such a guaranty is here again emphasized. Changes in the administration of the National Food and Drugs Act make it quite probable that the law will be more strictly enforced in some particulars in the future than it has been in the past. As the knowledge of the importance of pure and sanitary food becomes more widely known, and the results of investigations show that some practices which have been overlooked in the past are harmful, the definitions are being more closely drawn on adulterations and misbrandings, and it is quite likely that there will be prosecutions in the future for offences which in the past would have been overlooked, or at least passed over with a warning.

(398-12-10)

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

POULTRY DISEASES AND THEIR TREATMENT

Compiled by
RAYMOND PEARL, FRANK M. SURFACE, AND MAYNIE R. CURTIS.

ORONO, MAINE.
FEBRUARY, 1911.

This publication is mailed free to residents of Maine.
To others the price is twenty-five cents per copy.

TABLE OF CONTENTS.

LIST OF ILLUSTRATIONS.

POULTRY DISEASES AND THEIR TREATMENT.

Introduction.

It is probably safe to say that considerably more than 50 per cent of the correspondence of those engaged in poultry work in the agricultural colleges and experiment stations in this country relates to poultry diseases. The poultryman or farmer sees that some, or perhaps all, of his birds are ill, and he straightway writes to the nearest college or station to know what the disease is, and what to do for it. The Maine Station has for many years been the recipient of a great number of such inquiries. It is an unfortunate, but in the nature of the case an unavoidable fact, that in many instances it is quite impossible to make any really satisfactory reply to these inquiries. In the vast majority of cases the person who writes the letter is quite untrained in pathology and either describes no symptoms at all or only those very general ones which are common to nearly all the ills of poultry. To one who has not handled this class of correspondence it would seem almost incredible that there should be so many letters of the following type: "I have lost about a third of my chickens in the last few days. They seem a little dumpish for a while and then die. What is the trouble and what shall I do for it?" To diagnose and prescribe on such a basis of information is impossible. Yet the hard fact remains that the correspondent's chickens *were* ill and *did* die, and he *needs* help to get out of the trouble.

To meet this need so far as possible, and in response to a definite request on the part of the organized agricultural interests of the State the present work has been prepared. What it aims to do is to give a clear and reasonably complete compilation and digest of the information now existing in the literature regarding the commoner diseases of poultry, their diagnosis, etiology, treatment and prognosis. It should be clearly understood that the book is essentially a compilation. The Maine Station has never conducted any special investigations regarding poultry diseases, and does not propose to in the immediate future at least. No one connected with the Station at the present time has any expert, first hand knowledge of poultry pathology. This being the case, the Station assumes no responsibility for the contents of this book beyond that involved in the compilation and editing. That is to say, the Station does not guarantee that any of the remedies or treatments herein proposed will cure any diseased condition. It merely puts before the public what appears to be the best and most reliable information now existing regarding these matters. If this information is incomplete, or fails in the attainment of the desired end, the fault lies with the original authority not with the compiler. Further it should be said that no attempt has been made to discuss all the detailed technical accounts of the scientific study of avian pathology, appearing in technical journals in this country and Europe, and the work is, therefore, not complete in this sense. This material is primarily of interest only to the professional student of pathology. This book is not written for him at all, but for the practical poultryman.

It is not intended that this book should displace any of the standard works on diseases in the poultryman's library. On the contrary it is intended merely to supplement these. In fact the writers would most urgently advise that every poultry keeper buy either one or both of the following books:

"The Common Sense Poultry Doctor" by John H. Robinson, Farm Poultry Publishing Co., 232 Summer St., Boston, Mass. Price 50c. This seems to the writers to be, on the whole, the best existing book on diseases for the practical poultryman.

"The Diseases of Poultry." By Dr. D. E. Salmon. For sale by Schmid's Bird & Pet Stock Emporium, 712 Twelfth St., N. W., Washington, D. C. Price 50c. This book gives a more thorough treatment of the subject, but is written rather more from the standpoint of the veterinary practitioner than from the standpoint of the practical poultryman.

In writing this work free use has been made of the standard authorities on the subject, including the books cited above, as well as the following:—

"Diseases of Poultry," by Leonard Pearson.

"Farm Poultry Doctor," by N. W. Sanborn.

"Reliable Poultry Remedies," published by the Reliable Publishing Co., Quincy, Illinois.

"Die Krankheiten des Hausgeflügels," by F. A. Zürn.

"Manual of Poultry Diseases," by Vale.

"Diseases of Poultry," by F. Woodroffe Hill.

Also use has been made of the portions of standard works on poultry husbandry, which deal with disease.

In every case acknowledgement is made to the authorities cited.

CHAPTER I.

General Considerations Regarding the Treatment of Poultry Diseases.

There is general agreement on the part of authorities on poultry pathology and practical poultrymen of long experience that in general, "doctoring" poultry is not advisable. The reasons for this attitude are primarily the following:

1. The unit of production with poultry (i. e., the individual bird) is of relatively small value, and if a man's time is worth anything it is too valuable to spend treating sick chickens individually unless they are show specimens of great individual value.

2. The "cured" chicken is a menace to the owner, because its identity is likely to be overlooked or forgotten, with the result that it goes into the breeding pen and perpetuates through its offspring the constitutional weakness which was one fundamental factor in bringing about the result that it, rather than some of its fellows, was ill.

This point of view has been well stated by Wright in the following words:

"In a large proportion of cases of disease, the birds *ought* to die or be killed. Even where there is no constitutional taint, the fact that they have succumbed to circumstances which have not affected others, marks them out as the weakest, which unaided Nature would assuredly weed out, and which if we preserve and breed from, perpetuate some amount of that weakness in the progeny. Rheumatism, for instance, can be cured; of that there is no doubt. But the vast majority who have had such success, agree that the effects are either *never* recovered from as regards strength and vigor, or else that the original weakness continues; and the same may be said of some severe contagious diseases, such as diphtheritic roup, which may affect the strongest. On the other hand, many diseases also apparently contagious, and so attacking healthy birds under certain predisposing conditions of exposure or other coincident strain upon the system, do not appear to leave serious results behind them, and are tolerably definite in symptoms and character. It is these which may be most successfully treated, and in which treatment is most worth while where fowls of value are concerned. But it is significant that nearly all breeders who rear really large numbers of poultry, gradually come to the conclusion that, except in special cases, with valuable birds, the most economical treatment of serious disease occurring in a yard is—execution. Concerning this matter each must judge for himself."

In the case of the utility poultryman, keeping poultry solely for the eggs and meat they produce, practically the only diseased conditions which it will pay him to treat at all are those in which the treatment can be applied to the flock as a whole, without the necessity of handling individual birds. Thus, for example, in cases where the flock "goes off its feed," or has simple indigestion or a simple cold, the birds can be treated successfully as a flock. On the other hand, in the case of the fancier, who has individual birds of considerable value there will be a much wider range of diseases which he will feel that it is profitable for him to treat. There are, of course, certain diseased conditions which demand individual treatment, but in which the treatment is so simple and the outcome is almost certain to be so good, as to justify its employment even in the case of birds of ordinary value. An example of such a condition is found in a crop bound bird. Robinson sums the matter up very well in the following basic rule for poultry doctoring:

"Give treatment when it can be applied to a flock conveniently and with reasonable expectation of beneficial results, and treat individuals, if necessary, when treatment is simple, easy, and needs to be administered but very few times."

Prevention Rather Than Cure the Ideal.

The aim of every poultry keeper, whether his interest is in the fancy or the utility end of the business, should be to breed and manage his birds so as to prevent entirely, or reduce to a minimum, the occurrence of disease. In other words, the attitude should be that the end to be sought is to prevent the occurrence of disease, rather than to rely on a rather dubious ability to cure it after it is there. Such a standpoint is sound from every point of view; it is in line with the whole development of modern medicine. The poultry doctor should regard his function as the same as that of the Chinese physician, who is primarily employed to keep the patient from becoming ill, only secondarily to cure him.

Now there are fundamentally two factors involved in the continued maintenance of good health in poultry (or, for the matter of that, in any other animal). These are:

1. *A sound and vigorous constitution,* which if present, is something innate and "bred in the bone," and which, if *absent, must be bred into the stock.*

2. A system of *poultry management (including feeding, housing, etc.) which is thoroughly and absolutely hygienic.*

Let us consider each of these factors separately in some detail.

Breeding for Health, Vigor, and Sound Constitution.

To have a high degree of constitutional vigor in the foundation stock is one of the most certain assurances that the poultryman will not be troubled with disease. This is of primary importance. In order to breed constitutional vigor into the flock the poultryman must train himself to recognize at a glance the condition of his birds. Are they in good condition or not? Regarding the aspect of fowls in health and disease Salmon has the following to say:

"We say that a bird is in good health when it appears lively, has a clear eye, a bright red comb, is quick and active in its movements, has a good appetite and when the various organs perform their functions in the manner in which they are observed to act in all birds that are vigorous and thriving. On the other hand, we say a bird is diseased when some function or functions of its body are not performed as they are the great majority of individuals, or when some organ presents an unusual form or appearance. Disease has, therefore, been defined as a life the manifestations of which deviate more or less from the normal. Practically, we say a bird is diseased when we observe that one or more of its functions are not carried on in a normal manner, or when we find unusual growths, injuries, or parasites affecting any of its organs."

In a recent article Dr. P. T. Woods (Amer. Poult. World, Vol. 1, Jan. 1910) gives some excellent advice in regard to breeding for health and vigor. This is, in many respects, the best brief summary of this important subject which we have been able to find in the literature. He says:—

"*The Health Type.*—For all practical purposes, the type of health and strength and the type of weakness, of lacking bodily vigor, are easily differentiated. Do not mistake the purely nervous energy of closely bred thoroughbreds for an indication of vigor. This may be simply the mettlesome spirit of the thoroughbred and alone is of no great value as a guide to health; combined with satisfactory physical qualities it is a desirable asset."

"*Choosing the Male Bird.*—Always bear in mind that the male bird is for all practical purposes half of the flock. The male should be fully matured, well developed specimen, neither too young nor too old. Male birds from twelve months to two and one-half years old usually make the best breeders. He should be the son of sound healthy parents and should, so far as possible, inherit from them the qualities which are desired for chicks of his get. He should be particularly strong in all points or physical vigor, and Standard requirements, where his mates show any traces of weakness. Have him as nearly perfect in Standard shape as possible, and of medium size and weight for the variety. Too heavy males often seriously injure their mates and are not desirable in the breeding pen."

"The head should be rather large, broad and of good shape, well carried. The eye should be bright, round and full with no irregularities in shape of pupil. The comb, face and wattles should be a good healthy color, neither too pale nor too dark. The beak should be rather short, stout and set well at the base. The long, flattened beak of 'crow headed' birds or the misshapen 'hawk bill' are almost certain signs of physical weakness. The neck should be of medium length for the variety and rather full; the long, thin, 'scrawny' neck goes with the 'crow head.' "

"The body should be well filled out and carried in the well-set-up manner indicative of a well ordered system of nutrition,—a good digestion. The plumage should be bright, lustrous and carried rather closely for the variety."

"Mopey, dopey, loosely feathered birds with dull plumage and a listless 'don't care for life' manner are too short on good health to be of value as breeding stock."

"The legs should be medium short for the variety, strong and rather large boned and set well apart. The keel bone should be firm and straight. There should be no deformities."

"Leggy birds, knock-kneed and with crooked breast bones are always lacking in physical vigor even if it does not show on the surface."

"The male should be attentive and gallant to his mates, should have a clear lusty crow, free from any rattle at the end. He should be sound in wind and able to fight or run without shortness of breath or livid appearance of face and comb."

"A good breeder will have a good appetite and will usually be of a rather 'scrappy' disposition, disposed to resent any interference with his mates by other fowls or by the attendant."

"*Choosing the Female.*—The female should be a well-grown, well-developed, fully-matured pullet or sound and vigorous yearling or two year old. The health type will be active, alert and inclined to be talkative, 'singing' cheerfully, and disposed to scratch and forage. She is usually the first off the roost in the morning and the last to go to bed at night. Head, eye, condition of plumage and leg requirements are practically the same as those called for under 'Choosing the Male Bird,' making due allowance for sex."

"The body should be broad, deep, well filled out and medium large for the variety. The breast should be broad, full and well meated; the back should be broad and the tail well spread at the base. Wry tails, crooked backs or keels, or pinched tails should disqualify for the breeding pen. The abdomen should be well carried and rather full, but should not 'bag down.'"

CHAPTER II.

Poultry Hygiene.

Second in importance only to high constitutional vigor and health is attention to the basic rules of hygiene and sanitation in the management of poultry. In view of the prevalent misunderstanding or lack of understanding of these principles it seems wise to devote one chapter to an outline of the more important points which need to be looked after in hygienic poultry keeping. 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 insanitary 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. Again, many men who do not carry fire insurance on their buildings go through life without having any of them burn down. But this is no argument against the fact that it is a sound economic policy to carry fire insurance. 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 7 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 *at least* 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.

How to clean a poultry house: Not every poultryman of experience even, knows how *really* to clean up a poultry house. 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 dressing 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 it to dry. For this purpose 3 per cent cresol solution 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 this section. To complete the cleaning of the house, after the second spraying of disinfectant is dry 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 like Zenoleum, Carbolineum or a host of other "eums" which confront him at every turn in his reading of poultry periodicals, or he may buy a plain disinfectant like formaldehyde, or carbolic acid.

The 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, but after trying it out it was necessary to abandon it as a general poultry house disinfectant. The difficulty was that a man could not stand 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. Dr. P. T. Woods has recently advocated the formaldehyde gas method for disinfecting poultry houses, 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. Open drawers and doors of bureaus, wardrobes, and closets to allow free access of the gas. 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 permanganate and 3 pints of formaldehyde to each 1000 cubic feet of space.*

For general disinfectant purposes about a poultry plant the Station has found the cheapest and most effective disinfectant 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 this 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 satisfactory a 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. It can be obtained through any druggist. On the day that this was written the quotation on cresol in the New York market is 24 cents per pound. In purchasing this article one should order simply "commercial cresol."

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 ½ 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, 8½ 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 a 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

*See in this connection the modification of the Maine Station colony house to insure circulation of air, as given in U. S. Dept. Agr. Farmers' Bulletin 357.

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 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, but there are certain basic principles of hygienic feeding which must always be looked after if one is to avoid diseases. There are:

A. Purity. It should be a rule of every poultryman never to feed any material which is 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.* The Station has found green sprouted oats, when properly prepared, to be an excellent source of winter green food. Full directions for sprouting oats are given in Bulletin 179 of the Maine Station, a copy of which may be had upon application to the Director of the Station.

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 add enough of the stock solution 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 Station plant for some 2 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.

Dr. G. B. Morse, the well known authority on poultry diseases of the Department of Agriculture, had the following to say regarding this point in a recent address (Rel. Poult. Jour. Oct. 1910). After describing the potassium permanganate method, as well as two others, directed to the same end, but in the opinion of the present writers not so desirable as this, he goes on to say: "Water-borne diseases are frequent in the poultry yard. Clean and disinfect your drinking-fountains (and you must) ever so well, if you are permitting, consciously or unwittingly, to run at large one bird sick with any of the contagious diseases of the head parts or with bowel diseases, you may count on that water supply being contaminated in less than one hour's time. In the case of a large flock affected with flagellate diarrhoea I have myself found the flagellates in less than one hour's time in the drinking water which had been sterilized and placed in thoroughly disinfected fountains. Do you not see where such a condition as this forces you? Right up against the principle of the individual drinking cup. Ridiculous, do you say? Not a bit. I did not say 'the individual drinking cup,' but the 'principle of the individual drinking cup.' Boards of health are recognizing that by means of the common, public drinking-cup foul and terrible diseases are being spread among people. It is just so with your poultry, and while you cannot adopt the individual cup you can incorporate the principle of it in your hygienic methods by adding * * * * * one of the antiseptics named. It is true, in the proportions named, these remedies do not disinfect the water, only act as antiseptics, that is, act to hinder the developement of bacteria and other microbes. The water itself should be changed frequently. This hindering of microbian growth occurs not only in the fountain but is kept up in the intestinal tract."

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 3 year rotation is entirely feasible and serves its purpose well. Such a system of cropping would be something as follows: First year, chickens; second year, a hoed crop, like beets, cabbage, mangels or corn, the ground to be seeded down to timothy and clover after the crop is taken off; third year, in grass; 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 plowing and harrowing thoroughly annually, 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 appearance, 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. If the soil becomes at all foul it is a good plan to water it with a 1 per cent solution of sulphuric acid, or to apply a light dressing of gas lime."

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. Directions for dealing with this matter are given in detail farther on in this book in the chapter on External Parasites. 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, as in the song, it is wise to dig the grave "both wide and deep," especially deep. Otherwise, through the aid of foxes, dogs, skunks, or other creatures, the dead may "rise again" in a literal and most insanitary 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.**

CHAPTER III.

The Diagnosis of the Diseases of Poultry.

The first thing that the poultry keeper whose birds are ill wants to know is: *"What ails my chickens?"* Before he can use this or any other book on poultry diseases effectively in getting advice for the treatment of disease he must diagnose the trouble. It is the purpose of this chapter to help him do this, and in this way make this book more useful to the practical poultryman. At the outstart it should be said that *the absolutely certain differential diagnosis of particular diseases of poultry, by the farmer or poultryman, either on the basis of external symptoms or post-mortem examination is in nearly every case impossible. The best that can be done practically is to determine into what general class of diseases a particular trouble falls.*

There are two general sources of information upon which to base a diagnosis of disease. These are:

I. External symptoms.

II. Post-mortem examination.

EXTERNAL SYMPTOMS, WITH A TABLE TO AID IN THE IDENTIFICATION OF THE CHIEF CLASSES OF POULTRY DISEASES.

There are certain external symptoms which are characteristic in a way of nearly all diseases. These symptoms merely indicate that the bird is *sick;* they are of *no value* for purposes of differential diagnosis.

These general symptoms of illness may be described as follows: A sick fowl is usually quiet, and does not move about unless disturbed. It stands or sits with the neck contracted so that the head is pulled well in to the body, giving the bird a "humped up" appearance. The eyes are often closed, entirely or partly, giving the bird a sleepy appearance. Often the feathers are roughened and stick out all over the body. The comb and wattles may be dark or, on the other hand, may be very pale.

When a bird shows these general symptoms of illness it should be picked up and isolated and an effort made to obtain a more precise diagnosis. In doing this the following table of the chief external symptoms may be found of use.

This table aims to direct one to the discussion of *general classes* of disease. The identification of special individual diseases should be attempted only after reading over the chapters covering the general class involved. In general it should be kept in mind that *this table is not intended to tell the reader what the disease he finds is, but solely to tell him what parts of this book to read in any given case in order to make a diagnosis.*

Table of External Symptoms which may be of Some Value in Differential Diagnosis.

The numbers in brackets denote the pages to be consulted.

SYMPTOM.	Diseases which the symptom named *may* indicate.
Abdomen swollen..........	Peritonitis (72), Dropsy (73), White diarrhea (181).
Belching of gas............	Inflammation of crop (34).
Breathing abnormal (i. e.), too rapid, too slow, wheezing, whistling, snoring or in any different from normal.........................	Diseases of the respiratory system (85), Arsenic poisoning (44), Pericarditis (112), Gapes (195), Air-sac mite (110).
Choking....................	Arsenic poisoning (44).
Comb, pale.................	Tuberculosis (57), Dropsy (73), Air-sac mite (110), Infectious leukæmia (114), White diarrhea (181).
Comb first pale, but later dark......................	Enteritis (39).
Comb, very dark............	Liver disease (47), Blackhead (53), Congestion of lungs, (107), Pneumonia (108).
Comb, yellow...............	Liver diseases (47), Visceral gout (121).
Comb, with white, powdery scurf......................	White comb (150).
Constipation...............	Simple constipation (41), Indigestion (42), Inflammation of oviduct (165).
Convulsions...............	Arsenic poisoning (44), Copper, lead or zinc poisoning (44), Epilepsy (119), "Harvest-bug" (145).
Cough	Diseases of the respiratory system (85).
Crop, enlarged and hard...	Crop bound (32).
Crop, enlarged and soft.....	Inflammation of crop (34), Enlarged crop (36), Gastritis (36).
Diarrhea....	Diseases of the alimentary tract (32), Arsenic poisoning (44), Copper, lead or zinc poisoning (44), Blackhead (53), Tuberculosis (57), Cholera (66), Roup (90), White diarrhea (181).
Nostrils, discharge from...	Diseases of the respiratory system (85).
Emaciation	Tuberculosis (57), Aspergillosis (104), Visceral gout (121) Mites (132), White diarrhea (181).

Table of External Symptoms—Concluded.

The numbers in brackets denote the pages to be consulted.

SYMPTOM.	Diseases which the symptom named *may* indicate.
Eye, expansion of pupil....	Arsenic poisoning (44).
Eye, sticky discharge from.	Catarrh (87), Roup (90).
Face, swollen..............	Roup (90).
Droppings, bright emerald green......................	Cholera (66).
Fever, marked.............	Peritonitis (72), Aspergillosis (104), Infectious leukæmia (114), Inflammation of oviduct (165).
Lameness..................	Tuberculosis (57), Aspergillosis (104), Rheumatism (123). Scaly leg (135), Bumble foot (202).
Legs, roughened, with scales raised...............	Scaly leg (135).
Mouth, mucous discharge from......................	Congestion of the lungs (107), Pneumonia (108), Gapes (195).
Mouth, white, cheesy patches in................	Roup (90), Canker (103).
Nausea and *Vomiting*.....	Inflammation of the crop (34). Copper, lead or zinc poisoning (44).
Neck, bent backward.......	Strychnine poisoning (45), Congestion of the brain (119), Wry neck (123).
Neck, limp.................	Limberneck (123).
Paralysis	Copper, lead or zinc poisoning (44). Strychnine poisoning (45), Apoplexy (118), Heat prostration (118).
Saliva, copious secretion...	Arsenic poisoning (44).
Skin, puffed out in blisters.	Emphysema (194).
Skin, scaly and incrusted...	Body mange (144), Favus (147).
Staggering.................	Congestion of the brain (119), Leg weakness (192).
Thirst, excessive...........	Hypertrophy of the liver (50), Peritonitis (72), Aspergillosis (104), Tapeworms (76).
Tongue, hard and dry......	Pip (102), Diseases of the respiratory system (85).
Tumors on head...........	Roup (90), Chicken pox (150).
Urates, yellow.............	Cholera (66).
Vent, mass of inflamed tissue projecting from.......	Prolapse of oviduct (167).
Vent, skin inflamed.........	Vent gleet (177).

POST-MORTEM EXAMINATIONS.

Whenever a bird dies from a cause not entirely clear to the poultryman a post-mortem examination should be made in order to learn, if possible, from the condition of the internal organs what it was that caused death. The poultryman should familiarize himself with the appearance of the internal organs in a normal state of health, so that he may at once recognize any departure from these normal conditions.

The following directions and general advice regarding the making up of autopsies is taken from the English poultry journal "Poultry":

"*How to make a post-mortem examination, so that these various organs can be seen and examined, and so that a general opinion can be formed as to their condition of health or otherwise.* Let it be understood that a very large number of poultry which die are victims of some entirely simple complaint, such as enlargement of the liver, or tuberculosis in the lungs. These complaints are easily recognizable, and there is no reason at all why any farmer or amateur poultry keeper should not be able to form a general opinion as to whether his poultry are dying off from some such complaint as one or other of these. Take the dead bird and lay it on a wooden table or on a piece of strong board, breast uppermost. Spread out the wings and the legs, putting a small nail through the joint of each wing and through the center of each foot. It is not necessary for the bird to be entirely plucked; it will be enough to pluck the breast, and when this has been done pinch up the skin at the point of the breast bone, and cut it straight through from the vent to the crop. Having done this, draw back the skin on both sides so as to leave the flesh fully exposed, and then with a sharp knife cut through the flesh on both sides of the breast bone, and with a strong, blunt pointed pair of scissors, cut out the center of the breast bone entirely, taking particular care in doing so not to injure the heart, as a flow of blood from the heart will interfere with subsequent operations. When this has been done the principal organs will be seen clearly exposed."

"First of all examine the liver. To be perfectly healthy, it should be of a rich chocolate brown color, free from any specks, and free from any discoloration (although there are sometimes post-mortem discolorations at the edges, which are easily recognizable). If the liver contains any specks it is unhealthy, as it should not be what is known as pasty or rotten. Healthy and firm to the touch and of the proper color, is the general description to apply to the liver. The heart should then be looked at, and it should also be quite firm, free from any excessive covering of fat, and also quite free from little nodules of tuberculosis. Another thing about the heart is that it should be even lobed—that is to say, it should not be distended on one side and empty on the other; if it be so, the probability is that the bird has died from heart failure, and supposing it is known that the bird did die suddenly, this can at once be accepted as the cause—syncope, failure of the heart's action, which always ends in very sudden death, the bird simply dropping down dead without any warning. The lungs, which will be seen on either side at the back of the heart, are spongy looking bodies of a pink color. If a piece of one of the lungs can be cut off and be placed in a bowl of water it should float, not sink, or it will be unhealthy. Always look at the lungs for tuberculosis, which is usually to be detected there,* and is indicated by little cheesy nodules in the substance of the lungs, which cannot possibly be mistaken; sometimes the lungs and the heart will all be eaten by these tuberculous masses. If no disease has been found so far, proceed to examine the crop and the gullet, also the windpipe. With regard to the crop, it might almost be examined first if it is full of food, and apparently in a state of congestion, to see whether there be a stoppage in the opening from the crop to the proventricle. The gullet and windpipe can also be examined to see if there is anything unhealthy about them. Similarly an examination can then be made of the intestines, and in the case of a hen the egg organs can be carefully dissected to see whether there is a broken egg, or whether any egg substance has escaped into the cavity of the abdomen and set up inflammation."

"There is no difficulty about making an examination of the skull, and the amateur with a little practice will very easily be able to do this. The way to set about it is to start at one corner of the mouth, and with a pair of sharp pointed scissors cut around the skull to the other corner of the mouth; it will then be quite an easy matter to lift up the skull from the back, and the brain will be clearly seen. This should be perfectly clear, and if there be any trace of a slight effusion of blood, it will be positive evidence of an apoplectic seizure, and will confirm the symptoms of apoplexy, which are delirium, resulting, after a few hours or a few days helplessness, in death. These, then, are

* This is usually *not* the case (see below p. 62). This writer has probably mistaken aspergillosis lesions of the lungs for those of tuberculosis. Note added by compiler.

the principal points, and any amateur can make a simple matter-of-fact examination such as has been described, very often with considerable satisfaction to himself."

In order to get the benefit of the descriptions given in this book of the post-mortem appearances of organs in various diseases, the poultryman should proceed as follows. If the liver, for example, of a dead bird appears to be abnormal, look up in the index of this book the entry *"Post-mortem appearance of."* Under this will be found a heading "liver," followed by the page numbers 40, 47, 49 to 56, 61, 68, 113, 115, 121, 188, 194. This means that on each one of the pages listed will be found a description of the post-mortem condition of the liver in a bird dying of some particular disease. Similar entries are made for other organs. In this way the post-mortem examination may be made to aid directly and quickly in the diagnosis of disease.

CHAPTER IV.

Poultry Materia Medica.

It is the purpose of this chapter to give an account of the drugs and remedies which the poultryman will find it well to be supplied with; directions for making various solutions; tables of weights and measures and the like.

THE MEDICINE CHEST.

The following drugs and medicines will be found useful to have at hand.

Calomel (subchloride of mercury).—"This is a very useful alterative medicine for fowls, 1 grain pills frequently having a good effect on the liver. When given it should be followed in two hours by a dose of castor oil. Some authorities oppose the use of mercury in any form for poultry, but there have been numerous cases when it has produced good results." (Bradshaw.)

Cayenne.—"Is considered to be an excellent liver stimulant when given in small quantities. In cases of colds it is also useful, and forms one of the ingredients in the spices so much used to stimulate winter laying." (Bradshaw.)

Catechu.—"In powder or tincture form, in combination with powdered chalk, is a good remedy for diarrhea. The average dose of powdered catechu is from 2 to 5 grains, and of the tincture from 2 to 5 drops." (Bradshaw.)

Castor oil.—"Although apparently paradoxical, this is one of the best remedies for diarrhea. The latter is frequently due to some fœtid matter in the intestines; a dose of oil will usually remove this, and often diminish the diarrhea. It is also used in cases of crop-bound fowls. A teaspoonful poured down the throat, and the mass kneaded with the fingers, and then warm water poured down will soften the matter, and frequently effect a cure." (Bradshaw.)

Epsom salts (magnesium sulphate).—"Is one of the simplest, cheapest, and most effective poultry-yard drugs. It is useful in liver disease, diarrhea, and many other complaints. Half a teaspoonful for a full-grown fowl is a standard dose. It can be mixed in the soft food, but is more effective by starving the fowl for a few hours, dissolving the salts in warm water, and pouring it down the bird's throat. Epsom salts always act best accompanied with a good quantity of water." (Bradshaw.)

The following table of doses of Epsom salts for young birds has been worked out by Gage and Opperman:

Age of Bird.	Amount per Bird in Grains.	How Administered.
1 to 5 weeks	10 grains	In feed
5 to 10 weeks 7	15 grains	In feed
10 to 15 weeks	20 grains	In feed
15 weeks to 6 months.	30 grains	Two teaspoonful of water to every 30, 40 or 50 grains of salt.
6 months to 1 year	35 grains	
1 year and over	40-50 grains	

Cotton Seed Oil.—"Olive and salad oils are useful when hens are egg-bound, for diarrhea, and also for external use in dressing torn combs and other wounds. In eye troubles it takes the place of a simple lotion." (Bradshaw.)

Bichloride of mercury, 1 to 1000 solution.—To make this the simplest way is to buy of the druggist bichloride of mercury tablets, and ask him to label the box to show how much water a tablet must be dissolved in to make a 1 to 1000 solution. If one desires to mix it up for himself ask the druggist to make up some *1 gram* (15½ *grain*) powders of bichloride of mercury. Dissolve 1 of these powders in a quart of water. Put in enough laundry bluing so that the color will be deep blue. Then the solution, which is highly poisonous, will never be mistaken for water.

"1 to 1000 bichloride" is a germicide and disinfectant for external use, cleansing wounds and the like.

Medicines in Tablet Form.—One of the most convenient forms in which medicines may be administered is in tablets. Wholesale and mail-order drug houses carry extensive lines of these graded as to dosage. They may be administered to poultry very easily and conveniently by holding the bird's mouth open with one hand and with the other thrusting the tablet far enough back in the throat so it will be swallowed.

The following list of tablets will be found useful to the poultryman. They fairly well cover the medicines recommended in the body of this book. Any poultryman may get these either from his local druggist, or if he cannot furnish them, they can be purchased by mail at approximately the prices named from The Frank S. Betz Co., Hammond, Indiana.

	Price per 1000
Salicylic acid, 2½ gr.	.70
(For use in rheumatism.)	
Aconite root, 1-10 gr.	.50
(For use in fevers.)	
Antiseptic tablets, *Blue,* Corrosive sublimate, 7.3 grs.; Ammonium chloride, 7.7 gr. Price, 35c. per 100.	
(For making 1 to 1000 bichloride solution. One tablet dissolved in 1 pint of water gives a solution of that strength.)	
Bismuth subnitrate, 1 gr.	.80
(For intestinal irritation.)	
Calomel, ¼ gr.	.40
Iron, Quinine and Strychnine	.80
(For use as a tonic, dose 3 per day.)	

In administering tablets in the manner suggested care should be taken to see that they are swallowed, and not coughed up.

AN ANTISEPTIC OINTMENT FOR USE ON CUTS AND WOUNDS OF ALL KINDS.

The following ointment may be made up by the poultryman and will be found useful in the treatment of cuts, sores and wounds of all kinds of poultry and stock in general.

Oil of origanum	1 oz.
Cresol	¾ oz.
Pine tar	1 oz.
Resin	1 oz.
Clean axle grease	8 oz.

Melt the axle grease and resin and stir in the other ingredients. Pour off in a tin box or can to cool. In making this, clean axle grease from a freshly opened can should be used.

TABLES OF APOTHECARIES WEIGHTS AND MEASURES AND THEIR METRIC EQUIVALENTS.

APOTHECARIES WEIGHTS.

Pound		Ounces (Troy)		Drachms		Scruples		Grains		Grams.
1	=	12	=	96	=	288	=	5760	=	373.23
		1	=	8	=	24	=	480	=	31.10
				1	=	3	=	60	=	3.9
						1	=	20	=	1.30

APOTHECARIES MEASURE.

Gallon		Pints		Fluidounces		Fluidrachms		Minims		Cub. cm
1	=	8	=	128	=	1024	=	61440	=	3785.00
		1	=	16	=	128	=	7680	=	473.11
				1	=	8	=	480	=	29.57
						1	=	60	=	3.75

COMMON MEASURE.

A *teacup* is estimated to hold about 4 fluidounces, one gill.
A *wineglass* " " " " 2 " "
A *tablespoon* " " " " ½ " "
A *teaspoon* " " " " 1 fluidrachm.

CHAPTER V.

Diseases of the Alimentary Tract.

The arrangement of the digestive organs in birds differs from that in other domestic animals in that the mastication of the food does not take place in the mouth. The food of birds, consisting mainly of grains and seeds, is swallowed whole into the crop. It remains here until it is completely softened by the juices secreted by this organ. The food then passes into the stomach (proventriculus) where it is mixed with still other juices, and then into the gizzard. The muscular walls of the gizzard grind the softened food against the small pebbles (grit) which the bird picks up, until it becomes a paste. This paste is then passed into the intestines and mixed with the secretions from the liver, pancreas and the intestines themselves. The nutritive elements of the food are transferred through the intestinal walls, by means of the activity of the cells composing these walls, into the blood and are carried to various parts of the animal to be used in building up the tissues.

In the wild state birds are forced to hunt for their own food. They go about gathering in a few seeds here and there but probably at no time is the crop overloaded. Under conditions of domestication the birds are fed only once or twice a day and thus the crop is often gorged with a day's supply of food. Further the lack of sufficient grit, lack of exercise and the feeding of rich, soft mashes cause the birds to be predisposed towards indigestion. Under these conditions poultry are subject to a large number of disorders of the digestive system.

DISEASES OF THE CROP.

Impacted Crop (Crop Bound).

In general two immediate causes may be given for birds becoming crop bound. (1) The thin muscular walls may be paralyzed either through over-distention with dry grain or through some disease, as cholera and diphtheria. (2) The opening into the lower portion of the œsophagus may become clogged by long straws, feathers or other substances. In either case the crop fails to empty itself while the bird continues to eat until the crop is greatly distended and packed solid.

Impacted crop is a common disease of poultry. A large number of things have been assigned as a cause for this trouble. It is probable that the real cause lies in low vitality due to improper feeding and indigestion. On this point Robinson says: "We say that the dry hay the fowl may take into the crop causes impaction, but the fact is that it is only in occasional instances that it does cause impaction. Far oftener the fowl eats dry hay or corn fodder till its crop is bulging, and is never seen to be at all the worse for it. I have seen this so often, that though an occasional case of impacted crop might properly be attributed directly to the overloading of the crop, the occurrence of a number of such cases in a flock at about the same time, would suggest that the real cause was indigestion, or weak digestion. I have repeatedly given fowls, which all their lives had been handled to make and keep digestive organs in first class condition, all other conditions for developing cases of impacted crops, but have never been able to get a case that way."

Treatment.—If a large number of crop bound birds occur in a flock, it should be taken as a sign that something is wrong in the management. Measures should be taken to correct errors in feeding and thus give the birds a more vigorous digestion. In such epidemics other evidences of indigestion are usually present and the particular treatment of the flock will depend largely on these other symptoms. In general the birds should not be fed too much at any one time and they should be encouraged to take as much exercise as possible, and should have plenty of green food.

When a crop bound bird is found it must be treated individually. Treatment in such individual cases is quite often successful. The profitableness of such treatment must be decided by every poultryman for himself. If the crop bound condition is discovered and treated at the *beginning* of the trouble the bird will usually recover quickly and may make a profitable fowl. On the other hand if the condition has become chronic the vitality of the bird is greatly lowered. In this latter case it may recover but it will be a long time before it will repay the owner for his trouble and feed.

If swelled grain is the cause of the impaction the bird may often be successfully treated without an operation. In this case first give the bird a tablespoonful of castor oil. After allowing this a little time to work into the crop begin to knead the hard mass. After this mass has been softened hold the bird with head downward and attempt to work the grain out through the mouth. If unsuccessful in this or if the impaction is due to clogging with straw or other material it will be necessary to open the crop.

The following method for this operation is given by Sanborn (Farm Poultry Doctor): "If someone can hold the bird for you it will make the operation easier. Pluck out a few feathers and then cut through the skin over the crop a line about 1 inch long. This cut should be in the median line of the body. Then make an incision ¾ of an inch long through the crop. The distention of the crop will cause the opening to gape, and the mass will be in plain sight. With toothpicks, blunt pointed scissors, tweezers, or similar tools, take out the contents of the crop. This done run the finger into the crop and make sure that there is nothing remaining to obstruct the outlet to the organ. When sure all is right, take 3 or 4 stitches in the opening in the crop, making each stitch by itself and tying a knot that will not slip. Then do the same thing to the cut in the skin. For stitches use white silk (or if nothing better can be obtained) common cotton thread, number 60. Keep the bird by itself for a week, feeding soft food."

The above operation is not a difficult one and is usually successful. Care should be exercised to have the hands and instruments thoroughly clean. After the contents of the crop have been removed the wound and the empty crop itself should be *thoroughly* washed out with clean, warm (108° to 110° F.) water. The edges of the skin wound should be well greased with vaseline. It is well to feed the bird only milk for the first day or two.

Inflammation of the Crop.

Inflammation or catarrh of the crop usually accompanies more or less general disturbances of the digestive system. As a result of the irritated condition of the mucous membrane the functions of the crop are disturbed or arrested. It is said to be caused by eating indigestible, decayed, or poisonous food. "The foods and substances specially mentioned as causing inflammation of the crop are: Decomposed meats and putrid foods of any kind, unslaked lime, paint skins, rat poison, excessive use of condiments and spices, milled by-products containing too large proportions of hulls or other indigestible fibrous particles. Salmon notes that it may result from the presence of worms in the crop, and that it occurs as a complication with thrush, diphtheria, and cholera. It also occurs frequently with gastritis." (Robinson.)

Diagnosis.—"The most prominent symptom is distention of the crop, and on examination the swelling is found to be soft and due to accumulated liquid or gas, mixed with more or less food. The birds are dull, indisposed to move, and there is belching of gas, loss of appetite and weakness. Sometimes there is nausea and the affected bird attempts to vomit. Pressure upon the crop causes the expulsion through the mouth of liquid and gas having an offensive odor due to fermentation." (Salmon.)

Treatment.—The first step in the treatment of this disease is to empty the crop as completely as possible. This can be done by holding the bird head downward and carefully pressing and kneading the crop. After most of the contents have been expelled in this way give the bird several spoonsful of lukewarm water and then empty the crop as before. Give a slight purgative such as a small teaspoonful of castor oil. The bird should be kept without food for 12 to 20 hours and then fed sparingly on soft, easily digested material. Salmon recommends giving 2 grains of subnitrate of bismuth and ½ grain of bicarbonate of soda in a teaspoonful of water to relieve irritation and to correct acidity. Salicylic acid, 1 grain to an ounce of water, is also recommended. The dose is 2 to 3 teaspoonfuls. Hill recommends the feeding of mucilaginous fluids such as barley-water, thin solution of gum, etc. If the inflammation is due to eating poisons antidotes as given farther on (Chapter VI) should be used.

If inflammation of the crop is at all general throughout the flock an effort should be made to remove the cause. It is well to change the feed and give the birds more exercise. The addition of fine charcoal (small chick size) to the mash will ofen be of service, as the birds eat more of it in this way than when the charcoal is in a box by itself.

Enlarged Crop.

"The crop sometimes becomes very much enlarged and prominent, but hanging loosely, not bulging and hard, as in impaction of the crop. This form of permanent enlargement and displacement is called enlarged crop, slack crop, or pendulous crop. It may exist with little inconvenience and detriment to the fowl." (Robinson.)

According to Sanborn the cause of this is irregular feeding resulting in overloading. Robinson, however, says that while "this may be the cause in a great many cases, yet it can hardly be the sole cause, for cases of slack crop are not infrequently found in fowls that have been well and regularly fed. If a fowl is fed heavily, and from any cause (as indigestion) the crop remains full and distended too long, though this condition may in time be relieved in the natural way without interference of the keeper, the effect on the crop is the same as if the overloading had occurred because of irregular feeding. If this condition is repeated several times the walls of the crop become in some degree permanently distended."

An enlarged crop and an enlarged or "baggy" abdomen are frequently associated in the same bird. These are probably due to too heavy feeding without sufficient intervals between meals and without sufficient exercise.

Treatment.—As stated above, a "baggy" crop often gives little or no apparent inconvenience to the fowl. In the case of a very valuable bird it might be worth while to operate. Sanborn states that this defect can be remedied by cutting out of the enlarged portion of the crop a diamond or oval shaped piece of tissue about 2 inches long and 1 inch wide. The edges should be sewed together and treated as directed for impacted crop. (Cf. p. 34). The general surgical methods described in the chapter on Poultry Surgery (Chapter XX) should be followed.

DISEASES OF THE STOMACH (PROVENTRICULUS).

Inflammation of the Stomach—Gastritis.

The stomach or proventriculus in fowls is a rather small organ. It is a thick, glandular walled section of the alimentary canal lying between the crop and the gizzard. Inflammation of this organ is usually associated with a similar disturbance of the crop. In a few cases there appears to be inflammation of the stomach alone. Diagnosis in this case is very difficult.

The cause of gastritis is usually regarded as the same as that of inflamation of the crop (cf. p. 34).

Diagnosis.—In general the symptoms are very similar to those in cases of inflamation of the crop (see p. 34). The birds present the general appearance of being sick, viz., loss of appetite, indisposition to move and roughness of plumage. Constipation quite often accompanies gastritis. However, if the inflammation extends to the intestines there may be diarrhea.

Treatment.—"If the disease is identified in its early stages, seek for its cause and endeavor to overcome it by removing the cause. Change the ration and give more easily digested food with some meat. Feed regularly, often, and a small quantity at a time. Give some cooked food with barley water or milk for drink, or put 20 grains of bicarbonate of soda to a quart of drinking water. In severe cases give 2 grains of subnitrate of bismuth 3 times a day in a teaspoonful of water. Counteract constipation with Epsom salts (20 grains) or castor oil (one teaspoonful) once a day as long as may be necessary." (Salmon.)

"Give rice water for drink, soft mash made with the water in which clover hay has been cooked. Arsenite of copper, 1/4 grain to each quart of the rice water (drink) will do for medicinal treatment." (Sanborn.)

As Robinson points out the important thing in treating this disease is to change the food in so far at least as to remove the cause of the trouble. Medical treatment without the removal of the original cause will be of little avail. The addition of fine (chick size) charcoal to the mash and the generous use of good green food are recommended.

DISEASES OF THE INTESTINES.

Simple Diarrhea.

In many fowls a condition of mild diarrhea is chronic throughout the life time of the bird. Again birds often acquire a slight diarrhea which will last for a longer or shorter time, but never becoming severe. In either of these cases the bird shows no symptoms of disease other than the watery droppings. No doubt such attacks are in some degree detrimental to the best health of the bird. In most cases of this simple diarrhea the bird will recover without any treatment. Nevertheless the careful poultryman will watch his dropping boards for signs of "looseness." When such are found in any quantity the methods of feeding and housing should be carefully examined to see if the cause does not lie in them.

Concerning the normal droppings of fowls, Robinson says: "Normally the droppings of fowls are rather dry, retain the shape in which they are voided, and may readily be removed, leaving the spot on which they had fallen either slightly stained, or not at all."

Further, about 1-3 of the normal droppings consists of a whitish substance. This is the uric acid and urates excreted by the kidneys and is removed from the cloaca along with the feces.

"Without marked departure from the normal, droppings may be wet—watery—with a tendency to flatten on the surface on which they rest. On boards they moisten the surface for some distance around them. * * * It is perhaps most appropriately described as "looseness." It is not diarrhea, though fowls having it are probably more susceptible to intestinal diseases than others. Mere looseness of the bowels is not accompanied by any offensive odor.

"When the excrement becomes soft and pasty or liquid in consistency and whitish, yellowish, greenish or brownish in color, and has a more or less marked offensive odor, the condition is properly described as diarrhea. The evacuations in diarrhea are often of such consistency that the water in them is not readily taken up by absorbents with which they come in contact, and they are decidedly nasty, not only adhering to utensils used in removing them, and making ordinary cleaning difficult, but soiling the feathers of the fowls and sticking to roosts, nests and feed troughs." (Robinson.)

Diarrhea may result simply from an upsetting of the digestive organs due to improper feeding or it may be a symptom of some more serious disease. Simple diarrhea may arise from the presence of indigestible matter in the alimentary canal, it may be due to exposure to heavy rains or to draughts in the roosting house. In the latter cases a cold develops which affects the bowels rather than the head and lungs. Diarrhea from colds occurs much more frequently than is generally supposed. This form of diarrhea can often be recognized by the greater amount of frothy mucus in the excrement. Young stock are much more susceptible to diarrhea from colds than are adult birds.

Among other common causes of simple diarrhea may be mentioned soured or decomposing food, too much green food at irregular times, too free use of animal food, allowing the birds access to water which has become soiled with excrement and allowed to stand in the hot sun until about putrid. Whatever may be the inducing factor the immediate cause is excessive bacterial fermentation in the alimentary canal.

Treatment—Simple diarrhea will usually require no treatment other than removing the original cause. This latter is by far the more important thing to be done. If neglected the condition may become chronic and may result in more serious disturbances of the alimentary system. It is often beneficial to replace part of the bran in the mash with middlings or low grade flour. Where in addition medical treatment seems desirable the first thing to do is to remove the fermenting material from the intestinal canal. This can be done with Epsom salts, using a small half teaspoonful to each bird. This should be dissolved in water and used to mix the mash. If more convenient a teaspoonful of castor oil may be given each bird. If the diarrhea is persistent Hill recommends 3 to 6 drops of chlorodyne as an unfailing cure.

Enteritis—Dysentery.

For practical purposes we may associate most of the severer forms of diarrhea with the above names. Simple diarrhea was defined as either a temporary or chronic affection of the intestines from which the bird appeared to suffer but little. Practically its only symptom is the watery or discolored discharge. Under the names of enteritis, dysentery or severe diarrhea there are listed several of the more serious infections of the intestines. From the medical standpoint enteritis is the name given to affections of the small intestines while dysentery is applied to the disease in the large intestine. The latter is usually accompanied by mucous and bloody discharges. In the diseases of poultry, however, it is hardly necessary for anyone other than a pathologist to distinguish betwen these different forms.

Etiology.—A variety of causes are responsible for these more acute forms of intestinal trouble. It may be a bacterial infection coming from filthy conditions. Foul drinking water, putrid meat or decaying food of any sort may be predisposing causes. Toxic enteritis or poisoning is caused by the birds eating such things as paint skins, lye, unslaked lime, salt, ergot of rye, arsenic and copper (in spraying mixtures) (cf. p. 44). Further simple diarrhea may develop into the more acute form. This latter is due to improper food, water or housing, and is probably closely associated with bacterial enteritis. Various intestinal parasites may cause severe diarrhea.

