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Cornell University — Agricultural Experiment Station.

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NINTH ANNUAL REPORT

OF THE

Agricultural Experiment Station.

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ITHACA, N. Y.

1896.

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TRANSMITTED TO THE LEGISLATURE FEBRUARY 15, 1897.

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STATE PRINTERS,  
ALBANY AND NEW YORK

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# STATE OF NEW YORK

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FEBRUARY 15, 1897.

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### NINTH ANNUAL REPORT

OF THE

## Agricultural Experiment Station of Cornell University.

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STATE OF NEW YORK — EXECUTIVE CHAMBER,  
ALBANY, *February 15, 1897.* }

*To the Legislature:*

I have the honor to transmit herewith the ninth annual report of the Cornell University Agricultural Experiment Station, being for the year 1896, together with appendices containing bulletins and also a detailed statement of receipts and expenditures for the fiscal year ending June 30, 1896.

FRANK S. BLACK.



# REPORT.

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*To the Commissioner of Agriculture, Albany, N. Y.:*

Sir.—I have the honor to transmit herewith the ninth annual report of the Agricultural Experiment Station of Cornell University, in accordance with the act of Congress of March 2, 1887, establishing the Station.

In addition to the general report of the director and the special reports of his scientific coadjutors, this document includes two appendices, one of which contains the bulletins published by the Station during the year and the other a detailed statement of the receipts and expenditures.

The Experiment Station of Cornell University is supported by an annual appropriation from the Federal treasury. But under chapter 437 of the Laws of New York for 1896 an appropriation of \$16,000 was made to the Station to be expended in horticultural investigations, experiments and instruction in the Fourth Judicial Department. This work has been the leading feature of the year, and the staff have been greatly encouraged by the growing interest which it has awakened in the rural population. The labors of the staff have been unusually arduous, and some of them have suffered in health in consequence. If it is the desire of the State that this work of university extension in agriculture be continued, the authorities of Cornell University stand ready to undertake it, though some improvements in the organi-

zation of the Station staff will be necessary in order to meet the constantly increasing demands which the work of the Station has already called forth.

I have the honor to be your obedient servant,

J. G. SCHURMAN,  
*President of Cornell University.*

## Report of the Director.

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*To the President of Cornell University:*

Sir: I have the honor to transmit herewith my ninth annual report, with those of the treasurer, the chemist, the botanist and the plant pathologist, the entomologist, the agriculturist, the horticulturist and that of the assistant professor of dairy husbandry and animal industry; together with an appendix of eighteen bulletins, covering the year ending December 31, 1896. Also a detailed statement of the receipts and expenditures for the fiscal year ending June 30, 1896.

The reports and bulletins give, in brief, an outline of the work undertaken and accomplished, with suggestions as to future operations, together with the results of the year's work, so far as they have been published. In addition to results reached by experimentation, much valuable information has been secured by studying the condition of various branches of agriculture in many localities throughout the State. In so large a State as New York the conditions as to climate, soil and tillage vary so widely that only by a study of growing crops in various localities, and where serious damage to plants occurs, can the most satisfactory results be secured.

Chapter 437 of the Laws of 1896 provided funds to be expended in the Fourth Judicial Department in "Conducting investigations and experiments in horticulture; in discovering and remedying the disease of plants, vines and fruit trees; in ascertain-

ing the best means of fertilizing vineyard, fruit and garden plantations, and of making orchards, vineyards and gardens prolific; in disseminating horticultural knowledge by means of lectures or otherwise, and in preparing and printing for free distribution the results of such investigations and experiments, and such other information as may be deemed desirable and profitable in promoting the horticultural interests of the State." The Federal law, known as the "Hatch Act," passed March 2, 1887, has a much wider scope and permits investigations to be carried on in all subjects related to Agriculture.

The funds provided by the State for carrying on this work have been expended, in part, in publishing information believed to be both desirable and profitable, though such information was not secured entirely by our own scientific investigations.

An effort has been made to awaken an interest in rural pursuits by imparting instruction to both young and old by means of schools and lectures at central points. The value of this work has been so heartily appreciated by the people, and so many have joined the agricultural science reading courses, that provision should be made for continuing the work. To do this a special corps of instructors and investigators will have to be provided, as the work has outgrown the provisions which have been made for carrying it forward. The present force can direct and simplify the work, supervise the expenditures and the publications, and select expert assistants to perform the major part of the work, but the staff, as now constituted, is unable to meet the demands which are made and which are increasing day by day.