Diagnosis.—It is often very difficult to distinguish between the different infections of the intestines in the living birds. Woods (Reliable Poultry Journal) gives the following symptoms of enteritis: "The affected bird is inactive and dumpish. The comb is at first pale and limp, and later becomes dark and purplish. There is an abundant dark or greenish diarrhea. Diarrhea may become bloody. The bird appears sleepy and unwilling to walk around. The bird may be sick a week or several weeks before death takes place. Some birds recover without treatment. The appetite may be voracious, or the birds may refuse to take food. The crop may be full of food, or may contain only a little slimy fluid. When the bird dies, the comb is always dark. Often the bird may appear dumpish and sleepy, and show a bad diarrhea; the owner, picking the bird up to examine it, finds it has lost weight; holding it head downward, a stringy, dirty liquid runs from the mouth, and death of the bird soon follows. In such cases, the bird has been sick several weeks before it was noticed. Examination of the body after death shows the liver enlarged or shrunken, according to the duration of the disease. If of long duration the liver is shrunken. The spleen is usually enlarged. The intestines are inflamed and are full of mucus."

"The evacuations may show any or all of the color conditions commonly observed in cases of severe diarrhea, watery, mixed watery and solid, whitish, greenish, bluish green, brown, red, bloody. Particular colors or conditions may represent the degree to which different organs are affected, or indicate to an experienced eye the progress of the disease, but to the layman they have no special significance." (Robinson.)

Treatment.—If possible the cause of the trouble should be ascertained and removed. This is by all means the first and most important step to take. It is useless to spend valuable time in doctoring sick birds while the conditions which gave rise to the trouble are still present. In bacterial enteritis sick birds should be removed from the flock as soon as noticed. Houses and runs should be cleaned up and disinfected. Drinking vessels and food troughs should be scalded daily. Potassium permanganate should be used in the drinking water (cf. p. 16). Mix powdered charcoal with the mash. Feed less bran and more middlings in the mash. Do not feed too heavily.

After attending to the above hygienic measures the birds should be given a good physic. A teaspoonful of Epsom salts to each fowl, dissolved in water and mixed in the mash, is the most convenient way of treating a large number of birds. For medical treatment Salmon recommends one of the following:

"Subnitrate of bismuth, 3 grains; powdered cinnamon or cloves, 1 grain; powdered willow charcoal, 3 grains. Give twice a day mixed with food or made into pills with flour and water.

"Subnitrate of bismuth, 3 grains; bicarbonate of soda, 1 grain; powdered cinchona bark, 2 grains; mix and give 3 times a day in a paste made with rice flour. When diarrhea is arrested, bismuth and soda are no longer needed. Give as a tonic: Powdered fennel, anise, coriander, and cinchona—each 30 grains; powdered gentian and ginger each 1 dram, powdered sulphate of iron, 15 grains. Mix and give in the feed so that each fowl will get 2 to 14 grains twice a day."

Constipation.

Constipation occurs in adult fowls far less often than diarrhea. It frequently passes unnoticed unless very severe. This trouble is much more common in young stock than in grown birds. In adult fowls it often occurs in connection with indigestion, gastritis, or peritonitis. "A not infrequent cause is obstruction of the vent by accumulations of excrement on the feathers about it This is especially apt to occur following looseness of the bowels in fowls, which do not roost. Intestinal worms also may cause constipation by accumulating until their mass blocks the passage." (Robinson.)

Lack of exercise, or lack of green food are also occasional causes of constipation.

The *symptoms* are painful and ineffective efforts to evacuate the bowels. In the worst cases the vent becomes completely plugged with dry, hard feces. The birds appear dull, listless and without appetite.

Treatment.—"Adult fowls having constipation without obstruction of the intestines, that is merely difficult movements, should not require any treatment further than in correcting conditions and diet. When the passage is obstructed the treatment is according to the location of the obstruction. If it is at the vent with hard accumulation about the vent as well as in the intestine, the external accumulation must be removed first. This is accomplished by soaking in warm water, which loosens the attachment of the mass to the skin, and separates it enough to allow clipping the feathers about the vent to which the mass adheres. If the obstruction has filled the lower part of the intestine, there must be more soaking with warm water or softening with olive or sweet oil. Oil is applied between the accumulated excrement and the skin by using a small syringe or an oil can with very small nozzle. The process is a tedious one, and where the poultryman's time is valuable is unprofitable except in cases of valuable birds."

"When the obstruction cannot be reached in this way purgatives must be given. Those usually recommended for fowls, are castor oil, Epsom salts, and calomel." (Robinson.)

INDIGESTION.

Birds frequently suffer from disorders of the digestive system which are not easily classified under any of the diseases so far treated. Simple indigestion or dyspepsia most frequently results from overfeeding and the feeding of ground grains and meat without sufficient green food, are some of the causes usually given.

Symptoms.—The birds are dull and listless. They are inclined to sit on the roosts, and usually have but little appetite. Occasionally birds suffering from indigestion have an abnormal appetite and will eat ravenously quantities of foods which furnish but little nourishment, *e. g.*, grit. Indigestion is often accompanied by either constipation or diarrhea. In the latter case the symptoms are similar to those described under simple diarrhea (p. 37).

Treatment.—In treating indigestion it is important to observe the general rules of hygiene (cf. Chapter II). The house should be clean and as free from dust as possible. Sunshine should be able to reach every corner of the pens. The water dishes should be kept thoroughly clean and the supply of water should be kept pure and fresh. Use potassium permanganate in the drinking water as directed on p. 16. Use well balanced rations and feed at regular hours. Put fine (chick size) charcoal into the mash in considerable quantity. Enough should be used to make the mash decidedly black. This is a very important measure for the treatment of indigestion. Give the birds plenty of exercise. A small amount of a good stock tonic may help to bring the birds back into proper vigor. The following formula (from Me. Agr. Expt. Stat. Ann. Rpt. 1896) has frequently been used with good success.

Pulverized Gentian	1 lb.
Pulverized Ginger	1/4 lb.
Pulverized Saltpeter	1/4 lb.
Pulverized Iron Sulphate	1/2 lb.

These substances can be procured from any drug store and mixed by the poultryman. Use 2 to 3 tablespoonsful of the tonic to 10 quarts of dry mash.

Dr. N. W. Sanborn (Reliable Poultry Remedies) recommends the following treatment for indigestion: "If for 1 week at the beginning of the improved care you will add 1 teaspoonful of sulphate of magnesia to every quart of drinking water, and follow this for 2 weeks with 1/8 of a grain of strychnine to each quart of water, you will hasten the time when the birds will be well."

CHAPTER VI.

Poisons.

Poultry on free range about farms and especially on small city lots often obtain poisonous substances. Most of the poisons obtained by fowls are the so-called mineral poisons. The chief symptom of poisoning by these substances is acute inflammation of the digestive tract. The narcotic or vegetable poisons on the other hand cause severe congestion of the blood vessels in the spinal cord and brain.

Among the principal poisons likely to affect poultry may be mentioned the following:

Common Salt, Nitrate of Soda, Concentrated Lyes.—Common salt is most frequently obtained in excessive amount from eating salt meat or fish. Zürn says that 15-30 (½ to 1 oz.) grams of common salt will kill a healthy hen in from 8 to 12 hours. Nitrate of soda is used as a fertilizer and is eaten by hens along with worms, etc., which they scratch up. Lye is obtained only when carelessly left about the grounds. The treatment for such poisons according to Salmon is to give "abundant mucilaginous drinks such as infusion of flaxseed, together with stimulants, strong coffee and brandy being particularly useful."

Arsenic may be obtained either from rat poison or from various arsenical sprays used to kill insects. *Copper* is used in such spraying mixtures as Bordeaux. Where spraying has been done properly there should be no danger of the birds getting enough of the poison to injure them. Sometimes, however, the vessels containing the mixtures are emptied within range of the fowls or the substances are handled carelessly in other ways.

The symptoms of arsenic poisoning are given by Beeck (Die Federviehzucht 1908, p. 828) as follows: "Secretion of large quantities of saliva, choking, hiccoughing, great anxiety and nervousness, little or no appetite, thin, often bloody feces, slow and difficult breathing, unsteady walk, trembling and convulsions, expansion of the pupils. Death ordinarily occurs in a very short time." Treatment should be with sulphate of iron, calcined magnesia, or large quantities of milk. Salmon also recommends white of egg and flaxseed mucilage.

The special symptoms of copper poisoning are vomiting and diarrhea, the copper giving a blue or green color to the vomited matter and the feces. Evidence of violent pain may follow with collapse, convulsions or paralysis. The circulation and respiration are weak. Usually fatal in a few hours. Large quantities of milk, white of egg, mucilage, and sugar water are recommended.

Lead and *zinc* poisoning occur chiefly from eating paint skins. The symptoms so far as they have been observed in poultry do not differ greatly from those seen in copper poisoning. The treatment recommended by Salmon is the same as for copper. With lead poisoning the sulphates of soda, potash or magnesia are recommended with the object of forming insoluble sulphate of lead.

Phosphorus may be obtained from rat poisons or from heads of matches. If large quantities of phosphorus are eaten by the bird severe inflammation of the stomach and intestine occurs and death results in from 1 to 2 hours. If only a small quantity is eaten the symptoms, according to Beeck, are weakness, languor, ruffled feathers, lack of appetite.

Strychnine is usually obtained by poultry from rat poisons. The distinctive symptoms here, according to Beeck, is the twisting of the spinal column and paralysis. The neck is twisted backward so that the head is often held over the rump. The treatment recommended by Beeck is to give "inhalations of chloroform or internally 1 to 3 grains of chloral hydrate dissolved in 2 tablespoonsful of water. The amount to be given depends on the size of the bird.

Ergot of Rye is one of the vegetable poisons which sometimes causes serious trouble among poultry. This is especially true in European countries. In this country so little rye is raised and fed to poultry that there is little chance for poisoning. The cause of the poisoning is a fungus which attacks the rye plants. The symptoms of ergot poisoning are trembling, intoxication, great weakness and gangrene of the comb, beak and tongue. The treatment is to give strong stimulants such as "brandy, coffee, camphor or quinine."

Fowls are occasionally injured by eating the leaves of poisonous plants. The sense of taste, however, protects the birds in most cases. Mr. H. B. Green (Illus. Poultry Record, Vol. I, p. 689) says in this connection: "Woodlands and fields abound in poisonous plants, and yet it is seldom, except in the case of birds that have been starved of green food and have become ravenous for it, that fowls ever succumb to vegetable poisons as thus obtained. Protection apparently lies in the fact that undesirable plants have repulsive flavors. Especially in suburban poultry keeping, danger arises when flower borders are weeded, seedlings thinned out, and plant rubbish swept up, if the resulting collection is thoughtlessly given to fowls in confined runs. Such birds are generally always ready for green food in any form and in their eagerness to satiate the craving the bad is often taken in with the good."

TREATMENT FOR POISONS IN GENERAL.

The above paragraphs have dealt with poisons rather more fully than is usual in treatises on poultry diseases. In the great majority of cases a poisoned bird is not discovered until too late for treatment. Even if found in time it is usually not worth the poultryman's time to treat individual birds. The symptoms of the different poisons have been given in some detail with the hope that they may enable the poultryman to distinguish the kind of poisoning which they may encounter and may thus be able to remove the source of the trouble before other birds are affected.

CHAPTER VII.

Diseases of the Liver.

"The annual losses of poultry due to liver trouble in various forms are numerous. These diseases seem to occur chiefly among adult fowls, and to be more prevalent in the latter part of the winter and through the spring. The reasons for their frequency then are easily found. The common forms of liver trouble result from improper feeding and lack of exercise. These causes operate most extensively during the winter, and they usually operate slowly, and the symptoms of liver troubles are generally obscure and not recognized until a post-mortem of fowls dying without special outward symptoms shows a diseased condition of the liver. Hence liver trouble may become general and reach advanced stages in a flock before their presence is suspected. Meantime, the conditions which cause them may be continued, the owner of a flock not infrequently supposing that the absence of sickness in it contradicts the teachings of those who advise methods designed to preserve health, while as a matter of fact many of his fowls are in a quite advanced stage of some liver complaint." (Robinson.)

A large number of diseases of the liver are described by writers on this subject. In the great majority of these diseases there are no external symptoms by which one can be told from another. The most common diseases which affect the liver may, for the moment, be divided into two rough classes which it is highly important for the poultryman to distinguish. These again can only be distinguished in dead birds, but the occurrence of cases of either kind in any number gives the poultryman a clue as to what the trouble may be and a chance to correct it. In the first of these two classes a post-mortem examination shows the liver covered with nodules of a cheesy-like appearance when opened. These nodules occur not only in the liver but also in the spleen, intestine and other organs and sometimes in these latter regions without affecting the liver at all. With such symptoms we may be fairly certain that the trouble is tuberculosis and for a further discussion of this the reader is referred to Chapter VIII.

In the second class of these diseases the liver shows great enlargement and this is often accompanied or followed by fatty degeneration. This hypertrophy of the liver is what is generally spoken of by poultrymen as "liver disease." "Liver disease" as popularly interpreted includes a number of different diseases distinguished by the pathologist. Of these the ones most commonly treated in the diseases of poultry are Congestion of the Liver, Inflammation of the Liver, Atrophy of the Liver, Hypertrophy or Enlargement of the Liver, Fatty Degeneration of the Liver and Jaundice.

The diagnosis of these different diseases is based entirely on the post-mortem appearances. In no one of them are there any outward symptoms which distinguish it from the others. "Vale says it is impossible for the most scientific observer to diagnose either inflammation or congestion of the liver with positive certainty. The symptoms are much the same and outwardly are the general symptoms of disease." (Robinson.)

Further not only the symptoms but also the causes and the treatments of these several diseases are essentially the same. The names of the diseases themselves indicate in a general way the post-mortem appearances.

For these reasons it seems best to give a brief discussion of the general causes of "liver disease" and the usual treatment. This will be followed by a brief account of each disease and its special symptoms and treatment, if any.

Cause of Liver Disease.—Lack of exercise and overfeeding, especially with rich albuminous foods, are the most common causes of diseases of the liver. In addition to these Salmon mentions the obstruction of the circulation of the blood by disease of the heart and lungs. Sanborn says that congestion of the liver may be caused by any disease of the crop, gizzard or bowels that obstructs the circulation of the blood. Robinson says: "By far the larger proportion of the cases of liver trouble coming to my notice are accounted for by bad feeding conditions."

Diagnosis of Liver Disease.—There are no special external symptoms. Sanborn mentions as early symptoms: "Rough plumage, watery diarrhea, first brownish, then yellow; lack of appetite and indisposition to move. The comb may be purplish at first, becoming dark and then quite black." These, however, are all merely symptoms of disease in general that might apply to any one of a dozen or more ailments. The only certain method of recognizing the disease is by post-mortem examination. Every poultryman should be familiar enough with the normal appearance of the more important internal organs of a fowl to recognize abnormal appearances. In general, when post-mortem examination shows the liver larger or smaller than normal or congested with blood or marbled or spotted, we may assume that the bird probably had some form of liver disease. Of course, a diseased condition of the liver is often associated with other diseases, especially of the alimentary canal. Other organs should be examined in all cases to see if they are normal. Special care should be taken to distinguish tuberculosis from other diseased conditions of the liver and intestines.

Treatment.—Since it is not possible to recognize diseases of the liver by external symptoms, the treatment of individual birds is out of the question. If, however, post-mortem examinations show that a number of the birds are dying with liver trouble it is necessary to take some remedial measures regarding the entire flock. In this connection Robinson gives the following remarks and advice:

"Just as soon as it is suspected that there is liver trouble in the flock one or more indisposed birds should be killed and examined. If examination confirms the suspicion prompt measures should be taken to counteract bad tendencies. These should look first to good diet. Make the mash, if mash is used, light and bulky; feed green and vegetable foods liberally; compel exercise in scratching for food. Then get the fowls out a little every day, and if sanitary conditions in the house are at all objectionable correct them. When the conditions to which a flock has been subjected are such that a number of bad cases of liver trouble develop, it cannot be expected that corrective measures will arrest development and restore to health in every case. On the contrary, a few cases may develop in spite of remedial measures, and the fowls exposed to the disease are likely to give a much larger proportion of cases of sickness of various kinds afterwards than fowls that as a flock had always been healthy.

4

This being the case, it is generally good policy to dispose of a flock that has been through such an experience as this as soon as it can be done to advantage, and replace with always healthy stock."

With regard to the special diseases already mentioned the one most commonly met with on intensive plants at least is

Hypertrophy or Enlargement of the Liver.

The cause of this trouble is chiefly concerned with food. In our climate it occurs most frequently towards the end of the winter. The birds have been confined to their houses most or all of the winter months. Very often they are overcrowded. The rich winter ration is continued after the weather begins to get warm and less heating food is needed. This combined with too little exercise and not enough green food favor indigestion and the accompanying sluggish action of gizzard and intestines. These are the immediate causes of trouble with the liver. It is said that feeding too much corn and barley is also responsible for much liver trouble.

Symptoms.—Mr. H. B. Green, M. R. C. S., gives the following symptoms of hypertrophy of the liver. He believes this to be only a stage in the fatty degeneration of this organ. (Illustrated Poultry Record 1909, p. 691.) "The first sign that a fowl is tending towards fatty disease of the liver is increase in weight. The comb wattles and face remain a bright red or take on a dull bluish tinge from congestion. This sign of sluggish circulation tells of full blood vessels, and explains how it is that apoplexy so frequently supervenes at this period. The excrement is an important symptom to note. It is generally at first semi-liquid, of a dark yellow color, and evacuations are frequent. Thirst is noticeable and a large quantity of water is drunk, especially after feeding. The appetite remains good, although the bird is capricious in what it eats. A post-mortem examination of a fowl in this phase of the disease will show a liver considerably enlarged, of a deep red color, engorged with blood, shining and greasy as though it had been soaked in oil, but fairly firm under the knife. The intestines are laden with masses of fat, so also are the mesentery—or as it is termed by butchers, 'the leaf,'—the ovary and oviduct."

In the next stage "Diarrhœa increases, the excrement being perhaps bloodstained or blackened by congealed clots; the face, comb and wattles become a darker hue or if jaundice supervenes they may be pale or tinged with yellow bile; more fat is laid on internally and the liver will prove to be greatly enlarged. So large may this become by the deposit of fat globules between and in the substance of its cells that on one occasion I have removed from an Orpington cock a liver that turned the scale at a pound and a half. This stage is seldom passed and death usually takes place from syncope, or an accidental rupture of the softened liver."

Treatment.—Green says further: "Part of the treatment consists of a plentiful allowance of green food. Nothing in this way is better than freshly gathered dandelion leaves when procurable, for the taraxacum they contain is a valuable liver stimulant. It is not generally known that the sliced roots of the plants can be steeped in boiling water to make an infusion equally effective when the leaves are no longer obtainable. The roots should be gathered and stored in dry boxes. The infusion is conveniently mixed with the morning soft food and is always beneficial to birds in confinement as an occasional liver tonic."

Fatty Degeneration.

As noted in the above paragraphs, Green regards this disease as a later stage in the hypertrophy of the liver. Salmon, on the other hand, believes it to be a quite different disease. The latter author says: "On *post-mortem* examination the liver is found shrunken, hardened and marbled or spotted with areas of grayish or yellowish tissue. A microscopic examination shows the liver cells to contain droplets of fat and the liver tissue degenerated and largely replaced by yellow fat globules.

As the disease is not recognized during life, treatment is out of the question. If a number of cases occur in the same flock, give greater variety of food and a run on the grass. In addition, bicarbonate of soda may be given in the drinking water to the amount of 1 or 2 grains a day for each bird."

Atrophy or Wasting of the Liver.

This is very similar in many respects to the disease described by Salmon as fatty degeneration and probably arises from the same cause, *i. e.*, lack of variety in the food, especially lack of green food.

Symptoms.—Robinson says: "There are no special external symptoms. An examination of the fowl after death shows the liver shrunken and somewhat granular and sometimes of a yellowish cast."

Treatment.—See Salmon's treatment of fatty degeneration above. The flock should be given frequent (weekly) doses of Epsom salts.

Congestion and Inflammation of the Liver.

These are probably different stages of the same disease. The poultryman will find difficulty in distinguishing between this disease and that known as hypertrophy of the liver (cf. p. 50). The chief post-mortem difference is that in the latter disease the liver is more solid, not so easily torn or ruptured.

Diagnosis.—There are no external symptoms other than those of dullness and the general symptoms of disease. Salmon says: "It is difficult to make a diagnosis during the life of the bird. Post-mortem examination reveals a greatly enlarged liver engorged with blood, tender and easily torn or crushed."

Treatment.—Treatment of these diseases in individual birds is very rarely successful. The general treatment of the flock as recommended on p. 49 should be attended to. The chief medicinal treatment should probably be frequent doses of Epsom salts. Various authors recommend different medicinal treatments. For these see Robinson (pp. 71 to 74).

Jaundice.

Jaundice or biliary repletion is said by Megnin (Medicine des Oiseaux) to be due to long continued but moderate congestion of the liver. This leads to increased activity of this organ and is followed by the accumulation of a large quantity of bile in the gall bladder and ducts of the bird. This bile is absorbed by the blood vessels and causes poisoning which may lead to the death of the bird.

Diagnosis.—There are no specific external symptoms other than that the wattles and comb may be yellowish. This also occurs in other liver diseases. Post-mortem examination shows the gall bladder greatly distended with bile.

Treatment.—Give greater variety of food, especially more green food. Give Epsom salts frequently. Megnin recommends ½ to 1 grain of aloes.

This completes the list of the liver diseases most commonly treated as such by poultry veterinarians. There are a number of other diseases which especially affect the liver or are caused by deranged function of this organ. These may most conveniently be mentioned at this place.

Blackhead (Infectious Entero-Hepatitis).

Blackhead is essentially a disease of turkeys. It is not the intention of this work to treat diseases of poultry other than fowls. Consequently little will be said about this disease except as it applies to fowls. If further information is desired the reader is referred to the Rhode Island Experiment Station, Kingston, R. I., for bulletins relating to this disease. That station has been and still is studying this disease in a most thorough way.

Blackhead is a contagious disease affecting the liver and intestines, especially the blind pouches or ceca of the latter. The disease is very quickly fatal among turkeys. The turkey is apparently more susceptible than any other bird to this disease. In certain portions of this country where once turkey raising was a promising industry it has been practically annihilated. The disease is not usually as fatal to adult chickens but may cause very serious loses at times. It is now believed by several prominent investigators of this disease that white diarrhea, so destructive to young chicks, is caused by the same organism as blackhead. For further discussion of this see Chapter XIX.

The cause of blackhead disease according to Dr. Theobald Smith (Bur. An. Ind. Bul. No. 8) is a minute parasitic protozoan known as *Amoeba meleagridis.* More recently Drs. Cole and Hadley of the Rhode Island Experiment Station have claimed that the causative organism belongs to another group of protozoa known as *Coccidia.* Dr. Smith, however, still maintains that the former organism is concerned in the disease. The point to this discussion lies in the fact that the *Coccidium* has a very different life history from the *Amoeba,* consequently it probably has a different method of dispersal and different means must be used in combatting it.

Diagnosis.—There are no special external symptoms of this disease until in an advanced stage. The victim then begins to mope, loses its appetite and is inclined to sit apart with drooped wings. The head and comb take on a dark color from which the disease takes its name "blackhead." One of the most conspicuous symptoms is the diarrhea. Post-mortem examination shows the liver enlarged and disfigured with whitish or yellowish spots. The ceca are inflamed and often clogged with pus and fecal matter.

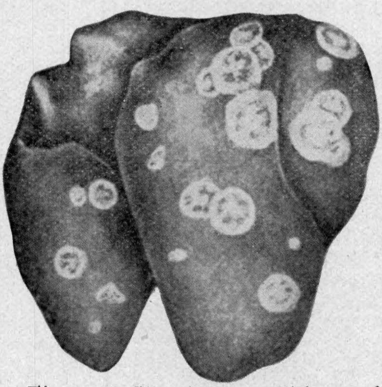


Fig. 1. Showing condition of liver in "blackhead." (Modified after Moore).

Treatment.—Medical treatment of turkeys affected with blackhead is of little avail, at least in the present state of our knowledge. Cole and Hadley (Rhode Island Expt. Stat. Bul. 141) recommend the following: (1) Isolate the sick bird from the flock and place it in a dry, well lighted location free from cold and draughts. (2) Feed sparingly on soft, light, easily assimilable food, with little grain, especially corn." The chief preventative measures are to keep the birds on fresh ground; to isolate any birds showing the least sign of disease, to destroy all dead birds and to protect the turkeys from contamination carried either by new stock or by other poultry or by wild birds as sparrows, crows, etc. Dr. Morse (B. A. I. Circ. 128) recommends for turkeys under 3 months old ½ grain copperas in the morning and a 2½ grain pill of salicylate of soda in the evening. Give Epsom salts every 3 or 4 days and keep the grounds and floors well sprinkled with lime.

With fowls the disease is not so virulent but it is still well to protect the flock from introduction of this disease. In this connection Dr. Cole (American Poultry World, 1910) says: "It is no uncommon thing for adult chickens and other poultry to die with all the pathological appearances of blackhead, which diagnosis has been confirmed with the microscope. Furthermore, infection there with this organism appears to be one of the principal causes of death of brooder chicks, which exhibit the symptoms of one form of the poultryman's greatest scourge, white diarrhea.' It has often been said of late: If you want to raise turkeys keep them away from chickens; it might be said with even greater emphasis: If you want to raise chickens, keep turkeys away from them."

Dr. G. B. Morse of the U. S. Department of Agriculture gives (Reliable Poultry Journ., Sept., 1910) a number of other diseases which affect the liver. Some of these which are not treated elsewhere in this circular will be mentioned in the following paragraphs.

Cercomoniasis.

This is frequently called "spotted liver." It, like many other liver diseases, is associated with intestinal trouble, especially severe diarrhea, that attacks poultry during the summer months. The disease is caused by a flagellate micro-organism known as *Monocercomonas gallinarum.* The post-mortem appearance of the liver in this disease shows usually slightly depressed yellowish necrotic areas or spots. This fact usually distinguished this disease from tuberculosis where there are prominent rounded cheesy nodules. In pigeons, however, this cercomonad is said to cause rounded prominent nodules about the size of a pea.

This same organism *(Monocercomonas gallinarum)* is also said to be responsible for other diseases. The most important of these is one form of roup. Canker in squabs and intestinal diarrhea in poultry are other diseases attributed to this parasite.

This disease can be held in check, it is said, by keeping the poultry plant well cleaned and disinfected and by giving the birds an occasional purgative, *e. g.,* Epsom salts.

In *aspergillosis,* the liver often presents the appearance of being "studded all over with minute, whitish or yellowish spots." This disease is discussed in Chapter XIX.

Sarcomatosis and Carcinomatosis.

In some cases the liver is affected with tumors or cancers. These are usually found in connection with similar developments on the ovaries.

Gout.

In cases of visceral gout the liver and adjoining organs are covered with a fine chalky sediment. This substance consists of crystals of urate of soda. See Chapter XV. for detailed description.

CHAPTER VIII.

TUBERCULOSIS.

Tuberculosis in fowls has long been a serious pest in Europe. Zürn in his "Krankheiten des Hausgeflügels," published in 1882, devotes several pages to the description of this disease as it occurred in Germany. Its appearance in this country, however, seems to have been much more recent.

Salmon, whose book was published about 1888, says that the disease "is by no means rare in the United States if the statements of our professional men are to be accepted." However, at that time very little had been done in the way of bacteriological diagnosis and no doubt many of the early reports were unreliable.

The disease was first reported on the basis of bacteriological examination in 1900 by Pernot (Oregon Agr. Expt. Stat. Bull. 64). In 1903 Moore and Ward reported investigations on avian tuberculosis in California (Proc. Am. Vet. Med. Assoc. 1903). They found "a number of flocks in which the mortality from the disease was very high." Fowl tuberculosis was reported from western and central Canada in 1904 by Dr. C. H. Higgins (Dept. of Agr. Canada, 1905). In 1906 it was reported from New York and in 1907 from southern Michigan. The disease has been reported in many other places within the last few years. It thus seems certain that the disease is widespread throughout the United States and Canada and in the future must be reckoned with by American poultrymen.

Tuberculosis may exist extensively among fowls, especially in large flocks, and yet not kill enough birds to attract attention to it. Reports show that farmers often lose 1 or 2 birds a year from what appears to be tuberculosis. In many places the loss seems to be gradually increasing. The existence of the disease in the flock fails to attract the attention of the owner because the losses are so evenly distributed throughout the year. Moore and Ward report a flock of 1400 birds from which 250 had died during the first year. Another man lost 300 birds out of a flock of 1460. Microscopic examination proved that these were dying of tuberculosis.

Tuberculosis is confined chiefly to adult or nearly adult fowls. Only very rarely, if ever, is it found in growing chicks. Further it is much more common in fowls than in other kinds of poultry. Two cases in wild geese were reported at the Ontario Agricultural College. Avian tuberculosis is said to be found in turkeys, pheasants, and especially in pigeons. Cage birds are particularly susceptible to this disease.

Etiology.—Tuberculosis is caused by a minute germ, the *Bacillus tuberculosis* of birds. These bacteria gain entrance to certain portions of the body and there multiply in vast numbers, causing the formation of small nodules or tubercles. The disease is highly contagious and is spread through the flock by the contact of healthy birds with the diseased ones, or with their discharges.

The relation of avian tuberculosis to that of man and other animals has attracted a great deal of attention. It is a subject of very great importance to the poultryman, not only on account of his flock but also on account of its relation to the health of himself and his family. In this connection, writing some years ago Salmon says: "Many outbreaks (of fowl tuberculosis) have been attributed to infection from eating the sputum of persons affected with consumption. The possibility of such infection is admitted by some authorities and denied by others. It is certain that poultry and pigeons are not easily infected experimentally with the tuberculosis of people, cattle and other animals which are classed together as mammals." On the other hand, "The bird or avian tuberculosis spreads rapidly from bird to bird and is easily transmitted experimentally to birds but it has little effect upon most mammals which are very susceptible to human tuberculosis. There is, consequently, a marked difference between avian and mammalian tuberculosis. The disease in the two cases does not appear to be absolutely distinct, but should rather be regarded as two varieties of the same malady."

In the last few years a great deal has been found out about tuberculosis in both birds and mammals. The results have been summarized and extended by Drs. Koch and Rabinowitsch in an extensive paper dealing with avian tuberculosis and its relation to mammalian tuberculosis (Virchow's Arch. f. Path. Anat. u. Phys., etc., Bd. 190, pp. 246-541, 1907). Their results may be briefly stated as follows: Attempts to infect fowls with mammalian tuberculosis, like the earlier negative results of other authors, have been fruitless. However, fowls are very easily infected with avian tuberculosis by feeding them parts of diseased birds. On the other hand, methods of infecting fowls other than feeding are not always successful even with avian tuberculosis. Other birds, especially cage birds, are very readily infected in various ways. Parrots, in particular, are susceptible not only to avian tuberculosis but also to mammalian and human tuberculosis. Also canary birds, sparrows, and various birds of prey were proven to be susceptible to both avian and mammalian tuberculosis. In these respects such birds differ materially from the domestic fowls.

On the other hand their later researches have made it apparent that a large number of mammals are susceptible to avian tuberculosis. These include not only the small laboratory animals as rabbits, mice and guinea pigs, but also cattle, hogs, horses, goats, and donkeys. Also avian tubercle bacilli have been found in cases of human tuberculosis. On the basis of such experiments and observations it appears that avian and mammalian tuberculosis are not caused by different species of bacteria but by different varieties of the same species. These varieties have developed because the bacilli have grown for a long period of time under different conditions. They are not so different, however, but that they may grow in the environment best suited to the other one.

It thus appears that while fowls are not very likely to contract tuberculosis from domestic animals or from man, yet fowls that have the diseases are a serious menace to the other animals on the farm as well as to the poultryman and his family. (Cf. further on this point p. 64 below).

Diagnosis. Tuberculosis in mankind is so serious a disease chiefly because it is so difficult to recognize it in its earliest stages. The same is true with the disease in fowls. There are positively no external symptoms by which the disease can be recognized in fowls before the advanced stages. Morse (R. P. J. Sept. 1910) says on this point: "There is a combination of symptoms that might serve to arouse your suspicions; steadily

Fig. 2. Breast bone of a fowl showing excessive emaciation in tuberculosis. (After Ward).

advancing emaciation; anemia, shown by pallor of comb wattles and the skin about the head; general weakness; lameness, ruffling of the feathers and in many cases diarrhea. When combined with the foregoing you notice a bright eye and a ravenous appetite you may have very strong suspicions."

Emaciation is one of the best symptoms and in the last stages of the disease becomes very marked. Pernot cites the case of a Plymouth Rock hen weighing 4 pounds that was reduced to 22 ounces. The emaciation is very marked in the muscles covering the breast bone. Fig. 2 shows the breast bone of a tuberculous hen from which the skin only has been removed.

Lameness is another symptom often shown in the later stages of the disease. This is caused by tuberculosis of the joints as has been proven in many cases. Such cases are often called "rheumatism" by poultrymen. Tuberculosis may also form tumors or ulcers or various outgrowths on the head and limbs of birds. Such forms of the disease are comparatively rare in poultry, however. Parrots are particularly affected with these external tubercles.

None of these symptoms, however, is more than an indication of the possible presence of the disease. Morse says: "At the post-mortem examination you may have your suspicions strengthened by finding liver, spleen, intestines and membrane uniting the intestinal folds (mesenteries) studded with yellowish white cheesy nodules of various sizes." Outside of the bacteriological test these post-mortem findings are the best proof of the disease we have. The liver is affected in nearly every case of fowl tuberculosis. However, as has been pointed out many times in these pages, a spotted condition of the liver is no sure sign of tuberculosis. Most of the other liver diseases of fowls cause a simple blotching of the tissue in which the center of each spot is usually depressed or at least only slightly raised. (Cf. Fig. 1, p. 54). In tuberculosis the liver is covered with numerous raised nodules varying greatly in number and size as shown in fig. 3. A section of the liver shows these nodules or tubercles distributed throughout the tissue.

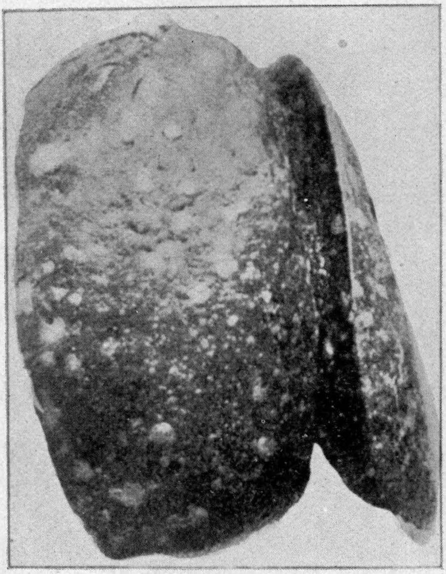


Fig. 3. Liver of fowl affected with tuberculosis. (After Ward).

Still more conclusive evidence is found if the spleen is covered with these same kind of nodules. The spleen in health is a small rounded purplish organ about ½ inch in diameter. It lies just above the liver in the region of the gall bladder. In cases of tuberculosis it is very frequently greatly enlarged and is studded throughout with the yellowish-white tubercles as shown in fig. 4.

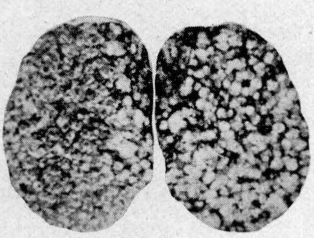


Fig. 4. Spleen from tuberculous fowl cut through the middle. (After Koch and Rabinowitsch).

Still another very important piece of post-mortem evidence is found if the intestines and the mesenteries are dotted with these rounded nodules as shown in fig. 5.

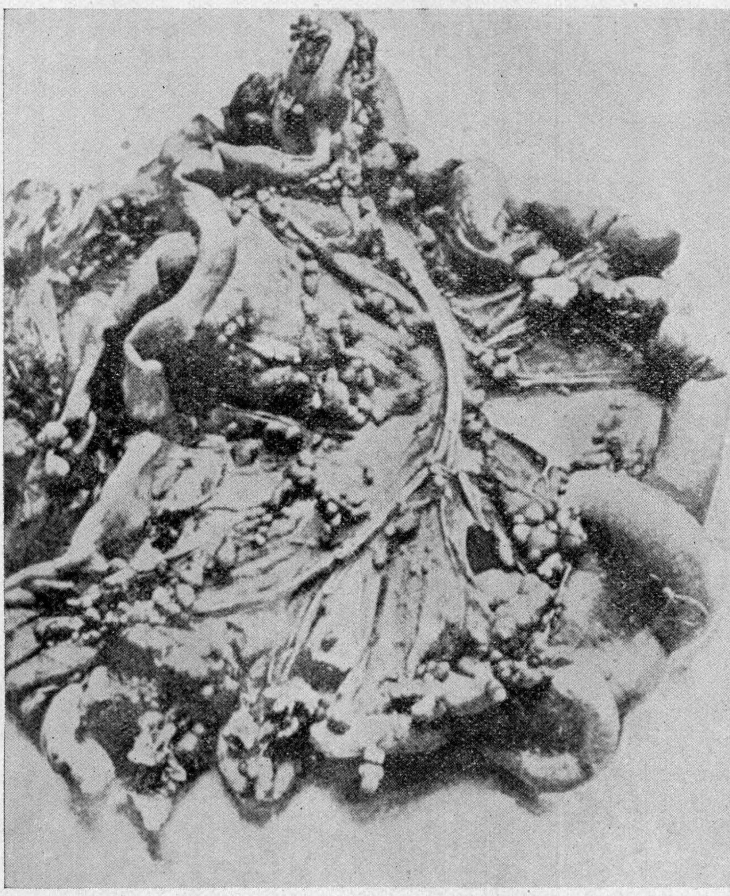


Fig. 5. Intestine and mesenteries of a fowl affected with tuberculosis. (After Ward).

The lungs are *very rarely* affected and then usually by the infection spreading from the liver on to the adjoining lung tissue. All this agrees with the fact previously stated that fowls are most easily infected through the digestive tract. Alteration of the bones, joints or other organs occur much more rarely and usually only in the most advanced stages of the disease.

If the post-mortem findings agree in essentials with those given in the preceding paragraphs we may be practically certain that we are dealing with tuberculosis. It should not be forgotten, however, that the pathologist would not be willing to pronounce the disease tuberculosis until he had taken a small particle of the cheesy material and after staining this in a particular way had demonstrated by microscopical examination that the tubercle bacilli were present.

Moore and Ward have carried on some experiments in the use of tuberculin in detecting this disease. Ward *(loc. cit.)* gives the results of trials on 21 hens affected with tuberculosis. In very few cases did the tests give positive results and these were so slight and irregular as to be useless as a method of diagnosis. Apparently there is little hope of success in this direction with fowl tuberculosis.

Methods of Contagion. The spread of tuberculosis from fowl to fowl takes place only when the living bacteria are transferred from the diseased to the healthy birds. From the fact that tuberculous lesions are most commonly found in the internal organs of the digestive system we may conclude that the bacteria usually enter the body along with the food. Examination of the tubercles situated along the intestine shows that in many cases these communicate directly with the interior of the digestive tract. These are constantly emptying enormous numbers of bacteria which are carried to the outside by the feces of the bird. Without doubt the droppings of tuberculous fowls are the most important factor in the spread of this disease. This is especially true when in addition the birds are fed upon ground which is partly covered with these droppings. Besides, the infectious material may very easily be carried by the feet and thus mixed with the food.

Ward states that there is no evidence to indicate that tuberculosis is spread through the egg. He cites in support of this the fact that badly diseased birds do not lay and second the absence of tuberculosis among young stock. Koch and Rabinowitsch, however, on the basis of later and more thorough work make the following statement (p. 431): "The possibility of the congenital origin of tuberculosis of fowls through the infection of the fertilized egg with bird tuberculosis is shown by our results. It is also demonstrated by our inoculation experiments on eggs." Further they have given experimental proof of the transfer of the bacteria of mammalian tuberculosis from the *inoculated egg* to the chick. As noted before it was very difficult to do this by feeding the hens food infected with mammalian tuberculosis.

In this connection it is of interest to mention a case of the apparent transfer of fowl tuberculosis to man. In the Medical Record (Vol. 31, 1887) there is recorded a case of human tuberculosis in France which apparently came from eating tuberculous fowls which "were cooked very little before being eaten." The case occurred "in a little hamlet of 10 cottages isolated in the midst of a large forest." No other source of infection could be discovered.

Treatment. Fowl tuberculosis when it reaches the stage at which it can be diagnosed cannot be cured under our present knowledge. Treatment of individual cases should not be attempted. After it has been ascertained by post-mortem (and if possible bacteriological) examination that the disease exists in the flock all suspected birds should be removed at once. If the disease is to be controlled it must be by keeping the healthy and the affected birds apart. The most serious thing about tuberculosis is that there may be many birds in the flock that are in early stages of the disease but do not betray their condition. Long before these birds show recognizable symptoms they are throwing out millions of bacteria which become a menace to the remainder of the flock.

If only one or two cases of tuberculosis are found it may be sufficient to simply disinfect the houses, yards, feeding troughs and drinking vessels. This should be done with some good disinfectant. (See Chap. II). Morse recommends also the liberal application of lime referring to the fact that "lime workers seldom suffer with tuberculosis." The runs should be cultivated and the houses should be open to the sunshine and fresh air at all times.

If, however, the number of birds dying of tuberculosis in the flock is increasing even though the increase is very gradual, more strenuous measures must be taken. Under these conditions Dr. Morse says: "Kill everything in sight, disinfect, allow the poultry plant to lie fallow for several months, disinfect again and buy fresh stock that is known to be healthy." This no doubt is the surest way to get rid of the disease and wherever possible it should be done. However, where the disease is found in large flocks of birds such measures would bankrupt the owner. Or a man may have a very fine strain of birds which he has spent many years in perfecting and which it would be impossible to replace. In such cases Morse proposes "Banging" out the tuberculosis according to the methods of new-herd-building in dairy cattle as proposed by Prof. Bang of Copenhagen. Morse's directions for "Banging" out tuberculosis are as follows: "Secure new or thoroughly disinfected ground, keeping it absolutely free from contact with the ground used by the infected flock. Erect new houses on this ground. Collect the eggs from the infected birds and wash them in 95 per cent alcohol or in a 4 per cent solution of some good coal tar disinfectant. Incubate these disinfected eggs in new incubators. When hatched, remove chicks to new brooder houses on the new ground. These growing chicks should be cared for by new men, that is to say, either different men from those that care for the old flock or if you are compelled to use the same men they should disinfect their hands and shoes and put on fresh overalls before handling the new stock. Have different feed bins and different pails for distributing it. As soon as you have built up a clean flock destroy the old and disinfect the ground occupied by them by the method outlined above."

This method is, no doubt, excellent in theory and if carried out with complete and *never-failing* attention to details might work. It is doubtful, however, whether in actual practice a poultryman would ever be able to carry it through successfully or profitably.

CHAPTER IX.

CHOLERA.

Fowl cholera is a virulent, usually fatal and highly infectious disease. It is entirely distinct from the ordinary forms of enteritis with which it is often confused by poultrymen. Fowl typhoid and infectious leukaemia are also often mistaken for cholera. Genuine fowl cholera is rather rare in this country but is much more common in Europe. This disease was first reported in this country about 1880 by Salmon (Rept. U. S. Comm. of Agric.). Owing to the lack of proper bacteriological methods at that time Salmon was not able with certainty to identify this disease with the European cholera. From certain experimental work he concluded that some of the symptoms exhibited by the disease in this country were different from those described by European writers. About 1894 Moore (U. S. Bur. An. Ind., Bul. 8) obtained material from several outbreaks of supposed cholera but found this disease to differ in several important respects from the European trouble. More recently Curtice (R. I. Expt. Stat. Bul. 87) has described a disease similar to that of Moore's under the name of fowl typhoid. What appears to be the genuine European fowl cholera has been reported several times within the last few years.

Fowl cholera attacks all varieties of poultry; also caged birds and many species of wild birds. "The infection generally occurs by taking food or drink contaminated with the excrement of sick birds. It is also possible for birds to be infected through wounds of the skin or by inhalation of the germs in the form of dust suspended in the air. They often take the germs into their bodies by consuming particles of flesh or blood from the carcasses of affected birds that have died or have been killed."

"The disease is generally introduced upon a farm or in a locality, with new birds, purchased for improving the flocks or with eggs for hatching. When it exists in a district it may be disseminated by wild animals or wild birds." (Salmon).

Diagnosis: Salmon gives the following as external symptoms: "The earliest indication of the disease is a yellow coloration of the urates, or that part of the excrement which is excreted by the kidneys. This in health is a pure white, though it is frequently tinted with yellow as a result of other disorders than cholera. While therefore this yellowish coloration of the urates is not an absolutely certain proof of cholera, it is a valuable indication when the disease has appeared in a flock and an effort is being made to check its course by isolating birds as soon as affected. In a few cases the first symptom is diarrhea in which the excrement is passed in large quantities, and consists almost entirely of white urates mixed with colorless mucus. Generally the diarrhea is a prominent symptom. The excrement is voided frequently, and consists largely of urates suspended in a thin, transparent, sometimes frothy mucus. The urates have a deep yellow color, which in the later stages of the disease may change to greenish or even a deep green."

"Very soon after these first symptoms appear the bird separates itself from the flock, it no longer stands erect, the feathers are roughened or stand on end, the wings droop, the head is drawn down towards the body and the general outline of the bird becomes spherical or ball shaped. At this period there is great weakness, the affected bird becomes drowsy and may sink into a deep sleep which lasts during the last day or two of its life and from which it is almost impossible to arouse it. The crop is nearly always distended with food and apparently paralyzed. There is in most cases intense thirst. If the birds are aroused and caused to walk there is at first an abundant discharge of excrement followed at short intervals by scanty evacuations."

In regard to the yellow or green excreta Hadley* says:

"This is a very characteristic symptom. The excrement of normal fowls is not yellow; and when it is green it is a dark green, approaching black. In cholera both yellow and green are bright; the green is often an emerald green. These different colors may occur either alone or separately and both are

*Bulletin 144 R. I. Agr. Expt. Stat. (In press.) The manuscript of this bulletin was very kindly loaned by Dr. Hadley.

usually accompanied by diarrhea and thick mucus. In case it is known that cholera is in the neighborhood, it is well for a poultryman to examine, from day to day, the character of the droppings on the dropping board."

"The course of the disease may be rapid or slow in its progress through the flock. It may take all within a few days, or the fowls may drop off by twos and threes through a period of several weeks. After the first symptoms appear the development in individual cases is usually rapid. Forty cases investigated by Salmon averaged 3 days, but many birds die within a few hours after the diarrhea sets in. The time required to develop the disease after exposure or inoculation is given by Salmon as 4 to 20 days." (Robinson).