Never before has there been such an awakening or such an earnest desire for instruction in rural affairs. The people of the State are calling for help in all lines of Agriculture; they de-

mand facts which may serve to give direct help, and instruction as to the best methods whereby desired results may be reached most economically.

Within the past few years much has been done, and well done, to instruct the rural population in those subjects which are directly related to the production of animals, the cultivation of plants and the betterment of rural homes. Thousands of publications are sent out by the Station annually, and we have reason to believe that they are read with pleasure and profit. Hundreds of letters are at hand which give evidence that the publications are highly appreciated.

It is found that many persons residing in the cities and villages own land which they either farm or control. These persons have shown unusual interest in the investigations which have been conducted and in the Station publications. It is believed that the interest shown by this class, who have a natural love for rural pursuits, is stimulating the country people, who have had fewer opportunities for study and research.

The eighteen bulletins published during the year contain 522 pages. About 12,000 copies of each issue have been sent out, or more than six million pages, embodying the results of investigations and observations made by the Station staff. In addition, some 700 bound copies of the complete transactions of the year are forwarded to other stations and to libraries.

Herewith appended is a list of the bulletins published since the organization of the Station under the Federal act of March 2, 1887, a copy of which is hereunto attached, and also chapter 437 of the Laws of the State of New York, passed May 9, 1896.

Bulletins of Cornell University Agricultural Experiment Station, 1888 to 1897.

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- \* 1 Experimental Dairy House.
- \* 2 Feeding Lambs for Fat and Lean.
- \* 3 Insectary of Cornell University. Wireworm.
- \* 4 Growing Corn for Fodder and Ensilage.
- \* 5 Lean Meat in Mature Animals.
- \* 6 Fodders and Feeding Stuffs.
- \* 7 Influences Affecting Sprouting of Seeds.
- \* 8 Different Rations for Fattening Lambs.
- \* 9 Windbreaks in their Relation to Fruit.
- \*10 Tomatoes.
- \*11 Saw Fly Borer in Wheat.
- \*12 Apparatus for Drying in Hydrogen and Extracting Fat.
- \*13 Leaching of Farm-yard Manure.
- \*14 Strawberry Leaf Blight.
- \*15 Sundry Investigations of 1889.
- \*16 Growing Corn for Fodder and Ensilage.
- \*17 Cochran's Method for Testing Milk.
- \*18 Experiences in Spraying.
- \*19 Condition of Fruit Growing in Western New York.
- \*20 Cream Raising by Dilution.
- \*21 Tomatoes.
- \*22 Grain for Cows at Pasture.
- \*23 Insects Injurious to Fruit.
- \*24 Clover Rust.
- \*25 Sundry Investigations of 1890.
- \*26 Egg Plants.
- \*27 Farm Manures.
- \*28 Forcing Tomatoes.
- \*29 Cream Raising by Dilution.
- \*30 Influence of Electric Light on Green-house Plants.



- \*31 Forcing English Cucumbers.
- \*32 Tomatoes.
- \*33 Wireworms.
- \*34 Dewberries.
- \*35 Combination of Fungicides and Insecticides.
- \*36 Grain for Cows at Pasture.
- \*37 Sundry Investigations of 1891.
  - 38 Native Plums and Cherries.
  - 39 Creaming and Aerating Milk.
  - 40 Removing Tassels from Corn.
  - 41 Steam and Hot Water for Heating Green-house.
- \*42 Electro Horticulture.
- \*43 Trouble of Winter Tomatoes.
- \*44 Pear Tree Psylla.
- \*45 Tomatoes.
- \*46 Mulberries.
- \*47 Feeding Lambs and Pigs.
- \*48 Spraying Apple Orchards.
  - 49 Sundry Investigations of 1892.
- \*50 The Bud Moth.
- \*51 Four New Types of Fruit.
- \*52 Cost of Milk Production.
  - 53 Ædema of the Tomato.
- \*54 Dehorning.
  - 55 Green-house Notes.
- \*56 The Production of Manure.
- \*57 Rasberries and Blackberries.
  - 58 Four-Lined Leaf-Bug.
  - 59 Does Mulching Retard Maturity of Fruits.
- \*60 The Spraying of Orchards.
  - 61 Sundry Investigations of the Year.
- \*62 The Japanese Plums in North America.
- \*63 Coöperative Test of Sugar Beets.
  - 64 On Certain Grass-Eating Insects.
- \*65 Tuberculosis in Relation to Animal Industry.

- \*66 Test of Cream Separators.
- \*67 Some Recent Chinese Vegetables.
- \*68 The Cultivated Poplars.
- \*69 Hints on the Planting of Orchards.
- \*70 The Native Dwarf Cherries.
- 71 Apricot Growing in Western New York.
- 72 The Cultivation of Orchards.
- 73 Leaf Curl and Plum Pockets.
- 74 Impressions of the Peach Industry in New York.
- 75 Peach Yellows.
- 76 Some Grape Troubles in Western New York.
- 77 The Grafting of Grapes.
- 78 The Cabbage Root Maggot.
- 79 Varieties of Strawberry Leaf Blight.
- 80 The Quince in Western New York.
- 81 Black Knot of Plums and Cherries.
- 82 Experiments with Tuberculin.
- 83 A Plum Scab in Western New York.
- 84 The Recent Apple Failures in New York.
- \*85 Whey Butter.
- \*86 Spraying of Orchards.
- 87 Dwarf Lima Beans.
- 88 Early Lamb Raising.
- \*89 Feeding Pigs.
- 90 The China Aster.
- 91 Recent Chrysanthemums.
- 92 Feeding Fat to Cows.
- 93 Cigar Case Bearer.
- \*94 Damping Off.
- 95 Winter Muskmelons.
- 96 Forcing House Miscellanies.
- 97 Entomogenous Fungi.
- 98 Cherries.
- 99 Blackberries.
- 100 Evaporated Raspberries in New York.

- 101 The Spraying of Trees and the Canker Worm.
- \*102 General Observations in Care of Fruit Trees.
- \*103 Soil Depletion in Respect to Care of Fruit Trees.
- 104 Climbing Cutworms in Western New York.
- 105 Test of Cream Separators.
- 106 Revised Opinions of the Japanese Plums.
- 107 Wireworms and the Bud Moth.
- \*108 The Psylla and New York Plum Scale.
- 109 Geological History of the Chautauqua Grape Belt.
- 110 Extension Work in Horticulture.
- 111 Sweet Peas.
- 112 The 1895 Chrysanthemums.
- 113 Diseases of the Potato.
- 114 Spraying Calendar.
- 115 The Pole Lima Beans.
- 116 Dwarf Apples.
- 117 Fruit Brevities.
- \*118 Food Preservatives and Butter Increaseers.
- 119 Texture of the Soil.
- 120 Moisture of the Soil and Its Conservation.
- 121 Suggestions for Planting Shrubbery.
- 122 Extension Work in Horticulture, 2d Report.
- 123 Green Fruit Worms.

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ACT OF 1887 ESTABLISHING AGRICULTURAL EXPERI-  
MENT STATIONS.

AN ACT to establish agricultural experiment stations in connection with the colleges established in the several States under the provisions of an act approved July second, eighteen hundred and sixty-two, and of the acts supplementary thereto.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That in order to aid in acquiring and diffusing among the people of the United

States useful and practical information on subjects connected with agriculture, and to promote scientific investigation and experiment respecting the principles and applications of agricultural science, there shall be established, under direction of the college or colleges or agricultural department of colleges in each State or Territory established, or which may hereafter be established, in accordance with the provisions of an act approved July second, eighteen hundred and sixty-two, entitled "An act donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts," or any of the supplements to said act, a department to be known and designated as an "agricultural experiment station:" *Provided*, That in any State or Territory in which two such colleges have been or may be so established the appropriation hereinafter made to such State or Territory shall be equally divided between such colleges, unless the Legislature of such State or Territory shall otherwise direct.

SEC. 2. That 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 or 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 ques-

tions 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.

SEC. 3. That in order to secure, as far as practicable, uniformity of methods and results in the work of said stations, it shall be the duty of the United States Commissioner of Agriculture to furnish forms, as far as practicable, for the tabulation of results of investigation or experiments; to indicate from time to time such lines of inquiry as to him shall seem most important; and, in general, to furnish such advice and assistance as will best promote the purpose of this act. It shall be the duty of each of said stations annually, on or before the first day of February, to make to the governor of the State or Territory in which it is located a full and detailed report of its operations, including a statement of receipts and expenditures, a copy of which report shall be sent to each of said stations, to the said Commissioner of Agriculture, and to the Secretary of the Treasury of the United States.