Examination of the dead birds shows inflammation of the digestive organs, kidneys and mesenteries in nearly all cases. According to Ward (Calif. Expt. Stat. Bul. 156) "punctiform hemorrhages are found upon the heart with almost absolute uniformity. The liver is very frequently marked with punctiform whitish areas." Sections show that the areas of necrotic tissue are present throughout the liver tissue. The blood vessels of the liver are congested. According to Ward the next most striking lesions are found in the reddened and bleeding mucosa of the first and second folds of the small intestine (next to the gizzard). These reddened areas can even be seen from the outside of the intestine. The intestinal contents are of either a cream colored pasty mass or may be brownish or even green in color. "Lesions are very rarely observed in other portions of the intestine. The ureters are noticeable in practically all cases by reason of the yellow-colored urates that they contain. The nasal cavity, pharynx and oral cavity frequently contain a viscous mucous fluid, probably regurgitated from the crop."

Etiology. Fowl cholera is caused by a bacterium known as *Bacterium bipolaris septicus*. It is closely related to the bacillus of rabbit septicaemia and the bacillus of swine plague. "Under the microscope the bacterium presents either a circular or oval outline. It is about 1 50-thousandth of an inch broad and 2 or 3 times as long. It grows best at from 85° to 105° F. It has no power of movement, does not form spores, and is easily destroyed by drying, by the ordinary disinfectants and by a temperature of 132° F. for 15 minutes." (Salmon).

Fowl cholera cannot be recognized with certainty except by a bacteriological examination. Practically, however, this makes but little difference to the poultryman. The methods of combatting cholera are not radically different from those used against similar infectious diseases. The occurrence of a number of sudden deaths in a flock indicate the presence of an infectious disease and call for the inauguration of sanitary and remedial measures at once. At the same time a letter describing the symptoms should be sent to the Division of Pathology, Bureau of Animal Industry, Washington, D. C. In this way the name of the particular disease can be determined and advice as to any specific treatment will be received.

Treatment. "The best authorities on the subject regard genuine cholera as practically incurable. It is said that none of the alleged remedies have proved effective in cases known to be true cholera, and the presumption is that the persons supposing they had cured cholera with them were treating some other disease. While treatment of affected individuals is regarded as futile, the spread of the disease may be limited and the disease stamped out by disinfection to destroy the germs on the premises, and by proper measures to prevent their further distribution." (Robinson).

Dr. P. T. Woods, who several years ago while manager of a poultry ranch in New Jersey, had considerable experience with cholera gives the following method of dealing with the disease. (Reliable Poultry Remedies).

"As soon as the disease is discovered, establish a pest house remote from the other poultry buildings, a place that can be easily and thoroughly disinfected. Isolate all suspected cases in the pest house as soon as you can find them. Give these birds a few drops of creolin in their drinking water (just enough to turn it faintly milky), or give them drinking water in which has been dissolved one one-tenth of a grain tablet of corrosive sublimate to the quart of water. All birds which show marked symptoms of the disease had better be killed and cremated at once. This is safest and best. Kill them by strangling or by a sharp blow with a blunt club, breaking the neck. Do not draw blood, as the blood is infectious, and you do not want to spill it. If they bleed, scrape up all the blood and burn with the body, and disinfect the place where it fell. Rake up and burn all litter used in houses or runs occupied by infected birds. Spray the runs and all parts of the buildings with a strong solution of creolin, or a 1 per cent solution of sulphuric acid in water. Do not use any litter until you are sure that the disease is eradicated. Thoroughly disinfect everything that could possibly be contaminated by the infected fowls, and repeat this as often as you find a new case. The runs or yards should be thoroughly disinfected and should be ploughed up often."

In connection with his work on an outbreak of fowl cholera in California, Ward points out the following important conclusion: "Cholera and other infectious diseases may exist in a fowl in a sort of inactive chronic condition and there is no doubt concerning the agency of such a case in spreading the disease. Thus, fowls not suspected of being diseased may have the disease smouldering among them. The fact that occasionally a single fowl dies of cholera means that a severe loss may occur at any time."

The practical recommendation for an outbreak of fowl cholera then is to kill and destroy all sick birds, confine all well birds to small runs. Disinfect these runs and the houses daily. After the outbreak is over and the birds have ceased dying it is best to market all flocks in which the cholera appeared. This latter precaution will often prevent a second outbreak some months later.

Methods of prevention are always the most satisfactory. The careful poultryman will guard his flock against all infectious diseases by methods of quarantine, disinfection and general cleanliness. At the same time the birds should be fed to keep them in the best of health. On these points read Chapter II.

Through the kindness of Dr. Philip B. Hadley the writers have had the opportunity to read the manuscript of Bulletin 144 of the Rhode Island Experiment Station dealing with fowl cholera. On the basis of his experimental work Dr. Hadley recommends subcutaneous injections of 5 per cent carbolic acid as a treatment for individual birds. In the summary of this bulletin Dr. Hadley says: "At the Rhode Island Station attempts have been made to prevent the development in fowls of cholera artificially produced by inoculation with the fowl cholera organism. The protective inoculations have involved subcutaneous inoculations with a 5 per cent solution of carbolic acid in amounts of from 2 to 4 c. c. daily."

"The results thus far secured show that the inoculations as given protected artificially infected birds, and did no harm to birds that were in normal health. They therefore suggest that subcutaneous inoculations with carbolic acid have a protective and perhaps a therapeutic value in fowl cholera."

CHAPTER X.

Diseases of the Abdominal Cavity.

Peritonitis.

The thin serous membrane which lines the abdominal cavity and covers the internal organs is called the peritoneum. Inflammation of this membrane may occur in connection with the inflammation of certain internal organs such as the intestines, liver, kidneys, etc. In these cases the inflammation extends from the diseased organs on to the wall of the body cavity. Peritonitis may also be caused by the entrance of foreign bodies into the abdominal cavity. It may further be caused by severe bruises or injuries of the abdominal wall.

Foreign bodies enter the abdominal cavity chiefly through perforation of the intestine. This may occur through severe inflammation, by sharp-pointed objects pushing through the intestinal wall or by parasitic round worms or other parasites puncturing the wall. In many cases mature eggs separate from the ovary but fail to enter the oviduct. Or, owing to rupture of the oviduct or a reversal of its peristalsis, the egg substance may enter the abdominal cavity. Usually these eggs are absorbed or walled off without very serious annoyance to the bird. In other cases they may cause severe peritonitis. Finally foreign bodies may enter the abdomen through such operations as caponizing.

Diagnosis.—The sick birds appear restless and lose their appetite. There is a high fever. The abdomen is swollen, hot and tender. Pressure on the abdomen produces evidence of sharp pain. Usually, but not always, a severe thirst accompanies peritonitis. As the disease progresses the bird becomes weaker, is unable to stand and the legs are drawn up close to the body often with convulsive movements.

Post-mortem examination shows the peritoneal membrane to be deep red in color (provided the bird has just died or has been freshly killed without bleeding). This membrane is usually covered with a thick opaque yellowish exudate. This gives it the appearance of being much thicker than usual. In some cases small lumps of whitish matter (pus) are found. The abdomen may contain more or less liquid which is usually yellowish and turbid and may have an offensive odor. If a miscarried egg is the cause of the trouble portions of this will usually be found.

Treatment and Prognosis.—Only very seldom is treatment for peritonitis successful. The disease is not usually recognized until in an advanced age. Zürn recommends wrapping parts of the bird in wet cloths and to give internally tincture of aconite, 2 drops (at the most) with a teaspoonful of water 2 or 3 times a day. Sanborn recommends 1 grain opium pills twice a day to relieve pain, and warm liquid foods such as meat juice and milk in equal parts.

Abdominal Dropsy or Ascites.

Etiology.—This disease is sometimes called chronic peritonitis. It is characterized by the accumulation of a large quantity of liquid in the abdominal cavity. In some cases the abdomen becomes so distended that it nearly or quite touches the ground when the bird is standing. Salmon says: "If examined by slight pressure of the hand the swelling is found to be soft and fluctuating; it will yield in one place and cause greater distension at another. That is, it gives the sensation of a sac filled with liquid."

Abdominal dropsy may begin with a mild case of peritonitis which has continued for a long time without becoming serious. In young chicks it is said to be due to an anæmic condition produced by bed feeding and insanitary conditions. In older birds it may also result from this same cause or may be due to some obstruction of the venous circulation either by a tumor or by some structural disease of the abdominal organs.

Diagnosis.—The most marked symptom, of course, is the enlarged, flabby abdomen. Salmon says: "Fowls affected in this way are dull, disinclined to move, generally feeble with pale comb and diminished appetite."

Treatment.—"Treatment of this condition is not profitable, but in special cases, stimulating diet with considerable animal food, tonics and diuretics, may be tried. Iodide of potassium or iodide of iron in doses of 1 grain is particularly indicated." (Salmon.) Tapping with a hollow needle or trocar through the skin and muscles of the abdomen and allowing the fluid to escape is also recommended. It will usually be found more profitable to kill the bird.

CHAPTER XI.

Internal Parasites.

Fowls are often seriously infested with internal parasites. The most important of these are various worms living in the alimentary canal. In popular usage these are spoken of simply as "worms." Various other internal parasites as the gape worm, the air sac mite, etc., are described in other sections of this book. The present discussion will be confined to intestinal worms.

Regarding these Robinson says: "Worms in small quantities inhabit the digestive organs of all fowls and animals without causing them serious inconvenience. It is even maintained by some authorities that in limited numbers these parasites are beneficial, though in just what way they are beneficial I have never seen stated, and it seems more reasonable, in the present state of knowledge of the subject, to claim no more than that when not too numerous they do no perceptible harm. Worms are contagious in that they are transmitted from fowl to fowl, probably always indirectly by being deposited on the ground by one fowl and taken from it by another; but if it is true as stated that worms in small numbers are always present, contagion is not required to account for their increase to troublesome numbers in many members of a flock simultaneously. The more reasonable assumption in the premises is that all these fowls alike were in a condition favorable to an excessive development of the parasites. This is a phase of the question on which the literature of the subject has done nothing—yet it seems to be the all-important point to determine."

Diagnosis of Worms in General.—Accurate diagnosis of worms in the intestines can be made only by finding the worms in the droppings of the fowls. Fowls affected with worms to any great extent frequently show the general symptoms of dullness and depression. Birds that are suspected of being affected with worms should be shut up in a coop and given a dose of some vermifuge or a purgative dose of Epsom salts. If careful observation of the droppings are made at frequent intervals the worms, if present, can usually be detected in this way. This is not, however, an infallible test. Regarding further measures Robinson says: "If efforts to secure evidence from the living fowls of the presence of worms fail, and the poultryman is at a loss to account for the trouble with his fowls, a suspected fowl should be killed and examined, and if this is still insufficient, the case should be taken to a competent veterinary. It is of greatest importance that the facts in such cases be learned and proper treatment given, for whether the worms cause the trouble or conditions exist which favor their increase, the situation is full of danger to the keeper of a flock in which serious trouble is associated with worms; and while I do not wish to unnecessarily alarm anyone, the fact that in recent years worms in epidemic form have put a number of poultry plants out of business, should be stated as a warning to poultrymen troubled with unidentified diseases presenting symptoms which might be associated with worms."

The principal parasitic worms which affect the digestive tract of fowls may be grouped into three classes as follows: Tape worms, round worms and flukes.

Tape Worms.

Tape worms have long been known to infest domestic poultry. Occasionally serious outbreaks of the tape worm disease occur in various parts of the country. These outbreaks are usually confined to comparatively small areas and are perhaps more common in the southern states.

Etiology.—The tape worms of poultry, like those which infest man and the domestic animals, are long, *flat, segmented* worms. (fig. 6.) The anterior end of the animal possesses a number of hooks or suckers by which it attaches itself to the walls of the intestine. Back of this head the entire animal consists of a long series of segments or proglottids. The segments nearest the head are the smallest and it is at this region that new segments are constantly being formed. The farther from the head they get the larger the segments become. Towards the posterior end of the worm the segments develop sexual organs and later become filled with eggs. As soon as the eggs are fertilized and mature the segment containing them drops off and passes to the exterior with the feces of the host. Each segment of this kind contains thousands of eggs.

If these eggs are to develop farther they must be swallowed by some intermediate host (as a worm, snail or insect). The egg then hatches into a 6-hooked embryo which bores its way from the intestine into the body cavity of the intermediate host. It here develops into a larval form known as a *cysticercoid*. When the intermediate host (worm, snail, etc.) is eaten by a chicken this larva continues its development and forms an adult tape worm. Thus there are two stages in the life cycle of a tape worm: that in the adult host and that in the intermediate host. Each species of tape worm, of which there are a great many, has its particular host, both intermediate and final.

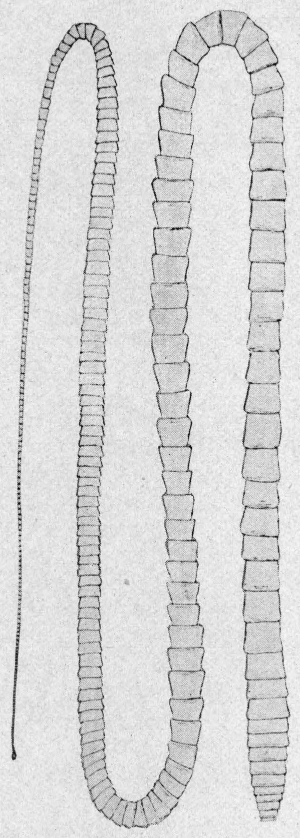


Fig. 6. *Drepanidotaenia infundibuliformis*, a tape worm of the fowl. (After Stiles).

According to Stiles (Bur. An. Ind. Bul. 12) there were up to 1896, 33 species of tape worms recorded for poultry. Of these 11 are recorded as occurring in chickens. The complete life history is known for only a few of these. Regarding the tape worms of chickens, Stiles (*loc. cit.*) says, p. 13: "(They) are *known* to become infected with one tape worm through eating slugs (Limax). They are *supposed* to become infected with a second through eating snails (Helix); by a third through eating flies and by a fourth through eating earth worms."

There seems but little need to give a description of the different species of tape worms found in chickens. The characters by which they are distinguished from each other are too minute and involved to be of use to the poultryman or farmer. If anyone is having trouble with tape worms in poultry the best thing to do is to send a portion of the intestine containing the worms to the Zoological Division, Bureau of Animal Industry, U. S. Department of Agriculture, Washington, D. C. In this way the worms will be identified and any specific remedies will be recommended.

Nodular Tæniasis.

Stiles says, p. 15: "At least one species of tape worm (*Davainea tetragona*) causes a serious nodular disease of the intestine of chickens which upon superficial examination may be easily mistaken for tuberculosis." Moore says (Bur. An. Ind. Circ. No. 3, 1895):

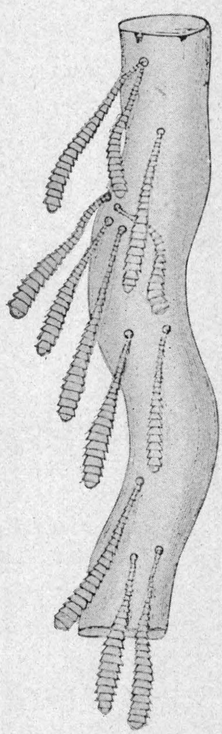


Fig. 7. Intestine of a fowl turned wrong side out to show tape worms in nodular taeniasis. After Pearson and Warren).

"Tuberculosis is the only known disease for which this affection is liable to be mistaken, and it is of much importance that the two diseases should not be confounded. The diagnosis has not in my experience been difficult, as in every case the attached tape worms were readily detected upon a close examination of the intestinal contents, or of the mucous membrane of the infected portion of the intestine. However, the worms are quite small and could easily be overlooked in a hurried or cursory examination. In case of doubt, if the affected intestine is opened and the mucous surface washed carefully in a gentle stream of water, the small worms will be observed hanging to the mucous membrane. This discovery, in the absence of lesions in the liver or other organs, would warrant the diagnosis of the tape worm disease."

Diagnosis.—The symptoms of tape worm disease are not specific. The general symptoms are similar to those of other worms (cf. p. 75). Regarding the symptoms of tape worms Stiles quotes the following from Zürn: "If numerous tape worms are present in the intestine of young or old fowls a more or less extensive intestinal catarrh develops, corresponding to the greater or less number of parasites present."

"The intestinal catarrh shows itself, especially in chickens and geese, as follows: The sick animals become emaciated, although the appetite is not especially disturbed. At times the appetite is even increased. The droppings are thin, contain considerable yellow slime, and are passed in small quantities but at short intervals. The poultry raiser must direct his attention to these thin, slimy, and often bloody droppings, for if any treatment against the tape worm is to be undertaken, this must be done as early as possible. In observing the droppings it should be noticed whether tape worm segments or eggs are present. The eggs can be seen, of course, only with the microscope."

"After a time other symptoms develop. The sick animals become dull and listless, remain apart from the rest of the flock —the feathers are ruffled and the wings droop, the appetite is lost and the birds allow themselves to be easily caught. Although it was stated that in the beginning of the trouble the appetite is not disturbed, the sick animals develop an intense thirst for cold water. When it rains they run under the eaves in order to catch water, and in winter are eager for ice water."

Since the examination of the feces for tape worm segments is rather unsatisfactory for the farmer or poultryman, Stiles says that "The best method for the farmer to follow is to kill one of the sick chickens when he suspects tape worms and to cut out the intestine. He should then open the intestinal tract from gizzard to anus in a bowl of warm water, and look for the parasites." (Cf. fig. 7). Finding the worms in the alimentary canal is the only certain diagnosis of the disease.

Treatment.—The chief drugs used for tape worms in fowls are: Extract of male fern, turpentine, areca nut, powdered kamala, pumpkin seed, pomegranate root bark and Epsom salts. The following extract from Salmon gives the principal methods of treatment and the doses: "One of the best methods of treating tape worms in fowls is to mix in the feed a teaspoonful of powdered pomegranate root bark for every 50 head of birds. In treating a few birds at a time it is well to follow this medicine with a purgative dose of castor oil (2 or 3 teaspoonsful). According to Zürn, powdered areca nut is the best tape worm remedy for fowls, but he states that turkeys are unfavorably affected by it. It may be given in doses of 30 to 45 grains mixed with butter and made into pills. Male fern is also a very effectual remedy and may be used in the form of powder (dose

30 grains to 1 dram) or of liquid extract (dose 15 to 30 drops). It should be given in the morning and evening, before feeding. Oil of turpentine is an excellent remedy for all worms which inhabit the digestive canal. It may be given in the dose of 1 to 3 teaspoonfuls, and is best administered by forcing it through a small flexible catheter that has been oiled and passed through the mouth and œsophagus to the crop. This medicine is less severe in its effects if diluted with an equal bulk of olive oil, but, if it fails to destroy the parasites when so diluted, it may be given pure. The method of administering medicine by depositing it directly in the crop can be advantageously used with many other liquid remedies, and should be adopted in all cases where it is important to have the full dose in the stomach in a short time. It does away with the uncertainty attending the giving of medicine in the feed or drinking water, and with a little practice is more expeditious than making and giving pills. The open end of the catheter may be inserted into a rubber bulb having one opening. Just sufficient air should be expelled from the bulb, so that the dose of medicine will be sucked up without

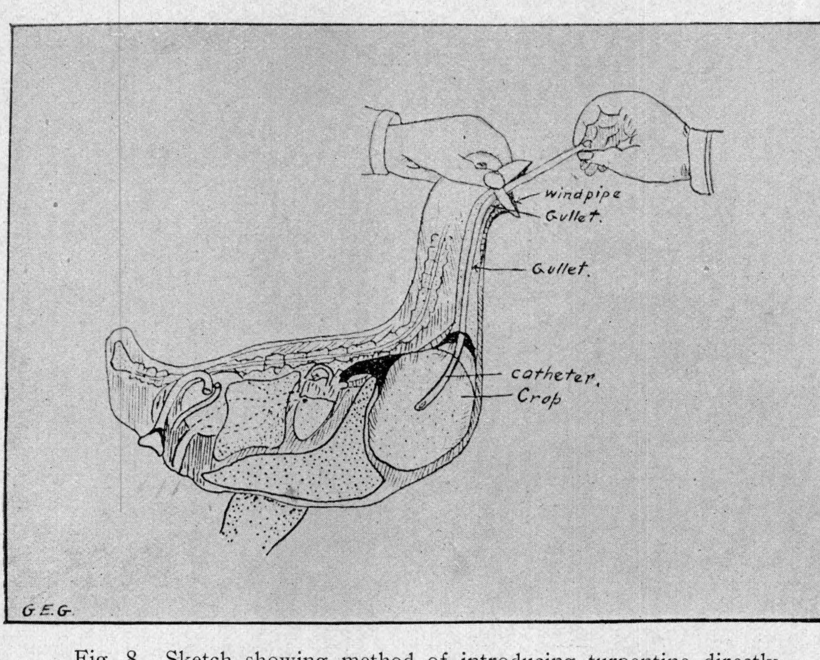


Fig. 8. Sketch showing method of introducing turpentine directly into crop. (From Gage and Opperman).

being followed by much air. The bird's head is then brought in a line with the neck, which is extended, the catheter is passed carefully to the crop, when a slight pressure on the bulb forces out the medicine, and the instrument is withdrawn. The operator should be sure that he avoids the trachea."

More recently Gage and Opperman* have found Epsom salts and turpentine a very effective remedy for Nodular Tæniasis. After careful consideration of the data they conclude that "40 to 50 grains of Epsom salts is sufficient for an adult fowl in order to clean out the intestinal tract so that the birds may take food. Then the turpentine should be introduced" as directed above. For younger birds the dose of salts should be proportionately less. In fowls from 6 months to 2 years old the salts are best given by dissolving in water and giving each fowl this liquid. For younger chicks the salts may be dissolved in warm water and used to moisten the mash or feed.

Prevention.—The following statement by Salmon gives some of the chief preventative measures: "Parasitic infestation of the digestive tract should be guarded against by hygienic measures so far as possible. One of the most important of these measures is to move the fowls upon fresh ground every 2 or 3 years, or certainly in all cases where such parasites are frequently observed in the intestines of the birds. Another practical measure, which may be adopted at the same time, is to remove the excrement daily from the houses and destroy any parasites or their eggs which may be in it, by mixing it with quick lime or saturating it with a 10 per cent solution of sulphuric acid. The acid is cheap, but requires that great care be taken in diluting it, owing to danger of its splashing upon the clothing and flesh and causing severe burns. It should always be poured slowly into the water used for dilution, but on no account should water be poured into the acid as it will cause explosions and splashing."

"When treating diseased birds these should always be isolated and confined, and their droppings should either be burned or treated with lime or sulphuric acid as just recommended. Without these hygienic measures, medical treatment can only be partially successful."

Stiles says: "An extermination of slugs will insure immunity against *Davainea proglottina,* but no precise directions can be

*Md. Agric. Expt. Stat. Bul. 139, 1909.

given to prevent chickens from becoming infected with other tape worms until the life history of these parasites is better understood. It will be well, however, to keep the chickens housed in the morning until the sun is well up and the ground is dry, for they will thus be less likely to meet with the supposable intermediate hosts of other worms."

Round Worms.

Round worms can be found in the intestine and especially the ceca of almost any fowl. They are much more common than the tape worms. Normally the round worms cause no serious trouble to fowls. Under certain conditions, however, they may become so numerous as to be a serious menace to the flock. At such times they have a decided effect on the digestion; the irritation often causes diarrhea. When in large numbers, they sometimes become rolled and matted into a ball which may cause complete stoppage of the intestine.

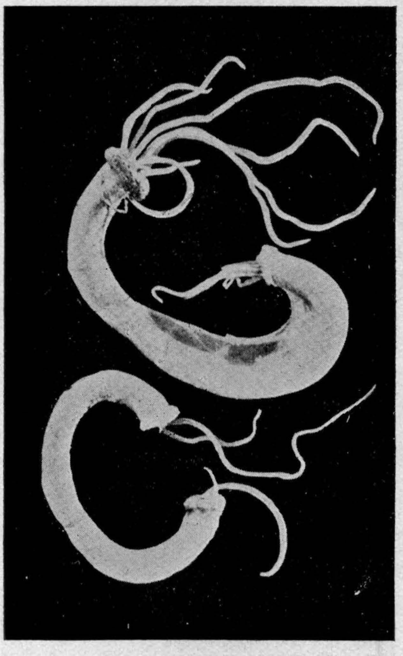


Fig. 9. Worms protruding from a section of the intestine of a fowl. (After Bradshaw).

The round worms are white in color and vary in length from 1-3 inch to 5 inches. The head end is sharp pointed, while the tail end is more blunt. Round worms are seldom passed in the feces unless present in very large numbers. When a worm is passed it soon dies in the droppings or is eaten by another fowl.

Dispharagus spiralis, a small worm about 1-3 inch in length, is often found in the œsophagus and occasionally in the crop or intestine.

Dispharagus nasutus, about ¼ inch long, occurs in the walls of the gizzard of fowls. It sometimes becomes so numerous as to cause serious loss.

Heterakis perspicillum, from 1½ to 3 inches long, is very common in the intestines of fowls. They sometimes become very numerous and may become rolled into rather large balls which obstruct the passage of the food.

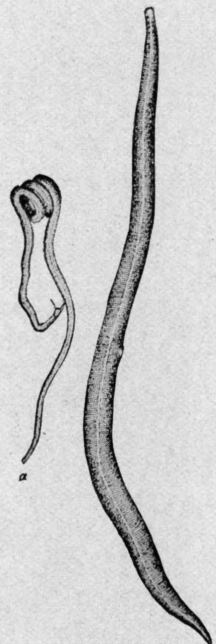


Fig. 10. *Heterakis perspicillum.* a, male. b, female. x2. (From Salmon).

Several other species of the genus *Heterakis* also infest fowls and other poultry.

Diagnosis.—The symptoms of round worms are similar to those of all worms (cf. p. 75). There is evidence of indigestion. The comb becomes pale and there may be diarrhea.

Treatment.—The remedies mentioned on p. 79 for tape worms are also useful for round worms. The remedy most commonly advised is to give 2 grains santonine for each bird. Dissolve this in water and use to mix the wash. As recommended on p. 79, all droppings should be collected and examined, also put out of reach of the birds.

Vale recommends the following: "Beat a new laid egg with 1 tablespoonful of oil of turpentine and mix thoroughly by shaking. Give a teaspoonful of the mixture night and morning for a few days; or divide ¼ of an ounce of areca nut in powder, into 4 parts, and give 1 part each morning, fasting, with a dessertspoonful of sweet oil 2 hours after each powder."

Flukes.

Flukes or trematode worms are small, flat and usually oval-shaped. Fig. 11 gives a fair idea of the appearance of these parasites.

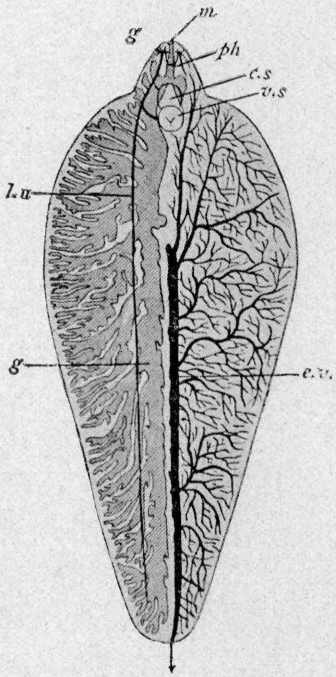


Fig. 11. Trematode worm or fluke showing internal structure. (From Thompson after Sommer).

Regarding these parasites in poultry, Theobald (Parasitic Diseases of Poultry, London) says: "The Trematode worms or Flukes found in the fowl are 3 in number. One is found in the egg (*Distoma ovatum*), the others in the œsophagus and intestines."

"The Fluke found in the œsophagus of the fowl is known as *Cephalogonimus pellucidus,* a transparent reddish fluke about 9 mm. long. These were found by Von Linstow and Railliet. In the intestines Neumann enumerates 7 species, namely, *Notocotyle triscrialis Distome oxycephalum,* Rud., D. *dilatatum,* Miriam, *D. lineare,* Zeder, *D. ovatum, D. armatum,* Molin, and *Mesogonimus commutatus,* Sons. These, however, are not all distinct; *dilatatum* is undoubtedly the same as *oxycephalum; armatum* is also probably the same."

"None of these Trematode worms are of any pathological importance, although, as is well known, they often cause serious maladies in other animals. All the Flukes that have two hosts undergo a complicated metamorphosis, the early stages always taking place in some water-molluse. Those found in *Gallus domesticus* have not had their life-histories worked out."

CHAPTER XII.

Diseases of the Respiratory System.

Anatomy and Physiology.

The respiratory organs of birds are the nasal passages, the pharynx, larynx, trachea, lungs and air sacs. The form and general appearance of the lungs and trachea are shown in fig. 12.

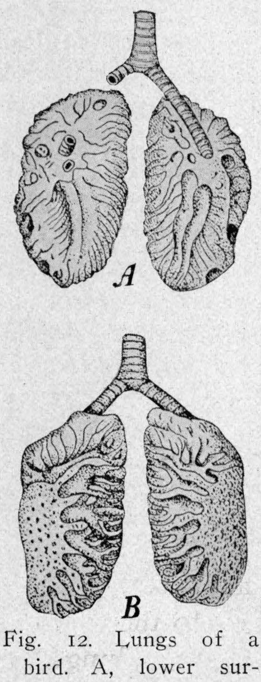


Fig. 12. Lungs of a bird. A, lower surface. B, upper surface. (After Salmon).

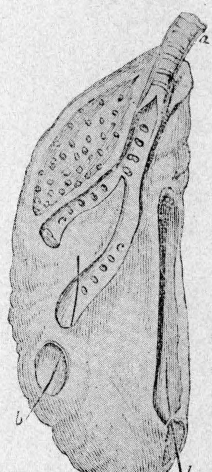


Fig. 13. Right lung of a goose. A, primary branches. b, and b′, openings into abdominal and thoracic air sacs. c, c, secondary bronchi. (After Owen).

The respiratory apparatus differs somewhat in structure and function from that of mammals. As in mammals the trachea (wind-pipe) divides into the primary bronchi, one passing to each lung. In birds these bronchi do not divide and subdivide as in mammals but each passes to the posterior end of its lung and where it opens into the abdominal air sac. This relation is shown in fig. 13.

In the lung the primary bronchus gives off branches (secondary bronchi) some of which end blindly (cf. fig. 13). The secondary branches give off branches (tertiary bronchi) all of which end blindly (cf. fig. 14). This tubular system makes up the air-containing portion of the lungs. It is imbedded in a net-work of almost naked blood vessels which make up the spongy tissue of the lungs (cf. fig. 14). The aeration of the blood takes place through the walls of these vessels. The relations of this tubular system of the lungs are shown in fig. 14.

The air sacs are very large, thin-walled sacs which open into the bronchial tubes as described. They function chiefly as reservoirs of air so that fresh air is supplied to the lungs twice during each breath. The air passes through the lungs into them during inspiration and during expiration the lungs are filled with the air forced back from the sacs. Some aeration of blood takes place in the sacs and they also help to reduce the relative weight of the body. In addition to aeration of the blood, the respiratory apparatus eliminates most of the waste moisture of the body and is, therefore, the temperature regulator. In mammals this function is performed by the sweat glands and the secretion of the kidneys. Birds have no sweat glands and the secretion of the kidneys contains relatively little moisture.

The air passages are lined with mucous membrane and this membrane is the seat of several diseases. Diseases are easily transferred from one part of the respiratory system to another, since the passages and also the lining membranes are continuous from the nostrils to the air sacs. There are also diseases of the vascular part of the lungs. Some of these diseases are caused by unfavorable conditions as exposure to cold, draughts of air, or moist air or to improper food. Others are due to specific organisms. Most of the latter are contagious. Exposure to unfavorable conditions also reduces the ability of the birds to resist infectious diseases.

Catarrh.—(Simple Catarrh; Non-contagious Catarrh; Cold.)

One of the most common diseases of the air passages is catarrh (cold). It is often hard to distinguish this disease from early stages of roup and diphtheria. The characteristic symptoms of the latter disease should be carefully looked for, lest the flock become infected with a dangerous contagious disease. In cases where there is a suspicion of either of these diseases it is better to isolate the sick birds. Catarrh is non-contagious. It usually affects only a few individuals in the flock, but in cases of exposure of the flock to the unfavorable conditions which cause the disease it may occur in quite a number of birds at the same time.

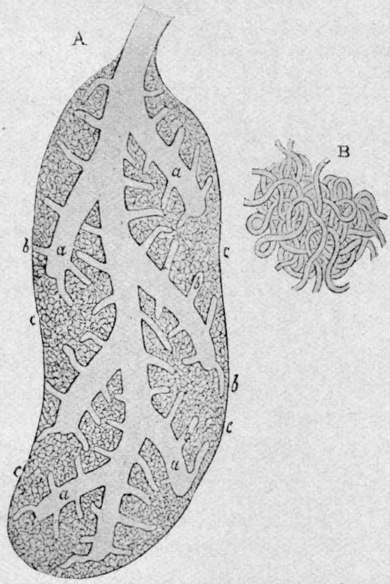


Fig. 14. A—Lobule of the lung of a bird represented in ideal longitudinal section; a, a, secondary bronchi; b, b, tertiary bronchi. B.—Plexus of blood vessels which chiefly compose the pulmonary tissue. (After Owen).

Diagnosis. Salmon gives the following description of the symptoms of this disease: "In simple, non-contagious catarrh, the affected birds are more or less dull, they are disinclined to move, their appetites are diminished, they sneeze and the mucous membrane is thickened, causing some obstruction to breathing through the nostrils. There soon appears a thin, water discharge which later becomes thicker and glutinous, the eyes are often watery, the eyelids swollen and sometimes held together by a thick, viscid secretion. In very severe cases, the birds are somnolent, the plumage is erect and roughened, the nostrils are completely obstructed by the thick secretion, the breathing is entirely through the mouth and is accompanied by a wheezing or snoring sound, the appetite is entirely lost, a thin liquid escapes from the mouth and the bird soon becomes exhausted and dies."

Etiology. The cause of catarrh is exposure to cold, to draughts of air, to damp atmosphere due to improper housing conditions, or to wet weather. Weak stock or improperly nourished birds are more likely to be affected by these conditions than strong, vigorous and well fed individuals.

Treatment. With strong, healthy stock it is usually only necessary to remove the cause. It is a good practice, however, to give red pepper (capsicum) with the food. Salmon gives the formula and dose of a tonic recommended by Megnin.

"Gentian root	4 drams
Ginger	4 drams
Sulphate of iron	2 drams
Hyposulphite of sodium	1 dram
Salicylate of sodium	1 dram

These substances are to be pulverized and then thoroughly mixed. The dose is 3 to 4 grains a day for a medium-sized fowl. Its effects are stimulating and tonic."

In severe cases, the eyes, mouth, and nostrils may be washed once or twice a day with one of the following solutions which are given in order of preference:

1. Boracic acid 3 per cent solution.
2. Creolin 1 per cent solution.
3. Hydrogen dioxide mixed with equal parts of water.
4. Carbolic acid, 2 per cent solution.

Prognosis. A great majority of the birds recover in a few days if the cause is immediately removed. If the cause continues to act they may become worse and die, or the disease may become chronic and persist for a long time.

Bronchitis, Croup.

This disease may follow catarrh as a direct extension of the inflammatory processes in the membrane of the nasal cavities and throat to the mucous membrane of bronchial tubes.

Diagnosis. The symptoms of bronchitis are the symptoms of a hard cold (severe catarrh) with rapid breathing and cough. It may be distinguished from a cold by the peculiar sounds made in breathing. In the early stages of the disease this is a whistling sound made by the passage of the air over the dry, thickened membrane. As the disease advances mucus collects in the tubes and the breathing is accompanied by a rattling or bubbling sound. Under favorable conditions the symptoms do not usually pass beyond this stage but soon disappear. In very severe cases the birds become very sleepy and refuse to eat. The wings droop. The feathers are roughened and breathing becomes more and more difficult, until finally the bird dies. The less severe forms of the disease may become chronic while the symptoms of rattling breath and coughing up mucus may persist for a long time. In this form of the disease the birds appear well except for the above symptoms.

Etiology. When it follows a hard cold, bronchitis may be caused by an extension of the inflammation of the mucosa of the throat to the mucosa of the bronchial tubes. It may also be caused directly by exposure to cold, draughts, and dampness; or it may result from irritation of the mucous membrane caused by inhaling irritating vapors, dust or foreign particles.

Treatment. Place the patient in a warm, dry, well ventilated but not draughty rooms. Feed bread or middlings moistened with milk, and add to this food 2 grains of black antimony twice a day. A demulcent drink is often beneficial. A very good one is made by steeping a little flax seed in water. Other demulcent drinks are made by dissolving honey or gum arabic in water. This treatment is sufficient for mild cases. Salmon recommends the following treatment for severe attacks: "If the attack promises to be severe, it may sometimes be checked in the early stages by giving 10 drops of spirits of turpentine in a teaspoonful of castor oil and repeating this dose after 5 or 6 hours. It should not be continued after there are signs of purging, for fear of exhausting the strength of the patient. In the very acute cases, where the whistling or snoring sounds with the respiration indicate a croupous form of inflammation, and where the gasping shows great obstruction of the air passage, relief may be obtained by giving from 3 to 6 drops of either the syrup or the wine of ipecac."

"Medicines should be administered very carefully in diseases affecting the trachea and bronchi, as otherwise they may enter the air passages and increase the irritation."

Prognosis. In the ordinary and chronic forms the birds usually recover. In the more severe forms a large per cent of the affected birds die.

Influenza (Epizootic, Grippe, Distemper).

This disease is mentioned by Woods as "a contagious germ disease closely association with roup." Robinson gives a brief statement of the diagnosis, treatment and prognosis of this disease as follows: "Briefly stated, the symptoms are of a sudden and severe cold, with high fever, generally diarrhea, and extreme debility. In very severe cases death may ensue within a few hours after the fowl is observed to be sick. Usually the bad cases linger for a day or two, while those that recover run for a week or 10 days. Treatment the same as for bad colds."

Quite possibly this is not a separate disease but is either a severe form of cold occurring in many individuals of a flock which has been exposed to unfavorable, insanitary conditions, or is a mild form of roup.

Roup (Contagious Catarrh, Diphtheria, Diphtheritic Roup, Canker).

Veterinarians have distinguished two diseases belonging to this general class of troubles as follows: (a) roup or contagious catarrh when only catarrhal symptoms are present, and (b) diphtheria, diphtheritic roup and canker when diphtherial patches and false membranes are formed. The bacteriologists Moore, Harrison and Streit, consider these different stages of the same disease. Cary not only considers these as one disease but also believes that sorehead, chicken pox or *epithelioma contagiosum* is also a form of this disease. These questions cannot be settled with the present knowledge of the causes of these diseases. The evidence for considering roup and diphtheria as successive stages in the same disease seem much better than the evidence that sore-head is a form of this disease. In the present work sore-head is treated separately.

Roup is a disease of very great economic importance. It is widely distributed causing a large annual death rate, and also reducing the value and production of affected flocks since many birds contract the disease in a chronic form and become worthless for egg production or breeding. Such birds preserve the germs of the disease and this leads to fresh outbreaks whenever the flock is exposed to unfavorable conditions.

Diagnosis. Harrison and Streit* give a very good descrip-

---

*Harrison, F. C., and Streit, H., Roup. Ont. Agr. Coll. & Expt. Farm. Bulletin 125, Dec. 1902, pp. 1-16.

tion of the symptoms of roup from early to late stages. The following account is quoted from their bulletin:

"The general condition of roupy birds varies very much. After the first symptoms of the disease, which is usually a putrid catarrh from the nostrils, the affected fowl is generally restless, separates from other members of the flock, becomes dull, cowers in the corner of the coop or mopes in the corner of the pen, with its head drawn close to its body and often covered with its wings."

"If there is a severe discharge from the nostrils or eyes, then the feathers upon the wings or back are likely to be smeared with it, stuck together, and after some time fall out; and the eyes often shut, the lids being glued together by the sticky discharge from them."

"A fowl in a sleepy condition, or moping as described, frequently arouses itself for a time, takes food, and especially water, and then gradually returns to the apathetic condition."

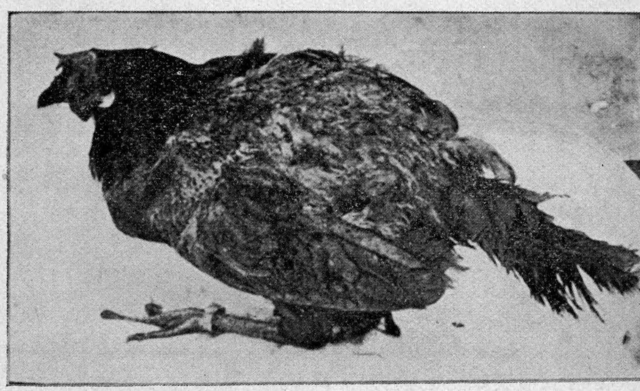


Fig. 15. Showing appearance of a hen a day before death from roup. (From Harrison and Streit).

"Many fowls having the disease in a chronic form keep their normal appetite for a long time, and seem very little disturbed physically, whilst others, especially when the face or eyes become swollen, lose their appetite, grow thinner and thinner, and finally become too weak to stand or walk around, when they lie down and die in a few days. During the last stage diarrhoea, with offensive yellow or green discharge, often sets in and causes death in a short time."

"Many poultry keepers assert that roupy birds show fever; and it is certain that the head is often very hot, but the body temperature is normal, or only very slightly higher than normal."

"*Special Symptoms of Roup.* By the term roup we generally understand a more or less putrid discharge from the nostrils, which lasts for weeks or even months. The disease often follows a common cold, to which fowls, especially young fowls and those of the more delicate breeds, are much predisposed."

"In the first stages of roup, the birds often cough or sneeze, and the breathing is noisy, caused by the partial closing of the air passages, which become blocked with the discharge from the nostrils. When the air passages are entirely closed by the discharged products, the fowl has to open its beak in order to breathe."

"Sometimes a yellowish cheese-like mass forms in the nostrils, growing quickly and pressing the upper walls of the nose upwards; and if this mass is removed, an uneven bleeding surface is left, which forms a new cheesy mass in from 24 to 48 hours."

Fig. 16. Showing swelling of head in severe roup. (From Harrison and Streit).

"Whilst many roupy birds show only the above mentioned symptoms, others become more seriously diseased. The face of roupy birds is very often swollen, especially between the eyes and the nostrils; and this swelling, which is hot and sore, sometimes grows into a tumor as large as a walnut—generally firm and hard. (See fig. 16). A bird in this condition is frequently found scratching at the tumor with its claws or wings, as if endeavoring to remove it. If the tumor grows on the inner side, towards the nasal passage, it forces the roof of the mouth downward, and the upper and lower beak are slowly pressed out of their normal position, so that the bird cannot close its mouth."

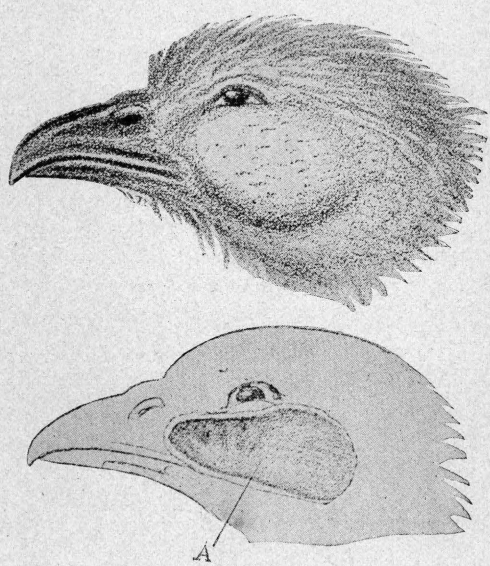


Fig. 17. Head of a bird. The lower figure shows the maxillo-ocular sinus, which opens into the socket of the eye and communicates with the nasal cavities. The upper figure shows the roup tumor on the head caused by the filling of this cavity with cheesy pus. (From Megnin).

"On making an incision into the tumor, we find a solid, cheesy, yellowish matter, which may be pulled out like the root of a plant; but it usually has to be broken into small pieces in order to get it out. Around this mass, there is a more or less smooth, grey or brownish membrane that is capable of again forming a cheesy mass similar to what has been removed."

"The mass itself, when not attended to, often grows into the nasal canals, and blocks them up completely. Generally combined with the formation of the tumor on the face, there is an affection of the eyes; or the eyes become diseased without the preliminary discharge from the nose, in which case poultry keepers speak of fowls as suffering from "roup of the eyes."

"*Roup of the Eyes.* The first symptom of the eyes is generally an inflammation of the eye-lids. These become red, swollen and hot; then the mucous membrane and glands of eyes become inflamed and begin to secrete a liquid—at first clear, and then of a grey, slimy, putrid character, which dries on the feathers at the side of the head, causing them to stick together or fall out. If the secretion is retained in the eye socket, it undergoes a change, becoming a yellowish, solid, cheesy mass of the same appearance as that found in the nasal tumor. This cheesy mass either forces the eye out of its socket, or the inflammation entirely destroys it. These cheese-like masses form in one or two days, and may reappear after many daily removals."

"All these affections, described above, may be localized on one side; but often both nasal passages and both eyes are affected at the same time."

"Combined with the symptoms of roup above described, there often are patches of a greyish yellow exudation firmly adherent to the mouth, throat, etc. These patches are called "false membranes," and on account of their somewhat close resemblance to the membrane which is formed in human diphtheria, it has been thought by some writers that the avian and human diseases are the same. Here, however, let it suffice to say that the weight of evidence is against this contention."

Fig. 18. Head of a fowl 22 days after inoculation with a culture of the roup bacillus. A.—False membrane. (From Harrison and Streit).

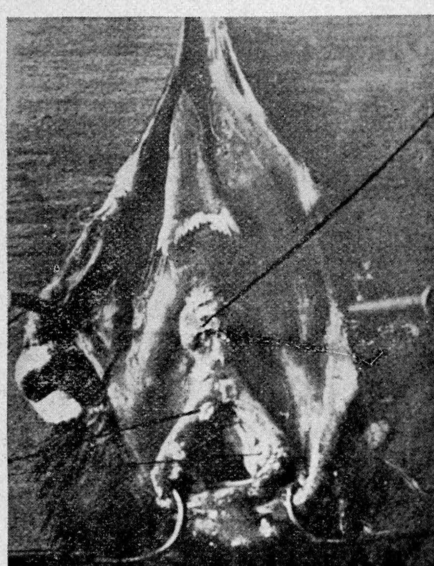


Fig. 19. Throat and bottom of mouth with false membrane (*m*) 14 days after inoculation. (From Harrison and Streit).

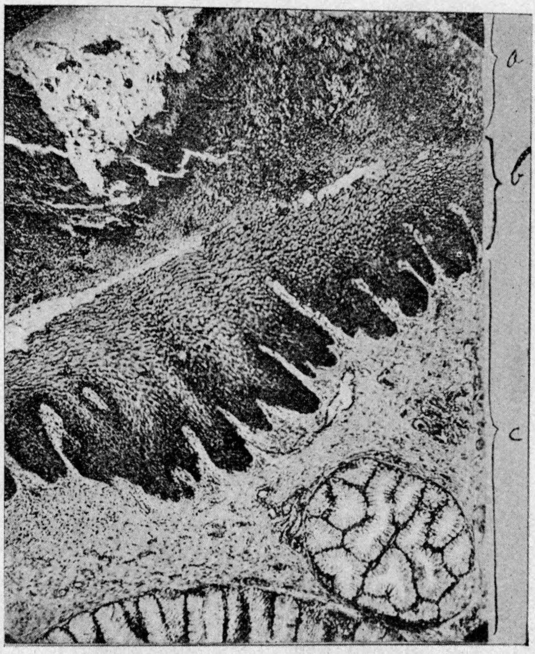


Fig. 20. A section of a false membrane of a roupy fowl. (a)—false membrane; (b), epithelium; (c), sub mucosa. (From Harrison and Streit).

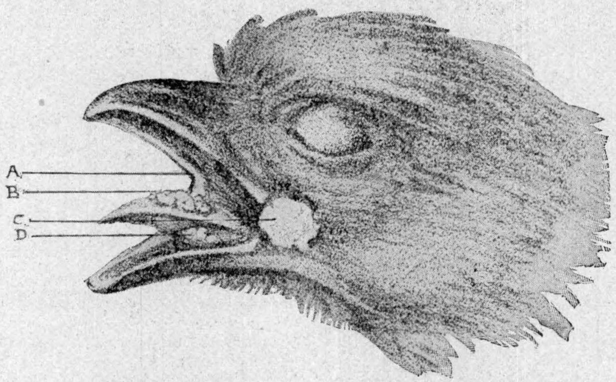


Fig. 21. Head of a bird with diptheritic roup affecting the mouth and tongue. A. B, C and D.—False membranes. (From Megnin).

"We may also point out that many poultry keepers who notice the false membrane on the throat and mouth of their fowls, regard the disease as quite different from the catarrhal form, and call it "canker," which is probably a popular form of the word "cancer."

"Whether the disease is characterized by false membranes, offensive discharges, or cheesy masses, the cause is the same, as we have many times experimentally demonstrated."

"At one or several places in the mouth or throat, these yellowish, smooth or uneven membranes appear, and either remain small and disappear after a few days or grow thicker, spread, and become firmly attached to the mucous membrane; and if they (the false membranes) are removed, an uneven, bleeding surface is exposed, which looks like a true cancer."

"After the appearance of the membranes the adjacent submucous tissue sometimes becomes inflamed, and finally the growths are found to be similar to those so often seen at the side of the face—containing solid cheesy matter in the center."

"When the throat is blocked by these false membranes, the animal's breathing becomes abnormal, and the air passing through the throat produces loud noises. Gradually, the visible mucous membrane and the comb turn blue, and the fowl finally dies from suffocation."

"*The Course of the Disease.* The course of roup is usually of long duration. A simple, putrid discharge from the nose may stop in 3 or 4 weeks, and similarly false membranes may soon disappear; but generally the symptoms last for months. When the eyelids become swollen and tumors appear, the case is usually chronic. Affected birds may be better for a few days or weeks, and then become very weak again. Damp, cold weather usually intensifies the disease.

"It is well known that fowls may be more or less sick from roup for one or even several years and these birds should have the greatest care and attention, for they are generally the cause of new outbreaks. Once introduced, roup may remain in a flock for many years. The first cold and moist nights of the fall and early winter cause all kinds of catarrhs, which in many instances are followed by roup. Roup spreads rapidly in the winter time and may attack from 10 to 90 per cent of the fowls in a flock. Towards spring, the disease gradually disappears; during the summer months, a few birds remain chronically affected; and then the first cold nights give the disease a fresh start."

"Young fowls and fowls of the fine breeds are especially liable to roup. While some poultrymen maintain that birds once having suffered from roup never take the disease again, most of the experimental evidence tends to show that no acquired immunity exists, as sometimes happens after other diseases. Some fowls are, however, naturally immune, and never take the disease. In the course of our own experiments, a white chicken which had never had roup, was inoculated with repeated and large doses of the roup germ, but without effect."

Etiology. Several organisms have been isolated from the lesions of birds suffering from roup. Four of these have some claim to be considered the cause of the disease. These include 3 species of bacteria and one protozoan. There is also some evidence that the cause of the disease is an invisible virus. While the specific organism or organisms which cause the disease are not certainly known its infectious nature is well established. It is probably carried from one individual to another in a flock, by the particles of dried secretion in the air or possibly by the food and drink contaminated by the diseased birds. It may be introduced into a flock by the bringing in of birds from an infected flock, or by birds that have contracted the disease at shows. Possibly it is sometimes carried on the shoes or clothing of persons coming from infected yards or houses. While a source of infection is necessary for the production of the disease it does not appear to attack birds when the mucous membrane is in a healthy condition. It is most apt to attack birds that are suffering with catarrh. When a flock once becomes infected the birds which develop a mild chronic form of the disease serve as sources of infection whenever exposure to cold and dampness causes catarrh in the unaffected birds. Thus in infected flocks an outbreak of roup usually follows catarrh caused by exposure and this fact has led some poultrymen to think that the disease may be caused directly by exposure. In some flocks it appears annually with the cold damp weather of late autumn and breaks out again at every radical change of temperature and moisture conditions throughout the winter. Vigorous and properly nourished birds are better able to resist catarrh and consequently roup than those that are delicate and improperly fed.

Treatment. The best treatment is prevention. The disease can be prevented by stopping all sources of infection. Some things to keep in mind are:

1. In introducing new birds always procure them from uninfected flocks.

2. Isolate all new birds and all birds that have been exhibited at shows for 2 or 3 weeks to make sure that they do not develop the disease.

3. Exclude from uninfected house and yards poultry and all other animals, including men, coming from those that are infected.

4. Do not use implements as hoes, shovels, etc., that have been used on infected premises.

5. Keep the birds in a good hygienic condition, well nourished and in dry well ventilated houses and roomy yards.

When the disease has been introduced into the flock careful precaution may prevent its spread.

1. Immediately separate from the flock any bird that shows symptoms of the disease.

2. Disinfect the yards and houses. A 5 per cent solution of carbolic acid may be used on the yards. Remove the litter from the houses and disinfect freely. This 5 per cent carbolic solution may also be followed by whitewash, or better use the cresol solution described in Chap. II.

3. Use potassium permanganate in all drinking water. (See Chap. II.)

4. Keep watch of the flock so that any new cases may be isolated at once.

5. *Burn or bury deep all birds that die.*

The disease is amenable to treatment but this treatment must be individual and requires a great deal of time. It must be continued once or twice a day for quite a long time. It is, therefore, very expensive and consequently impracticable for ordinary stock. Moreover birds apparently cured are likely to become the source of infection for later outbreaks.

Robinson well says: "I have cured many very bad cases, but quit treating them years ago, because I found that as long as I cured roup I had more roup to cure." No better advice than is implied in this could be given. If the stock is only of ordinary value it is better to kill all birds that develop the disease. If the flock is badly infected and the disease appears again and again when conditions favor its development, it is better to dispose of the flock and disinfect thoroughly, using new runs when starting again. New stock may be obtained from uninfected flocks or from incubator chickens raised on a fresh range.

In the case of valuable show birds treatment may perhaps be advisable.

Harrison and Streit give the following methods of treating roup:

"The germs of roup are not very resistant; they can easily be destroyed when present in cultures, or somewhere outside the animal; but in the animal tissue, they are very difficult to kill, because they penetrate into the tissue; and unless this too is killed, the germs continue living for a long time."

"Roup may be cured by remedies, if the treatment is careful and judicious. Obstinately reappearing false membranes can be successfully treated by burning the diseased tissue with a strong acid (hydrochloric acid 50 per cent to 75 per cent) or other caustic, such as silver nitrate. If the eyes and nose are attacked, they have to be carefully washed, at least twice a day, with an antiseptic solution, such as 2 per cent boracic acid in a decoction of chamomile flowers, or ½ per cent solution of corrosive sublimate. Thus the micro-organisms are killed or at least, the diseased products which are discharged are removed, and the irritation caused by them; also the transformation into large cheesy masses is prevented."

"We had chickens badly affected with roup of the eyes, which were cured with boracic acid and chamomile. On account of the smallness of the nostrils and nasal canals, it is very difficult to get the antiseptic solutions into the nose and nasal cavities; but it can be done with a small syringe. If this treatment is too troublesome, then the nostrils, at least, should be washed and opened several times a day, to allow the secretions to pass away. We have treated chickens for 14 days by daily washing with a 2½ per cent solution of creolin and glycerine. After the washings, small plugs of cotton wool, filled with mixture, were placed in the nostrils and lachrymal ducts. This remedy did not cure the roup, although the same mixture readily kills the roup bacillus in cultures in from 2 to 3 minutes. The greatest hindrance to a sure cure by remedies which have been used locally, is the ability of the germ to penetrate into the tissue and the many secondary cavities of the nostrils which cannot be reached by the antiseptic."

"Another method of treatment which gives excellent results, especially in the early stages of roup, is the use of 1 to 2 per cent of permanganate of potash. Fowls are treated in the following manner: The nostrils are pressed together between thumb and forefinger in the direction of the beak two or three times. Pressure should also be applied between nostrils and eyes in an upward direction. This massage helps to loosen the discharge in the nostrils and eyes. The bird's head is then plunged into the solution of permanganate of potash for 20 or 30 seconds, in fact the head may be kept under the solution as long as the bird can tolerate it. The solution is thus distributed through the nostrils and other canals and has an astringent and slight disinfecting action. This treatment should be given twice a day and continued until all symptoms have disappeared."

"If there are solid tumors in the eyelids, they should be opened so that the skin may bleed freely. The cheesy matter should be removed and the surrounding membrane touched with a 5 per cent carbolic acid or silver nitrate solution, and then a cotton plug put in again to prevent the cavity from healing too quickly. We have cured chickens in this way in about a fortnight."

"As all these methods of treatment demand a good deal of time and care, they cannot well be used for whole flocks, but the more valuable fowls may be treated in this manner. Farmers and poultrymen should first try the permanganate of potash method of treatment as it is the easiest to employ."

"Food remedies influence roup only by strengthening the fowls and assisting nature to throw off or conquer the disease."

Sanborn (Reliable Poultry Remedies) recommends the use of an atomizer to apply the disinfecting solutions to the nasal passages and mouth.

He recommends the following solution for a spray for all the mucous surfaces:

Extract of witch hazel, 4 tablespoons,
Liquid carbolic acid, 3 drops,
Water, 2 tablespoons.

He applies the spray twice a day squeezing the bulb 5 times for each nostril and twice for the mouth.

Salmon recommends washing the cavities of the nose and throat with peroxide of hydrogen, diluted 1 to 3 times with water.

The birds which are being treated should be kept in a dry, warm, well ventilated room with good nourishing food. The drinking water should be frequently changed.

Prognosis. In infected flocks this disease caused a direct annual loss of 10 to 15 per cent of the flock. Also many birds contract a chronic form of the disease which affects them for months or years. Careful individual treatment will save the lives of many birds, but such treatment is economically inadvisable except in case of very valuable birds.

"Pip" (Inflammation of the Mouth).

Robinson describes "pip" as follows: " 'Pip' is a term in very common use among poultry keepers, and applied chiefly to a symptom occurring in many cases of cold or fever when the nostrils being obstructed and the fowls breathing through the mouth the skin of the mouth and tongue become hard and dry, and a bony tip may form on the tongue by the hardening and drying of the skin of that member, this condition being aggravated when catarrhal discharges adhere to the skin and dry and accumulate."

Etiology. It would appear to be the case that the symptoms above described originated from different causes in different cases. The trouble may be due to specific infection, though a particular organism has not yet been definitely isolated as the cause. In some cases the symptom is apparently purely physiological, arising from a failure of the mucus-secreting glands to function properly, owing to a lowered physiological condition.

Treatment. The essential points in the treatment of this diseased condition is first to treat the primary cause (cold, catarrh, etc.). In removing the scale or "pip" gentle measures are to be followed, otherwise a raw surface likely to ulcerate, will be left.

The following advice as to treatment, given by Salmon, is excellent.

"In case of simply drying of the mouth, it is sufficient to moisten the tongue with a few drops of a mixture of equal parts of glycerine and water. In case there is redness of the membrane, or if the epithelium is beginning to separate, or if a deposit has formed, add 20 grains of chlorate of potash to each ounce of this mixture. An excellent remedy for such cases is made by dissolving 15 grains of boric acid in an ounce of water. Both of these solutions are harmless and may be freely and frequently applied. When the epithelium is separating, it should be kept moistened with the glycerine mixture and its detachment may be somewhat facilitated by loosening it with a pin or the point of a penknife, but great care should be exercised, the sensitive tissues should not be touched and no blood should be drawn."

Prognosis. In and of itself "pip" is not a serious matter. It is, however, usually associated with other disorders of the respiratory system, which may be very serious. Regarding this matter Salmon says: "The exaggerated idea prevalent as to the dangerous character of 'pip,' probably arises from its being associated with serious diseases of the respiratory organs and from the fatal results which follow the forcible tearing away of the dried epithelium, leaving a bleeding and ulcerating surface."

Canker.

Membranes formed in diphtheritic roup are sometimes called canker, but there are frequently found cheesy patches on the mucous membrane of the mouth or tongue which are not associated with roup. These growths are frequently, at least, the result of a traumatic injury to the membrane. Male birds frequently have canker where they have been picked in the mouth by other males when fighting. The growths are made up almost entirely of pus germs. These growths should probably be considered as suppurating wounds. An unhealthy condition of the mucous membrane of the mouth due to digestive disorders is sometimes accompanied by spots of canker.

A good treatment for canker is undiluted creolin applied with a cotton swab. The swab should be held against each sore for a short time. The whole surface of each patch should be treated. Another good treatment is to wash the sores with hydrogen peroxide 1 part and water 1 part.

Thrush.

This term is also sometimes incorrectly applied to the false membranes of diphtheria but there are at least two cases of true thrush on record. That is, in two cases microscopic examination has shown that the patches, which in both these cases were in the lower part of the oesophagus and crop, were made up of spores and filaments of the fungus *Saccharomyces albicans.*

This fungus causes thrush in children and calves. This disease may also occasionally affect the mouth. It is impossible to distinguish it from other diseases causing similar formations except by microscopic examination. The treatment is the same as for canker.

Aspergillosis (Mycosis of the Air Passages).

This is a very common disease of poultry, often mistaken for tuberculosis. In adult fowls it is frequent cause of the condition known as "going light," while in young chickens it probably ranks next to white diarrhoea as a lethal agent.

The discussion of this disease here relates primarily to adult fowls. Aspergillosis in young chicks is treated in Chap. XIX.

Diagnosis. Salmon gives the following account of the symptoms of this disease. "In the early stages of the disease no symptoms are noticed, and it is only after it has progressed considerably that these become apparent. The affected birds do not follow the flock; they are very weak, scarcely able to stand, and consequently remain by themselves and move about very little. They remain in a recumbent position, resting upon the sternum, are sleepy, and, if forced to run, soon fall from exhaustion. The plumage is dull and rough, the wings are pendant, the eyelids partly closed, the head depressed. The respiraton is accelerated and accompanied by a rattling or snoring sound, particularly during the expiration, and becomes difficult and labored, the bird opening its beak from time to time, in order to take a long inspiration. The temperature of the body is elevated, the thirst increased and the appetite is diminished or disappears. There is more or less catarrh of the trachea and bronchi, with emaciation and diarrhea leading to death from exhaustion in from 1 to 8 weeks. When the disease is limited to the air-sacs of the interior of the body, emaciation may be the only symptom; but when it extends to the bones there may be lameness with swollen and painful joints."

"In examining the birds after death, the seat of the disease may be found in the trachea, bronchi, lungs, and various air-sacs, and other internal organs. It is sometimes, though rarely, found in the nostrils and in the air-sacs of the interior of the bones. Two kinds of lesions are found. There may be tubercles resembling those of tuberculosis. These are whitish or yellowish nodules varying from the size of a pinhead to that of a pea. They may be isolated or joined together in masses of considerable proportions. These tubercles are generally found in the depth of the tissues, and even in the marrow of the bones. On the mucous membrane lining the air-tubes and air-sacs, the second form of disease process is seen. This consists of a membranous formation, ⅛ of an inch or more in thickness, which bears upon its surface a growth of the fungus. These membranous patches are at first soft, but become firmer with age, and are yellowish or greenish in color, resembling a fibrino-purulent exudate. They adhere closely to the mucous membrane which is there thickened and inflamed. The air-sacs are sometimes obstructed by these growths which may in time become caseous or even calcareous. These changes may also be seen in the intestines, the mesentery, the liver and in other organs."

"The membrane lining the air-passages may, also, be found ulcerated, and the ulcers may be either naked or covered with a growth of the fungus."

"In the very acute and rapid cases, the lungs may simply show inflammation, or there may be formation of pus or abscesses in the lungs, kidneys, liver and spleen as in pyaemia or septic infection. In some of these cases there may be extensive hemorrhages, either locally or throughout the body, and these may constitute the only apparent alterations."

"A microscopic examination reveals the spores of filaments of the fungus in most of the lesions, whether these are acute or chronic. The nature of the disease may consequently be determined by a post-mortem examination, but the diagnosis is uncertain and difficult during the life of the bird."

Etiology. The disease is caused by moulds of the genus *Aspergillus* which grow on the mucous membrane of the air passage. The four parasitic species in order of their importance are *Aspergillus fumigatus, Aspergillus nigrescens, Aspergillus glaucus, Aspergillus candidus.* The appearance of one of these moulds, when greatly magnified is shown in fig. 22.

Fig. 22. *Aspergillus fumigatus.* Greatly enlarged. (After Mohler and Buckley).

These moulds and their spores occur on dead organic material like straw, grain, etc. They are inhaled in breathing or swallowed with the food. This being the case the importance of avoiding musty litter, and mouldy or musty grain of all kinds is apparent. As with most other diseases the resistance of the individual against infection is here an important matter. Some fowls will be able to stand musty litter and grain without any harm, while others will promptly develop aspergillosis. When once present in a flock aspergillosis is probably transmitted from generation to generation through the eggs.

Treatment. The disease is prevented by having clean, dry, well ventilated houses and avoiding the use of mouldy litter or grain. Vigorous birds under sanitary conditions are fairly resistant. No medical treatment is known to be effective. Salmon gives a list of treatments which have been suggested and says "No form of treatment yet suggested, however, is very promising and the effort should be to prevent rather than cure." All birds that die should be burned or buried.

Prognosis. The disease in adult fowls is ordinarily not recognized as such until an affected bird comes to *post-mortem* at which time the prognosis is certainly extremely unfavorable. So far as concerns ridding a poultry plant of the disease, however, the outlook is favorable if energetic sanitary measures along the lines indicated above are applied.

Congestion of the Lungs.

Congestion of the lungs is a distension of the blood vessels which make up the vascular portion of those organs. The pressure of these distended vessels may close the smaller air passages, or a vessel may burst, filling the bronchi. In either case the patient soon suffocates.

Diagnosis.—The symptoms of this disease are difficult rapid breathing, sleepiness and an indisposition to move. A bloody mucus sometimes flows from the mouth. The comb is dark red or bluish from lack of oxygen in the blood. Symptoms appear suddenly and death occurs within a few hours.

Etiology.—This disease is caused by chilling the surface of the body. This contracts the surface vessels and a larger volume of blood is sent to the internal organs. The pressure on the small elastic vessels of the lungs is too great and they either close the air passages by pressing against them or the vessel walls are ruptured by the internal pressure and the air passages become filled with blood. This disease most often occurs in denuded birds (hens during moulting or young birds which have failed to feather out) or small chicks which have been exposed to cold or allowed to run out in cold, wet weather.

Treatment.—The rapid course of the disease makes treatment impracticable. Prevention is the only cure. Birds should be well nourished with plenty of green food and should be especially protected from cold and wet when moulting. Also chicks which are in a stage between down (chick) and juvenal feathers need special protection. This disease often attacks brooder chicks and indicates something wrong with the brooding. The cause should be immediately sought out and removed, or considerable loss will follow from continued exposure of the flock.

Prognosis.—This disease is usually fatal in a few minutes or hours after its symptoms are noted. According to Salmon the patient sometimes develops pneumonia.

Pneumonia.

This disease is a step beyond congestion of the lungs. The vessels are not only distended but liquid escapes through their walls and coagulates in the air spaces. The lung of a chick dead of pneumonia is dark colored and firm and heavier than water. A normal lung floats but a lung filled with this coagulated serum sinks.

Diagnosis.—The symptoms resemble those of congestion of the lungs. Salmon gives the following symptoms: "The breathing is rapid, difficult and painful. There may be coughing with discharge from the mouth or nostrils of thick, adhesive mucus, grayish or yellowish in color or tinged with blood. The bird stands with ruffled plumage, drooping wings, head drawn in, and every appearance of severe illness. There is loss of appetite from the first, with thirst and constipation.

On examination of the lungs after death one or both of these organs are found dark in color, engorged with blood and solidified. The pneumonia may take either one of two forms. There may be what is known as broncho-pneumonia, in which case the inflammation affects more particularly the bronchi and the lung is not much solidified. The bronchial tubes in this case are more or less filled with thick mucus and exudate. In the other form, called croupous pneumonia, the tissue of the lung is principally affected. It is then that the lung is solidified by the filling up of the air-cells. A piece of lung so affected, if dropped into a bucket of water, sinks to the bottom, while healthy lung tissue will float. The bronchial tubes and air-sacs are also in some cases filled with a thick, yellowish fibrinous exudate which blocks up these air-passages and becomes partly solidified."

Etiology.—The cause of pneumonia in birds is not known. Salmon suggests that it may be caused in birds as the similar disease is known to be in some of the mammals and man. Robinson briefly summarizes Salmon's statement as follows: "He says it is supposed that to produce pneumonia there must be with the causes that produce congestion of the lungs the agency of a germ, a species of bacteria, harmless when the lung is in normal condition, but harmful when conditions which cause congestion are present."

Treatment.—Ordinarily it will not be advisable to treat this disease. *A cure is unusual and involves such an amount of care and nursing as to make it a most unprofitable proposition.* The following treatments have been advised by different persons.

"1.—'Keep the bird in a room of about 70 degrees, with steam from boiling water if possible. Give every 6 hours 1 grain phenacetin, and 1 grain sulpho-carbolate of zinc, mixed with bread crumbs enough to make a pill. Feed on raw eggs and milk. Tincture aconite in the drinking water, or 1 drop every 2 hours in the egg and milk, will help control the hard breathing. If successful in saving the bird, build up its strength with tonics such as nux vomica or quinine.' (Sanborn.)

"2.—'The bird should be immediately housed and kept warm. Counter irritation must be applied over the region of the lungs by wetting the skin under the feathers on the back with tincture of iodine. Stimulants should be administered 3 or 4 times a day—2 drops of spirits of camphor and 10 drops of brandy in a teaspoonful of warm milk. Soft, nutritious diet, especially chopped beef, is necessary. Beaten egg and port wine is also useful. Three or 4 drops of chlorodyne may be given in a teaspoonful of linseed tea to relieve the more distressing symptoms; and ultimately, if the case progresses favorably, mineral tonics and cod liver oil are favorable in establishing convalescence.' (Hill.)

"3.—'Place bird in a warm room and cover with a piece of blanket, leaving the head uncovered that it may have plenty of air. Give linseed tea frequently in small quantities. To make this tea: Pour a pint of boiling water on an ounce of flaxseed, and keep hot, but not boiling, for two hours. Strain to remove the seeds. The liquid may then be used as a drink, or medicines may be given in it. Dissolve enough nitrate of potash in the drink to give the bird about 1 grain 3 times a day. If the bird is failing and becomes sleepy, with comb turning dark, mix 15 drops of tincture of digitalis with 1 ounce of water, and give 10 drops of the mixture every 2 hours. To give medicine use a medicine dropper, and be careful to avoid getting it into the air passages. When the bird begins to improve, give a grain of quinine, or 10 drops of cod liver oil twice a day.' (Salmon.)"

Tuberculosis.

This disease in birds does not usually affect the respiratory system, but is more commonly confined to the abdominal viscera, and is discussed with the diseases of the organs of alimentary tract (Chap. V).

The Air-Sac Mite.

A species of mite (*Cytodites nudus*) infects the air-sacs and bronchi of poultry.

Diagnosis.—When the birds are not badly infested there are no external symptoms. If badly infested the bird may become anæmic and listless and finally die of exhaustion. Or, if the air passages are seriously obstructed by the collection of parasites and mucus there will be a rattling in the throat and coughing, and death may result from suffocation. The presence of the parasites is often found only on examination of dead birds. They appear as a yellow or white dust, each particle of which is a mite. If closely watched the particles may be seen to move.

Etiology.—The mite probably enters the air-sacs by crawling in the nostrils and finding its way down the trachea and bronchi to the sacs. The parasites are able to live only a short time outside the bird's body. The mouth parts of these mites are modified into sucking tubes. They attack the mucous membrane of the air-sacs and bronchi. When the number of parasites is small they cause no serious inconvenience to the bird. When there are a large number present they may cause inflammation of the membrane and secretion of mucus or they may seriously obstruct the air passages.

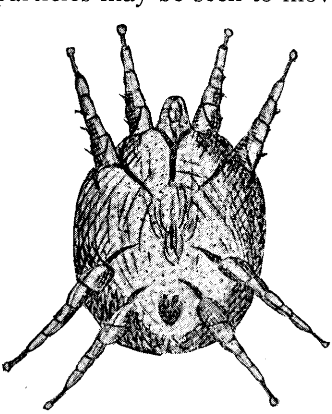


Fig. 23. *Cytodites nudus.* The air sac mite. Greatly enlarged. (After Theobald).

Treatment.—Treatment of infested birds is probably useless. Feeding sulphur with the food or compelling the birds to inhale the fumes of burning sulphur or burning tar or the steam of boiling tar water has been recommended.

If a flock is infested with this parasite it is best when possible to start a new flock with incubator chicks raised on a new range and carefully protected from infection from the old flock. Or stock may be purchased from an uninfested flock. Birds with this parasite should not be bought or sold for breeding or laying purposes, as the flock into which they are introduced will become infested from them. Since this parasite can not live long outside the bird's body, the houses, runs, etc., do not remain infested long after all the diseased birds have been removed.

Prognosis.—A bird once infected is probably never free from the parasite but may live a long time little harmed by its presence.

CHAPTER XIII.

Diseases of the Circulatory System.

Pericarditis (Inflammation of the Pericardium, Dropsy of the Heart Sac).

This disease is often found associated with other diseases of the circulatory system and with diseases of the lungs and air-sacs and also with soreness of the joints.

Diagnosis.—A differential diagnosis of this disease during life is not usually possible. Salmon gives the following symptoms: "There is great weakness, difficult breathing, the head being thrown backwards, and the breath drawn through the mouth in order to obtain sufficient air. If forced to run the bird soon falls. In a case observed by Hill there was tumultuous action of the heart and occasional spasms." Examination of a bird dead from this disease shows the heart sac full of serous liquid and sometimes the cavity is divided by false membranes which may attach to the heart as well as to the pericardium.

Etiology.—The causes of this inflammation are not known. It may result from exposure to cold or dampness.

Treatment.—Treatment is impossible since the disease can not be diagnosed until after death. Successive cases in the same flock indicate exposure of the flock to cold or wet weather or to confining the birds in insanitary houses. These conditions should be remedied. Salmon also recommends in such cases "2 to 4 grains of bicarbonate of soda to each bird daily in the drinking water."

Endocarditis (Inflammation of the Internal Membranes of the Heart).

In the examination of dead birds it is sometimes found that the membrane lining the heart is reddened and coagulated lymph may adhere to it. Little is known of this disease in fowls. It cannot be distinguished from pericarditis except by an examination of the heart. The cause and treatment suggested for that disease probably apply equally in these cases.

Myocarditis diptheritica.

According to Zürn, Bollinger has described a bacterial disease of the heart and blood vessels of fowls and pigeons. The disease is caused by a bacterium which resembles the bacterium of roup. The disease attacks the lining membrane of the heart and blood vessels, causing inflammation and the breaking down of the tissue. It especially affects the valves of the heart and aorta, where round or oval colonies of the bacteria are found on the membrane. In these patches fibrin and red and white corpuscles are mingled with the organisms. The walls of the small vessels of the lungs, liver, spleen, kidneys and intestines are also affected. The liver, spleen, and kidneys are enlarged. The bacteria are numerous in these organs as well as in the blood.

Little is known of the frequence of the occurrence of this disease and nothing of methods of treatment.

Enlargement of the Heart (Hypertrophy).

The heart of a fowl is sometimes enlarged. According to Cadeac this enlargement most frequently affects the right side of the heart. The muscle may be fatty and degenerate.

Diagnosis.—The distinctive symptom of this disease is a very rapid beating of the heart.

Etiology.—The cause of this hypertrophy of the heart muscle is not known, but it is probably due to some derangement in the nutrition of the muscle. The palpitations are increased by excitement or fright.

Treatment.—The disease is not usually recognized while the bird is alive. Treatment is therefore not possible.

Prognosis.—A hypertrophied heart may function for a long time. The violent beating may cause rupture of a blood vessel; sometimes several vessels are ruptured at the same time.

Rupture of the Heart and Large Blood Vessels.

Internal hemorrhage due to the rupture of the heart or large blood vessels often occurs in full blooded fowls.

Diagnosis—The bird becomes weak and drowsy, passes into a comatose condition and dies with the characteristic appearance associated with bleeding to death.

Etiology.—In full blooded fowls any excitement or over-exertion which causes an increase in the rate of heart beat and an increased blood pressure may result in a rupture of the heart or one of the large vessels.

Treatment.—The accident can not be predicted and treatment is impossible.

Prognosis.—The bird dies in a short time.

DISEASES OF THE BLOOD.

Various cases of an alteration in the number of white corpuscles in the blood of fowls have been described. Most of these descriptions are based on from one to three cases, and from the descriptions it appears that the investigators have found several different blood diseases. Most of these diseases when tested did not prove infectious. They are impossible to distinguish except by microscopic examination and most of them are probably quite rare. Only one of these diseases seems to be of any economic importance. This is *Infectious Leukæmia,* first described by Moore (Ann. Rep. Bur. An. Ind. 1895-1896).

Infectious Leukæmia.

This is a bacterial disease often mistaken for fowl cholera but caused by a different species of bacteria and the lesions produced are somewhat different.

Diagnosis.—The following symptomatology is quoted from Moore: "From the statement of the owners of the fowls in the different outbreaks and from the appearance of those in which the disease was artificially produced, little can be positively recorded concerning the distinctive or characteristic symptoms. The only fowl examined ante-mortem from the natural outbreaks was first seen only a few hours before death, when it was unable to stand. If held in an upright position, the head hung down. There was a marked anæmic condition of the mucosa of the head. It had an elevation of nearly 3 degrees of temperature. An examination of the blood showed a marked diminution in the number of red corpuscles and an increase in the number of white ones. In the disease produced artificially by feeding cultures of the specific organism there was in most cases a marked drowsiness and general debility manifested from 1 to 4 days before death occurred. The period during which the prostration was complete varied from a few hours to two days. The mucous membranes and skin about the head became pale. There was an elevation of from 1 to 4 degrees of temperature. The fever was of a continuous type."

"Although the course of the disease in the different fowls was usually constant, there were many variations. In a few individuals the time required for fatal results was from 2 to 3 weeks, but ordinarily death occurred in about 8 days after feeding the virus, the rise in temperature being detected about the third day and external symptoms about the fifth or sixth, occasionally not until a few hours before death. The symptoms observed in the cases produced by feeding correspond with those described by the owners of affected flocks."

Dr. Moore found the only constant lesions to be in the blood and liver. The change in the blood as noted above was a decrease in the number of white cells. The change in the liver is described by Moore as follows:

"The liver was somewhat enlarged and dark colored, excepting in a few cases in which the disease was produced by intravenous injections. A close inspection showed the surface to be sprinkled with minute grayish areas. The microscopic examination showed the blood spaces to be distended. The hepatic cells were frequently changed, so that they stained very feebly, and not infrequently the cells were observed in which the liver cells appeared to be dead and the intervening spaces infiltrated with round cells. The changes in the hepatic tissue are presumably secondary to the engorgement of the organ with blood."

Dawson's diagnosis of the disease (An. Rep. Bur. An. Ind. 1898, p. 350) differs somewhat from the one given by Moore.

It is very difficult to distinguish this disease from fowl cholera except by identifying the bacteria which produce the diseases. Moore contrasts the characteristic lesions in the appended columns:

Fowl cholera	*Infectious leukaemia.*
1. Duration of the disease from a few hours to several days.	1. Duration of the disease from a few hours to several days.
2. Elevation of temperature.	2. Elevation of temperature.
3. Diarrhea.	3. Diarrhea very rare.
4. Intestines deeply reddened.	4. Intestines pale.
5. Intestinal contents liquid, muco-purulent, or blood stained.	5. Intestinal contents normal in consistency.
6. Heart dotted with ecchymoses.	6. Heart usually pale and dotted with grayish points, due to cell infiltration.

Fowl cholera	*Infectious leukaemia*
7. Lungs affected, hyperaemic or pneumonic.	7. Lungs normal ,excepting in modified cases.
8. Specific organisms appear in large numbers in the blood and organs.	8. Specific organisms comparatively few in the blood and organs.
9. Blood pale (cause not determined).	9. Blood pale, marked diminution in the number of red corpuscles.
10. Condition of leucocytes not determined.	10. Increase in the number of leucocytes.

Attention should be called to the fact that as yet there seems not to have been a careful study of the condition of the blood in fowl cholera. Dr. Salmon observed many changes in this fluid which may have been similar to or identical with those herein recorded.

On p. 201 of Dr. Moore's paper he gives the method of differentiating the two bacteria. This is, of course, dependent on microscopic examination and cultural tests. A full description of *Bacterium sanguinarium* is given by Moore on pp. 188-191 of the paper cited above.

Etiology.—The disease is caused by a non-motile, rod-shaped bacterium (*Bacterium sanguinarium.*) This bacterium causes the disease when injected into the blood or when fed. In a few cases fowls are known to have contracted the disease by picking up the droppings of infected fowls.

More recent work* indicates that there is at least one sort of transmissible fowl leukæmia which is dependent upon a filterable virus, rather than upon a visible organism.

Moore says: "This disease of fowls has not been found in flocks where a good sanitary regime has been enforced. It is highly probable that it is a filth disease, being dependent upon unfavorable environments quite as much as the specific organism for the ability to run a rapidly fatal course and of spreading to the entire flock."

Treatment.—Prevention is the only known treatment. A maintenance of generally sanitary conditions and the avoidance of the introduction of diseased birds are effectual. If the dis-

---

*Ellerman, V., and Bang. O., Cent. f. Bakt., Orig., 1908 xlvi, p. 595; Ztschr f. Hyg. u. inf .Krnkh., 1909, lxiii, p. 231.

Hirchfield, H., and Jacoby, M., Ztschr f. klin. Med. 1909-10, lxix, p. 107.

ease appears in the flock separate the diseased birds, disinfect the premises, and place the flock under sanitary conditions. The disease will probably disappear, as it is difficult experimentally to maintain an infection when the birds are kept under sanitary conditions.

Prognosis.—Diseased birds usually die in from a few hours to two weeks, but they may recover.

CHAPTER XIV.

Diseases of the Nervous System.

Apoplexy (Hemorrhage of the Brain).

In this disease the bird usually drops dead or paralyzed without showing any previous sign of illness. The only abnormality found on examination of the dead bird is clotted blood on the brain.

Etiology.—The cause of this disease is the rupture of a blood vessel in the brain and the pressure on the brain due to the blood which escapes. The cause of this rupture may be an unhealthy condition (usually a fatty degeneration) of the walls of the brain blood vessels. The immediate cause of the rupture is increased blood pressure due to fright, over-exertion, or strain in laying (hens often die on the nest). This disease is more apt to attack very fat birds and the degeneration of the vessels is supposed to be due to too rich food or to overfeeding.

Treatment.—Treatment of the affected birds is useless. So-called "apoplexy cures," of which there are some on the market, should be left strictly alone by the poultryman. Only *very rarely* can apoplexy be recognized till after the bird is dead, and then all the pills or potions ever invented for the purpose of swindling a gullible public will be of no avail. If *several successive* deaths from apoplexy occur, modify the ration, giving more green food and less meat and corn. See that the birds have plenty of range.

Prognosis.—The bird is usually found dead or dies in a little while.

Heat Prostrations.

In very warm weather heat prostrations may occur, especially among heavy fowls. This is sometimes considered to be the same thing as apoplexy. The birds suddenly drop insensible or paralyzed.

Etiology.—The cause is pressure on the brain, due to heat, but the blood vessels are not ruptured as in apoplexy.

Treatment.—Mild cases may be treated by applying cold water to the head and keeping the bird in a cool, quiet place.

Prognosis.—Mild cases may recover. Others usually result fatally in a short time. As a preventative avoid overcrowding in hot weather. If the range is not provided with natural shade, supply artificially shaded places in which the birds may find protection from the hot sun during the middle of the day.

Congestion of the Brain (Vertigo, Cerebral Hyperæmia).

A number of abnormal physiological conditions may lead to a congestion of blood in the brain. This is usually associated with a diseased condition of other organs, and hence often occurs as a complication with other diseases. It is sometimes due to injury of the head.

Diagnosis.—Pearson (Diseases of Poultry) gives the following diagnosis of this disease: "It is characterized by staggering, stupor, unusual movements such as walking backward or walking in a circle, unusual and irregular movements with the wings and feet and twisting the head backward or to the side. Sometimes the bird will fall on its side and make peculiar movements with its feet and wings as though attempting to run or fly."

Etiology.—The congestion of the brain is sometimes due to blows on the head or to fright or other intense excitement. Often it is associated with acute indigestion or with the presence of parasitic intestinal worms.

Treatment.—Apply cold water to the head. Administer a laxative (2 teaspoonsful of castor oil, or 30 grains of Epsom salts given in water or 1½ grains of calomel). Keep the fowl in a cool, quiet place. If this treatment is not efficient Salmon recommends 1 to 5 grains of bromide of potassium dissolved in 1 tablespoonful of water 3 times a day. If intestinal worms are found in the droppings after the laxative, treat for the removal of these parasites (p. 79).

Prognosis.—The bird may recover if the cause is removed.

Epilepsy.

This somewhat rare disease is characterized by occasional fits. Between these the birds appear normal.

Diagnosis.—Pearson (Diseases of Poultry) describes the behavior of the bird during the fit as follows: "The fowl will make beating movements with its wings, its legs will draw up and it will fall down, sometimes turn over on its back, or it may stand upright with its legs apart, head turned backward and mouth and eyes opening and closing spasmodically."

This spasm passes away after a time and leaves the bird in a normal condition.

Etiology.—It is often impossible to discover any cause of the disease. It is said to be sometimes caused by tumors on the brain and sometimes by intestinal worms.

Treatment.—The only cases that can be treated are those caused by the presence of intestinal worms. An affected bird should be put up and given a laxative and if intestinal worms are passed treat the patient for the removal of these parasites (p. 79).

The birds may live some time with occasional fits and may recover. Cases caused by intestinal worms are definitely cured by removing the parasites.

CHAPTER XV.

Diseases of the Kidneys, Rheumatism and Limberneck.

Gout.

Gout is a rather common disease among fowls. It is due to a failure of the kidneys to eliminate the urates. The uric acid content of the blood is greatly increased and the urates are deposited on the surface of the visceral organs, in the tissues of the urinary apparatus and around the joints in the form of crystals of urate of soda. In fowls two forms of the disease occur; the visceral, and the articular.

Visceral Gout.

In visceral gout the only symptoms shown by an affected bird are a loss in weight or "going light" and a slight yellowish tinge to the skin, comb and wattles. The bird has a good and often abnormal appetite. Death occurs suddenly. An examination of the abdominal cavity shows that all the organs and serous membranes are covered with a chalky or talcum-like powder. This powder has a mother-of-pearl luster and on microscopic examination is seen to be composed of small needle-like crystals. These are crystals of urate of soda. These crystals are also found in the urinary organs. The ureter and collecting tubules are often filled with a mass of these crystals. Drs. Hebrant and Antoine give the following test for the urate of soda.

Dissolve the crystals in nitric acid and evaporate in a watch glass. This gives a red onion peel mass which turns purplish blue on the addition of a solution of caustic potash.

Articular Gout.

In this form of the disease the crystals of urate of soda are in nodules around the joints especially of the feet and toes. These nodules sometimes appear like strings of beads on the under side of the toes. They contain a white or creamy thick liquid composed mostly of the crystals. They are at first soft but later become very firm. The presence of the nodules causes stiffness and soreness of the joints and the birds become indisposed to stand or walk. Sometimes the nodules ulcerate, discharging a stringy pus and exposing the cavities of the joints to the air. The development of fistulas cause the death of the bones. The disease is slow in its development and advanced stages are seen only in old birds. The birds lose weight and in advanced stages diarrhea sets in and death from exhaustion follows.

Early stages of this disease are often mistaken for rheumatism on account of the stiffness and soreness of the joints.

Etiology.—The cause of this disease is a disturbance of the normal physiology of excretion so that the uric acid which should be excreted by the kidneys is first retained in the blood and then deposited within the body as crystals of urate of soda. The disturbance is probably due to a diet which is too rich in proteids.

Treatment.—In case of articular gout Salmon recommends rubbing the affected joints with camphorated or carbolic ointment. In well developed cases it is more profitable to kill the birds than to treat them. Visceral gout is not usually recognized while the bird is alive. Prevention is the only reliable treatment for either form of gout. Birds should be kept under sanitary conditions and given plenty of green food. When several birds develop the disease it is well to give the whole flock Epsom salts (¼ to ½ teaspoonful per bird) and to reduce the amount of meat scrap and increase the quantity of green food.

Prognosis.—The disease, especially the articular form, is chronic and advanced cases are only found in old birds. Badly diseased birds may live a long time. Mild cases may recover on corrected diet.

Other Diseased Conditions of the Kidneys.

In the examination of dead birds cases are often observed where the kidneys are diseased. They are often enlarged. Sometimes they contain dark points caused by the rupture of small blood vessels, and in other cases they may contain abscesses. Micro-organisms have been obtained from some cases of diseased kidneys. Nothing is yet known of the causes of these specific diseased conditions in poultry. Some of the cases of under-development, especially of pullets, are apparently due to enlarged kidneys. In such cases the birds usually lose their appetite, become emaciated and their feathers are roughened. No dependable diagnosis of diseased kidneys can be made on the living fowl. When several cases occur care should be taken to see that the flock receives a balanced ration with plenty of green food, as diseased kidneys may occur from too much protein in the food.

Rheumatism.

A lameness or stiffness is usually considered rheumatism. Many such cases are due to tuberculosis of the joints (p. 60), and others to articular gout (p. 121), but there are muscular and joint inflammations caused by exposure which are properly considered rheumatism. This disease is an inflammation of the connective tissues of the muscles and joints.

Etiology.—It is caused by exposure to cold or dampness. The occurrence of several cases in the flock indicates something wrong in the housing conditions.

Treatment.—The disease is prevented by keeping the fowls in dry, warm, well ventilated houses with well drained runs.

Prognosis.—Fowls protected from further exposure and given a good ration with plenty of green food usually recover.

Limberneck.

This is not properly a disease but a *symptom* which accompanies several diseased conditions. A fowl is said to have limberneck when partial or entire nervous control of the neck muscles is lost. The neck may hang limp so that the head falls on the ground between the feet. Sometimes the bird is able to raise the head from the ground by making a great effort.

A bird is sometimes said to have limberneck when the dorsal or lateral neck muscles are tense, the head drawn convulsively backward, but this is more often called "wry-neck."

Both limberneck and wry-neck are due to nervous disorders which arise from several different causes. "Wry-neck" is usually associated with direct brain or nerve irritation and occurs in epileptic spasms, but also sometimes occurs in rheumatism. Limberneck is usually associated with colic, acute indigestion, intestinal parasites, or ptomaine poisoning.

No treatment for limberneck *as such* can be advised. Effort should be made to ascertain and cure the diseased condition which is responsible for this symptom.

Cases due to rheumatism, colic, indigestion, intestinal parasites, and some of those due to poisoning may recover, if the real cause can be ascertained and treated soon enough.

CHAPTER XVI.

External Parasites.

Vigilant and continuous attention is necessary to keep fowls free from external parasites. At least 32 species of arachnids and insects are known to be parasitic on fowls. Some of these like the red mites visit their host only to take food and spend the rest of the time on the under side of the roosts, in cracks and crevices and various other places of seclusion. Others like the lice normally stay on the birds, although occasionally some individuals crawl off, especially into the nest. Some of these parasites live upon the surface of the skin and upon the feathers, deriving their nourishment either by sucking the blood like the red mite, or by chewing the skin and feathers like the lice and some of the mites. Some of the mites, however, bore under the skin, causing skin diseases known as scabies or psoric diseases. The most common of these diseases are scabby or scaly leg and depluming scabies.

The economic importance of these external parasites is very great. Fowls infested with one or several of these species of parasites are not profitable. They make a smaller growth in the same time with the same food and their egg production is not equal to similar birds not so infested. Not only are they constantly robbed of some of their tissue and blood but their rest is disturbed. Sleep is as important to the normal physiology of a bird as it is to that of a man.

Keeping a Poultry Plant Free from External Parasites.

It is not necessary for a poultryman to be able to distinguish the 32 species of parasites or to know their life histories in order to keep his plant free from them. It is only necessary to know that some of them stay on the birds and can only be exterminated by treating the birds (usually with a powder) while others spend most of their time on the under sides of the roosts in cracks and can best be exterminated by contact sprays containing cresol or kerosene. A single application is not efficient in either case but treatment must be repeated 2 or 3 times at intervals of a few days to destroy those that hatch after the treatment or are concealed beyond its reach. A routine procedure by which a poultry plant can be kept free from parasites is very useful. The following method has proven very successful at the Maine Experiment Station and is described in Circular 352 of that Station:

"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 later 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 in Chap. II. 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 described on p. 135). Finally, any yearling, or older birds, whether male or female, which are to be kept over for the next year's work are given 2 or 3 successive dustings, at intervals of several days to a week between each application, with the lice powder described on p. 130, 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 of lice."

This method keeps the flock free from lice and the mites which live upon the surface of the skin, but would not destroy those mites which penetrate the skin and cause scabies. These and other more rare parasites should be destroyed when present by special methods. The description of, and treatment for each class of external parasite is given below.

A. LICE (MALLOPHAGA).

Lice are probably the most widely distributed parasite of poultry. They are so common that flocks of fowls that have not been treated to remove lice for a long time are almost sure to have one or more species present. At least 8 species of hen lice have been found and 5 of these are common. Bird lice are quite different from those which affect man and mammals.

The popular notion that lice may be transmitted from poultry to other animals is quite erroneous. Theobald (Parasitic Diseases of Poultry) says: "So particular are bird-lice that it is quite the exception to find one species upon two distinct kinds of birds. Fowl-lice will not even attack the duck nor duck-lice the fowl. Nearly every bird has its own particular Mallophagan parasite or parasites. They may possibly pass to some strange host for a short time, but they will not live and breed. Moreover, ... particular species attack restricted areas on the same host and are seldom found in other positions." Some of these lice are sluggish, nearly stationary, and confined to a restricted area of the body, while others are active and crawl over the entire body. The 8 known species are described in Theobald's "Parasitic Diseases of Poultry," pp. 23-29.