SEC. 4. That bulletins or reports of progress shall be published at said stations at least once in three months, one copy of which shall be sent to each newspaper in the States or Territories in which they are respectively located, and to such individuals actually engaged in farming as may request the same, and as far as the means of the station will permit. Such bulletins or reports and the annual reports of said stations shall be transmitted in the mails of the United States free of charge for postage, under such regulations as the Postmaster-General may from time to time prescribe.

SEC. 5. That for the purpose of paying the necessary expenses of conducting investigations and experiments and printing and distributing the results as hereinbefore prescribed, the sum of fifteen thousand dollars per annum is hereby appropriated to each State, to be specially provided for by Congress in the appropriations from year to year, and to each Territory entitled under the provisions of section eight of this act, out of any money in the Treasury proceeding from the sales of public lands, to be paid in equal quarterly payments, on the first day of January, April, July, and October in each year, to the treasurer or other officer duly appointed by the governing boards of said colleges to receive the same, the first payment to be made on the first day of October, eighteen hundred and eighty-seven: *Provided, however,* That out of the first annual appropriation so received by any station an amount not exceeding one-fifth may be expended in the erection, enlargement, or repair of a building or buildings necessary for carrying on the work of such station; and thereafter an amount not exceeding five per centum of such annual appropriation may be so expended.

SEC. 6. That whenever it shall appear to the Secretary of the Treasury from the annual statement of receipts and expenditures of any of said stations that a portion of the preceding annual appropriation remains unexpended, such amount shall be deducted from the next succeeding annual appropriation to such station, in order that the amount of money appropriated to any station shall not exceed the amount actually and necessarily required for its maintenance and support.

SEC. 7. That nothing in this act shall be constructed to impair or modify the legal relation existing between any of the said colleges and the government of the States or Territories in which they are respectively located.

SEC. 8. That in States having colleges entitled under this section to the benefits of this act and having also agricultural experiment stations established by law separate from said colleges, such States shall be authorized to apply such benefits to experiments at stations so established by such States; and in case any State shall have established under the provisions of said act of July second aforesaid, an agricultural department or experimental station, in connection with any university, college, or institution not distinctively an agricultural college or school, and such State shall have established or shall hereafter establish a separate agricultural college or school, which shall have connected therewith an experimental farm or station, the Legislature of such State may apply in whole or in part the appropriation by this act made to such separate agricultural college or school, and no Legislature shall by contract express or implied disable itself from so doing.

SEC. 9. That the grants of moneys authorized by this act are made subject to the legislative assent of the several States and Territories to the purposes of said grants: *Provided*, That payment of such installments of the appropriation herein made as shall become due to any State before the adjournment of the regular session of its Legislature meeting next after the passage of this act shall be made upon the assent of the governor thereof duly certified to the Secretary of the Treasury.

SEC. 10. Nothing in this act shall be held or construed as binding the United States to continue any payments from the Treasury to any or all the States or institutions mentioned in this act, but Congress may at any time amend, suspend, or repeal any or all the provisions of this act.

Approved, March 2, 1887.

AN ACT making an appropriation for horticultural investigations  
by the Cornell University Experiment Station.

*The People of the State of New York, represented in Senate and Assembly, do enact as follows:*

Section 1. The sum of sixteen thousand dollars, or so much thereof as may be necessary, is hereby appropriated out of any money in the treasury not otherwise appropriated, to be paid to the Agricultural Experiment Station at Cornell University, to be expended in the fourth judicial department, in conducting investigations and experiments in horticulture; in discovering and remedying the disease of plants, vines and fruit trees; in ascertaining the best means of fertilizing vineyard, fruit and garden plantations, and of making orchards, vineyards and gardens prolific; in disseminating horticultural knowledge by means of lectures or otherwise, and in preparing and printing for free distribution the results of such investigations and experiments, and such other information as may be deemed desirable and profitable in promoting the horticultural interests of the state. Such experiment station may, with the consent and approval of the Commissioner of Agriculture, appoint horticultural experts to assist such experiment station in the fourth judicial department. Such experts may be removed by such experiment station in its discretion, and may be paid for their services such sum as may be deemed reasonable and proper, and as shall be approved by the Commissioner of Agriculture. All of such work by such experiment station and by such experts shall be under the general supervision and direction of the Commissioner of Agriculture. The sum appropriated by this act shall be paid by the treasurer of the state upon the warrant of the comptroller, to the treasurer of Cornell University, upon such treasurer filing



with the comptroller a bond in such sum and with such sureties as the comptroller may approve, conditioned for the faithful application of such sum to the purposes for which the same is hereby appropriated. Such sum shall be payable by the treasurer of Cornell University upon vouchers approved by the officers or agents of such university having charge of such experiment station, and such vouchers shall be filed by the treasurer of Cornell University in the office of the comptroller of the state.

I. P. ROBERTS.

## Report of the Treasurer.

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The Cornell University Agricultural Experiment Station in  
account with the United States Appropriation, 1895-6.

### *Dr.*

To receipts from treasurer of the United States as per appropriation for fiscal year ending June 30, 1896, as per act of Congress approved March 2, 1887. . . . .	\$13,500 00
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### *Cr.*

By salaries . . . . .	\$8,405 98
Labor. . . . .	1,098 29
Publications. . . . .	793 74
Postage and stationery. . . . .	257 46
Freight and express. . . . .	32 20
Heat, light and water. . . . .	5 36
Chemical supplies . . . . .	312 65
Seeds, plants and sundry supplies. . . . .	600 73
Fertilizers. . . . .	148 74
Feeding stuffs . . . . .	157 13
Library. . . . .	80 94
Tools, implements and machinery. . . . .	96 46
Furniture and fixtures. . . . .	394 13
Scientific apparatus . . . . .	276 18
Live stock . . . . .	20 00

Traveling expenses.....	\$146 45
Contingent expenses .....	10 00
Building and repairs.....	663 56
	<hr/>
	\$13,500 00
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We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the Cornell University Agricultural Experiment Station for the fiscal year ending June 30, 1896; that we have found the same well kept and classified as above, and that the receipts for the year from the treasurer of the United States are shown to have been \$13,500.00, and the corresponding disbursements \$13,500.00, for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance on hand.

And we further certify that the expenditures have been solely for the purpose set forth in the act of Congress approved March 2, 1887.

H. B. LORD,

R. H. TREMAN,

*Auditors.*

[L. s.]

Attest:

EMMONS L. WILLIAMS,

*Custodian.*

## Report of the Chemist.

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*To the Director of the Cornell University Agricultural Experiment Station:*

Sir.—One hundred and eighty-four samples were analyzed in the chemical laboratory of the Experiment Station during the year 1896, as follows:

Five samples of milk, for fat; four samples of manure leachings, for fertilizing value; fifteen samples of manures, ditto; fourteen samples of grain, straw and chaff, ditto; six samples of soil, for nitrogen, phosphoric acid and potash; six samples of clover, for nitrogen; complete analyses of eleven samples of straws, grain and chaff; sixteen samples of corn and five samples of beans, for fodder value; sixty-seven samples of soils, for moisture; nineteen samples of grapes, for sugar and acid; three samples of Paris green, for arsenic; four complete analyses of fertilizers; four samples of sugar beets, for sugar; one sample of corn, for moisture; and one sample of "Callerine," a food preservative.

Investigations are in hand on the urine of the horse, the relation of the composition of celery to its quality and the estimation of the pentosans.

G. C. CALDWELL.

## Report of the Botanist.

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*To the Director of the Cornell University Agricultural Experiment Station:*

Sir.—Since the presentation of the last annual report from the Botanical Division several changes have been necessitated in the organization of the staff of the department, owing to the resignation of Professor Albert Nelson Prentiss on account of prolonged illness, during last February. Professor Prentiss has since died and it seems fitting here to call attention to his long service in the University, and to his continued interest in the advancement of the work of the Experiment Station by promoting the investigations of these botanical subjects which are peculiarly related to Agriculture.

In the reorganization of the Division the Cryptogamic Botanist was appointed Botanist. Dr. E. J. Durand, the Assistant Cryptogamic Botanist, being transferred to the instructing staff of the University, Mr. B. M. Duggar was appointed Assistant Cryptogamic Botanist of the Experiment Station.

During Dr. Durand's connection with the Division of Botany he made a special study of a serious disease of current canes which had been called to our attention from various localities in New York. These investigations have occupied considerable time owing to the desirability of tracing the life history of two different but closely related fungi which are parasitic on the canes. This has been done by the aid of pure cultures in arti-

ficial media. The bulletin is now ready for publication. It treats of the general character of the disease, the structure of the fungus, its development, and suggestions for treatment. The fungus belongs to a genus which contains several very injurious parasites of plants.