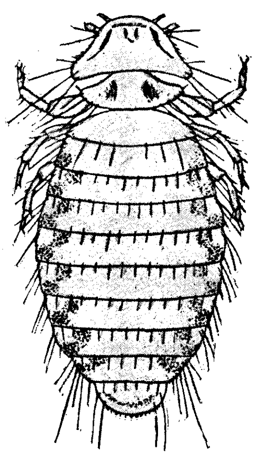


Fig. 24. The common hen louse (*Menopon pallidum*) Greatly enlarged. (From Banks).

The most common and widely distributed hen louse found in this country is *Menopon pallidum*. This louse is shown in fig. 24.

Another species of this genus (*Menopon biseriatum*), which closely resembles *M. pallidum*, is also sometimes found. These are active lice living on all parts of the body. They often crawl on to the hands when handling or plucking birds, and may sometimes be found in the nests.

There are several other lice which sometimes infest poultry. Each of these species is confined to a special region of the host. Although capable of crawling about, the lice of these species for the most part remain nearly stationary, often with their heads buried in the skin and their bodies erect. Two species, *Lipeurus variabilis* and *Lipeurus heterographus*, live among the barbs of the wing and tail feathers. *Goniodes dissimilis* is found under the wings and on the rump. The appearance of two of the species mentioned, viz., *Lipeurus variabilis* and *Goniodes dissimilis,* is shown in figs. 25 and 26 respectively.

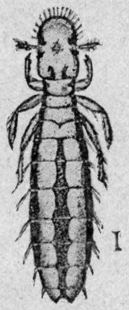


Fig. 25. *Lipeurus variabilis.* A louse that infests poultry. Much enlarged. (From Banks after Denny).

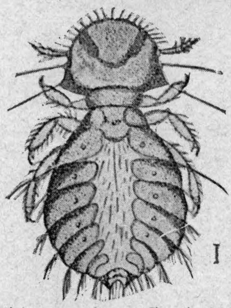


Fig. 26. *Goniodes dissimilis,* a louse that infests poultry. Much enlarged. (From Banks after Denny).

A short account of the mode of life; the conditions which favor their presence; their effect upon the birds; and the generalized life history of hen lice are given in Leaflet No. 57 of the English Board of Agriculture, pp. 3 and 4. From this source the following is quoted:

"These *Mallophaga* have not a piercing mouth, their mouth is simply used for biting. They subsist upon the productions of the skin and fragments of feathers. They cause violent itching, and bite sharply, and must produce considerable pain when present in large numbers, as is too often the case. The feathers, especially the saddle hackle, generally show notched edges with lice infestation. Eight distinct species of lice attack fowls. The presence of these lice is generally ascribed to too uniform or insufficient nutrition, or else to damp, dark, and dirty runs, especially those badly ventilated. Food, either when uniform or insufficient, has no effect upon their presence. Dark, damp places, however, when dirty, are sure to harbor all these pests, especially when badly ventilated. It is also said that breed affects their presence, but observation tends to show that all breeds are more or less subjected to infestation. In every case they set up severe irritation and inflammation of the skin, which often leads to stunted growth, and even death. Lice and other parasites flourish on unhealthy birds."

"*Life-history of Lice.*—All the lice breed fairly rapidly. The eggs or nits are laid upon the down feathers, as a rule; they are often beautifully sculptured objects, oval in form. In about 6 to 10 days they hatch into small, pale, active lice, which at once commence to irritate the birds. The adults are occasionally found in the nests. Some species are found copulating in the nests, others always on the birds. They live a considerable time. *Menopon pallidum* (Fig. 24) has been kept alive for months upon fresh feathers, the quill epidermis being especially eaten. Before reaching the full-grown state as many as 10 or 12 moults apparently take place, there being little difference in each stage, except the gradual darkening of the markings."

The eggs or nits of hen lice are shown in fig. 27.

Fig. 27. Feathers showing eggs or "nits" of the common hen louse. Enlarged (Original).

Methods of Introduction and Infestation.—It is generally agreed that lice and other parasites flourish best in insanitary surroundings. There must, however, be a source of infestation. Lice are brought to a new place by introducing infested birds. They spread from bird to bird (a) directly during copulation (an infested cock often infests the whole flock), or (b) when two hens occupy a nest together, or (c) from mother to chick. They also pass indirectly from bird to bird by crawling off one bird first on to the nesting material and later on to another bird which uses the same nest. Doctor Sharp has also observed several lice clinging to the body of a fly parasitic upon chickens. Lice are so much more common than the parasitic fly that it is probable that this insect is of little real importance in the distribution of the lice.

All the lice breed very rapidly. In 8 weeks the third generation is mature and in this generation the estimated number of the offspring of a single pair is 125,000 individuals. It seems important to eradicate an infestation if possible as soon as discovered. However, if kept under sanitary conditions and furnished with plenty of attractive dust, vigorous birds will hold external parasites in check. With some attention to sick birds, setting hens and young chicks, the parasites will give little trouble on a plant conducted with due regard to the principles of hygiene and sanitation (cf. Chap. II).

Diagnosis.—"It should be remembered at all times that the external animal parasites are the most common and frequent cause of trouble in the poultry-yard and pigeon-cote. If the birds are not thriving and conducting themselves satisfactorily, look for these pests, take measures to repress them, and in most cases the results will be surprising and gratifying. When anything is the matter with a horse the maxim is *examine his feet,* and when anything is found wrong with poultry or other domesticated birds, the maxim should be *look for lice.*" (Salmon.)

Adult hens may harbor quite a number of these parasites without showing any symptoms which indicate their presence. If they are unthrifty and broody hens leave their nests they should be examined for lice. The biting and digging of the claws of the lice may cause sores and the nervous irritation and loss of sleep may cause general debility and bowel trouble. Little chickens are very susceptible and often die. Lice are frequently found in large numbers on birds suffering from roup, gapes, etc. In some cases their presence has rendered the birds more susceptible to other disease, while in others it is probable that the birds lack sufficient energy to dust themselves.

The sure test for the presence of lice is, of course, finding the lice. Part the fathers under the wing, on the back and around the vent and examine the exposed skin. Examine the head and neck feathers and look between the large feathers of the wing. When present the parasites are easily found by anyone who is familiar with them. It seems incredible that serious infestations can escape the eye of any poultryman.

Treatment.—Sanitary surroundings and liberal range help the birds in their attempts to keep themselves free from lice. The dust bath is very efficient in holding the pests in check. It is doubtful, however, whether the dust boxes which used to be almost universally kept in the poultry house are of any real value. It is a noticeable fact that dust boxes are much less used now than formerly. This Station has not made use of them for a number of years. As commonly made these boxes are too small, and too shallow, and are not filled with the proper kind of material. Hens will use them, in most cases, only as a last resort if at all.

When possible, birds should be given access to dry, sandy ground, and they will provide their own dust bath. Some authors advise adding insect powder to the earth in dust boxes for bad infestations. It is doubtful whether under the best of circumstances this does anything but waste the insect powder. It is better to apply the powder directly to the bird and furnish clean earth for the dust bath.

When hens are used for incubating and brooding it is necessary to give some individual treatment to brooding hens and young chicks. It is also necessary to treat sick hens which are not able to use the dust bath. While it is theoretically possible to exterminate the pests and keep the flock free from them by avoiding the introduction of infected birds, this ideal condition prevails in very few poultry plants. In almost all flocks there are enough lice present to cause trouble if conditions favor their development. Robinson gives a very good method for preventing troublesome outbreaks in the following words:

"Treat with insect powder every sick fowl, every fowl that has been cooped for some days where it could not dust itself, every sitting hen when set, and at least twice again during the period of incubation, the last time just before the eggs are due to pip; treat the young chicks and hen when a brood is taken from the nest, and at intervals of a week until 3 weeks old."

How to Make an Effective and Very Cheap Lice Powder.

When the treatment of individual birds for lice becomes necessary some kind of powder dusted into the feathers thoroughly, seems to be, on the whole, the most effective and advisable remedy. The powder used must be of such nature, however, that it will be *effective*. There are so-called "lice powders" on the market which are no more effective than an equal quantity of any inert powdered substance would be. It is not only a waste of money but of time as well to use such powders. At the Maine Station no lice powder has been found that is so satisfactory as that originally invented by Mr. R. C. Lawry, formerly of the poultry department of Cornell University. The following matter regarding this powder (which can be made at a cost of 5 cents per pound) is quoted from a circular issued by the Maine Station:

"In using any kind of lice powder on poultry, whether the one described in this circular or some other, 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.

"The *lice powder* which the Station uses is made *at a cost of only a few cents a pound* in the following way:

"*Take 3 parts of gasoline,*

"*1 part of crude carbolic acid;*

"To get the proper results *only the 90-95 per cent. carbolic acid should be used for making lice powder.* 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 now, 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."

"Mix these together and add gradually with 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."

"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."

Next to the Lawry powder probably pure pyrethrum or Persian insect powder is as cheap and effective as anything to be had.

A time-honored and effective treatment for lice, especially for young chicks, is greasing. The grease most often used is lard or sometimes lard and sulphur. The latter should not be used for young chicks. The lard is applied with the finger to the head, neck, under the wings and around the vent. Greasing is a somewhat tedious but very effective treatment for lice, especially on young chicks, since lice usually attack them on the head and neck.

Prof. W. R. Graham, in conversation with one of the writers, has strongly recommended the use of blue ointment (*Unguentum hydrargyri,* U. S. P.) to rid birds of lice in cases where individual treatment was demanded.

B. MITES—ACARINA.

Eighteen species of mites are parasitic upon fowls. Only 4 of these are sufficiently injurious and widely distributed to be of great economic importance. Occasionally one or another of the other species becomes sufficiently abundant to be of local importance. The mites are small 8-legged animals related to the spiders. Some of the mites parasitic on the fowl visit their host only to feed, as the common red mite; others remain on the surface of the skin or on the feathers, as in the case of depluming scabies. Others live under the skin, causing deep-seated skin diseases like scaly leg; still others find their way into the internal regions of the body, living either on mucous membranes like the air sac mite (p. 110) or upon the connective tissue like the connective tissue mite.

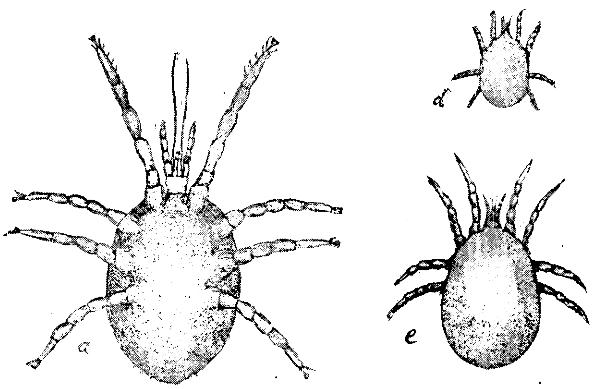


Fig. 28. The common "red mite" of poultry, *Dermanyssus gallinae,* a, adult. d and e, young. (After Osborn).

The most common and most injurious mite parasitic on fowls is the common fowl mite or red mite, *Dermanyssus gallinæ.* These mites are present in almost every poultry house that is not kept very clean. When they are present in large numbers they are a serious pest. This mite is a little more than ½ millimeter long. The female is a little larger than the male. When empty they are gray with dark spots, but usually they appear some shade from yellow to dark red according to the amount of fowl's blood they contain. They visit the fowls only to feed and spend the rest of the time on the under sides of the roosts, in cracks and crevices, under collections of droppings or other filth and in the nesting material, especially if such material is dirty straw. The mites breed in these places. They reproduce very rapidly, especially in spring and summer. The eggs are laid in concealed places, usually in cracks containing filth or in dirty nesting material. The young mites are white and have only 6 legs. Their first food is probably filth or decayed wood. They moult several times and their cast skins are often seen as a white powder on the perches. After the first moult the larvæ have 8 legs. The mites are able to live and reproduce for months at least without animal food, but when they are associated with fowls the older larvæ and adults depend upon the blood of the fowls for food. They usually attack the birds at night but sometimes are found feeding on laying or brooding hens during the day. They pierce the skin with their needle-like jaws and suck the blood. The irritation due to the biting of a number of these creatures disturbs the rest of the bird and the loss of blood may be considerable. The mites thrive best in dark, damp, dirty houses and may be found in such houses for months after all fowls have been removed. They will bite man or other mammals, causing severe irritation, but do not remain on strange hosts for any length of time. Fowls should not be allowed to roost in sheds with other animals, as the sheds may become infested with the mites which will disturb the other animals as well as the fowls.

Diagnosis.—If the birds are not doing well, especially if they appear emaciated and dejected, they should be examined at night for mites. In the day time the ends and under sides of the roosts and the cracks in them should be examined. Numbers of the mites are often found by prying up a loose cleat or splitting off a wide loose sliver. They may often be found in old straw nests.

Treatment.—Clean, dry, well ventilated houses which get plenty of sunlight are seldom badly infested. The first step in eradicating or controlling the pest is thoroughly to clean the houses. Remove the droppings and all the old nesting material. Clean and when possible scrub or wash with a stream from the hose all the perches, nests, floors and walls. Spray or paint the perches, nests, walls and floors with a 5 per cent solution of cresol (see Chap. II for directions for making this). Prof. H. C. Pierce has tested various remedies for mites and finds none so effective as this. Use plenty of solution and make the spraying thorough. Every crack and crevice should be flooded.

Another spray successfully used is: 3 parts kerosene and 1 part crude carbolic acid. Still a third, kerosene emulsion is recommended by the United States Department of Agriculture. Their method of making this spray as given in Circular No. 92 is as follows: "To make this, shave ½ pound of hard soap into 1 gallon of soft water and boil the mixture until the soap is dissolved. Then remove it to a safe distance from the fire and stir into it at once, while still hot, 2 gallons of kerosene or coal oil. The result is a thick, creamy emulsion. Dilute this stock mixture with 10 parts of soft water, and apply as a spray or with a brush, being careful to work it into all cracks, crevices, and joints of the building."

With any of these sprays it is necessary to make two or more applications at intervals of a few days to destroy the mites which hatch after the first application. The liquid may be put on with a hand spray pump or with a brush. Cleanliness, fresh air and sunlight are cheap and effective preventatives.

Scaly Leg.

A minute mite, *Knemidocoptes* (*Dermatoryctes*) (*Sarcoptes*) *mutans*, is the cause of a contagious disease affecting the legs of fowls, turkeys, pheasants, partridges and cage birds. According to some authorities it sometimes affects the comb and beak also. The mites excavate places under the skin where they live and breed. The most thorough study yet made of this parasite and its effect on birds is that of Haiduk.*

Diagnosis.—This very common disease is easily recognized by the enlarged roughened appearance it gives the foot and shank. This appearance is shown in fig. 29, with a normal leg for comparison.

The disease is present in most flocks unless especial care has been taken to exclude it. It is slightly contagious, but usually only a few birds in a flock appear to be infected. The scales on the foot and leg of an affected bird are raised by a crusty substance deposited beneath them. The lesions usually appear first near the joints between the toes and foot. The parts affected first appear to be enlarged and then the scales are raised, giving the roughened appearance shown in B fig. 29. In early

*Haiduk, T. Die Fussräuder des Geflügels. Inaug. Diss. Giessen, 1909, pp. 1-58, Taf. I-VI.

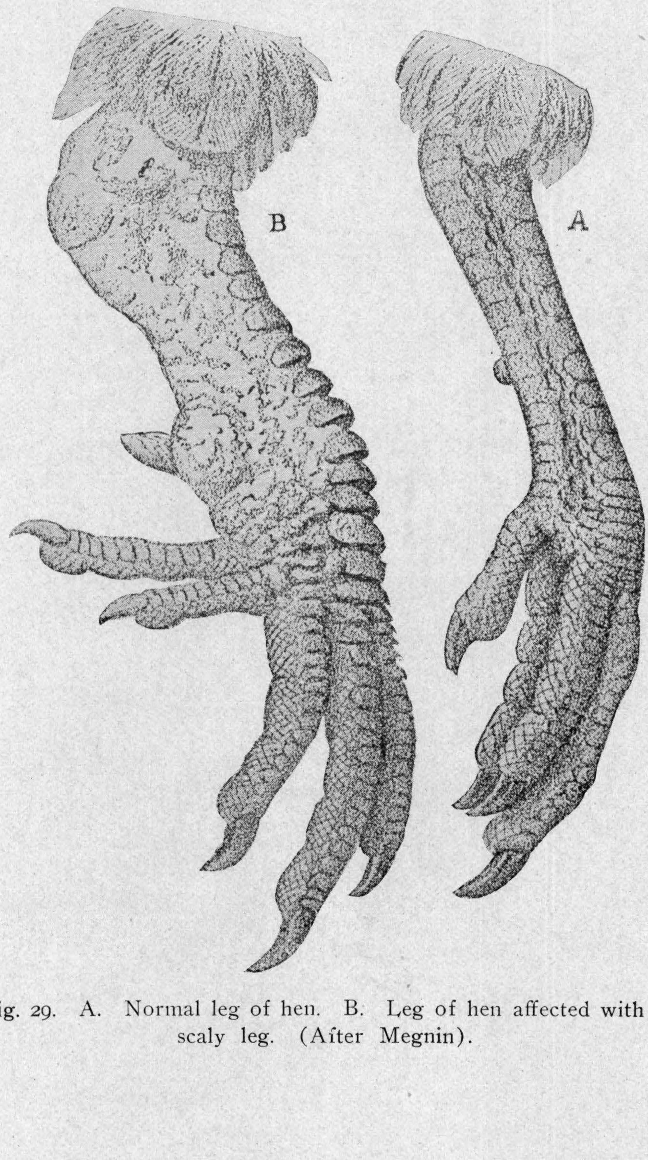


Fig. 29. A. Normal leg of hen. B. Leg of hen affected with scaly leg. (After Megnin).

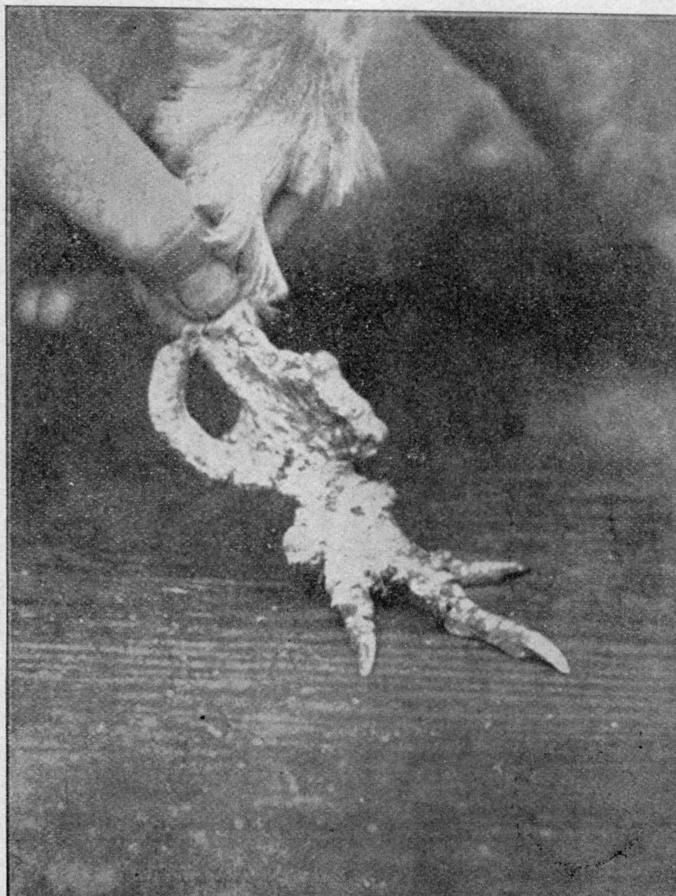


Fig. 30. Photograph of the leg of a hen affected with scaly leg. (After Haiduk).

stages the disease does not appear to disturb the general health of the fowl. As it progresses the birds become lame and sometimes the foot becomes so badly diseased that joints or even whole toes drop off. The photograph of a badly affected leg is shown in fig. 30. The two legs are usually affected equally.

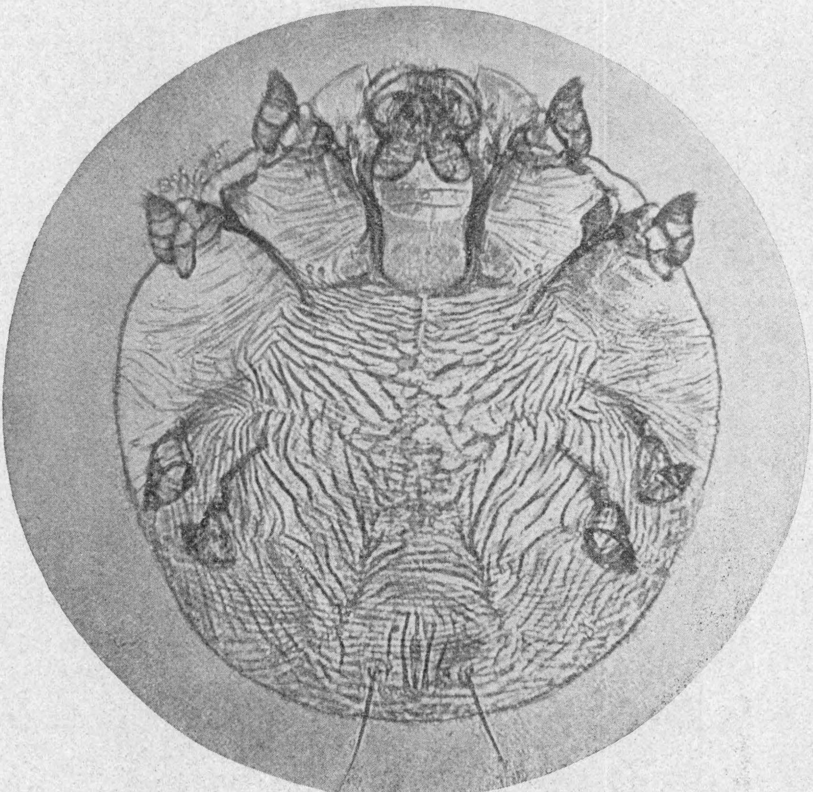


Fig. 31. Photograph of the adult female of the mite *Knemidocoptes (Dermatoryctes) mutans.* (After Haiduk).

Etiology.—The disease is caused by the minute parasitic mite *Knemidocoptes mutans* (figs. 31 and 32).

Fig. 32. Photograph of the six-legged larva of *Knemidocoptes* (*Dermatoryctes*) *mutans*. (After Haiduk).

The mites bore under the scales of the foot and leg and burrow deeper and deeper into the tissue. They set up an irritation which leads to multiplication of cells and the exudation of serum. This accumulation forms crusty deposits beneath the scales. These crusts contain many depressions in which are imbedded female mites containing eggs. The larvæ and the males are usually found beneath the crusts. The relations just described are shown in fig. 33, which is a picture of a section of the skin of a "scaly" leg.

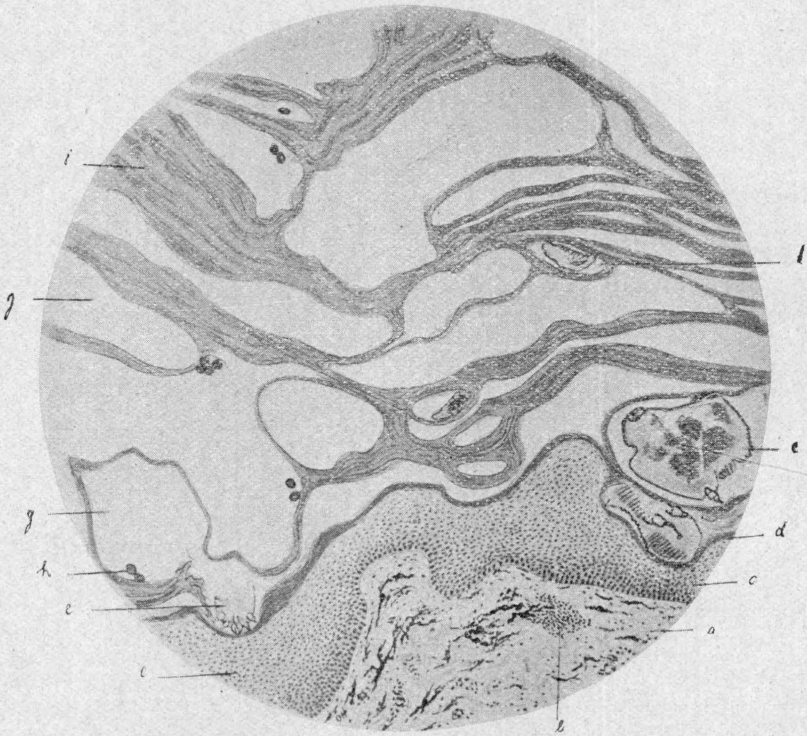


Fig. 33. Section of the skin of the leg of a fowl affected with scaly leg.

a. Papilla with pigment cells.
b. Lymphatic tissue in the papilla.
c. Epidermis: stratum profundum.
d. Epidermis: stratum corneum.
e. Section through a mite.
é. Section through a mite showing head and 2 pairs of legs.
f. Young mite.
g. Cavity excavated by mites.
h. Excrement of mite.
i. Horny layer between the mite excavations.

(From Haiduk, after Olt).

As the disease progresses the mites which are becoming constantly more numerous penetrate very deep into the tissues, causing lameness and sometimes the loss of some of the toes.

The infection from bird to bird probably takes place on the roosts or from mother to chick. Robinson believes that the birds most likely to be infected are those with a deficient supply of oil in the skin. The conditions which favor its spread in a flock are dry, barren runs, especially on alkaline soils or in yards filled with ashes or cinders. Foul roosting places also favor the spread of the disease. The disease is easily cured and it is worth the trouble of any poultryman to cure all the affected birds and to examine any birds purchased that infected ones may be treated before they are introduced into the flock.

Treatment.—Individual treatment is necessary to cure the disease. This treatment consists in the application of some penetrating oil to the diseased parts. A large number of oils and ointments have been used successfully. If the case is not far advanced and if there is no especial hurry about bringing about the cure the application of the oils or ointments at intervals of 2 or 3 days will soon do the work. If the birds must be cured quickly for show or sale purposes the cure is hastened by removing the scales and crusts before applying the medicine. This may be done by brushing with a stiff toothbrush before each treatment. Or the feet may be soaked for a few moments in warm soapy water and then brushed. When the disease is far advanced it is best to begin the treatment by the removal of the scales.

Haiduk's experiments show that one of the very best cures for scaly leg is *oil of caraway. This is best applied in an ointment made of 1 part of oil of caraway to 5 parts of white vaseline.* Oil of caraway is very penetrating and is not nearly as irritating as some of the treatments more usually advised. This ointment should be rubbed into the leg and foot every few days until signs of the disease disappear.

Hill recommends daily application of an ointment made of equal parts of vaseline and zinc ointment, or in severe cases of one made of 1 ounce of sulphur, ½ ounce of oxide of zinc, 1 dram of oil of tar and 2 ounces of whale oil mixed together.

There are two common remedies used successfully by poultrymen. These are irritating and should be used with some caution. They have the advantage of being quickly applied. The best of these is probably a mixture of 1 part of coal oil or kerosene and 2 parts of raw linseed oil. If a quick cure is imperative a half-and-half mixture may be used. Robinson in Farm Poultry, May, 1907, recommends a quick and easy method of applying this. It is to take a tall quart measure of the liquid to the hen house at night and dip both legs of each infected bird into the measure of oil, holding them there for a moment and then allowing them to drip for a moment more and then replacing the hen on the roost. With any treatment which involves the use of kerosene care must be taken not to wet the feathers of the leg, as this causes irritation and sometimes burns the skin much as the human skin is burned when it is rubbed with kerosene and covered with flannel.

A second method of applying kerosene is to put a teaspoonful of the oil in a quart measure of water and treat the birds by the method given above The same care should be taken not to wet the feathers.

The advantage of these treatments is their easy and rapid application to a number of birds.

Depluming Scabies.

The mite *Sarcoptes lævis* var. *gallinæ* (fig. 34) is the cause

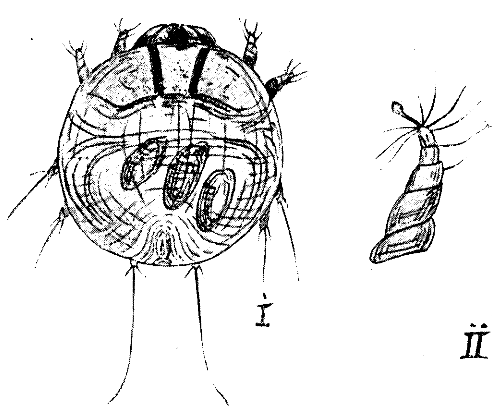


Fig. 34. Egg containing female *Sarcoptes Jaevis* var. *gallinac.* (After Theobald).

of a kind of scabies in fowls which causes the feathers to break off at the surface of the skin.

Symptoms.—This disease usually appears in spring and summer and is characterized by the dropping off of patches of feathers on different parts of the body. It usually begins at the rump and spreads to the head and neck, back, thighs and breast. The large wing and tail feathers are not usually lost. The exposed skin is normal in appearance. Around the stumps of the lost feathers and at the end of the quills of feathers near the bare spots are masses of epidermal scales. On microscopic examination these scales are found to be composed of numerous mites and their debris. The irritation of the mites often causes the birds to pull their own feathers. Birds affected often pull each others' feathers. Some of the so-called feather eating is due to the presence of this parasite, but fowls sometimes pull each others' feathers when the parasite is not present. Salmon says this disease does not affect the general health of the bird and does not appear to disturb gain in flesh or egg production, but Theobald says that the disease checks egg laying in hens and affected cocks become emaciated and sometimes die.

Etiology.—The mite *Sarcoptes lævis* which causes this disease is smaller than the one which causes scaly leg. They live at the base of the feathers in the epidermal debris referred to above. A flock becomes infected by the introduction of one or more birds carrying the mites. The mites are spread from bird to bird by the male in copulation. The distribution is often very rapid so that the whole flock is soon affected.

Treatment.—The disease should be prevented by taking care not to introduce infested birds. If it appears all affected birds should at once be isolated. The mites yield easily to treatment. The infested areas may be rubbed with some of the less irritating ointments recommended for scaly legs (see p. 141).

The following list gives some ointments in the order of their desirability for use on the body.

Oil of caraway ointment (1 to 5).
Balsam of Peru.
Creolin treatment (1 to 10).
Helmerich's ointment.

Salmon gives a modification of the latter ointment which he considers an improvement for use in depluming scabies.

Flowers of sulphur, 1 dram,
Carbonate of potash, 20 grains,
Lard of vaseline, ½ ounce.

Scabies may also be cured by liquid applications. The two following preparations are recommended by Salmon: A solution of balsam of Peru in alcohol (1 part of balsam to 3 of alcohol) or 1 dram of creolin, 2 ounces of glycerine, ½ ounce of alcohol and ½ ounce of water. Either of these liquids are applied by rubbing into the skin. The application should be repeated every 4 or 5 days until the disease is cured.

Other Mites Affecting Poultry.

Another form of *Body Mange* or scabies is found associated with the mites *Epidermoptes bilobatus* and *Epidermoptes bifurcatus,* but it has not been certainly demonstrated that they are the cause of the disease. Present evidence indicates that they are.

The disease closely resembles *favus* (p. 147) but usually does not affect the head. The regions commonly attacked are the neck, breast, the wings and the body under the wings. It sometimes affects the entire body, including the head. The skin becomes irritated and shows an accumulation of scales or crusts especially at the base of the feathers.

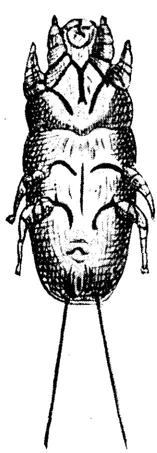


Fig. 35. *Symptectoptes cysticola.* Connective tissue mite. (After Theobald).

The mites live on the skin at the base of the feathers. Since the mites are sometimes found on birds which show no signs of scabies and since the disease so closely resembles favus, which is known to be caused by a fungus, it is sometimes supposed that this mange is also due to a fungus and that the mites are inoffensive.

Five species of mites have been recorded which live upon the feathers of fowls. These are fairly abundant but do no harm.

Two mites live within the body of fowls. One of these, the air sac mite, is described elsewhere (p. 110). The other the connective tissue mite, *Symplectoptes cysticola,* is found in the connective tissue of the fowls. They produce local irritations giving rise to tubercles but apparently do not affect the health of the bird.

The larvae of the so-called "harvest-bug" (which is not a *bug* at all) *Tetranychus (Thrombidium) (Leptus) autumnalis* sometimes attacks poultry. The appearance of this mite is shown in fig. 36.

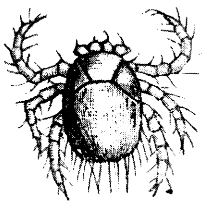


Fig. 36. "Harvest bug," *Tetranychus* (*Leptus*) *autumnalis,* larval form. (After Murray).

This small brick red mite, rarely visible to the naked eye, is bred upon berry and currant bushes, vegetables and grain, but when opportunity offers it bites almost any animal, often attacking man. It sometimes causes considerable mortality among late hatched chickens which frequent its breeding places. The parasites fasten themselves so firmly by their claws and palpi that they can only be detached by force. They produce intense irritation which often leads to epileptiform symptoms and death follows in a few days. Theobald suggests dusting flowers of sulphur among the feathers when the parasites are present. Probably the Lawry lice powder (p. 130) would be more effective. When these parasites are abundant chickens should be kept away from the places where the mites breed.

Other External Parasites.

The *dove cot bug* or "bed-bug" of poultrymen, found in pigeon lofts, sometimes invades neighboring hen roosts. It probably sometimes attacks fowls. It resembles closely the bed bug found in dwelling houses and like this pest is hard to exterminate as it can live almost indefinitely on dead organic matter. This tick hides in cracks during the day and attacks its host only at night. Persistent repetition of the sprays recommended for hen roosts infected with red mites (p. 134) will destroy these parasites.

Leaflet No. 57 of the English Board of Agriculture gives the following brief account of the *hen flea, Pulex gallinae (or avium):*

"The fleas, which are true insects, belong to the order of flies *(Diptera).* They feed upon the blood. One species only lives upon the fowl, namely the bird flea *(Pulex gallinae or avium)* which attacks also most other birds. The hen flea, as it is generally called, is abundant in dirty fowl runs, and especially in the nests where straw is used. The adult flea is dark in colour, and, as in all fleas, is devoid of wings. The fleas are provided with very sharp piercing mouths. They are what are termed 'partial parasites'—parasites that only go to their hosts to feed. The fleas are not noticed on the birds because they generally attack them at night; then, however, they do much harm, causing constant irritation and loss of blood, and depriving them of rest."

"*Life-history of Hen Flea.*—The female flea lays her eggs (nits) chiefly in the nests amongst dust and dirt and in the crevices of the walls and floor. These nits give rise to pearly white maggots, with brown horny heads, which can often be found in the bottom of the nests amongst the dust. These larvae are mature in 2 or 3 weeks, then they reach about 1-6 of an inch in length. In warm weather they may be full fed in even 10 days. They then spin a pale cocoon amongst the dirt, in which they pupate. The pupa is at first pale brown, then dark chestnut brown. In this condition the flea remains 10 to 21 days, when the pupa hatches into the adult. They breed all the year round, but chiefly in warm weather. It is well to remember that, whenever there are dark and dirty hen roosts, there are sure to be a number of *Pulex gallinae*."

Treatment. These parasites do not usually occur under sanitary housing conditions. When they occur the houses should be cleaned and sprayed as for red mites (p. 134). Theobald recommends the use of excelsior or shavings instead of straw for nesting material as the fleas do not breed as readily in this material.

CHAPTER XVII.

Diseases of the Skin.

Favus (Baldness or White Comb).

This disease of the skin attacks poultry as well as man and the domestic mammalia. In mammals it is called *tinea favosa* or *favus.*

Diagnosis. The disease usually appears first as small gray white spots on the comb, wattles, eye lids and around the ears, that is, on the unfeathered parts of the head. The spots enlarge and run together forming a scaly crust which becomes thicker until in 3 or 4 weeks it may be as much as 8 millimeters (1-3 inch) thick. The scales which make up the crust are often formed in concentric rings, the margins raised and the centers depressed, so that the scale is somewhat cup shaped. When the crust is removed the skin appears irritated and in places the surface is somewhat raw. The disease spreads to the feathered parts of the head, the neck, and the region around the vent. The base of the feathers becomes surrounded by concentric rings of the scaly material. The feathers become dry, erect, and brittle and finally break off or fall out leaving a disc-shaped scale with a depression at the bottom where the base of the feather was located. The bird's head and neck and patches around the vent become bare of feathers. The exposed skin is covered with the cup-shaped scales. Sometimes the disease spreads over the whole body until the bird becomes nearly naked. The diseased bird has a peculiar disagreeable odor, sometimes likened to the odor of a musty grain or to mouldy

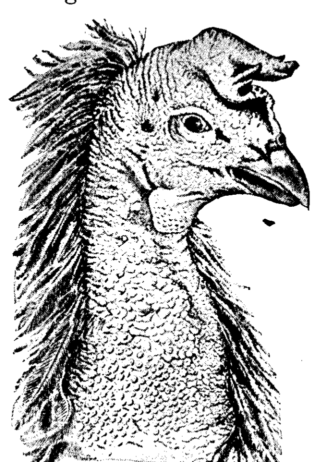


Fig. 37. Head and neck of a fowl affected with generalized favus. (After Pearson).

cheese and sometimes to cat's urine or to macerating animal material. In early stages the general health does not appear to be affected but as the disease advances the bird loses its appetite, becomes poor and exhausted, and finally dies.

Etiology. The disease is caused by the fungus *Achorion schonleinii.*

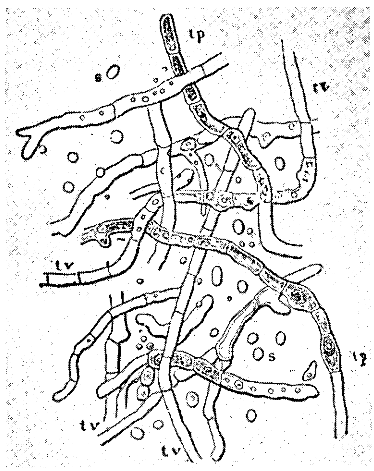


Fig. 38. The fungus *Achorion schonleinii* which causes favus in poultry. tv.—Empty tubes of mycelium. tp.—Tubes of the mycelium containing protoplasm and spores.

This fungus is found in the cup like scales on the skin and in the quills of the feathers of the diseased parts. If the favic cups or scales are moistened with weak acetic acid and examined under the microscope it will be seen that they are formed of branching, thread-like mycelial tubes of the fungus closely interwoven with one another, spores of the fungus, and epithelial scales from the skin of the host imbedded in a viscid substance secreted by the fungus. Some of the tubes of the mycelium contain spores. Many of the spores are found free among the filaments. They are usually found in groups of 3, 4 or 8.

Both the mycelium and spores of the fungus are found in the quills of the feathers of the diseased parts. The fungus sometimes penetrates even the barbs of the feathers.

Favus is a contagious disease and gets into a flock by the introduction of an affected bird. It is less likely to attack strong, vigorous birds than those in poor condition. It usually starts at a point where the skin is broken. Young birds are more susceptible than old ones. The large Asiatic breeds are specially liable to take the disease. No breed is entirely immune.

Megnin and some other authors consider this disease distinct from the favus of man and other animals, but numerous recorded observations indicate that it is the same disease and may be communicated to man. In handling affected birds, therefore, care should be exercised to prevent infection of cuts or scratches.

Treatment. Diseased birds should not be introduced into a flock. If the disease has been accidentally introduced the affected birds should be isolated as soon as possible. The flocks should be watched in order to discover and isolate any new cases that appear.

In early stages the disease yields readily to treatment. Zürn considers treatment economically advisable only before the feathered parts of the body are attacked. The disease may sometimes be cured at a later stage. The value of the affected bird must determine whether or not it is worth treating.

As much of the crust as possible should be removed. This is best done by first softening the scabs with warm water or with oil or glycerine. Robinson recommends scraping with the back of a knife or a spoon handle. The parts should then be painted with tincture of iodine or should be bathed with corrosive sublimate solution, 1 part of the sublimate to 1000 parts of water, and then rubbing with the ointment described on p. 30. In using the corrosive sublimate solution it should be borne in mind that this solution which unless colored with some dye looks exactly like water is extremely poisonous to men and animals when taken internally. Dishes or bottles of corrosive sublimate should never be left where they can be accidentally mistaken for water.

Lard and sulphur are often used successfully in the treatment of favus. Use nearly as much sulphur as lard and work them into a smooth salve. In early stages the disease usually yields to application of lard or oil alone.

Prognosis. In early stages the favus may be cured at the expense of a small amount of attention. After the feathered parts become affected a cure requires considerable labor as the fungus is better protected from the applications.

White Comb.

This name is often used for favus, but some authorities (e. g., Vale) use it to designate a condition of the comb characterized by a white powdery scurf of the surface. The comb is light colored and the white scales or flakes are particles detached from the epidermis. This condition is thought to be due to anemia. Wright says that it "appears generally due to dirt, or overcrowding in small space, or want of green food." The only treatment advised is to place the birds under sanitary conditions and give them a good balanced ration.

Chicken Pox (Sore Head or Epithelioma Contagiosum).

This contagious disease of poultry, although widely distributed in the northern states, is less common and serious here than in the Gulf States and Hawaiian Islands. It is impossible at present to decide whether this is a distinct disease or a form of roup which affects the skin of the head. This can only be determined when further investigations have revealed the real cause of these diseases.

Diagnosis. The disease usually appears as warty nodules on the unfeathered parts of the head. They look like the tumors in the nasal passages and eye sockets of birds affected with roup.

Freidberger and Frohner* give a good description of these nodules on the skin of the head, as follows:

"Their favorite seats are those parts of the head that are not covered with feathers; root of the beak, neighborhood of the nostrils, angles of the mouth, lobes of the ear, parts adjacent to the auditory meatus, wattles, surface of the face, edges of the eye-lids, intermaxillary space, and especially the comb. They sometimes spread over the feathered parts of the head, throat and neck, and may occur on the outer surface of the thighs, abdomen, under the wings and in the vicinity of the cloaca. At first these epitheliomata appear in the skin, as flat nodules, which soon become prominent, and which vary in size from a poppy seed to a millet seed. Later on, they usually attain the size of a hemp seed. They are of a reddish-gray or yellowish-gray color, often show distinctly in their earlier stages of development a peculiar greasy, nacreous lustre; and are rather firm

*Freidberger and Frohner. Veterinary Pathology (Vol. I. Hayes transl). Quoted from Cary.

to the touch. Their surface soon becomes covered with a dirty-gray, yellowish-brown or red-brown crust. They are discrete and disseminated in considerable numbers on the erectile tis-

Fig. 39. Sore-head crusts on comb, eye-lids and skin. (After Cary).

sues, etc. They vary in size according to their age; and frequently lie rather close to one another, so that the affected parts look as if coarsely granulated; or they are crowded together in such a manner as to give the appearance of large warts with divisions through them, or mulberry-like hypertrophies. Even single nodules, to say nothing of the groups, may attain the size of a lentil, pea, cherry-stone, broad bean or larger object. The older they become the rougher, and more covered with knobs will be their incrusted surface."

"If the edges of the eye-lids be affected by these tumors, the lids will become nodular, swollen and closed. The conjunctiva in this case also suffers; it projects outwards because catarrhally inflamed; assumes a yellowish color at the seat of eruption; and its surface becomes covered with crusts. Purulent conjunctivitis may appear and the inflammation may spread to the sclerotic and cornea, with keratitis and panophthalmia as the result. If, as sometimes happens with pigeons, the eruption of nodules extends over the whole of the skin of the eye-lids and its neighborhood, the entire eye will become covered with mulberry-like proliferations of various sizes."

The presence of these nodules on the epithelium of the head is often (but apparently not always) accompanied with characteristic roup lesions of the nasal cavities, mouth and throat. As long as the disease is confined to the skin of the head the general health of the bird does not seem to be affected. Recovery may take place without treatment in from 10 to 20 days. The nodules in such cases dry up and fall off. Usually, however, the disease is not self-limited, but advances. The eyes may become closed so that the birds cannot see to eat. They get poor and die from exhaustion. When the mucous membrane of the mouth developes diphtheritic membranes death occurs earlier than in other forms.

Etiology. The lesions of this disease resemble the lesions of roup and many of the same micro-organisms are found in the two cases. The organisms isolated from the lesions of sore-head include several bacteria, a coccidium, a yeast and several moulds. The coccidium, one of the moulds, and one of the bacteria have each been considered the cause of the disease by different workers. The real cause of the disease and its relation to roup must be determined by further investigations. The following discussion of the etiology of sore-head is given by Cary (Chicken-Pox or Sore Head in Poultry. Alabama Agric. Expt. Stat. Bulletin 136):

"*Transmission and Dissemination.* It is evidently infectious; because the disease in all its forms, spreads rather rapidly from one chicken or pigeon to another. Ward, Harrison and others have transmitted, in some cases quite readily by carrying small amount of diseased material (exudate and blood), from a sore-head chicken to healthy chickens. It is also quite certain that chicken pox and pigeon pox are identical or one and the same disease."

"Mosquitoes, gnat flies, chicken mites (ticks), chicken lice, chicken foot mites (*Sarcoptes mutans*) and possibly cock-roaches may sometimes be carriers of the real virus. It seems quite certain that mosquitoes can transmit the virus from water or some other source, under certain conditions. Warm and wet weather seem to increase the virulency of the virus and favor the rapid transmission of the disease. It is not impossible that ants may have a role to play in the transmission or cause of sore-head."

"*Pathological Anatomy.* On the skin the small, greasy-like nodules, or hypertrophied nodules of the skin, contain epithelial cells that have in them 'greasy' refractive bodies that stain yellow with picro-carmine and the nuclei of the epithelial cells become 'reddish brown' in color. Nearly all the epithelial cells in the nodule appear larger than normal and contain the refractive bodies. In the younger epithelial cells these bodies (young coccidia) are relatively small and occupy 1/4 to 1-3 of the epithelial cavity. In the older or outer or cast-off epithelial cells these refractive bodies are said by Freidberger and Frohner to occupy the entire cavities of the epithelial cells. The invaded or infested epithelial cells are unusually larger than the epidermal cells of the healthy neighboring skin. Among the cast-off mass of epithelial cells are found round refractive bodies and numerous nuclei of leucocytes or pus cells. The subcutaneous connective tissue is hyperaemic (congested) and is infiltrated with cells (leucocytes and nuclei of disintegrated cells). Possibly some of the small nuclei-like bodies among the cells in the subcutis may represent one stage in the development of coccidia. Many observers have, also, found various bacteria in the nodule and subcutis."

"In the diphtheritic membranes on the mucous surfaces of the mouth, pharynx, larynx and oesophagus, the epithelial cells are sometimes invaded by refractive bodies in the same manner as the epithelial cells of the skin and in the mass of diphtheritic exudate and cast-off cells on the mucous surface may be found the well formed coccidia * * * *. But the refractive bodies are not found in the epithelial cells of mucous exudates of skin nodules in every case. I have found them only in the early development of the nodule and the diphtheritic exudate, and have never found the mature coccidium in the nodules of the skin."

"When the exudate on the mucous surface or the crust of the nodule of the skin is torn off the raw surface bleeds rather freely and a fresh mount of this blood contains a short oval bacillus, numerous round bodies usually said to be nuclei of leucocytes; and a few polynuclear leucocytes. Repeated inoculations in the comb, wattles, skin and conjunctiva and oral mucosa of healthy chickens of various ages, with this blood, fresh from under a nodule or a diphtheritic exudate, has failed to produce positive infective results. I have also tested it on pigeons with like negative results."

"The exudates on the mucous membrane of the throat, mouth or larynx appear to be very much alike in all forms of the disease."

"The *period of incubation* is said to vary all the way from 2 to 20 days. In December I placed a newly-purchased barred Plymouth Rock cock (18 mos. old) in a yard with my chickens, many of which were recovering from sore-head, and in 24 hours this cock developed a good case of sore-head on the wattles, comb and eye-lids. There were mosquitoes in the roosting house. The period of incubation varies with mode of transmission, virulency of the virus, the weather (rapid in damp warm weather and slower in cool and dry weather), and the age and condition of the chicken or pigeon. Chicks from broiling size up to 7 or 8 months old seem to be most susceptible. Chickens with large combs seem to be more susceptible than birds with small combs and wattles."

Treatment. The introduction of diseased birds into healthy flocks should be avoided. The same precautions should be practised in the isolation of sick birds and disinfecting the houses as is advised for roup (p. 99). When the disease is localized a small amount of individual treatment cures many cases. The crust or nodules should be removed and the places treated with creolin (2 per cent solution) or corrosive sublimate (1-1000) (p. 29) and dusted with iodoform. The iodoform may be put into the eye. When the disease is not far advanced one such treatment may be followed by daily greasing with the ointment recommended on p. 30 or with vaseline or lard. In bad cases the iodoform should be used daily for a few days and then the ointment. When cases have roup or diphtheritic symptoms treat as recommended for roup (p. 100).

Prognosis. "The mortality is said to vary from 50 to 70 per cent of the affected birds. I judge this a low per cent of losses if birds are left to themselves with proper care or treatment. But if individual treatment is patiently and regularly applied the mortality can be cut down to less than 20 per cent. If only the skin of the head, and the comb and wattles are involved, one should lose less than 10 per cent. If the mouth and pharynx are also involved, less than 10 per cent should die. But if the nasal passages and trachea are involved, or the intestines become involved,—good care and treatment may save 50 to 80 per cent." (Cary).

CHAPTER XVIII.

Diseases of the Reproductive Organs.

The direct economic importance of poultry lies in the production of two things, viz., meat and eggs. For the production of the latter the poultryman is dependent upon the activity of the reproductive system of the hen. Under natural conditions in the wild state, the progenitors of the domestic fowl laid relatively few eggs. Judging by other species of wild birds of the present day, however, it is highly probable that the wild progenitors of poultry possessed the potential ability to lay much more than the usual number of eggs provided they were removed from the nest as fast as laid. Under domestication this practice of removing the eggs as fast as laid, together with the feeding of rich foods, and still other factors, lays heavy demands upon the reproductive system. It is not remarkable that an organ system which under conditions of nature produced from 12 to perhaps 30 units per annum, frequently breaks down under the strain of producing from 100 to 250 per annum of the same kind of units. It could only be expected that, as is actually the case, the egg producing organs would be particularly liable to disease.

ANATOMY AND PHYSIOLOGY.

In order that the discussion of the diseases of the reproductive organs may be intelligible it is desirable to preface it with a brief account of the anatomy and physiology of the organs of reproduction in the hen. Because of the fact that the corresponding organs in the male are less subject to disease, on the one hand, and are perhaps better understood by the poultryman, because of the prevalence of the practice of caponizing, on the other hand, it will not be necessary to discuss the male in detail in this connection.

The organs concerned in egg production in the hen are shown graphically in fig. 40. This picture and the accompanying ex-

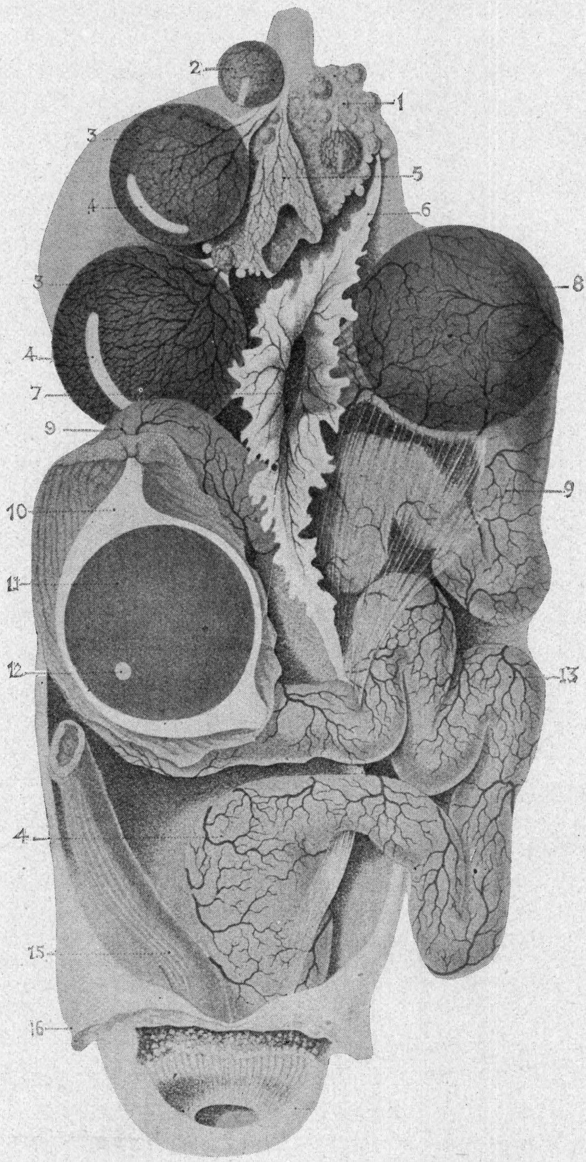


Fig. 40. The reproductive or egg producing organs of a hen. See text for explanation of figures. (After Duval).

planation of it will make clear the various parts of this organ system. All of the points shown in the figure may easily be demonstrated on a hen, killed during a period of laying activity. It should be noted that this picture is somewhat diagrammatic and not in accord with normal conditions in respect to at least two points. These are: (1) there are two eggs in the upper portion of the oviduct. Normally there would be but one there at a time. (2) The proportionate lengths of albumen portion, isthmus and uterus are not correctly indicated.

In this figure the various numerals have the following significance:

1. The *ovary;* region in which the ovules (later to become yolks) are still small in size.

2. An *ovule* in an intermediate stage of development, larger than those at 1, but still not ready to pass into the oviduct to be laid. It is contained in a very vascular capsule, known technically as the *follicle.*

3. 3. Ovules still larger and containing more yolk. The lower one is nearly ready to leave the ovary and pass down the oviduct.

4. It will be noted that on all the larger follicles there is one region (forming a line) in which there are no blood vessels. This region (4, 4) is known as the *stigma.* Here the follicle wall breaks and allows the ovule (yolk) to leave the ovary preparatory to laying.

5. An empty *follicle* in which the *stigma* has opened and the yolk passed out.

6. Anterior end of the margin of the *funnel (or infundibulum)* of the *oviduct* or egg-tube. When an ovule is about to be discharged from the ovary these funnel lips or margins wrap around that portion of the ovary, so that the ovule may certainly pass into the oviduct and not into the abdominal cavity.

7. Opening of the *funnel.* Through this opening the yolk passes into the oviduct.

8. A yolk which has just passed through the funnel opening into the upper portion of the oviduct.

9. 9. *Albumen secreting portion* of the oviduct in which the greater portion of the albumen or white of the egg, is secreted by glands in the walls of the oviduct in this region.

10. First layer of albumen, or white, secreted about the yolk.

From this layer are formed the *chalazae*, or cords of twisted, thickened albumen, at each pole of the yolk.

11. Yolk, around which albumen is being secreted.

12. The *germinal disc*. This is the living portion of the egg, from which the future chick develops, the main mass of yolk serving as food material for the developing embryo during the process.

13. Anterior end of the *isthmus* of the oviduct. The primary function of the isthmus is to secrete about the egg the *shell membrane*, the dense white membrane closely adherent to the inside of the shell of an egg.

14. The *uterus*, or *shell gland*, in which the shell is put on the egg.

15. The *rectum*.

16. The walls of the abdomen cut and folded back.

17. External opening of the *cloaca*, or common space into which open (a) the rectum, (b) the oviduct and (e) the ureters, or kidney ducts.

The processes concerned in the formation of an egg are thus summarized by Lillie (The Development of the Chick, New York, 1908, pp. 23-25):

"The formation of an egg takes place as follows: The yolk, or ovum proper, escaped by rupture of the follicle along a preformed band, the stigma (fig. 40), into the infundibulum, which swallows it, so to speak, and it is passed down by peristaltic contractions of the oviduct. The escape of the ovum from the follicle is known as the process of ovulation. During its passage down the oviduct it becomes surrounded by layers of albumen secreted by the oviducal glands. The shell-membrane is secreted in the isthmus and the shell in the uterus (fig. 40). The ovum is fertilized in the uppermost part of the oviduct and the cleavage and early stages of formation of the germ-layers take place before the egg is laid. The time occupied by the ovum in traversing the various sections of the oviduct is estimated by Kölliker as follows: Upper two-thirds of the oviduct about 3 hours (formation of albumen), isthmus about 3 hours (secretion of shell-membrane), uterus 12 to 24 hours (formation of shell and laying). These figures are only approximate and it is obvious that they are likely to vary considerably in different breeds of hens."

"Some of the details of these remarkable processes deserve attention: The observations of several naturalists demonstrate that the ripe follicle is embraced by the funnel of the oviduct before its rupture so that the ovum does not escape into the body-cavity, but into the oviduct itself. Coste describes the process in the following way: 'In hens killed 17 to 20 hours after laying I have observed all the stages of this remarkable process. In some the follicle, still intact and enclosing its egg, had already been swallowed, and the mouth of the oviduct, contracted around the stalk of the capsule, seemed to exert some pressure on it, in other cases the ruptured capsule still partly enclosed the egg which projected from the opening; in others finally the empty capsule had just deposited the egg in the entrance of the oviduct.' "

"The existence of double-yolked eggs renders it probable that the oviduct can pick up eggs that have escaped into the body-cavity. But in some cases ova that escape into the body-cavity undergo resorption there."

"Immediately after the ovum is received by the oviduct it appears to become softer and more flexible (Coste). The uppermost portion of the oviduct then secretes a special layer of albumen which adheres closely to the vitelline membrane and is prolonged in two strands, one extending up and the other down the oviduct; these strands become the chalazae; the layer to which they are attached may, therefore, be called the chalaziferous layer (Coste) of the albumen. The ovum then passes down the oviduct, rotating on the chalazal axis, and thus describing a spiral path; the albumen which is secreted abundantly in advance of the ovum is therefore wrapped around the chalaziferous layer and chalazae in successive spiral layers and the chalazae are revolved in spiral turns. The main factor in propulsion of the ovum along the oviduct appears to be the peristaltic movements of the latter; it is probable that the cilia which line the cavity have something to do with the rotation of the ovum on its chalazal axis."

With this account of the anatomy and physiology of the female organs of reproduction in hand we may proceed to a considerations of their diseases. These diseases fall at once into two classes: (a) those affecting the ovary and (b) those affecting the oviduct.

DISEASES OF THE OVARY.

Atrophy of the Ovary.

By "atrophy" of the ovary is meant a diminution in size of that organ accompanied with a cessation of its physiological activity. It may shrink to the size and appearance which it has in a very young bird. The following sorts of atrophy of the ovary may be distinguished. The different sorts are separated from each other, not because of any difference in the end result, but because of the different etiological factors concerned.

1. Physiological atrophy.
   a. Temporary.
   b. Permanent.
2. Congenital atrophy (Pseudo-hermaphroditism).
3. "Black atrophy."

A physiological diminution in size or partial atrophy of the ovary occurs normally in fowls when after a period of laying they go into a more or less prolonged resting period. The condition of the ovary is usually (in fowls under 2 years old) only temporary. The organ resumes its normal size and activity after a time. In old birds (3 to 6 or more years of age) it not infrequently happens that the ovary passes into an atrophied condition, and remains permanently in that condition thereafter. In such cases the bird as a whole, and the ovary in particular, may be perfectly healthy, showing no sign of disease. Cases of permanent physiological atrophy of the ovary have been observed at this Station as follows:

One case in a White Crested Black Polish.

One case in a Cornish Indian Game.

Several cases in Barred Plymouth Rocks. All of the latter were birds of very high fecundity (200 or more eggs per annum) in their pullet years.

It should be noted that in what is here called permanent physiology atrophy of the ovary there is *no* associated change of the secondary sexual characters. That is, the hen does not assume cock plumage, spurs, enlarged comb and wattles, nor any other of the secondary sexual characters normal to the male. This indicates that in permanent physiological atrophy (just as is known to be the case in temporary) the only function of the ovary which is disturbed is that which is involved in egg formation. The activity of the organ in regard to producing an internal secretion which in some way controls the secondary sexual characters remains unchanged.

As *congenital atrophy* of the *ovary* are to be classed cases of pseudo-hermaphroditism in fowls. In such cases a true, functioning ovary never develops. There may be a body which in gross features resembles an ovary, but it is inactive and does not take even the first steps in oogenesis (egg formation).

There may or may not be a testis like body present in these cases. Not only is the egg producing activity absent in such cases, but also in many of them at least, the internal secretion normally produced by the ovary is lacking also. The bird then takes on some or all of the secondary sexual characters of the male. The appearance of such a bird is shown in fig. 41.

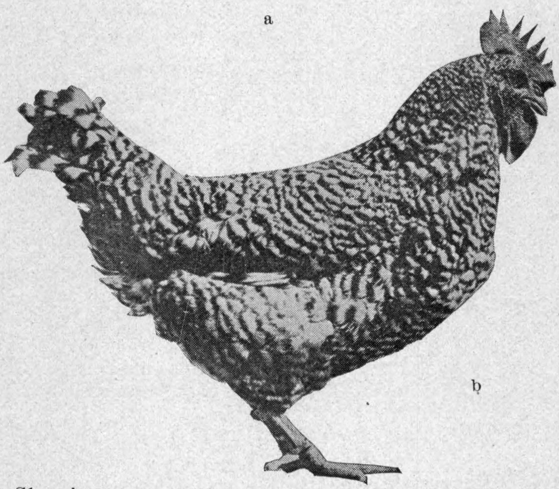


Fig. 41. Showing a case of incomplete hermaphroditism. In front of the line a-b the bird has the characters of the male, behind it the characters of the female. The ovary was not functional in this bird. (Original).

As "black atrophy" of the ovary is here designated the peculiar disease of the ovary first observed more than a century ago in England as occurring in pheasants. The striking feature of the disease is that under its influence the bird assumes the plumage appropriate to the male. The change in the ovary and oviduct induced by the disease appears to be an atrophy accompanied by a blackening which is probably a true melanosis. The following account of an outbreak of this disease about 50 years ago, written by Hamilton (Proc. Zool. Soc., London, 1862, p. 24) is of interest: "In the years 1858, 1859, and 1860 this peculiar alteration of structure in the female organs of generation in the Pheasants was particularly prevalent in some parts of England. I had the opportunity of examining many specimens, and was able completely to confirm Mr. Yarrell's views on this subject. Indeed, the majority of the birds were young females, many of them being birds of the year, some being in their first moult. I found also that the plumage varied and approached that of the male, not in accordance with the age of the bird, but with the amount of disease of the generative organs. The greater the destruction of the ovarium and oviduct. the nearer the plumage assimilated that of the male."

"For example, in birds with the hen-plumage predominating, the ovarium and oviduct exist as in the fecundating hen, the small ova lying in considerable numbers in the ovarium, the ovarium and oviduct showing dark lead-coloured masses of disease."

"In birds with the plumage of the male in a measure exceeding that of the female, the ovarium is considerably diminished in size, dark-coloured, and containing only a few blackened ova; the oviduct is spotted with dark patches, and considerably contracted."

"And thirdly, in birds with the male plumage predominating over that of the female, the ovarium is reduced to a small dark amorphous mass, resembling the coagulated blood, the presence of ova cannot be detected, and the oviduct is almost entirely obliterated at its junction with the ovarium. Thus it seems that there are 3 distinct phases in this peculiar abnormal state of the generative functions."

"I have also noticed that, in most cases where the male plumage is in excess of the female, the tail-feathers are particularly long, some being as much as 19 inches in length."

"Although Mr. Yarrell states that this condition of the female generative organs is not confined to the *Phasianidae,* and that it has occurred in the gold and silver pheasants, partridges, peafowls, common-fowl, common pigeon, king-fisher, and common duck, and that other classes of animals are liable to an influence similar in kind, particularly among insects and Crustacea, yet this disorganization is rarely observed except among the *Phasianidae,* and particularly when these birds are produced in a domestic state, i. e., on the present system of breeding pheasants in preserves. Very few *battues* take place in which some of these birds (generally designated males) are not killed and mixed indiscriminately with the heaps of the slain."

"As to the cause of this disorganization, if it occurred only in the old female, or if it were a common occurrence among birds either of different genera or of the same genus, it could be easily accounted for; but when it is generally found existing among a class of birds which are bred in vast numbers in a particularly artificial manner, it leads one to suppose that the cause must be connected with this condition."

In regard to all sorts of atrophy of the ovary it should be said that there is no known way to treat them. Such cases when they appear must be accepted by the poultryman as one of the vicissitudes of the business.

Gangrene of the Ovary.

Salmon and other writers on poultry diseases following him have designated as gangrene a condition of the ovary relatively often found at post-mortem. Salmon's discussion of the matter is as follows: "This disease is quite common with all varieties of poultry. On examination of the ovary after death, the ova are found in different stages of development, but instead of being yellowish-pink in color, with the blood vessels well defined, they are brown or black, easily crushed and the contents broken down into a putrid liquid. Death is caused partly by peritonitis and partly by the absorption of the products of decomposition."

"The cause of this trouble is not well understood. It has been attributed to the birds being too fat thus compressing the ovary and hindering the evolution of the ova. As it may occur in birds which are not fat and as it is evidently accompanied by the penetration and multiplication of bacteria, it is possibly an infectous disease."

We have not been able to find anywhere in the literature that there has been a thorough investigation of this disease.

Ovarian Tumors.

Tumors and cancerous growths on the ovary are not uncommon. These include several sorts of interest to the pathologist, but not to the practical poultryman. From the literature it appears that at least the following (and probably other) kinds of new growths are found to occur on the ovary with greater or less frequency.

1. Benign tumors, of several types, including yolk tumors.
2. Carcinoma.
3. Dermoid cysts.

"Treatment is, of course, impossible in these cases as the nature of the disease is not determined until after the bird's death. If such abnormal conditions are frequently found, it is an indication that there is a predisposition in that direction in the strain of birds. The only way to correct this is to kill off the flock and obtain different blood." (Salmon).

Abortion of Eggs.

Regarding this matter Wright (New Book of Poultry, p. 574) has the following to say: "This is not to be confounded with the laying of soft eggs. These last are laid when mature, and usually by fat birds; but when violently driven or startled, or subject to violence of any kind, or even if suddenly and greatly terrified, immature yolks are sometimes detached from the ovary and expelled. This is most likely to happen with pullets not yet laying but about to lay, and being a real miscarriage or abortion, may wreck the constitution of a valuable bird unless attended to. It is distinguished from the other by not occurring as a rule in fat birds; by the immature and small size of the yolk or yolks; generally also by hemorrhage; and always by signs of illness of chicks afterwards. Any such bird should be placed for a few days in a quiet and comfortable but rather dark pen, with a nest in case of need, and fed on a little bread and milk. Quiet rest is the main thing, but 20 grains bromide of potassium may be dissolved in half a pint of drinking water. With such care the event may be entirely recovered from."

Yolk Hypertrophy.

There are a number of cases on record where the yolks formed by the ovary have been very much larger than normal. These "giant yolks" are due to a diseased condition of the organ, possibly contingent upon too much forcing for egg production. Such cases have been described by Gurlt (Mag. f. d. ges. Tierheilk, 1849) and more recently by von Durski (Die pathol.

Veränderungen des Eies und Eileiters bei den Vogeln. Berlin, 1907). When yolks become very large in this way they may break loose from the ovary without any rupture of the follicle wall along the stigma but a breaking or tearing loose of the stalk or pedicle of the follicle.

Failure of Follicle Wall to Rupture.

Closely connected with the last diseased condition is one discussed by von Durski in which the follicle wall fails to rupture and release the yolk. In consequence of this, in the case described by von Durski, the follicle wall became stretched and pulled out into a long and very much twisted stalk. This stalk held the hard, and decayed yolk fast to the ovary. In cases of this kind the stalk sometimes breaks, and the yolk enclosed in the follicle and with the end of the stalk attached, passes down the oviduct acquiring albumen, membranes and shell. In still other instances the stalk breaks and the follicle and contained yolk drops into the abdominal cavity.

DISEASES OF THE OVIDUCT.

Diseases of the oviduct are relatively common and cause a steady, and probably in the aggregate rather large loss to the poultryman. Fortunately some of the diseases of the oviduct are more amenable to treatment than are those of the ovary. Further these diseases in many cases show plain external symptoms at a relatively early stage. Then they may be recognized and treated while it is still possible to effect a cure. This is usually not the case with ovarian diseases.

The general external symptoms of the commoner diseases of the oviduct are very much like those of constipation. The poultryman watching his birds is indeed rather likely to confuse the two. But if so no harm is done. The thorough cleaning out of the alimentary tract, and stimulation of the liver indicated in the treatment of constipation is the very best thing to be done in cases of inflammation and similar disorders of the oviduct.

Inflammation of Oviduct.

This is one of the most important and common diseases of the oviduct. It may occur alone or in association with other morbid conditions of this organ.

Diagnosis. Hill (Diseases of Poultry) gives the following symptoms: "A bird affected with inflammation of the egg passage suffers acutely. At first there is a continual and violent straining (sometimes resulting in apoplexy). The wings are dropped and the feathers puffed out. The vent is usually hot and if a thermometer be inserted the temperature will be found high, frequently 105 to 107 degrees.* As the inflammation proceeds the bird becomes more and more mopish and exhausted but does not strain so violently, pain and exhaustion acting as preventatives. Ultimately the temperature becomes lower, the body cold and with a few, convulsive gasps the sufferer dies."

To these symptoms Salmon adds the following, basing his account largely upon the statements given by Zürn: "The bird at first shows indications of a desire to lay without being able to produce eggs or it may lay eggs containing more or less blood or eggs without shells or small and misshaped eggs containing albumen but no yolk, or finally the yolk may be dropped without any covering of albumen or shell. As the inflammation increases there is high temperature, straining and an effort to rub the abdomen upon the ground. In later stages the bird becomes dull, indisposed to move, the comb is pale, the plumage rough and the temperature falls to normal or below."

Etiology. There are probably to be distinguished three classes of causes which lead to inflammation of the oviduct. These are:

1. Physiological; from irritation due to too frequent laying or from too stimulating foods or condiments.

2. Traumatic; from irritation due to too large eggs, or to the breaking of eggs within the oviduct, or similar causes.

3. Specific infection; it is probably that alone or in combination with the causes classed under 1 and 2 a specific infection of the lining membranes of the oviduct may occur.

In an inflamed oviduct there very often is a copious sero-fibrinous exudate. This hardens about any foreign body (egg, broken egg, etc.) which may be in the oviduct, and by accretion causes this foreign body to increase in size. This, of course,

*There must be some mistake about this. 105° to 107° are not at all high temperatures for the domestic fowl. In fact in our experience at this Station 105° would seem to be a slightly subnormal temperature rather than one indicating fever.

makes it still more irritating which in turn provokes further inflammation of the walls of the duct. One sometimes finds relatively enormous masses of material in a diseased oviduct, which have been built up in this way. There is an extensive literature on these "egg concrements" or "yolk tumors" built up either in the oviduct or in the abdominal cavity by hardened fibrous exudate, about an original basis of a broken, or miscarried, or aborted yolk or yolks. It is not necessary to review this literature here as it is only of interest to the specialist.

Treatment. If this disease is to be dealt with at all the treatment must be individual, since it is something which will never affect considerable numbers of the flock at the same time. If individual treatment is to be successful it must be begun at a relatively early stage of the disease. Therefore, it is important that a bird showing the symptoms which have been described above should be isolated at once and as a first step in the treatment given a purgative dose of Epsom salts (see p. 29). All stimulating foods such as meat, green cut bone, linseed meal and similar substances, as well as condiments like condition powders, pepper, etc., should be immediately taken away from the bird. A light ration and plenty of green food should be given. Salmon recommends following the purgative with ½ drop of tincture of aconite root 3 times a day. Equally effective, and much easier to administer, will be found 1-10 gr. aconite root tablets (see p. 30).

Prolapse of the Oviduct (Eversion).

It not infrequently happens from one cause or another, that the lower portion of the oviduct becomes everted and projects from the vent as a mass of red or purplish tissue. This condition is known as *prolapsus* of the oviduct.

Diagnosis. The diagnosis of this diseased condition is simple and consists merely in the observation of the prolapsed oviduct. If there is a mass of red or bloody tissue projecting from the vent one is safe in diagnosing prolapsus. The only point which needs particular attention in the diagnosis is as to the degree to which prolapsus has occurred when the bird is discovered. The importance of this lies in the fact that on it depends the treatment which it is advisable to give. Where the prolapse is only partial and is discovered early it is advisable to treat it by the methods outlined below. If, on the other hand, the prolapse is extensive and has existed for some time before the bird is seen so that the mass of tissue has turned a blue or purplish color or has been pretty extensively picked and torn by the other birds in the pen, then it is useless to carry on any treatment and the proper thing to do is to kill the bird at once.

Etiology. Prolapse of the oviduct may be caused by a number of different things. It is observed not only in old hens, but, in our experience, quite as frequently in pullets. The fundamental cause of the condition is, of course, a weakness of the oviduct walls, and ligaments, chiefly in respect to their muscular portions, which makes the oviduct unable to stand the strains put upon it in egg production. The immediate cause may be either:

1. Straining to lay a very large (double yolked) egg. This is perhaps the most common cause.
2. Straining to lay when there is an obstruction in the oviduct (egg bound).
3. Constipation. The rectum full of hardened feces stimulates all organs in that region of the body to expulsive reflexes.
4. Zürn says that often times feces may become lodged in the cloaca in a sort of blind pocket, and then set up the same expulsive reflexes as an egg in the cloacal or vaginal regions normally does. In the effort to expel this foreign body the oviduct may become everted.

The most serious thing about prolapsus is that if not discovered very shortly after it occurs it is almost sure to result fatally, because the everted portion will become so badly infected as to cause blood poisoning, or the protruding mass of tissue will be picked and torn by the other birds in the pen until there is no hope of repair, whatever the treatment.

Treatment. As stated above, the advisability of treating prolapsus depends upon its degree and duration before discovery.

In treating this condition the first thing to endeavor to do is to remove the cause. That is, if the bird is constipated give it a rectal enema of warm soapy water, followed by ¼ teaspoon of Epsom salts by the mouth. If there is a lump of feces lodged in the cloaca this should be carefully removed. The protruding mass of tissue should be washed with warm 1 to 1000 bichloride of mercury solution, or a warm ½ per cent cresol solution. After the protruding parts are thoroughly cleansed they should be well greased with vaseline, or with the ointment already recommended (p. 30). Then with the fingers well greased an effort should be made to replace the protruding mass in the body. In doing this one should proceed with the greatest gentleness. In most cases with care and patience it is possible to reduce the prolapsus, that is, to get the extruded tissue back into the body in approximately its normal position.

After the parts have been carefully replaced in normal position the next point to be considered in the treatment is to insure that they shall stay there. That is to say, it is necessary some way to bring about a healthy degree of contraction of the muscular walls of the oviduct so as to hold the parts in place permanently. In order to do this Salmon recommends the use of ergot. Robinson follows Salmon in this recommendation. It should be said, however, that it is doubtful whether this treatment is advisable. Ergot is a rather violent poison for poultry. It seems likely that the treatment recommended by Salmon and Robinson is based on a theory that the action which ergot has on the mammalian uterus will be duplicated on the fowl's oviduct rather than upon actual experience in administering the drug to poultry. The measure recommended by Zürn to bring about a healthy contraction of the replaced oviduct in cases of prolapsus would seem to be simpler and on the whole more likely to yield desirable results than the ergot treatment. Zürn recommends that a lump of ice be placed in the cloaca after the prolapsed oviduct is returned to its place and that this treatment be followed up for some hours.

The bird should be kept in a small coop, partly darkened, where there will be every inducement for it to remain perfectly quiet. The success of the treatment depends very much on keeping the bird quiet for a few days. It should be fed only a light and unstimulating ration with plenty of green food.

Prognosis. If discovered early enough prolapsus is curable.

Obstruction of the Oviduct ("Egg Bound").

Perhaps the commonest of all diseased conditions of the oviduct is that which leads the poultryman to say that a bird is "egg bound." By this is meant that there is something in the oviduct which the bird is not able to pass to the outside and which in turn prevents the normal passage of eggs. In many cases this is not properly speaking a disease at all but rather an accident. Other cases, however, depend upon a true diseased condition of the oviduct.

Diagnosis. Salmon describes the following symptoms: "When fowls are egg bound they at first go frequently to the nest, making efforts to lay but are unable to accomplish this function. They are restless and evidently in more or less distress. Later they become dull, with rough plumage and are indisposed to move. On examining the bird by pressure of the finger about the vent, the egg can be distinguished as a hard body in the posterior part of the abdominal cavity. In case of prolapsus, the everted oviduct may be easily seen."

In this connection, however, it should be noted that these general symptoms which Salmon describes are observed in mild form in a great many cases with birds which subsequently lay the egg without trouble. In many instances the extrusion of an egg which is finally successfully laid is attended with a good deal of difficulty. There are all degrees of gradation between this somewhat difficult but still normal laying and the condition of complete obstruction of the oviduct where the egg cannot be passed at all. The practical consideration to which this leads is that one should not be too hasty in applying treatment for the egg-bound condition. A diagnosis of the trouble, in other words, should not be finally settled upon until there remains no doubt that the hen is not going to pass the egg without help from the outside.

It must also be remembered that in many cases of obstruction of the oviduct, the obstruction is so far up that it cannot be felt from the outside. In such cases the diagnosis must be made upon the general behavior of the hen, and in particular in regard to going frequently on the nest without laying.

Etiology. In considering the causes of obstruction of the oviduct it is necessary to distinguish between several different sorts or categories. This may be done as follows:

1. Simple "egg bound" condition, in which a normal egg is lodged in the uterus or vagina and cannot be expelled. This inability to expel the egg may be due to any one or a combination of the following causes acting together:

a. Egg of too large size, so that it is mechanically difficult or impossible to force it through the natural passage. Robinson regards this as the most common cause.

b. Exhaustion (true physiological fatigue) of the muscular walls of the oviduct. This condition results after long continued and unsuccessful attempts to expe lthe egg. It leads to

c. Atony and paralysis of the duct in which the muscular walls are incapable of making any effective contraction at all.

2. Complicated "egg bound" conditions in which the fundamental source of the trouble is not simply mechanical, and in which usually the portions of the oviduct anterior to the uterus are involved. In this general category the following sorts of cases are to be included.

a. Atony and paralysis of the upper portions of the oviduct. This condition may exist for a long time without being recognized.

b. Inflammation of the oviduct leading to the formation of fibrous exudate which accumulates in the duct, until it may form a mass of relatively enormous size (usually with one or more yolks as a nucleus) completely obstructing the duct, and eventually leading either to gangrene or rupture of the walls, or both.

c. Volvolus, or twisting of the oviduct about its own long axis, completely obliterating the cavity.

d. Stenosis or stricture of the oviduct. This may result from several causes. One frequent one is that in laying a very large egg the oviduct wall becomes torn to greater or less degree, and subsequently heals. The scar tissue contracts the cavity and a stricture is thus caused.

Treatment. Whether treatment is or is not likely to be effective depends upon which of the two main categories above defined any given case belongs to. Simple obstruction of the oviduct may be successfully treated. In cases of complicated obstruction treatment is not indicated, for a variety of reasons. These conditions are in the first place difficult to diagnose, and offer little prospect of successful cure even after a diagnosis has been made.

The best advice which has come to our attention for the treatment of the simple egg bound condition was published some years ago in the English Journal "Poultry" and is here quoted verbatim:

"It is a good plan to watch those birds that are about to lay. Should they visit the nest frequently during the course of the day and leave without depositing an egg, it is almost certain that something is wrong and when a pullet is in such a state there are three good remedies that may be tried. The first is: Take the bird up gently, and hold her so that her stern is over the mouth of a jug of boiling water, that the steam arising therefrom may get to the parts and help to relax and procure delivery of the egg. If this has not the desired effect after an hour's rest in a quiet coop, the vent should be oiled gently with a feather, and the hen given a powder composed of 1 grain of calomel and 1-12 grain of tartar emetic. The powder may be mixed in a bolus of food, and put into the bird's crop. If it be acting properly a marked improvement should be noticeable in the bird a few hours afterwards, while a second powder given two days subsequently will probably complete the cure. It is advisable for a while to feed the fowl sparingly on a somewhat low diet, withholding any fat forming food, and giving lime-water to drink, after the system is rid of the powder. The second remedy was advocated by Dr. H. B. Greene, * * * * * * and is best applied when the egg can be felt. It is:—Let an assistant, seated on a chair, hold the bird firmly on his knees on its back, with the vent directed away from him. Seating yourself opposite, with the finger and thumb of the left hand outside the bird's body, push the egg firmly but carefully towards the vent, until it is plainly visible, and, keeping it in that position, with a bradawl in the right hand puncture the egg shell, evacuate the contents of the egg with an egg-spoon, and afterwards with a pair of tweezers break down and take out the shell piece by piece until assured by passing the finger into the vent, that the cloaca is empty. Special care must be taken to avoid injuring the bird with the point of the awl; and one's assistant must maintain a steady and firm hold on the fowl. A third method of relieving an egg bound hen was recommended by a correspondent in our issue of June 10, 1898, and has since been frequently tried by several poultry keepers, and found very efficacious. 'When a hen is in that state I hold her over some hot water, bathing the vent at the same time. After this I use a small penknife (blunt) in the following manner:—Placing the edge of the blade along the first finger so that the end is level with the finger end, I push the finger with the knife into the vent until they touch the egg; then I begin to scrape until I hear that I have scraped the rind or skin away from the egg (I mean outside the egg). The hen is then placed on the nest, and I will guarantee she will lay in 20 minutes, or in most cases even less than that. I got this advice from a man who has kept poultry on a small scale for 50 years. I have tried it several times, and have never known a hen to be egg bound a second time. This method, it would appear, saves the egg. The great thing throughout is to keep the bird quiet, and in future to avoid extra fat forming food.' "

Prognosis. Good in cases of simple obstruction if taken in hand early; bad in all cases of complicated obstruction.

Rupture of the Oviduct.

In some cases of complicated obstruction, and in cases of severe inflammation the walls of the oviduct may break and allow the contents to escape into the abdominal cavity. In such cases death usually ensues in a relatively short time as a result of peritonitis. These cases are incurable; indeed the trouble is usually not known till after the bird dies. The lower portion of the oviduct (vagina) or the cloaca may be ruptured in passing a very large egg. If the wounds made in this way are relatively small they will usually heal without any trouble. If, on the other hand, such tears are extensive they may very easily become infected, and unless treated properly in accordance with the general directions given in Chapter XX for the treatment of wounds, the bird will die of blood poisoning. Regarding cases of this kind the following excellent discussion (presumably written by Mr. J. H. Robinson) appeared in Farm Poultry some 6 years ago (Vol. 16, p. 230). The writer says that this trouble of rupture of the oviduct near the vent he "used to have with Buff Leghorns, and to a lesser extent with other varieties of the Leghorn. Leghorn hens quite generally lay larger eggs in proportion to their size than others. Some of them lay eggs very much larger in proportion to their size than layers of large eggs in the larger breeds. As a result of this the difficulty of laying is correspondingly increased. When a pullet begins to lay she may lay small eggs, which are easily passed. As warm spring weather comes she lays more eggs, and also larger ones. Suppose one day there is a slight tear or a strain on a part of the oviduct in laying. The part is not badly damaged, but it is sore, a little inflamed, and cannot be stretched as it was before to permit the passage of the egg. But the egg is there and must be extruded. A larger tear in the parts is the result. There may be blood enough flow to make the egg quite bloody, but the injury be not yet serious. With the next egg conditions are still less favorable for a safe extrusion, and perhaps a very bad rupture results, ending in the course of a few days fatally."

"I don't think it profitable to attempt to treat such cases. Some cures may be effected, but it is not always easy to check laying without starving the hen, and even that treatment may not operate quickly enough to avoid a bad rupture. Every egg passed while the vent and adjacent parts of the passage are not in normal condition is a possible cause of fatal trouble."

"The best way to treat this trouble is to prevent it by selecting medium sized eggs for hatching. Select breeders of good size; select good but not excessively large eggs from these; use males from stock of the same characteristics, and avoid the use of males (and of hens too) that are narrow bodied."

Gangrene of Oviduct.

This may result from severe and complicated obstruction. What is meant by "gangrene" is that the walls of the oviduct die, and putrefy. This causes general blood poisoning from which the bird dies. Gangrene of the oviduct most frequently follows severe cases of complicated obstruction where there is a mass of fibrous exudate deposited in the oviduct. There is not the slightest hope of successfully treating such cases.

Breaking of Egg in Oviduct.

It sometimes happens that an egg in the upper portion of the oviduct, before it has acquired any shell, is by accident broken. There is a belief common amongst poultrymen that this is always immediately fatal. There is but little discussion of the subject in the literature but our experience here indicates that two sorts of results may follow the breaking of an egg in the oviduct. These are:

1. An inflammatory condition of the oviduct is induced leading to copious secretion from the glands of the albumen portion of the duct and the isthmus. There is also a copious fibrous exudate, and the final outcome is a severe case of complicated obstruction of the oviduct. Death in these cases may be delayed for a long time after the original accident. In the absence of inflammation recovery may possibly occur.

2. Death within a short time (2 to 3 hours) after the breaking of the egg, without visible lesion of any organ of the body. The oviduct is not even inflamed. Absolutely the only things

which are not normal in such cases are (a) the broken egg in the oviduct, and (b) the fact that the bird is dead. We have had several such cases come to autopsy. They are very puzzling. In them is to be found the basis for the poultryman's belief as to the fatal character of this accident. In reality it seems probable that in these cases the thing which caused the egg to be broken was also the cause of the death of the bird. That is, a blow, or any sort of sudden shock violent enough to break an egg in the oviduct might also very well be the cause of death. Such cases need further study.

Abnormal Eggs.

Owing to various diseased conditions of the oviduct many different kinds of abnormal eggs are produced by fowls. The explanation of the different types of such eggs is usually tolerably clear if one gets definitely in his mind the normal physiology of egg production as outlined above. We shall consider here only some of the more important general classes of such abnormal eggs. Such eggs are very interesting from the scientific standpoint but are of relatively little practical significance to the poultry keeper because of the rarity of their occurrence.

Soft-shelled Eggs. These are eggs laid without a sufficient amount of shell substance covering the shell membrane. The immediate cause lies in a failure of the uterus to function properly. Regarding this class of abnormal eggs Wright has the following to say: "Soft eggs may be caused by lack of shell-material, which, if discovered, points to the remedy, the most rapid being pounded raw oyster-shell. Or they may be caused by the fowls being driven or frightened, in which case they soon cease, and nothing need be done unless the injury has been so severe as to prematurely detach small and unripe yolks, when the case becomes a real *abortion,* or they may be caused by condiments and too much animal food, spices in particular leading frequently to all sorts of trouble with the egg-organs, particularly in the Mediterranean races of poultry. A few small doses of Epsom salts or jalap, and cessation of the extra stimulus, will remedy this. But far the most usual cause is simple over-feeding. A little careful investigation will find which is in fault, and that will indicate the appropriate remedy. Want of shell material is far less common than it used to be; over-feeding or over-stimulation probably more so."

Small, Yolkless Eggs. These little eggs, variously called "wind-eggs," "cock eggs," "witch eggs," "luck eggs," etc., are familiar to every poultry keeper. They contain no definitely formed yolk, and to the casual observer seem to consist of nothing but a small shell filled with white. The laying of one of these eggs is popularly supposed to mark the end of a laying period. This belief is without foundation in fact. They may be produced at any time. Unpublished data collected over a period of years at this Station in regard to such eggs indicate that three factors are fundamentally concerned in their production. These are:—

1. The bird must be in an active laying condition; the more pronounced the degree of physiological activity of the oviduct the more likely are these eggs to be produced.

2. There must be some foreign body, however minute, to serve as the stimulus which shall start the albumen glands secreting. This foreign body may be either a minute piece of hardened albumen, a bit of coagulated blood, a small piece of yolk which has escaped from a ruptured yolk, etc.

3. It seems likely, though this is a point not yet definitely settled, that ovulation (i. e., the separation of a yolk from the ovary) must precede the secretion of albumen around the foreign body to form one of these eggs.

Double and Triple Yolked Eggs. Eggs with two yolks are, of course, quite common. They result from a disturbance of the time relations of ovulation, of such nature that two yolks

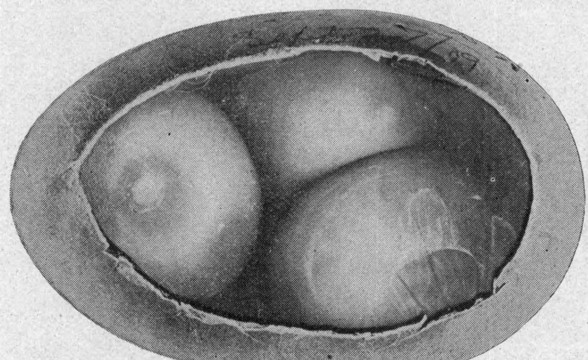


Fig. 42. Triple yolked egg. (Original).

get into the oviduct at nearly the same time and become surrounded by common layers of albumen.

Eggs with three yolks are very rare. An egg of this kind laid by a pullet at this Station is shown in fig. 42.

Inclusion in Eggs. The number of different foreign substances which at one time or another have been found enclosed in eggs is great. The list includes blood streaks or spots, blood clots of firm consistency and often considerable size, lumps of bacteria, worms, fecal matter, etc., etc.

From the practical standpoint the only inclusions which need consideration are blood spots. Many inquiries are annually received at this Station as to what causes these spots and what to do to get eggs which will be free from them. These inquiries are most frequent in the spring months. *The only thing which can be done in such cases is to candle the eggs, and sell only those which show no spots.* Hens which are perfectly normal often lay eggs with blood spots, especially in the spring of the year when laying is heavy. The blood which makes the spot probably comes in most cases from the ovarian follicle. When this ruptures a little blood escapes into the oviduct and is caught up in the albumen. The so-called "liver" or "meat" spots in eggs are in nearly every case thoroughly hardened, well packed together, blood clots. They may be of large size. These inclusions *do not* represent, as they are sometimes said to, portions of the oviduct wall which have been torn off and enclosed in the egg.

Eggs of Abnormal Shape. There are many other kinds of abnormal eggs besides those here discussed, but as they have no practical significance it is not desirable to devote further space to them. In closing this section we append some figures showing in outline some of the curiously shaped eggs which have been found.

Vent Gleet (Cloacitis).

This is a true venereal disease of poultry. It usually begins with a hen but is transmitted in copulation to the male, and by him to other birds in the flock.

Diagnosis. Salmon gives the following clear account of the symptoms: "The first symptom observed is the frequent passage of excrement which is voided in small quantities almost as rapidly as it reaches the cloaca. Often the bird endeavors

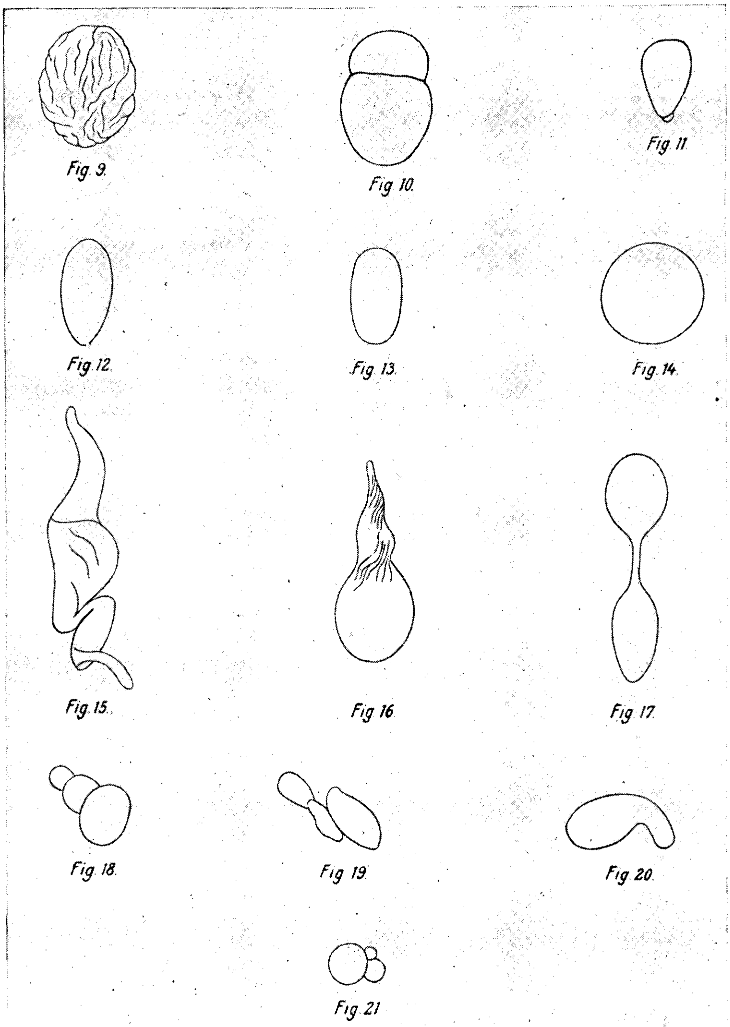


Fig. 43. Showing shapes of abnormal eggs sometimes found. (From von Durski after Landois).

to drop excrement when cloaca is entirely empty. This action is due to the tenderness and irritability of the cloaca which gives to the bird the sensation of fullness, and produces spasmodic contractions. If an examination is made the mucous membrane is found in the early stages to be red, dry, swollen and hot. In a day or two a discharge makes its appearance. It is, at first, thin and watery, but soon becomes white, purulent, and offensive. This discharge collects upon the skin and feathers about the vent, obstructs the passage and irritates the parts with which it comes in contact. The soiled skin becomes red and inflamed, it may be abraded by friction or by the bird picking at it, and thus sores or ulcers are started which may become quite troublesome."

Etiology. The cause of the disease has not yet been thoroughly worked out. Wright suspected it to be identical with human gonorrhea because of the similarity of symptoms, infectiousness, etc. However, he has not been able to isolate the *Gonococcus,* or specific germ of gonorrhea from affected birds.

Treatment. The following is the treatment outlined by Wright: "Any hen found with it should at once be isolated, and the male bird carefully examined, and if necessary also isolated. Give 30 grains Epsom salts, and twice a day inject first a 4 per cent solution of cocaine, and immediately afterwards a solution of nitrate of silver 4 grains to the ounce. The fifth day commence a small copaiba capsule daily, and inject acetate of lead, 1 drachm to the pint. Feed rather low meanwhile, and dust any sore places outside with iodoform or aristol. If not well after 2 or 3 weeks, we would kill the bird, as the disease is not quite free from danger; for if the operator should touch his eyes accidentally before he has cleansed his hands, the result might be a most violent inflammation."

"Break Down."

Sanborn (Farm Poultry Doctor) gives an account of this trouble, which, while brief, is to the point, and says all that really needs to be said about the matter. Especially to be commended is the last sentence.

"This is the 'baggy condition' often seen in old hens that have had too much corn. The rear part of the abdomen is crowded with fat and hangs down, sometimes to the ground, giving a very unhandsome appearance to the bird. The ceasing to feed corn and other fat-producing foods will sometimes remedy this condition, but a bird that has been allowed to get into such a shape is spoiled for life both as a layer and breeder. The hatchet and pot should be the fate of such a bird."

Diseases of the Male Reproductive Organs.

A number of diseases of the male reproductive organs have been described but they are all of no practical significance, for the reason that no poultryman ought ever to use as a breeder a male bird that ever had any disease of these organs, whether it had been "cured" or not.

CHAPTER XIX.

Diseases of Chickens.

White Diarrhea.

Of all the diseases which the poultryman is called upon to fight, there is probably none so destructive, year after year, as the disease (or diseases) known as "white diarrhea." The loss of chicks ascribed to this cause varies in different years and is different places from 10 to 90 per cent. It is perhaps not too much to say that more than 50 per cent of the chicks hatched throughout the country are lost from white diarrhea in its various forms. The number of inquiries concerning this disease which are annually received, and the amount of space devoted to it by the poultry press, lead one to believe that "white diarrhea" is perhaps the worst enemy with which the poultryman must contend.

White diarrhea is more common among artificially hatched and brooded chicks than among those which have been hatched and cared for by hens. However, it is by no means unknown among the latter. Many poultrymen report as heavy mortality from this disease among hen hatched and reared chicks as from those which were incubated and brooded by artificial methods.

Almost any chick that comes out of the shell apparently healthy on the 21st day will live for the first week. If white diarrhea is going to strike the brood they usually begin to show symptoms about the end of the first week or later. The heavy loss of chicks from this disease occurs between the ages of 1 and 3 weeks. Where the brood is badly affected chicks may continue to die until the fourth or fifth week. On the other hand if a brood goes through its first 3 weeks of life without being attacked by this disease it is practically safe from its ravages. White diarrhea then may be said to be limited to the first 3 weeks of the chick's life so far as serious mortality from it is concerned. The reason for this no doubt is that the digestive system of chicks under 3 weeks old is so delicate that even a slight disturbance makes a very serious handicap for the chick.

Etiology. Within recent years a large number of studies concerning the cause, prevention and cure of white diarrhea have been conducted. Investigations have been carried on by state and national institutions as well as by many private individuals. Consequently a large number of alleged causes of the disease are given by different writers. Among these may be mentioned: Debilitated breeding stock, improper incubation, improper brooding, overheating, chilling, poor ventilation, over-crowding, poor or improper food and filth as well as specific bacteria, fungi or other parasitic organisms.

Dr. Geo. B. Morse in the Reliable Poultry Journal for July, 1909, classifies the causes of diarrhea in chicks as follows:

"First among these causes is the class of physical agents. Under this title I would place such agencies as heat or its lack, moisture or its lack, producing what we call in human medicine, the diarrhea of relaxation. Such a condition is produced in the intestinal tract that a large amount of serum is driven through the intestinal wall into the lumen of the intestine, and in doing so the cells are loosened, and thus we have the development of a catarrh. This condition may be brought about by the agencies just mentioned."

"Another class of agencies may be designated foreign bodies, and in this class I place such diarrheas as originate from improper feeding, too early feeding or feeding wrong material. We know, from analogy, that in mammalians whether human or the lower animals, such a condition is possible."

"Then we have another large class of intestinal derangements or catarrhs or inflammatory conditions produced by what we call living agents or parasites. These produce what we may call parasitic inflammations. Now, we must subdivide this class into two, and we may get rid of one substance at once by placing in it those catarrhs or inflammations produced by the larger parasites, macroscopic parasites, such as worms."

"Thus we come to the other sub-class of parasites causing derangements in the intestines, the microscopic parasites or micro-organisms. This sub-class of diarrhoea-producing micro-organisms falls naturally into 3 groups. Having already referred to the animal kingdom in speaking of worms we shall take our first group of parasitic micro-organisms from that same kingdom; these are the protozoa, the lowest animal forms. The other two groups of micro-organismal agents of enteritis are found in the plant kingdom; they are bacteria and molds. Hence, the 3 groups of microscopic agents of intestinal inflammation are protozoa, molds and bacteria."

It is doubtful if many of the cases of true *white diarrhea* are caused by the physical or mechanical agents mentioned in Dr. Morse's first two classes. In most cases true white diarrhea appears to be an infectious disease. Such disease we know is caused by some form of parasitic organism. Without doubt improper incubation, brooding and feeding, resulting in weakened chicks, very often lay the foundation for the attacks of parasitic organisms. In many cases these faulty methods of handling the eggs and chicks appear to be the real cause of the disease while they are really only indirect causes.

From this it should not be understood that such things as poor food, poor brooding and weakened breeding stock are of no importance in the study of white diarrhea. It is just exactly these predisposing factors which result in chicks with weak constitutions, easily overcome by disease germs. Without doubt the points at which most progress can be made in combatting such diseases are in the methods of incubation and in the care of the chicks for the first 3 weeks of their lives. Nevertheless it should not be forgotten that the death of the chick is caused by the ravages of some minute parasitic organism.

Within recent years several investigators have discovered organisms which they believe to be the specific cause of white diarrhea. Three of these may be mentioned at this place: (1) *Coccidium tenellum* or *cuniculi* producing the disease called "coccidiosis." (2) *Bacterium pullorum* producing "bactillary white diarrhea" and (3) *Aspergillus fumigatus* and allied species, producing aspergillosis or brooder pneumonia of chicks. Of these the first two diseases will be considered in some detail in the following paragraphs. Aspergillosis is treated in a separate section of this chapter (cf. p. 193).

Intestinal Coccidiosis.

In Circular 128 of the Bureau of Animal Industry, U. S. Department of Agriculture, Dr. G. B. Morse published a preliminary account of some investigations on the cause of white diarrhea. Microscopic examination of the intestines of chicks dying

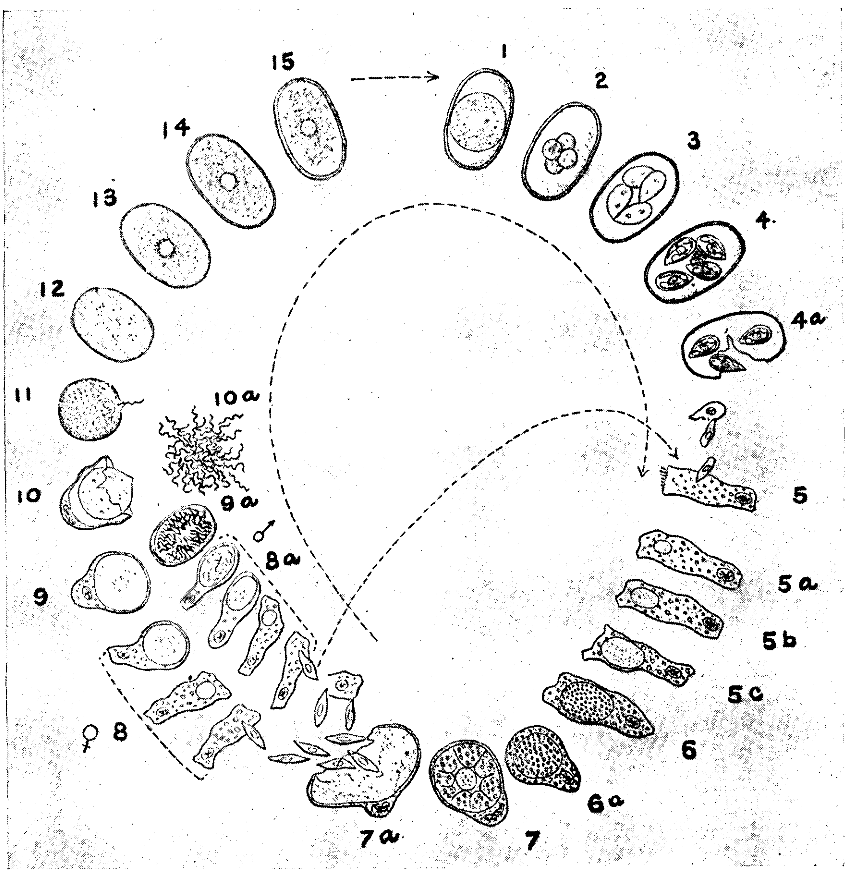


Fig. 44. Diagrammatic representation of the life history of a Coccidium. (After Cole and Hadley).

with this disease revealed the presence of large numbers of protozoan organisms which he identified as *Coccidium tenellum.* At practically the same time Drs. Cole and Hadley of the Rhode Island Experiment Station reported finding a similar organism in white diarrhea chicks. They identified it as *Coccidium cuniculi.* These two species of coccidium are so nearly alike that it is very difficult to distinguish them except by prolonged study of their life cycles. Various species of coccidia have long been known to infest many domestic animals. In all cases that have been studied they produce very serious diseases.

The life history of a coccidium is very complicated yet in order to combat this parasite most successfully it is necessary to know something of its life history. Fig. 44 represents the different stages in the life history of these parasites. If one should examine with a microscope the contents of one of the ceca of a chick which died with this form of white diarrhea he would find forms somewhat like No. 1 in the figure. These are the oöcysts or permanent cysts of the coccidium. The membrane around the outside of this cyst is very tough and will withstand almost all methods of disinfection. It will live and even grow in sulphuric acid. It can be killed, however, by drying. The size of these cysts is about 14-25000 inch and 21-25000 inch. If this cyst is placed under the right conditions for development the first step is for the protoplasm to divide into 4 spherical bodies which are called sporoblasts (fig. 44, 2). Each of these sporoblasts then divide into two sickle-shaped sporozoids (cf. fig. 44, 3 and 4). These sporozoids are then set free in the intestinal tract (4a) and each one penetrates with its pointed end an epithelial cell of the intestine as at No. 5. In the figure 5a, 5b, 5c, 6 and 6a, represent the succeeding stages of growth of the organism within the intestinal cell. As shown in 6a and 7 the parasite grows so large that it completely fills the cell and finally these cells are broken down and torn off the intestinal wall. The stage of the parasite shown at 6a and 7 is known as the schizont. The next step is for the schizont to break up into a larger number of sharp pointed bodies as shown at 7a. These escape and enter other epithelial cells just as the somewhat similar bodies did at 5. At this point the organism may do one of two things. The small sporozoids from 7a may develop exactly like the sporozoids did from 5 to 7. This part of the life cycle, as shown by the shorter arrow from 7a to 5 may be repeated any number of times.

If, however, the conditions are not very good, *i. e.,* the bird is about to die the sporozoids undergo an entirely different development as shown at numbers 7 to 15 (fig. 44). Here the sporozoids enter the epithelial cells and some develop into very large (egg) cells (female element) as shown at 8, 9 and 10. Others go through the development shown in 8a, 9a and 10a, forming a very large number of minute motile zooids or sperms (male element) which unite with one or more of the large egg cells as shown at 11. After this sexual union there is developed the öocyst like No. 1, with which we started. At all stages of this disease many of these cysts are carried to the outside with the feces and upon being picked up serve to infect other chicks. Death is caused by the parasite attacking so many of the intestinal cells that the chick is no longer able to digest its food. There are also secondary effects by which the kidneys are deranged and throw out a large amount of white urates, hence the name "white diarrhea."

Diagnosis. The symptoms of coccidiosis are similar to those of other forms of white diarrhea. (cf. p. 189). The only exception is that according to Morse the ceca are always distended with yellowish-white cheesy matter. In other forms of white diarrhea this may or may not be the case. These different forms of white diarrhea have been too little studied yet to permit of an exact differential diagnosis on external symptoms even supposing that ever to be possible. With the aid of a microscope the finding of coccidial cysts in the fecal matter would indicate that these were causing the disease.

Dr. Hadley has carried out some feeding experiments with these coccidia and has found that he is able to produce the disease in chicks more than two days old. As will be mentioned later (p. 188) it is said that infection with the bacterium of bacillary white diarrhea cannot take place after the chick is 48 hours old. It is possible that further work will show that these facts are of some importance in distinguishing these two forms of the disease.

Bacillary White Diarrhea.

In May, 1908, Dr. L. F. Rettger and Mr. S. C. Harvey published a paper on "Fatal Septicemia in Young Chickens or

'White Diarrhea.'" (Journ. Med. Research). From a large number of observations and experiments they came to the conclusion that white diarrhea was caused by a bacterium. A number of later papers by Dr. Rettger have appeared since then (e. g., Journ. Med. Research, July, 1909; Am. Poult. World, Vol. 1, Nos. 3 and 5; also Rettger and Stoneburn, Storrs Agr. Expt. Sta. Bul. 60). In all of these the fact has been clearly brought out that at least one form of white diarrhea is caused by a bacterium.

Dr. Rettger took chicks which had died with all the symptoms of white diarrhea and by the ordinary bacteriological methods obtained pure cultures of a bacterium which had certain definite reactions and habits of growth. By these methods this bacterium can be distinguished from other kinds. To this species of bacteria he gives the name *Bacterium pullorum.* Now if entirely healthy chicks were inoculated with the pure culture of this bacterium they almost invariably showed symptoms of white diarrhea and in many cases died. To cite only one case; at the Storrs Experiment Station (Bull. 60) 210 White Leghorn chicks were hatched from healthy stock. These were divided into several lots, some of which were infected by feeding bouillon cultures of *Bacterium pullorum.* Other lots were used as controls. The results were as follows: "During the first two weeks the comparative mortality was as follows:

Control lots (84 chicks) 5 deaths or 6 per cent.

Infected lots (126 chicks) 22 deaths or 18 per cent.

At this time the chicks in the control lots averaged 15 per cent more in weight than those in the infected lots and appear in every way greatly superior to them."

In many cases Dr. Rettger was able to find *Bacterium pullorum* pure in the artificially infected birds. Further he was able to obtain the same bacterium from a large number of different chicks gathered from widely different localities. Dr. Rettger says (Am. Poult. World, January, 1910): "From the blood of the liver, heart and lungs I have repeatedly found the organism—*Bacterium pullorum.* More recently I have been able to obtain the organism without difficulty, from the unabsorbed yolk and in some instances from the crop of the affected chicks. In some chicks that were quite young at the time of death (2 or 3 days) the same bacterium may be found in the intestines. In older birds it is obscured by the common and rapidly growing intestinal organisms, particularly the colon bacillus."

Dr. Rettger has also been able to find this same organism "in (a) the ova in the ovaries of the hens, (b) the yolk of fresh laid eggs, (c) eggs incubated for varying lengths of time and (d) yolk sacs of fully developed chicks still within the shell." This, together with the evidence that the organism does produce white diarrhea, shows pretty conclusively that one source of infection is the hen. The feeding experiments with pure cultures of the bacillus apparently show that the infection must begin within the first 48 hours after the chicks are hatched. Several investigators have shown that it is impossible to infect chicks by feeding after they are two days old. It may be said that Dr. Rettger has proven that at least one form of white diarrhea is caused by a bacterium. The relation of this form of the disease to that caused by other organisms is still a subject for investigation.

Diagnosis. The external symptoms of bacillary white diarrhea are much the same as those given for the disease in general (cf. p. 189). The following post-mortem appearances are reported by Rettger and Stoneburn:—

"Crops—Empty or partially filled with slimy fluid or with food."

"Lungs—Apparently normal. (Tubercles not observed)."

"Liver—Pale, with streaks and patches of red. These apparently slightly congested areas are usually large in size."

"Kidney and Spleen—Apparently normal."

"Intestines—Pale, and for the greater part empty. A small amount of dark grayish or brownish matter frequently present."

"Ceca—With few exceptions but partially filled with a grayish soft material. Only occasionally cheesy or firm contents."

"Unabsorbed Yolk—Usually present varying in size from a pea to a full-sized yolk. The color may vary from yellow to brownish green or nearly black. In consistency there is also much variation. It may appear perfectly normal, distinctly gelatinous, or watery. Frequently it is observed in the character of custard and again more or less dry and firm. Unless the chick has been dead for some time the yolk is usually not found putrid, but merely stale."

"The chick as a whole appears more or less anaemic and emaciated. The muscles of the wings, breast and legs may be almost completely wasted away."

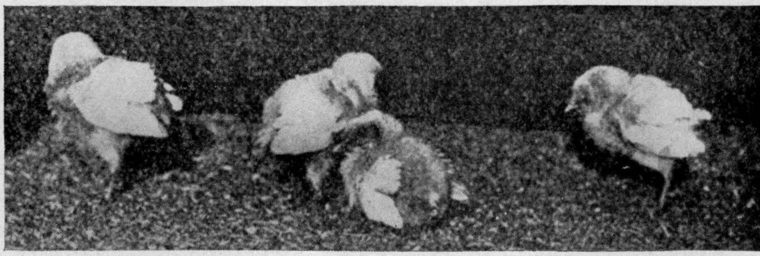


Fig. 45. Ten day White Leghorn chicks showing symptoms of bacillary white diarrhea. (After Rettger and Stoneburn).

The chief difference between this and coccidiosis appears to be in the contents of the ceca (cf. p. 186).

Diagnosis of White Diarrhea in General. The symptoms of white diarrhea are in general the same for the different forms of the disease. They may be briefly stated as follows: The affected chicks appear stupid and remain under the hover or hen much of the time. They isolate themselves from the rest of the flock and appear indifferent to what goes on about them. Their feathers become rough and the wings droop (cf. fig. 45). There is progressive loss of weight. The birds eat little or

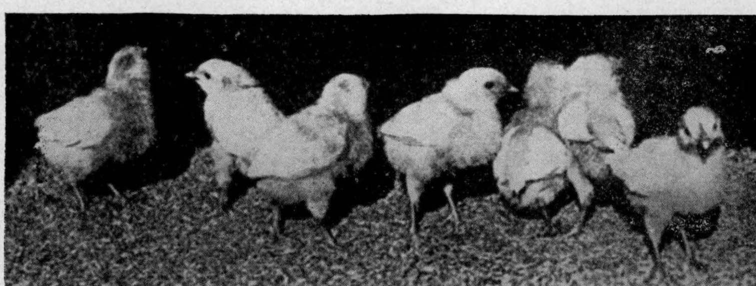


Fig. 46. Normal ten day White Leghorn chicks. (After Rettger and Stoneburn).

nothing and appear unable to pick up their food. Their actions in this direction are chiefly mechanical. The characteristic whitish discharge from the vent very soon makes its appearance. The discharged matter may be creamy or sometimes mixed with brown. The discharged matter is more or less sticky or glairy. In many cases it clings to the down in sufficient quantity to plug up the vent. This condition is known as "pasting up behind."

Many of the chicks chirp or peep constantly or will utter a shrill cry apparently of pain, when attempting to void the excreta. These sounds are often characteristic of the disease.

In many cases the chicks present the appearance of being "short backed" or "big bellied." Dr. Woods describes this as follows:

"The weakling is almost always big-bellied, the abdomen protruding to the rear so that it bunches out behind, well out of line with the vent, with the result that the chick looks as if the tail piece and backbone has been pushed forward and in just above the vent." (Cf. fig. 45).

In some cases the chicks die with but little warning and show few of the above symptoms. In other cases the sick chick will last a long time showing all the symptoms mentioned.

Post-mortem examination often reveals but few lesions. One of the most striking things is the loss of flesh if the disease has lasted for some time. The alimentary canal is usually nearly empty except for some slimy fluid. The organs are all very pale. The liver may have a few streaks showing congested areas. Some of the unabsorbed yolk may or may not be present. There is considerable variation in its appearance. It is not usually putrid unless the chick has been dead for some time.

The ceca are often filled with firm, cheesy or soft grayish material depending apparently to some extent upon the form of the disease (cf. pp. 186 and 188).

Treatment. The treatment of white diarrhea depends somewhat on the cause. If it is due to improper feeding or brooding of course the only treatment consists in removing the cause. This will prevent the trouble in the later flocks and will help those already affected. A small dose of a good purgative such as Epsom salts will probably help in bringing the chicks into better condition. Dr. P. T. Woods recommends giving the chicks scalded sweet milk with a little grated nutmeg 4 times a day. He also recommends boiled rice as food. They should have plenty of charcoal before them and in their mash. They should also have green food every day. If green food is not available raw vegetables may be substituted. Some good antiseptic should be used in the drinking water. Potassium permanganate as recommended on p. 16 may be used. Dr. Morse recommends also bichloride of mercury, using 10 of the 1-1000 grain tablets to one quart of water. Also 10 grains of iron sulphate to the gallon of water is said by some to be good. It is the opinion of the writers that neither of the latter two is as desirable for use as an antiseptic for the water as permanganate.

These recommendations apply to any case of white diarrhea whatever its cause. In the forms of white diarrhea caused by parasitic organisms specific modes of treatment or of prevention may be recommended. In the case of coccidiosis Dr. Morse says that the eggs should be dipped in 95 per cent alcohol or a 4 per cent solution of a good coal tar disinfectant before they are placed in the incubator. The incubators and brooders should all be thoroughly disinfected every time they are used. The treatment of sick chicks should be as recommended above.

In the case of bacillary white diarrhea the same recommendations for disinfection of incubators, brooders and the premises should be followed. Dr. Rettger says that it is only during the first 48 hours that the chick can be infected. Consequently the very greatest care should be taken during those first two critical days. However, the fact that the bacterium has been found in the yolk of the unhatched—even of the unlaid egg—indicates very clearly that something more than disinfection is necessary to stamp out the disease. Very great care should be exercised in picking out breeding stock. It is very likely that the hens which lay the eggs infected with the bacteria were chicks which recovered from white diarrhea. The bacteria still continue to live over in their bodies. Every effort should be made to locate and remove the source of infection. If there is widespread infection on the farm, eggs for hatching should be obtained from other places where there is little or no white diarrhea.

On methods of preventing and eliminating bacillary white diarrhea Rettger and Stoneburn give the following.

"If the disease makes its appearance among the flocks of chicks every effort should be made to ascertain the source of the infection. This may be (a) breeding stock upon the place, (b) eggs for hatching secured from other breeders, or (c) newly hatched chicks purchased from others."

"If the breeding stock proves infected there are two courses of procedure open; (a) market the entire flock or refrain from using their eggs for hatching, or (b) install trap nests in the breeding pens and by means of accurate pedigree records ascertain which individual hens are producing infected chicks, and remove such hens from the breeding flock."

"Since infection may be brought upon the place through purchased eggs or stock, such purchases should be made from farms where bacillary white diarrhea is not common."

"If bacillary white diarrhea is known to be present on the place steps should be taken to prevent the spread of the infection, and, if possible, to effect a cure. (As to the latter we do not feel justified in offering any suggestions at this time)."

"*Prevention.* Since the disease cannot, apparently, be transmitted through the food supply after the chicks have reached the age of 3 or 4 days, every means should be pursued to prevent the spread of the infection during this critical period. We suggest:

The segregation of the chicks in small lots during this interval.

Perfect disinfection and cleanliness of brooders and brooder coops.

Food and water supplied in such a manner as to prevent contamination by the droppings."

"The use in the brooder of a liberal amount of fine, absorptive litter which will quickly cover and seal up the droppings."*

"Raise and maintain the vigor and vitality of the breeding stock and chicks by every reasonable means known to the poultryman."

Leg Weakness.

The term "leg weakness" is sometimes used by poultrymen to indicate the lameness due to rheumatism in adult birds. Regarding this form of the disease see p. 123. The more usual use of the term "leg weakness" is to denote a disease or ailment which is found in growing chicks, from 1 month to 6 months of age. It is said to be more common among cockerels than pullets and is more frequent in the heavier than the lighter breeds. The chief cause of the trouble seems to be that in birds growing rapidly and fed heavily the weight sometimes increases faster

*For this purpose we have used alfalfa meal with much satisfaction.

than the strength. This results in a weak kneed, wobbling bird. The disease is sometimes ascribed to other causes such as over-crowding,. close, unventilated quarters, overheating, etc. Salmon says "It may develop in young chickens kept in brooders in which the heat is not properly distributed or where there is too much bottom heat, also in those which are kept constantly upon wooden floors." Regarding these cases Robinson says "Where such conditions are present the leg weakness is more likely to be an accompaniment of diseases which plainly show other symptoms."

Diagnosis. The symptoms are indicated in the name of the disease. It first appears as an unsteadiness in the walk. This may gradually become worse until the bird is unable to stand alone and is constantly tumbling over. The birds are found sitting while eating and are inclined to walk very little. When the trouble first appears there is little else wrong with the bird. The eye and comb are bright and healthy, the appetite is good. Later, however, the bird being weaker than the others gets less grain and becomes thin, feathers out poorly and is a distressed object. It is said that rheumatism can be distinguished from leg weakness by the swelling of the joints in the former disease.

Treatment. This consists chiefly, of course, in removing the cause. Since the most common cause is the overfeeding with fat producing foods, the amount of these should be reduced. The weak birds should be removed to a pen by themselves. Substitute bran, wheat and oatmeal for the corn and corn meal. Give skim milk, if possible, instead of water. *Feed plenty of green food.* This is one of the most important measures. Sanborn recommends rubbing the legs with tincture of arnica and adding ½ teaspoonful of tincture of nux vomica to each quart of drinking water.

Aspergillosis or Pneumomycosis.

This disease, which is discussed on p. 1, not only occurs in hens but it is also a very common and fatal disease in young chicks. It often occurs with white diarrhea and the double disease was for a long time considered as one. Poultrymen designated the cases in which the lesions occurred in the lungs as "lungers." Investigation has shown that there are two diseases which may occur separately or together.

Diagnosis. This disease is characterized by a dumpish sleepy condition of the chick. The wings are pendulent. Breathing is rapid and sometimes accompanied by snoring sounds. A whitish diarrhea is present. A differential diagnosis between this and the coccidial white diarrhea is only possible by an examination of the dead birds. In aspergillosis, yellowish tubercles which closely resemble those of tuberculosis occur in the lungs and in the walls of the air sacs and often also in the intestines, mesentery, liver and other organs. In very acute cases the lungs are simply inflamed, death occurring before the formation of the tubercles. The mycelium and spores of the fungus may be found by microscopic examination of the tubercles and this fungus may be obtained by inoculating cultures from these tubercles.

Etiology. The disease is caused by the spores of an *Aspergillus* usually *A. fumigatus,* fig. 22. This is a very common fungus and the spores are widely distributed in nature. The spores are often found on the food or on the litter and are inhaled or taken in with the food. Incubator chickens are often infected from the incubators and brooders and hen hatched chickens from the straw or chaff in the nests. Sometimes the chicks get the disease from chick food not properly cared for. It is possible that this disease as well as the coccidial and bacillary white diarrhea is sometimes carried in the egg. The spores and mycelium are often found in the digestive tract of hens and it is not unlikely that they may work up the oviduct from the cloaca and infect an egg before it gets its shell.

Treatment. The treatment of diseased chicks is useless. When they are infected the spores develop on the membranes and new spores are formed which spread the infection throughout the respiratory system and also to the other organs. The only effective treatment is prevention. Keeping the flock under good hygienic conditions with clean food, litter and nesting material reduces the chance of infection and keeps the chicks in a vigorous condition in which they are able to resist the disease. The dead chicks should be burned or buried.

Prognosis. The disease is fatal so far as known.

Emphysema.

This name is applied by Robinson to a disease of young chicks in which the skin puffs out in the sides of the neck near its juncture with the body. The size of the puff varies somewhat. In mild cases it is about the size of a hickory nut. Sometimes there is one puff, sometimes several. A few cases have been reported "where the puffing covers nearly the whole body, the skin of the chick being so inflated that locomotion becomes difficult." (Robinson).

According to Vale the trouble generally occurs in growing chicks which have been confined in close quarters. It is often associated with some lung trouble. It seems to be due to obstruction of the air passages and the rupture of some of the air sacs. The air thus escapes into the tissues beneath the skin. While not common this disease does occur in Maine. Some cases were reported to the Station while this work was in preparation.

The treatment suggested by Vale is to puncture the skin with a needle and to give 2 grains nitrate of iron to each wine glassful of drinking water. Robinson, however, says: "It is rather to be recommended that no effort be made to treat such chicks. Even if cured of the trouble, they rarely develop satisfactorily."

Gapes.

Gapes is a disease which attacks domestic poultry and many species of wild birds. In fowls it is more frequently observed in young chicks. It occurs also in adult fowls but rarely causes enough inconvenience to attract attention. The disease is due to the presence of minute parasitic worms in the air passages.

Diagnosis. "The symptoms of gapes are frequent gaping, sneezing, a whistling cough with discharge of mucus and worms, dumpishness, weakness and drooping wings. When badly affected, the bird shakes its head frequently, gapes and coughs as if suffocating, droops and is not able to keep up with the rest of the flock, and stands in "dumpish" position with eyes closed, wings drooped, mouth open and tongue protruding." (Woods, Rel. Poult. Rem.)

The correctness of a diagnosis for gapes should be tested by determining whether or not the worms are present in the trachea. When chicks are dying from a disease supposed to be gapes the trachea of a dead bird may be examined. If the trouble is gapes the worms will be found attached in pairs to the mucous membrane of the trachea.

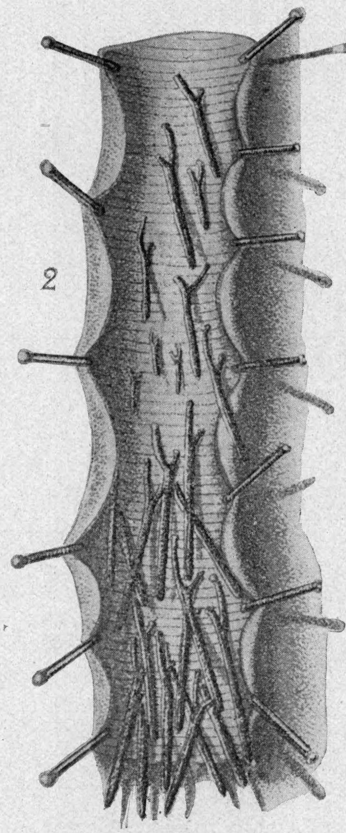


Fig. 47. Trachea (windpipe) of a pheasant showing gape worms *(Syngamus trachealis)* attached to the mucous membrane. (After Megnin).

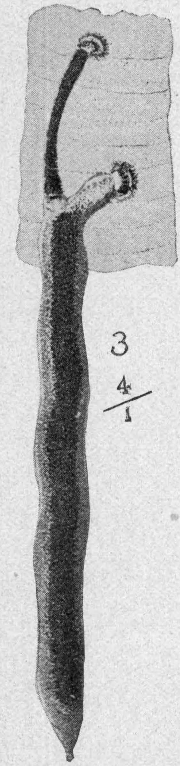


Fig. 48. A pair of *Syngamus trachealis,* attached. (After Megnin).

The two sexes are joined together in such a way that a pair looks like a double headed worm. The female is about ½ inch long and the male about 1-5 inch. The worms are pale in color when empty but when they have been feeding they are red with the blood of the chick. The presence of the worms in the trachea of a living chick may be demonstrated by passing a gape worm extractor (a loop of horse hair or fine wire or a feather with the vane removed except at the tip) carefully down the trachea for some distance turning it around to loosen the worms and drawing it out. If the worms are present some will be removed with the extractor.

Fig. 49. A pair of *Syngamus trachealis.* A, male. B, female. (After Megnin).

The presence of the worms causes an irritation and inflammation of the membrane and stimulates the secretion of mucus. Some of the accumulation of worms and mucus is expelled by coughing. Sometimes part of it is swallowed and expelled with the feces. The loosened material may be drawn into the deeper air passages during inspiration. Death may occur from suffocation due to the obstruction of the air passages with worms and mucus, or weak individuals may die from loss of blood.

Etiology. The only cause of the disease is the nematode or thread worm *Syngamus trachealis* Siebold, called the gape worm, red worm, or forked worm. (See figs. 47 to 49). These parasites obtain their nourishment by sucking the blood from the mucous membrane of the trachea. They are attached in pairs to the membrane by their sucker-like mouths. Beside bringing about a considerable loss of blood the worms cause irritation and inflammation of the membrane and a copious secretion of mucus. The two sexes are so closely attached to each other that they can not be separated without tearing. The body of an adult female is swollen with thousands of eggs and occasionally contains some embryos. The eggs are not laid but escape when the body of the female is ruptured. This may take place with the decomposition of the worm or the body may be torn by the coughing of the bird. The eggs may develop and grow to adult worms within the trachea of the same bird. The worms, eggs and embryos are often coughed up. Sometimes they are swallowed and then some of the eggs and embryos may be passed with the feces. The worms coughed up are eagerly eaten by the same or other birds and the ova and embryos are often taken with contaminated food and drink. Developing embryos have been found in earth worms living in infected poultry yards, and these will cause gapes if fed to chicks.

The eggs and embryos need only warmth and moisture to develop. Eggs may develop in the digestive organs. It is not known how the embryos reach the trachea from the digestive organs. A large number of those eaten never reach the trachea but are either digested or voided with the feces. Salmon says: "Although there are some thousands of eggs in the adult worms, 10 to 15 worms have been fed to a single chicken, and, as a result, not over 4 or 5 embryos would reach and develop in the trachea." According to Theobald, Ehler found copulated worms where several of the females were full of worms 10 days after feeding ova to healthy chicks. Wet clay soils are especially favorable to the gape worms, and they thrive best in warm, wet weather.

Treatment. In eradicating the disease it is important to isolate all affected birds so that the worms and ova coughed up or voided with the excrement may not be eaten by the other chicks or contaminate the food, drink, and the ground of the runs. Burn the bodies or at least the heads and necks of all dead birds. The feed troughs and water dishes should be scalded and the houses, and coops disinfected. Use potassium permanganate in the drinking water. If possible provide fresh runs on which there has been no poultry for several years. The following paragraph from Robinson is much to the point:

"Preventive treatment to be fully effective, seems to require that fowls be kept away from infected ground for several seasons. It is said that ground from which poultry is kept for three years, the land meanwhile being sown to grass or cultivated, will be entirely free from the gape worm. To a poultry keeper whose area of land is small this means moving or keeping no poultry for several years. Where land is abundant gape worms can often be avoided by moving the poultry to a plot not recently occupied by them. Treatment to disinfect the soil by destroying the gape worms in it, the object being to continue the poultry on it, is not often profitable."

The following methods have been recommended for disinfecting the ground. It is doubtful if these are economically advisable.

Treating the ground with air slaked lime and spading.

Sprinkling with one of the following solutions:

1 per cent or 2 per cent sulphuric acid.

2 ounces of copperas dissolved in a pail of water.

½ ounce of crystals of potassium permanganate to a barrel of water.

The lime or acid treatments are most often recommended. The infected birds should be kept in houses easily cleaned and disinfected and this should be done frequently to prevent reinfection of the recovering birds. Theobald advises an addition of 3 drams of salicylate of soda to each quart of drinking water to destroy eggs and embryos that may contaminate it.

The individual surgical method may be profitably practiced in some cases. It seems to be the only sure method yet advised of ridding an infested bird of the parasites. Wright gives the following description of the method:

"The old-fashioned cure was to strip a small quill-feather, all but a small tuft at the point, and (moistening it in turpentine or not) introduce it into the trachea, turn it round, and withdraw it with the worms. This is effectual, but requires care to prevent lacerating the wind-pipe or causing suffocation. In this way 30 worms have been successfully extracted from one chicken. A very much better method is to take two *straight* hairs from a horse's tail, laid together, tie a knot on the end of the pair, and cut off the ends close to the knot. This is passed straight (i. e., without twisting) down the windpipe as far as it will go without bending, then twisted between the finger and thumb and drawn out. A trial or two may miss, but usually 5 or 6 attempts will bring up 4 or 5 worms, and the hairs inserted in this way, without twisting, do not seem to hurt the chicks, and are used with the greatest facility. The bringing up of even from 4 to 10 worms, and the failure of more to come after a blank trial or two, may usually be reckoned as a cure."

Wire gape worm extractors may be bought from dealers in poultry supplies, or one can make one for himself by taking No. 30 wire, forming a loop at one end just big enough to go easily down the trachea, and then twisting together the ends of the wire to form a long handle. Worms removed should be burned.

Prognosis. This disease is often fatal in young chicks from one to four weeks old, especially in small weak birds. Young chicks and in most adult fowls it often causes little inconvenience. These fowls, however, are constant sources of infection. The removal of the worms from the trachea if skilfully done so that the delicate membrane is not injured usually effects a cure but this individual treatment requires considerable time and the value of the chicks must determine whether or not it is economically profitable.

CHAPTER XX.

Poultry Surgery.

It is proposed to consider in this section those pathological conditions of poultry which demand surgical treatment for their cure. At the outstart it should be said that poultry bear and recover from surgical operations very well. The common practice of caponizing, usually done without any aseptic precaution whatever and with small losses from infection, is sufficient evidence of this. Probably no mammal would bear opening the abdominal cavity (which is done is every caponizing operation) with such entire and nearly uniform freedom from ill effects as attends this operation with poultry. The reason why poultry make such excellent surgical subjects lies in their marked resistance to all pyogenic (pus producing) germs.

The Treatment of Cuts, Tears and All Open Wounds.

Very severe wounds may be successfully treated by adhering to the following procedure:

1. Thoroughly wash the hands in warm water, using plenty of soap, before handling the wounds at all. After the hands have been well scrubbed, rinse them thoroughly in a pan of 1 to 1000 bichloride of mercury solution (p. 29) and dry with a *clean* towel.

2. Pull out the feathers in the region around the wound, and thoroughly cleanse it, using first *warm water,* and follow this with *warm 1 to 1000 bichloride solution.* A piece of clean soft cloth may be used for this purpose, or absorbent cotton. Make sure that the wound is *thoroughly* clean. Do not be afraid of hurting the bird. A little pain at the start is preferable to a dead bird later.

3. If necessary sew up the wound, using a good sized sewing needle and silk. Both needle and silk should be soaked in alcohol for 15 minutes before using. Small wounds need not be sewed. Large ones will heal much quicker and more certainly if they are sewed. If the wound involves the muscles as well

as the skin sew it up in two layers; one set of stitches including only the muscles, the other set only the skin.

4. Paint the skin in the region about the wound, *but not the wound itself* with dilute tincture of iodine.

5. Powder the wound well with iodoform.

6. Smear a thick layer of the ointment already recommended (p. 30) over all.

7. If the wound is very severe bandage it with a clean cloth.

The above treatment is only necessary in its entirety in very severe cases. Depending upon the gravity of the condition the following items in the treatment may be omitted in the order named:

7 may be omitted except in most serious cases.

7 and 3 may be omitted in less severe cases.

7, 3 and 4 may be omitted in still less severe cases.

7, 3, 4, and 1 may be omitted in still less severe cases.

In case of slight wounds which appear still to demand some treatment 6 and 2 or even 6 alone will suffice.

Abscess.

Should an abscess appear lance it with a clean sharp knife, making sure to cut to the bottom. Squeeze out the pus and core if there is one, and then proceed to heal it by following the treatment above outlined for wounds in general.

Bumblefoot.

This is an abscess of the foot which may result from a variety of causes, e. g., too high roosts, too narrow roosts, undiscovered wounds caused by stepping on nails, splinters of glass, etc. It is usually not discovered until the bird becomes lame.

The best treatment to follow is first to tie a cord *tightly* about the leg above the foot to control the flow of blood; then with a *clean*, narrow bladed, *sharp* knife open up the abscess *thoroughly*. Go clear to the bottom and dig out the core. Then follow *in detail, omitting nothing except 3,* the treatment given above for wounds. Two days after the first treatment take off the bandages and repeat the treatment, going through in order steps, 1, 2, 4, 5, 6 and 7. In some cases a third treatment after a lapse of 2 or 3 days may be necessary, but usually not if the first treatment is thorough.

Of course the bird under treatment should be isolated and kept in a small pen with soft litter on the floor.

Broken Bones.

If a bird is sufficiently valuable to warrant the trouble it is possible to set fractures of the long bones of legs and wings, and get successful union. A splint should be made for the affected part and carefully and thoroughly bound into place. Healing is rapid, and it should be possible to remove the splints in three weeks from the time they are put on if not before. In our experience firm union has occurred in less time than this.

Frozen Combs and Wattles.

In northern parts of the country frozen wattles and combs, especially in male birds, are very common occurrences. The trouble is more apt to be with the wattles than the comb, because the former dip into the drinking water and then freeze at times when if dry, they would not do so.

The following brief but adequate directions for treating frozen combs and wattles are taken from Farm Poultry, Vol. 15, p. 41: "First thaw the wattles or combs out by manipulating with the fingers well smeared with vaseline. Keep the bird in a cool (not cold) place, and anoint the frozen parts with a mixture of vaseline, 5 tablespoonfuls; glycerine, 2 tablespoonfuls; turpentine, one tablespoonful, once or twice a day. If he is not very badly frosted it probably will make no difference with his breeding a few months from now—provided he is not again injured the same way."

Anesthetizing Poultry.

From time to time requests come to the Station for information regarding the most satisfactory method of anaesthetizing birds. On this account it seems desirable to republish the following material extracted from a paper written some time ago by R. Pearl and Frank M. Surface on this subject (Jour. Amer. Med. Asso., Vol. 52, pp. 382 and 383).

"The difficulty which we have found to be inherent in anesthetizing the domestic fowl may be stated briefly in this way: If any anesthetic is pushed to the point at which the bird is in satisfactory condition for operative procedure in about 9 cases out of 10 the bird will die on the table from the effects of the anesthesia before the operation, if extensive, can be completed. If, on the other hand, the anesthetic is given less freely the bird does not lose its reflex excitability. Every time a cut is made or a nerve is pinched with the forceps the bird will struggle. Our experience in anesthetizing birds, which has now covered a large number of individuals, leads us to believe that the only middle ground between these two extremes is afforded by those cases (unfortunately too few) in which the individual idiosyncrasy of the bird toward ether makes it take the anesthetic well.

While we have made no detailed physiologic study as to the fundamental reasons underlying this difficulty respecting anesthesia which has been described, it seems reasonably apparent what these reasons are. Connected with the respiratory organs proper of a bird are the relatively enormous air sacs. During anesthesia the ether or chloroform vapor gets into these air sacs either by diffusion or directly as a result of respiratory movements. There is reason to believe that the vapor, once in the air sacs, stays there until it is absorbed by the tissues; in other words, it appears to be the case that the great bulk of an inhaled anesthetic in the case of birds must be eliminated from the body by way of the urinary organs rather than the respiratory organs. Assuming this to be the case there is no difficulty in seeing why forcing an anesthetic in a bird leads to disastrous results. The relatively enormous area for absorption afforded by the air sacs insures that a correspondingly large amount of the anesthetic will be taken up very quickly. This almost immediately affects the vagus center, with the consequent cardiac inhibition, respiratory failure and death.

The exact method of procedure which we now follow in anesthetizing birds is as follows: Immediately before beginning the administration of the anesthetic a 1-200 grain atropin sulphate tablet is dissolved in 1 c. c. of warm normal saline solution. The salt solution with the dissolved atropin is then injected subcutaneously in the axilla. Ether is used as the anesthetic. It is administered from a small improvised mask which admits of the condition of the comb being seen during the operation. Depending on how hard the ether is pushed, the bird is ready for operation in from 15 to 20 minutes after the anesthesia is begun. The dosage of 1-200 grain atropin to a bird may seem large, but we have never been able to see the slightest bad effect from it, provided the administration of ether was begun immediately after the injection of the atropin."

Glossary of Technical Terms.

Abdomen.—That portion of the body which contains the internal organs. Belly.

Air sac.—One of the membranous sacs filled with air in different parts of the body, especially in the abdominal region. They often extend into the cavities of the bones and connect with the lungs.

Albumen portion of oviduct.—See p. 157.

Anaemia.—A condition in which the blood is deficient either in quality or quantity. It is marked by paleness and loss of energy.

Anus.—The external opening of the intestine. Vent.

Apathetic.—Lacking in feeling or ambition. Indifferent.

Arachnida.—A class of invertebrate animals including among other groups the spiders, scorpions and mites.

Articular.—Pertaining to the joints.

Astringent.—Causing contraction and arresting discharges.

Atony.—Lack of normal tone or strength.

Atrophy.—A wasting of diminution of the size of a part.

Auditory meatus.—The opening into the ear.

Avian.—Pertaining to birds.

Axilla.—The region under the wing where the latter joins the body.

Bile.—The substance secreted by the liver. Gall.

Bronchi.—The tubes which lead from the end of the windpipe (trachea) to the two lungs. (cf. fig. 12).

Carcinoma.—A malignant tumor or cancer.

Catheter.—A tubular surgical instrument for discharging fluids from a cavity of the body or for distending a passage.

Cecum (*plural ceca*).—A blind intestinal pouch of which there are two in the fowl.

Cell.—The smallest element of an organized body that manifests independent vital activities. A morphological or structural unit of an organism.

Chronic.—Long continued but not acute.

Cleavage.—The division of the cells of an embryo.

Cloaca.—The enlarged portion of the alimentary canal just before the vent. The intestine, the ureters (tubes from the kidneys) and the oviduct open into the cloaca.

Conjunctiva.—The delicate membrane that lines the eyelids and covers the eyeball in front.

Contagious. A disease which is communicable by direct contact.
Copulation.—Sexual intercourse. With fowls "treading."
Cornea.—The hard transparent structure forming the anterior part of the eyeball.
Creolin.—A thick black liquid coal tar preparation. It has antiseptic properties.
Cresol.—A coal tar product with antiseptic and germicidal properties.
Cyst.—A sac-like growth which usually contains a liquid or a semi-solid.
Demulcent.—A soothing mucilaginous or oily medicine.
Dermoid cyst.—A form of congenital cyst often containing skin-like structures.
Diuretic.—A medicine that increases the activity of the kidneys.
Ecchymoses (ek-kim-o-ses).—Discoloration of the skin caused by blood outside of the blood vessels as in a bruise.
Emaciated.—Very lean or wasted condition of the body.
Enema. A liquid injection in the rectum or cloaca.
Enteritis.—Inflammation of the intestine. In human medicine confined chiefly to the small intestine.
Epidemic.—A disease that is widely prevalent in a community or locality.
Epidermis.—The outer or non-vascular layer of the skin. The cuticle.
Epithelioma.—A cancer or malignant tumor consisting chiefly of cells derived from the skin or mucous membrane.
Epithelium.—The covering or outer layer of the skin and mucous membranes.
Ergot.—A fungus which affects and finally replaces the seed of a cereal grass. Used chiefly in connection with the ergot of rye which is poisonous to poultry. Ergot as a drug has the property of causing the mammalian uterus to contract.
Etiology.—The causation of any disease.
Exudate.—A substance thrown out of the body or deposited in a tissue by a vital process.
Feces.—The excrement or undigested residue of the food discharged from the intestines. Dung. Droppings.
Flagellate micro-organism.—Any minute microscopic organism which swims through the water by means of the lashing of one or more hair-like structures (flagella).
Follicle.—See p. 157.
Gall bladder.—The reservoir for the bile or gall secreted by the liver. It is readily seen on the upper side of the liver.
Gallus domesticus.—The scientific name for the domestic fowl.
Gangrene.—See p. 174. Gangrene of oviduct.
Gastritis.—Inflammation of the stomach.
Hermaphrodite.—An organism which has both male and female reproductive organs.
Hemorrhage.—Bleeding. A copious escape of blood from the vessels.
Hepatic.—Pertaining to the liver.
Hyperaemia. Excess of blood in any part of the body.

Hypertrophy.—The morbid enlargement or overgrowth of an organ or part.

Immunity.—Security against any particular disease.

Infection.—The transmission of disease from one animal to another usually through some intermediate agent.

Infiltration.—The accumulation in a tissue of substances not normally found in it.

Inoculation.—The insertion of a virus into a wound or abrasion in the skin in order to communicate a disease.

Isthmus.—See p. 158.

Keratitis.—Inflamation of the cornea of the eye.

Larva.—The first stage in development after leaving the egg. Used in connection with insects, worms, etc.

Larynx.—A muscular and cartilaginous structure situated at the base of the tongue and connecting with the windpipe (trachea). It is the organ of voice.

Lesion.—Any hurt, wound or local degeneration.

Leucocytes.—White blood corpuscles.

Lymphatic. Pertaining to or containing lymph which is a transparent slightly yellow liquid which fills the lymphatic vessels. It corresponds in some respects to the serum or liquid portion of the blood.

Mammal.—Any vertebrate animal which suckles its young.

Melanosis.—Pertaining to an abnormal deposit of pigment.

Mesentery.—The fold of peritoneum attached to the intestines.

Metamorphosis.—In insects the change from larval to adult form as from caterpillar to butterfly.

Micro-organism.—Any minute (microscopic) animal or plant. Often used in referring to bacteria or germs.

Mite.—A small arthropod somewhat related to spiders. (Cf. fig. 31).

Mucosa.—The mucous membrane.

Mucous membrane.—The lining of the internal cavities of the body.

Mucus.—The viscid secretion of certain (mucous) glands.

Mycelium.—The thread-like portion of a fungus. (Cf. fig. 38).

Nacreous.—Resembling mother-of-pearl.

Necrotic.—Pertaining to dead or decaying tissue.

Nucleus (Pl. nuclei).—A spherical body within a cell. The nucleus is essential to the life of the cell.

Oesophagus.—That portion of the alimentary canal between the mouth (pharynx) and the crop.

Oral.—Pertaining to the mouth.

Ovary.—The female sexual organ in which the eggs develop.

Oviduct.—The tube through which the egg passes from the ovary to the cloaca.

Ovum. (plural ova).—The egg, particularly while on the ovary. (Cf. fig. 40).

Panophthalmia.—Inflammation of all the structures or tissue of the eye.

Papilla.—A small nipple shaped elevation.

Pathology.—That branch of medicine which treats especially of the tissue changes caused by disease.

Pericardium.—The membranous sac which contains the heart.

Peristalsis.—The worm-like movements of the intestine and oviduct by which the contents of these tubes are propelled.

Peritonitis.—Inflammation of the peritoneum or the membrane lining the abdominal cavity.

Pharynx.—That portion of the alimentary canal between the mouth and the oesophagus. It also communicates with the larynx and nasal passages at its upper end.

Prognosis.—The prospect as to recovery from a disease or a forecast as to the probable result of an attack of a disease.

Protoplasm.—A viscid granular material which forms the essential constituent of the living cell. Living substance.

Protozoa.—A class of unicellular animal micro-organisms.

Proventriculus.—That portion of a bird's alimentary canal lying between the crop and the gizzard. Often called the stomach.

Punctiform hemorrhages. Presenting the appearance as if punctured by a large number of fine prickle or needle holes from which the blood oozes.

Purgative.—Causing evacuations of the bowels.

Pyaemia.—Blood poison due to microbic origin.

Sarcoma.—A kind of tumor or cancer not always of a malignant nature.

Scabies.—A contagious skin disease caused by a mite.

Sclerotic.—Pertaining to the hard white fibrous membrane which with cornea forms the outermost coats of the eyeball.

Serum.—The clear liquid which separates from the clot and the corpuscles in the clotting of blood.

Spleen.—An oval shaped organ normally about one-half inch in diameter and of a dark red color. It lies immediately above the liver and between that and the proventriculus.

Spore.—The reproductive cell of many protozoa and of many lower plants. It is usually enclosed in tough membranes and is difficult to kill.

Stigma.—See p. 157.

Subcutaneous.—Beneath the skin.

Sub-mucosa.—The layer of tissue situated beneath the mucous membrane.

Syncope (sin-ko-pe).—Fainting. Failure of the heart's action.

Trachea.—The wind-pipe.

Traumatic.—Caused by an injury.

Therapeutic.—Pertaining to the art and science of healing.

Urate.—A salt of uric acid. A product of the secretion of the kidneys. The white part of a fowl's droppings.

Ureters.—The tubes leading from the kidneys to the cloaca.

Uterus.—See p. 158.

Vagina.—That portion of the oviduct between the shell gland and the cloaca.

Virulent.—Extremely poisonous or dangerous.

Virus.—Any animal poison, especially one produced by and capable of transmitting a disease.

Viscera.—The internal organs of the body.

INDEX.

(402-1-11)

University of Maine

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

STATE DEPARTMENT OF FORESTRY

AUGUSTA, MAINE

EDGAR E. RING, Commissioner.

SUGGESTIONS FOR WOODLOT OWNERS IN MAINE

by

JOHN M. BRISCOE, PROFESSOR OF FORESTRY,

UNIVERSITY OF MAINE.

Over eight years ago, Mr. Gifford Pinchot called the attention of the people to the necessity of protection and management of the then existing forest areas in the following words:

"The true way to save the forests is not to plant new ones, but to *protect* and *rightly use* those which are standing now. The extension of the forest to regions which are without it is a most important task, but it must no be confounded with the conservative use of the forests now standing. For such use there is no substitute whatever."

That this sound and simple advice has been accepted by the American people is evidenced by the tremendous strides that the forestry movement has taken in this country during the past decade. The demand for more detailed information is steadily increasing, and has, up to the present time, been supplied chiefly through the Forest Service. Much of this information applicable to any particular region is scattered through numerous bulletins and circulars which have been issued from time to time, and some of these are no longer available for general distribution, or are out of print.

It is therefore the purpose of this paper to collect and present in concise form for the use of the people of Maine the important facts already established as to the proper use of the existing woodlands, and the best methods for extending or re-establishing them, rather than the presentation of any original data.

The Maine Woodlot.

Almost every farm in Maine has its woodlot from which logs, posts, and fuel-wood are taken as they are needed. The woodlot therefore, constitutes one of the component, and by no means least important parts of the farm. As such, it deserves at least a pro rata share of the attention that is given to the other parts such as the corn field, the potato field, or the market garden. Like each of these other parts of the farm, it furnishes a regular supply of a very necessary commodity, the only difference being that the returns from the latter are annual while those from the woodlot are usually periodic, occurring sometimes only at long intervals. The very fact that the crop is a long time one, is all the more reason for giving it the same kind of careful and thoughtful attention that is now given to the management of agricultural crops.

While the average woodlot is rather small and can not be depended on to yield any very large or very regular supply of timber, and the quality of the product is sometimes not as good as that of virgin stands, yet the size of the tract devoted to the growing of timber can often be increased to advantage, and the quality of the wood produced may be greatly improved by more care in the method of cutting and a better understanding of the treatment required by the different kinds of trees forming the stand.

The extensive practice of forestry, it is true, can not be profitably undertaken in any large way by the average individual and must, therefore be left chiefly to the State and National Government; yet every land-owner, resident or non-resident, can practice good forestry on a small scale by using a little care and forethought and by the observance of a few simple rules.

SILVICULTURE.

Silviculture is as important to the up to date farmer for the management of his woodlot as is agriculture for the rest of his farm. The former, moreover, requires but little outlay of either time or money, and this little will be amply repaid; while agriculture requires a constant investment of both, but, on the other hand, yields quicker returns as a rule. The chief reason that silviculture is not more generally practiced by the individual is in most cases due to lack of information on the subject, and the engrossing attention required by other kinds of farm work. The woodlot will stand more neglect and abuse than any other part of the farm and still yield a fair return to the owner, and a well managed woodlot is a decidedly profitable form of investment. The truth of this statement is well demonstrated by the white-pine woodlots in the south-western part of the State which today bring large prices and are yearly growing more valuable.

The proper application of the principles of silviculture by the individual means the securing of the greatest yield, and this of the best quality, in the shortest time and at the least expense. Surely this is what every farmer and land-owner wishes to accomplish, but very often he is not sufficiently acquainted with the methods of procedure that are necessary in order to bring about the desired results.

Very often the idea of perpetuating the woodlot does not occur to him till after the best of the timber has been cut, or in some cases, not until the entire area has been clear-cut. It is then that the unsightly appearance caused by the loss of the trees causes him to wonder what to do with the area, and how it can ever again be made productive. In many cases, the soil is thin and poor and the site is of little or no value for the production of agricultural crops. There are many thousands of acres of land of just this kind in the State of Maine. Some have but recently been cut-over, and others have been lying idle for some time and have, in the meantime, grown up to a tangle of worthless vegetation and weed-trees, which in time may be followed by tree growth. This natural process, if unaided by man, is a very slow one and never gives the best results.

The practice of cutting only the best and largest trees without leaving any provision for seed-trees of the more desirable species to seed up the ground has also been decidedly detrimental to many of the woodlots. As a consequence of this practice, there is a gradual deterioration of the woodlot, not only as to the number but also as to the kinds of valuable trees; and the value constantly decreases not only on account of the lack of the available supply of merchantable timber, but also on account of the lessening of the percent of valuable species in the stand.

Today, most of the best woodlots in Maine are composed chiefly of white-pine, and these are situated, for the most part, in the south-western part of the State, thought there are, of course, many excellent woodlots outside of this part; but the growth is not so rapid, nor are the economic conditions as favorable for the growing of timber on small areas outside of that section.

Many farmers by giving a little care and attention to their woodlots have profited by thousands of dollars even within the past decade, and the prospects of good financial returns from growing timber are today better than ever. Clear-cutting without making any provision for the replacement of trees of any kind on the area is a great mistake, for much of the land now occupied by woodlots is absolutely unsuitable for agriculture, and can be profitably utilized only for tree growth. It must always be borne in mind, that, besides producing timber, forests build up the soil, conserve water, and help to prevent erosion.

Burning over recently cut areas is generally a mistake, for it destroys the natural condition of the forest floor, exposing the soil to the excessive drying of sun and wind, and greatly decreases the chances for securing reproduction of the better species; while the light, winged seeds of birch and aspen are blown in and soon take possession of the area, finding on the exposed mineral soil the most favorable place for germination.

It is possible that some of the land owners in the State may not be familiar enough with the laws of the State to know that two bills to encourage planting have already been enacted. One passed in 1872 and revised in March, 1909, provides for an exemption from taxation for 20 years for all lands planted with not less than 640 trees to the acre under certain prescribed conditions; and the other passed in January, 1909, (Senate Document No. 160.) provides for the distribution of prizes at stated periods for the best plantations in the State. This latter is known as the Benj. C. Jordan fund and consists of five cash prizes ranging in value from $500 to $25. Complete information as to the terms required of competitors for these prizes may be obtained on application to the Forest Commissioner by whom the awards are made.

For the individual owner of woodland in Maine, there is no tree better suited either for regeneration by methods of natural reproduction or for planting, than the white pine; and, therefore, its chief characteristics will be described in detail and directions will be given for the best methods of treatment for this species in particular.

Specific Characteristics of White Pine.

(Pinus strobus, L.)

Form and Size: On suitable sites, white pine grows to be one of the largest of the Eastern conifers, often attaining a height of from 100 to 150 feet and a diameter of from 3 to 5 feet, and often reaches an age of 250 or more years.

Very little virgin timber is now left in the State, however, and present stands do not as a rule average over 12 or 18 inches in diameter. Trees grown in forest form, that is close together, have straight, column like trunks clear of branches for 50 or 100 feet from the ground and open, irregular crowns while trees grown in the open have a more branchy and irregular form. The bark near the base of old trees is dark-brown and deeply furrowed, but it becomes thinner, smoother and of a lighter color further up on the trunk and also on young trees.

Local Range: White pine will grow throughout the whole of Maine, and its chief advantage for cultivation as a timber tree lies in the fact that though it makes its best development and most rapid growth on fresh, deep, sandy, well drained soils with a porous subsoil, yet it readily adapts itself to either dryer or more moist situations. It will grow on the dryest sands and on steep, rocky slopes, and also on moist clay flats; but it will not grow in low swampy places that are subject to periodic flooding. It will make excellent growth on non-agricultural lands, and is the best tree for reforesting burned or cut-over areas in this region. It will also make a very satisfactory wind-break or shelter-belt in exposed situations. It is wind firm and frost-resistant to a remarkable degree, but it should not be planted too near the sea coast since it can not well withstand the strong, salt-ladened sea breezes.

Types: In the natural states there are three distinct types of white pine stands in this State. They are:

1. Pure white pine stands such as are common on old fields where over 80% of the trees in the stand are White pine.
2. White pine mixed with other conifers, spruce and fir being most common in the mixture.
3. White pine mixed with hardwoods, birch, maple and beech in old stands, and poplar and aspen in young stands.

The first type is found chiefly on abandoned fields that have been reforested by natural regeneration, and this is the type that is most common in the south-western part of the State, south of the Androscoggin River. The other two types are general in their distribution.

Ability to Endure Shade: The seedlings, when young will endure and in fact will profit by considerable shade; but after the first few years, the trees require full light for their best development. They should, therefore, never be planted with any other trees that have a more rapid height growth for these latter would eventually overtop the pine and kill it out by excessive shading.

Rate of Growth: Figures taken from growth studies of plantations throughout New England show that the growth of these stands is more rapid than it is in the virgin forest of the same species, averaging from 1-4 to 1-3 of an inch each year. At this rate saw-timber may be produced in 60 to 70 years, and timber suitable for the making of box-boards, pails, and match stock in about half that time.

Quality of Wood: White pine is one of the best of our eastern species for general construction, but the supply for this purpose is no longer equal to the demand. It is light colored, easy to work, does not warp or twist, and has a moderately soft, smooth, straight grain.

Second-growth timber is apt to be more branchy and the lumber from it is therefore more knotty than that from virgin stands, but even this lower grade lumber finds a ready market for box-boards, pail-staves, woodenware, straight-staved cooperage and match stock. Being mostly sap wood, it is not as durable in the ground or in exposed places as the older pine.

Complete utilization is possible, the edgings being made into kindling and the shavings baled and sold for bedding.

Enemics: Young stands are susceptible to severe injury from fire on account of the thin bark of the trees at this stage of their development. It is necessary, therefore, to carefully exclude fire from plantations or areas being restocked by methods of natural regeneration. Older trees are more resistant but fire injures even these to a considerable extent.

After the trees are a little older, say from 5 to 20 years old, the greatest cause of damage is the white pine weevil, (*Pissodes strobi,* Peck.) a small snout beetle which in the larvae stage buries itself under the bark of the leading shoot. It seems to prefer the best and most thrifty specimens in the stand.

These tiny white worms eat their way through the living cambium which is between the wood and the bark, and by so doing usually succeed in girdling the shoot which is as a rule the leading shoot, causing it to turn brown, wither, and die. A side shoot then usually takes the place of the injured leader, but this causes a crook in the tree at this point, making a deformed stem right in the most valuable part of the tree, (the butt log), and thereby greatly lessening the merchantable value of the tree. The only remedy is to cut off the affected shoots and burn them while the grubs are still in them. This will prevent them from spreading to other trees, but will not, of course, save the affected trees. Spraying with a preventive wash consisting of one pound of whale-oil soap dissolved in 100 gallons of water with a little paris-green added, may keep off the weevil.

Animals should not be allowed to graze on planted areas or on those about to be reforested by natural methods. The damage done by them is chiefly in breaking and trampling the young seedlings and in packing the soil, since they seldom eat the pine tops on account of the resinous material contained in them which is distasteful to most animals.

Reproduction: White pine does not sprout but reproduces only from seed. The seed is in the cone or "burr" as it is sometimes called. These are borne on the under side of the branches and near the end and they consist of many scales arranged spirally on a central stem. On the upper surface of each fertile scale, two seeds are developed, each having a film-like wing attached to it. This wing is about four times the length of the seed itself, and acts as a sort of sail thereby facilitating the distribution of the seed by means of the wind when the cones open.

The length of the seed with the wing attached is from ¾ of an inch to 1 inch in length and from 1-10 to ⅛ of an inch in thickness.

It takes two years for the seed in these cones to mature, and the mature cones are from 4 to 6 inches long. The cones are usually borne only on 3 or 4 whorls of branches at the top of the tree, but trees grown in the open produce more seed than those grown in the forest.

Trees may bear seed when 20 years old, but these seeds are not usually very fertile, and crops of good seed are not produced as a rule before the trees are from 30 to 35 years old. After that age, some seed is usually produced each year, but large crops of seed occur only at intervals of from 5 to 7 years. The year of abundant seeding is called a seed-year, and it is important to note when these occur when methods of natural reproduction are being used. During the last week of August or the first of September, two-year-old cones turn brown and begin to open, most of the seed escaping by the middle or end of September. Most of this seed falls within a few hundred feet of the parent tree, but with a strong wind some of the winged seeds may be borne as far as half a mile or even a mile in some cases.

About 80% to 90% of the fresh seeds germinate under favorable conditions. The seed may also be kept over for several years, but the germination average is very much reduced, being only 40% to 50% in the second year and less each year after. It is, therefore, very desirable to procure only fresh seed for planting.

Management of the Woodlot.

Besides protection from fire and grazing, the practice of good forestry by the individual resolves itself into the observance of a few very simple rules of management. The method of treatment used will, of course, vary considerably with the present condition of the stand and the purposes of the owner. The latter must first be decided upon by the owner in each particular case; but for a better understanding of the former, stands may be divided into three groups: Young stands, varying in age from 20 to 40 years. Middle aged stands, from 40 to 80 years old. Old or mature stands, 80 years old or over.

YOUNG STANDS, 20 TO 40 YEARS OF AGE.

In young stands the trees are usually too much crowded for thrifty development. There are too many trees to the acre, and many of the trees of the better species are being choked and suppressed by the quicker growing but less valuable ones. In this case thinnings, or improvement cuttings as they are more properly called, are beneficial to the growth of the trees that are left in the stand. They are advisable, from a financial standpoint, only when the material taken out in the cuttings is large enough to be utilized in some way. In the improvement cutting, all trees that are dead, all that are hopelessly suppressed, and all those of inferior species that are interfering with the development of the better trees should be removed. The chief purpose of all thinnings of this kind is not to produce merchantable material, but to improve the growth and development of the remaining trees.

By the removal of certain trees, the remainder have a chance to expand their crowns and also have the benefit of all of the available nourishment that is in the soil, and are therefore able to make faster growth than if they were crowded and hampered by their undesirable neighbors. For this reason, thinnings of this sort shorten the time needed to grow the trees to a desired size. They may, therefore, prove to be a good and far sighted policy even in cases where the material removed is not valuable enough to pay for the operation at the present time.

MIDDLE AGED STANDS, 40 TO 80 YEARS OLD.

Later on in the life of the stand after the improvement cuttings have been made or the natural law of the survival of the fittest has been allowed to run its slow course, slightly heavier thinnings are made in order to provide additional growing space for the remaining trees.

In this thinning all dead and down trees, all crooked, suppressed, dying or badly injured trees should be removed. This opening up of the stand to more light and growing-space will greatly accelerate the diameter growth of the remaining trees.

Care should be taken not to open up the stand too much, but to maintain a complete crown cover for the forest floor, so far as it is possible. If too many of the trees are removed, the stand is subjected to several dangers, for if the protection afforded by the surrounding trees is suddenly removed, the trees are much more subject to be thrown or broken by the wind during severe storms. The exposure of the soil to drying by wind and sun is also increased, and even if the trees are not affected by any of these causes, they are apt to become branchy and of poor form for merchantable logs.

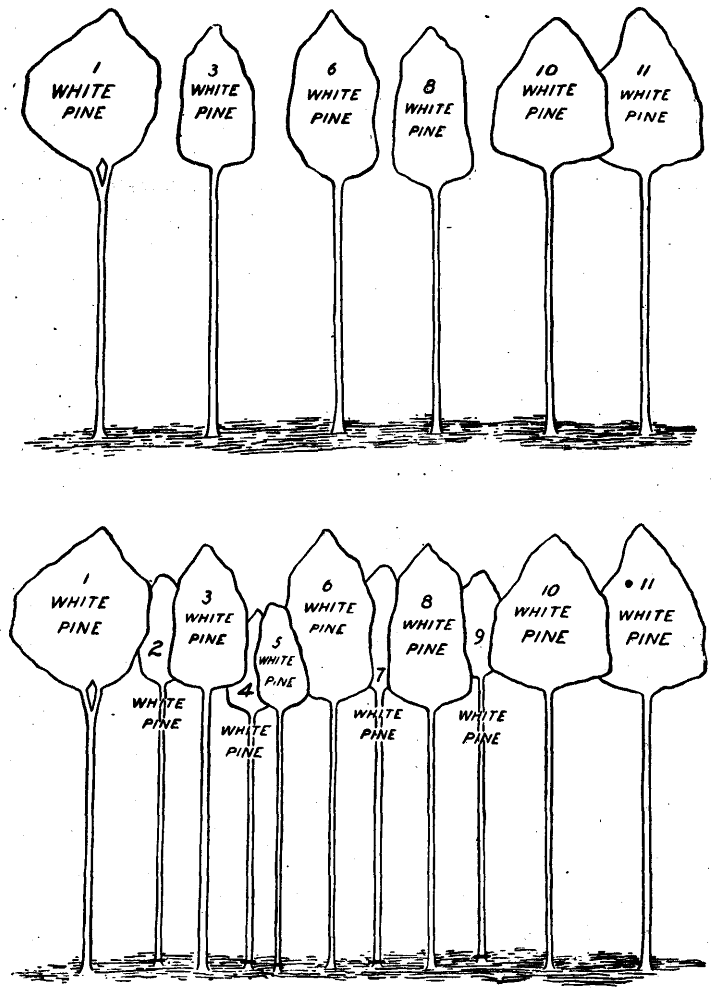
Pruning: Pruning the live branches of white pine or of conifers in general is never advisable since it is not only an economic waste but is often positively injurious.

The pruning of dead branches does no harm to the tree, but it is seldom advisable. In fully stocked stands this process is taken care of by nature, and it is not necessary if the pine is to be cut for box-boards, pail, or match-stock. The expense of the operation may, however, sometimes be warranted if the timber is to be grown for the purpose of producing saw-timber at the age of from 70 to 80 years. In such cases pruning is usually done when the stand is from 25 to 40 years old. The branches should be cut off smooth and as near the main stem as possible without injuring the bark of the stem. They may be cut with an upward blow of an axe or marking hatchet, and are usually removed about as far up on the stem of the tree as a man can conveniently reach.

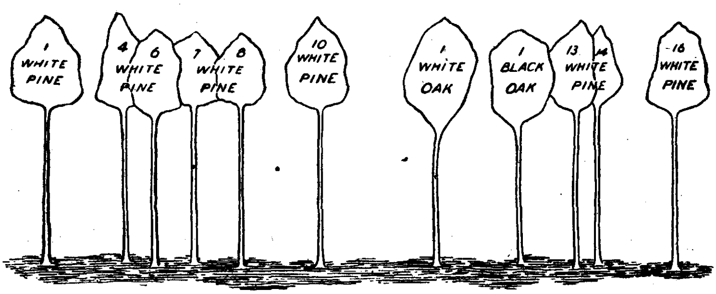
Thinning: Methods of thinning are shown in the illustrations. The descriptions and the figures follow.

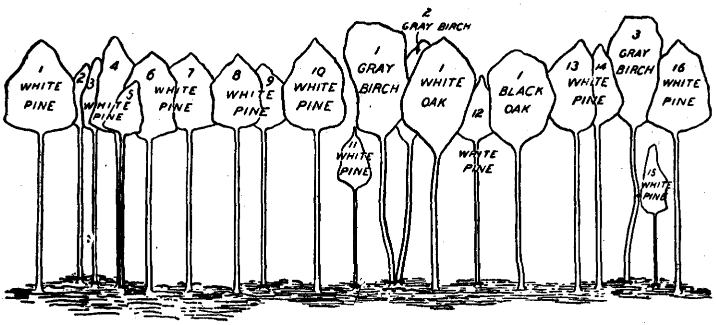
FIGURE 1. Pure stand of White Pine. Diameter, 5 to 10 inches; height, 45 to 55 feet. The stand is in need of simple improvement cutting. The trees to be removed on this principle are numbers 2, 4, 5, 7, and 9, all of which are either suppressed or partially suppressed, but still restricting the crowns of the better trees beside them. The trees left are vigorous enough and thick enough to restore the cover in a few years. The lower diagram shows the stand before thinning, and the upper diagram the same stand after the trees marked for cutting have been removed.

FIGURE 2. A stand of White Pine mixed with Gray Birch. Age, 25 to 30 years; diameters, 4 to 7 inches; heights, from 30 to 35 feet. The treatment is the removal of inferior trees which are crowding the better individuals. The Gray Birches, besides having almost reached maturity, are crowding the more valuable Pines. White Pine 2, 3, and 5 should be cut to relieve 1, 4, and 6; 9 to relieve 8 and 10; 11, 12, and 14 because they are either overtopped or falling behind. Gray Birches 1, 2, and 3 should be taken out to release the better trees which they are crowding. Lower cut before cutting; upper cut after cutting.



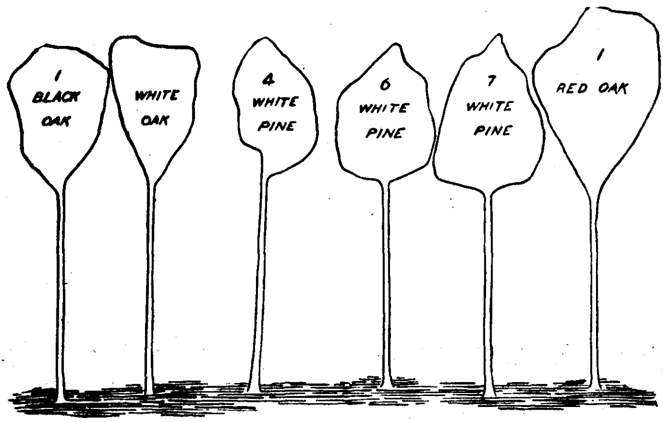
For description of figures see page 11.

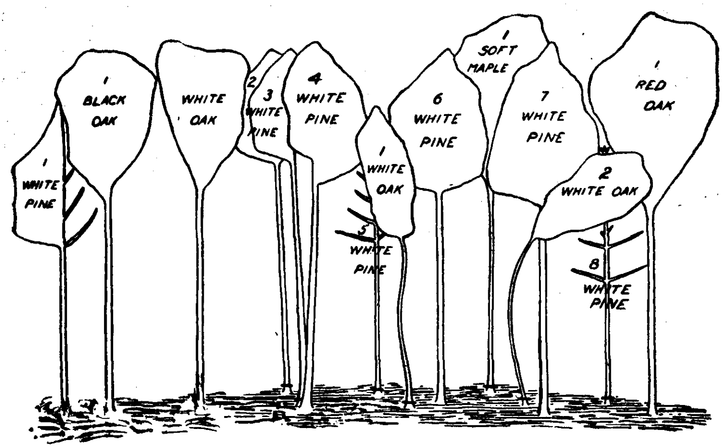




For description of figures see page 11.

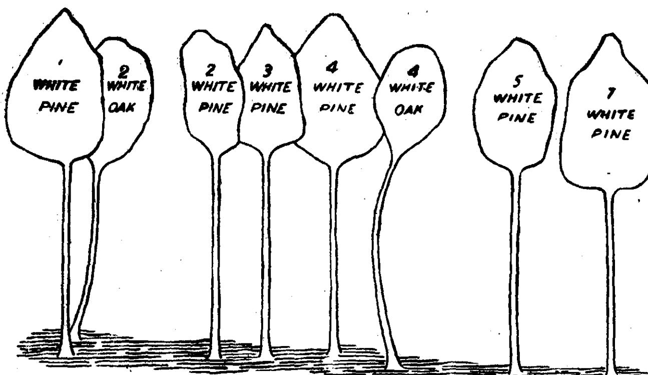
FIGURE 3. Mixed White Pine and Oak. Diameters, 5 to 8 inches; heights, 30 to 35 feet; age, 30 to 40 years. This stand furnishes a good example of the need for cutting both in the dominant and the subordinate class of trees. Of dead, suppressed, or partially suppressed trees, the best of which are already succumbing to the main crop, White Pines 1, 2, 3, 5, and 8 and White Oaks 1 and 2 are cut to relieve the leading individuals beside them and to utilize the wood before it decays. Of the dominant trees, Red Maple 1, a comparatively inferior species, is cut because it is beginning to overtop White Pines 6 and 7, both thrifty trees, and together more valuable than the Maple. The decision in such cases must depend on the relative health and value of the upper and lower trees.

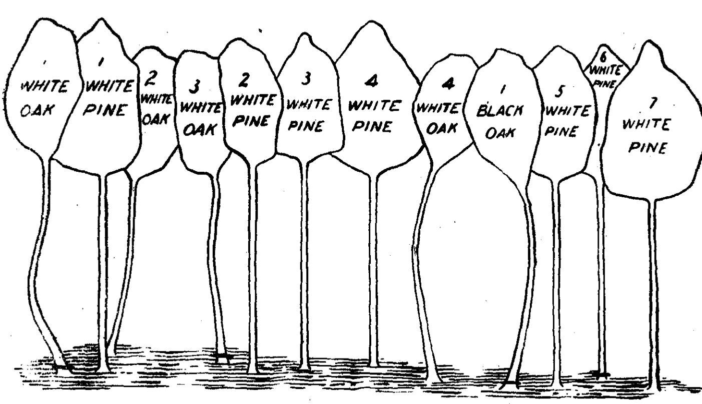




For description of figures see opposite page.

Figure 4. White Pine in mixture with White Oak. Dominant trees 4 to 7 inches in diameter, 30 feet in height, and 25 to 30 years old. The treatment required is a light improvement cutting of a stand too thick for its best development. Such are White Oaks 1 and 3, Black Oak 1, and White Pine 6. In all these cases the trees cut are not sufficiently behind the others in height and development to be unmistakably in need of removal, but they are all either defective or so placed that the crowns of adjacent trees will be able to utilize the room. The lower diagram shows the stand before, and the upper diagram the same stand after the cutting recommended.





For description of figures see opposite page.

MATURE STANDS, 80 YEARS OLD OR OLDER.

In old or mature stands, cuttings should be made in such a way that natural reproduction will quickly follow in the openings made throughout the stand. If possible these cuttings should be made the year before a good seed-year in order to obtain the best results and to insure the succession of the right species. If the openings are made too long before a good seed-year, grass and weeds soon come in and sometimes also the less desirable tree species, and take complete possession of the ground.

In the final cutting or harvesting of the crop, some provision should be made for the leaving of seed trees to assure the natural replacement of the old stand by young pine seedlings.

Nearly all of the white pine woodlots are at present cut clean and the logs sawed by a portable mill placed at a convenient point on the lot. This is the best and cheapest method and includes in some parts of southwestern Maine the working up of the tops for fuel. Very rarely is any provision made for the natural seeding of the ground cut over. This is the point of vital importance for Maine, because pine land is of little value for agriculture and should be made to yield crop after crop of pine. Most of our waste lands here are just as good quality as the forest lands of northern Germany or the southern part of the Scandinavian Peninsula and they can be, and should be made as productive. Although the present owner of the pine land may not himself cut the second crop of timber, he will have the satisfaction of knowing that the value of his land is constantly increasing while if left to itself it would soon deteriorate and become almost worthless "waste land."

Cutting so as to get a natural replacement of the pine by young pine seedlings costs the owner but little if any outlay of time or money, while it makes sure another crop of trees instead of allowing the land to become barren or to support only a scanty growth of bushes and gray birch. This waste condition that is so frequently seen throughout the State arises directly from the lack of trees to provide natural seeding.

There are two methods of cutting, either of which may be used successfully on the woodlots of Maine.

The Scattered Seed-tree Method: Every acre of a pine woodlot has usually two or three trees on it that are shortboled and low-branching because they began growing in advance of the rest and received full sunlight. Very frequently these few trees did the original seeding for that land. They do not pay for cutting and sawing or at best bring a very small return. Such trees, however, have a very great value as seed-trees, since they are wind firm and will not die from exposure after the others have been cut down. Spindling, slender trees if left for this purpose will surely die or be blown down. Four or five pines are sufficient to seed one acre, provided they are sufficiently old to bear plentifully. They should be left on the western half of the acre, if possible, since the prevailing winds are westerly during the time of year that the seed escapes from the cones.

If it is desired to burn up the branches and tops after lumbering, the debris must be removed from the foot of the seed-trees. If there is little danger from fire these tops may remain and will soon decay after the young growth gets started. A light growth of birch may first occupy this cut-over land but this will serve as a protection to the tender pine seedlings which will appear later beneath them. The birch should, however, be removed when the young pines are well established.

The Strip Method: This method may be used to advantage where the woodlot is a large one. Successive strips of the forest are cut, beginning on the east side of the tract and working west, or in other words, at right angles to the prevailing winds. Advantage may be taken of a seed-year for the time in which to cut one strip. The seed-years can be judged by the presence of little cones in the tops of the trees during the previous year. The strips should be not more than two or three times as wide as the trees are high if a complete seeding of the ground is desired. The wind will blow the seed from the adjacent woods over the newly cut land and after a few years, the seedlings having appeared, a new strip may be cut and so on until the land is all lumbered and naturally re-seeded. The natural principle on which this method is based may be understood by noting the thick reproduction of pine in pastures or old fields on the easterly side of any pine woodlot.

Where no method of establishing a new stand by natural reproduction can be practiced, planting will have to be resorted to. This involves a greater expenditure at the outset but will often be a profitable investment. However, anyone following these few simple rules may be reasonably sure of a fair profit on the investment which he has left in his woodlands, and he may, moreover, have the satisfaction that is felt in knowing that every part of his property is being put to its best use.

Very frequently open, scattered stands of white pine reproduction with short, branchy trees may be greatly improved by inter-planting with seedling stock between these trees in order to form a complete stand. As the newly planted trees grow, they will gradually shade out the lower branches of the older trees and the value of these trees will be increased as well as the general increase in the value of the stand on account of being fully stocked.

While in this case an absolutely uniform spacing between the trees will not usually be possible, an attempt should be made to have all the trees in the stand about six feet apart at the time of the planting.

When considering the advisability of using any sort of practical forestry in the management of a tract, the question which very naturally arises is: How long a time will it take to produce merchantable timber, and what will this timber be worth when ready for the market? In other words, what kind of an investment is the practice of forestry for the individual from a financial standpoint? The following figures, taken from the United States Forest Service Bulletin No. 63, will best answer these questions. The data from which these figures were obtained were collected from actual stands of white pine in the New England States, and they are the most authentic and authoritative figures obtainable at the present time.

Rate of Growth in Diameter of Dominant White Pine.

Age.	Diameter inside bark, one foot high.	Average annual growth for each 10 years.	Average time required to grow one inch.
Years	Inches	Inches	Years.
10	1.3	0.13	8
20	5.8	.45	2
30	9.3	.35	3
40	11.8	.25	4
50	13.8	.20	5
60	15.8	.20	5
70	17.4	.16	6

Volume of Single White Pine Trees.

Diameter 4½ ft. high.	Volume excluding bark.	Diameter 4½ ft. high.	Volume excluding bark.
Inches	Cords	Inches	Cords
4	0.025	11	0.215
5	.030	12	.260
6	.045	13	.305
7	.065	14	.355
8	.090	15	.415
9	.120	16	.490
10	.165	....	....

Yield of Fully Stocked Stands of Second-Growth White Pine.

Age of stand.	Average height.	Total trees per acre.	Merchantable trees per acre.	Yield per acre.
Years	Feet	Number	Number	Cords.
10	5	2,220	....	....
15	9	1,700	....	....
20	14	1,600	....	....
25	22	1,310	400	11
30	32	1,090	510	21
35	45	885	620	30
40	54	690	540	38
45	62	510	460	45
50	68	400	380	53
55	72	300	300	65
60	76	260	260	80

Possible Profits To Be Derived from an Acre of Second-Growth White Pine of Various Ages.

Age.	Yield.	Value of land and wood.	Total cost to date.	Profit.	
				Total.	Average net annual %.
Years	Cords	Dollars	Dollars	Dollars	Percent.
10	....	4 00*	5 50†	....	....
15	....	4 00	6 57‡	....	....
20	....	4 00	7 94	....	....
25	11	59 00	9 69	49 31	10.9
30	21	109 00	21 04	87 96	11.0
35	30	154 00	43 81	110 19	10.0
40	38	194 00	80 33	113 67	8.8
45	45	229 00	133 55	95 45	7.2
50	53	269 00	207 26	61 74	5.7
55	65	329 00	307 95	21 05	3.4
60	80	404 00	446 87	....	....

* It is assumed that the land is worth $4. and that until the stand is 25 years old it has no greater value. From that time on the price that the wood will bring is added.

† This figure is the value of the land plus 12 cents per year paid for ten years, with interest compounded annually at 5%.

‡ This and succeeding figures in this column are 3% of the value at the end of the preceding period, paid for 5 years with interest compounded annually at 5%.

These figures show that the profits in second-growth white pine may be as high as 11 per cent per year where the land is valued at not over $4 per acre, the annual outlay is not over 12 cents per acre, and the stumpage price of the wood is not less than $5 per cord. The interest rate culminates at about the thirteenth year, yet the lot pays a good profit up to the time it is 50 years old, and many owners prefer to hold their timber for the higher returns, though the latter years do not yield so high a rate of interest as the earlier.

In considering this question of profit it should always be remembered that a low initial cost always prolongs the time during which a profitable rate of interest can be earned. In other words, if land in this section is worth only $2 per acre instead of $4, the interest accumulates more slowly, and profits are prolonged in proportion. Further, these figures must be taken only as indicative of what white pine lots may yield in New England. The actual returns from any tract may be higher or lower, according to the local conditions and the way the owner counts the annual costs.

PLANTING.

All methods of securing reproduction by means of natural regeneration presuppose the existence of a mature stand of the desired species, or at least seed-trees of that species. Where these are absent, planting must be resorted to. As to which of these two methods of reforesting is the most desirable will depend on a number of local circumstances in each particular case, the most important of these are the soil, the site, and the economic conditions in the locality where the reforesting is to be done.

While planting costs more in the beginning, many arguments may be advanced in favor of this method. The results are surer and the stand is established in a single year while natural regeneration is a slow process requiring a period of years, usually ten or more to be successfully accomplished. Furthermore, in planting, the distance between the trees is equal from the start giving all the trees in the plantation an equal chance, while in the natural method the seedlings are usually more or less scattered in patches or groups which may be very thick in some places but of unequal distribution over the area. The equal spacing established by planting gives equal root and crown space for the development of the small trees and makes all of the further operations in the management of the stand much easier.

Plantations should be started from nursery grown stock rather than from seed sown on the area direct. Direct seeding is expensive and is not usually very successful here. Never plant the cones. Very often they have no fertile seeds left in them and if they have it is a wasteful method. Where only a few hundred plants are needed, it is usually cheaper and always easier to buy them from a nurseryman than to raise them. There are now in this country many dealers in forest tree seeds and seedlings who make a specialty of this kind of stock. A list of these dealers will be sent on request to all applicants. (Address the request to the Department of Forestry, University of Maine, Orono, Maine.)

It is probable that within the year a forest tree nursery will be established in connection with the State forestry department which will be able to supply seedlings at the actual cost of production to prospective planters in the State.

Stock purchased from dealers should be secured in the early spring just at the time that it is desired to set out the plantation. On arrival, the seedlings should be unpacked immediately and note taken of their condition. Careless packing and delay in transportation may have injured some of the seedlings so that they are not fit to plant. In this case, claim should be made on the shipper or the transportation company whichever is at fault.

After being unpacked, the young seedlings should have their roots dipped in a pail or puddle of thin mud. If not planted immediately, the plants should be "heeled-in." This heeling in process consists of having their roots and stems entrenched and well covered with earth firmly packed down over them, care being taken not to cover or injure the foliage or tops of the trees. They should never be allowed to dry out, but in a shady place the plants thus treated may be kept for several weeks if necessary awaiting a convenient planting time.

Two or three year old seedlings are sufficiently large for planting in most cases, but two year old transplants, that is seedlings that have grown one year in the seed-bed and have then been transplanted for one year's growth in a transplant bed, have as a rule better developed root systems and are therefore better plants for use under less favoable conditions of soil or site.

METHOD OF PROPAGATION.

If many thousand plants are to be used by one owner or in one neighborhood, it is cheaper to raise them from the seed. If the trees are to be grown in a home nursery, the seed may be purchased, but a large saving may be made by collecting it in the neighborhood, if this can be done. Cones should be gathered during the latter part of August or in September before they begin to open. They may be picked from standing trees, or from felled trees if lumbering operations are being conducted nearby. When gathered, the cones should be spread out on a sheet or floor, where they will be exposed to the sun, yet protected from wind and rain. Within a week they will open and allow the seed to drop out. A thorough stirring will separate the seed; after which the cones may be raked away. One bushel of cones will yield one-half a pound to 1 pound of clean seed, which will average from 29,000 to 30,000 seeds per pound. Seeds may be stored over winter by placing them in small sacks and hanging the sacks in a cold, dry place.

The most successful method of raising seedlings is by sowing the seed in nursery beds. Seed beds should be composed of fine, loose, fairly fertile soil, moderately moist but always well drained. The soil must not be too rich; otherwise the seedlings will suffer when transplanted to the less favorable conditions of the permanent site. A convenient size for seed beds is 4 by 12 feet, with a path about 18 inches wide between the beds, so that the plants can be weeded and cared for with ease. The seed should be sown in drills 4 to 6 inches apart, or broadcast over the beds, and lightly covered with fine earth. Sowing should not begin until the ground is warm enough to cause rapid germination. Seed may be safely sown at the time garden vegetables are planted. After a seed bed is sown the surface should be "firmed" with a board or light roller.

The plants will begin to appear in from 3 to 5 weeks. Like other conifers, they will require partial shading during the first season, but subsequently can endure full sunlight, especially in New England. A shade frame of lath supported 18 inches above the bed will serve the purpose.

One pound of white pine seed is sufficient to sow 500 linear feet of seed drill, or about 200 square feet of surface, with drills 6 inches apart. Even with proper care some seeds may fail to germinate promptly, but about 10,000 plants may be expected from every pound of fertile seed sown. White pine seed retains its vitality for several years, and when kept in cold, dry storage a fair percentage has been known to germinate after five years. Fresh seed, however, is always to be preferred.

Two years after sowing, the seedlings should be transplanted in the spring from the seed bed to nursery rows, in order to develop a good, fibrous root system. They may be set out 3 inches apart, in rows from 12 to 18 inches apart. The roots should be set slightly deeper than they were before. The best method of transplanting is to open a shallow trench of the proper depth with a spade, and set the plants by hand, carefully covering the roots of each plant with fine soil and gently firming it. Transplants, if thoroughly cultivated and weeded, will be ready for final planting at the beginning of the fourth season. At this age they should be from 6 to 9 inches high and have a well-developed system of fibrous roots.

In the early stage of the white pine a very injurious fungus must be guarded against. If the soil becomes soaked, or sufficient light and air are withheld, ideal conditions for the action of the fungus exist, and the result is the "damping off" of large numbers of the young trees. In shaded seed beds, when the quantity of rain is sufficient to endanger the young trees, the damping off may be checked by so raising one side of the shade frame that it acts as a partial roof. Dry sand sprinkled over the seed bed will usually tend to hold the fungus in check.

Birds and field mice are often very troublesome around coniferous seed beds. If danger from such sources is expected, the seed may be coated with red lead mixed with linseed oil before sowing. This is distasteful to most birds and rodents and is usually quite effective. Another method is to protect the beds by wire netting and similar devices until the seedlings are sufficiently developed to be free from danger.

SETTING IN THE FIELD.

White pine seedlings should be planted on the permanent site in the early spring when the ground is dry enough to work. In most cases the site will not need preparation previous to planting.

The roots must not be allowed to become dry during the planting. Even brief exposure of the roots to the sun and air will cause the plants to die.

The distance apart at which the plants should be set depends upon the character of the site and whether the pines are to be planted in mixture with some other trees or in a pure stand. The usual distance is 6 by 6 ft. apart. In this region white pine is usually planted in pure stands, but it also produces excellent forest conditions in mixture with a number of other species, the chief of which are, European larch, Norway spruce, red oak, and hard maple. When planted in mixture with larch, the pine should constitute two-thirds of the stand.

Mixed with the other species, the stand should be composed of an equal number of white pine and the associated species planted alternately. On account of the increased danger from insect and fungus enemies, it is advisable not to start planting operations too soon after logging.

CARE AND CULITVATION.

Cultivation in this region is unnecessary. Persistent dead branches should be removed when possible, but it is not advisable to prune live ones. When there is a demand for small material, the stand may be profitably thinned, as described in detail, at the age of from 20 to 30 years, removing at the same time all suppressed or intermediate trees which are not needed in the stand to shade the ground or to assist in naturally developing the large trees.

Fire must be kept out of these stands, since the bark of the young trees is thin and easily damaged, and injuries from this source cause rapid decay.

Information regarding general nursery practice and planting may be obtained from the publications of the Forest Service, which may be procured from the Superintendent of Documents, Government Printing Office, Washington, D. C., for a nominal price.

Insect damage, if serious, should be reported promptly and specimens of the affected parts sent to the Maine Agricultural Experiment Station, Orono, where they will be identified and measures suggested for their control.

SOME PUBLICATIONS FROM WHICH ADDITIONAL INFORMATION MAY BE OBTAINED.

Bi-annual Reports of the Forest Commissioner of the State of Maine.

U. S. Department of Agriculture Year Book 1899, 1905 and others.

U. S. Forest Service Bulletin No. 42, The Woodlot. (Now out of print.)

U. S. Forest Service Bulletin No. 45, Planting of White Pine in New England. Price 20c.

U. S. Forest Service Bulletin No. 63, The Natural Replacement of White Pine on Old Fields in the New England States. 10c.

U. S. Forest Service Bulletin No. 76, How to Grow and Plant Conifers in the Northeastern States.

U. S. Forest Service Circular No. 67, White Pine Planting Leaflet free on application to the U. S. Forest Service.

U. S. Dept., Agri. Farmers' Bulletin No. 228, Forest Planting and Farm Management. Free.

U. S. Dept., Agri. Farmers' Bulletin No. 173, A Primer of Forestry I.

U. S. Dept., Agri. Farmers' Bulletin No. 358, A Primer of Forestry II.