During the last year I have given considerable time to the investigation of the diseases of timber trees, and a bulletin on this subject is nearly ready for publication. Also a bulletin on anthracnoses of plants which is the result of several years study will be ready for publication before very long.

Mr. B. M. Duggar, the Assistant Cryptogamic Botanist, has conducted a number of investigations with remarkable vigor and has already accomplished a considerable amount of important work, though he has been connected with the department for only six months. Besides the work which he did in the Horticultural Schools of the State during the summer and autumn, I would call attention to the following investigations by him. He has nearly ready for publication a bulletin dealing with a serious trouble of stored celery. This rot of celery is caused by a species of *Septoria*, which during the summer is the cause of the so-called spot of celery. He has been able to demonstrate that the same fungus carried into the houses in the autumn in storing the celery spreads there on the plants with entirely different appearances and effects. He has also in progress an investigation on several different kinds of rot of celery grown in houses during the winter. This will in the future be presented as a second bulletin. Another very important piece of investigation is that of the pear and quince leaf spot, which owing to the long period required for the complete development of the parasites connected with it, will require a longer time for

its completion, but there is scientific evidence now on hand to indicate that important information can be published concerning these diseases when the investigations are completed. Besides these definite lines of investigation Mr. Duggar has others in progress on several other plant parasites, all of which in the future will contribute to the knowledge of the life histories of these low forms of plant life, which it is desirable to know in order to determine rational methods of treatment. Mr. Duggar has also conducted considerable of the correspondence, answering the letters of inquiry about plant diseases.

I cannot close without acknowledging the important aid which Professor Rowlee of the Botanical Department has given in attending to the correspondence upon subjects with which he is familiar.

Considerable additions have been made to the apparatus in the department which aids materially in the prosecution of the work.

GEORGE F. ATKINSON.

## Report of the Entomologist.

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*To the Director of the Cornell University Agricultural Experiment Station:*

Sir.—As the carrying out of the Entomological work of the Station has been performed during the past year almost entirely by the Assistant Entomologist, I have requested him to prepare a report on it, which I hereby transmit.

JOHN HENRY COMSTOCK.

*To the Entomologist of the Cornell University Agricultural Experiment Station:*

Sir.—The year 1896 has been an exceedingly busy and interesting one for the Entomological Division of the Station. So far as insect pests are concerned, the year has been rather a remarkable one in New York State. The codlin moth, plum curculio and other insects which can usually be depended upon to harass the fruit-grower every year were noticeably much less destructive. But the year was marked by the appearance in injurious numbers of several insects that had not attracted serious attention anywhere in our State for more than a decade; they were thus new pests to many farmers and fruit-growers. The army worm (*Leucania unipuncta*), the green fruit worms (*Xylina* sp.), the pistol-case-bearer (*Coleophora malivorella*), and the peach twig-worm (*Anarsia lineatella*) were these apparently "new" insect pests that have ravaged New York crops during the past year. Our notes contain considerable new information



about all of the above insects and several others, and this knowledge is being put into the form of bulletins as fast as possible.

The following bulletins were issued from this Division during the year:

No. 107. Wireworms and the Bud Moth.

No. 108. The Pear Psylla and the New York Plum Scale.

No. 123. Green Fruit Worms.

Another on the pistol-case-bearer is ready for publication, and our investigations in 1896 resulted in sufficient material for at least three more bulletins which we hope to have ready for publication before next spring. In these three bulletins we expect to discuss the army worm in New York State, a currant stem-girdler and a new raspberry cane-magot, and the codlin moth. The first will contain many new figures, the second much new information, accompanied by new illustrations, and the third will embody some very important, as well as new, facts regarding that apparently best-known of all fruit pests—the apple worm or codlin moth.

Some important results have been obtained in our extensive peach borer experiment, and new ideas suggested by these are now being tested. We shall continue the experiments another year at least.

Considerable work has been done by this Division under the auspices of the so-called Experiment Station Extension or Nixon bill. The investigations undertaken resulted in material for Bulletin 123 and for the bulletin on the pistol-case-bearer, just completed. The Assistant Entomologist spent over a month in giving instruction in the horticultural schools held in different parts of the Fourth Judicial District.

The correspondence of the Division continues to increase rap-

idly, and now occupies a large share of our time. But, believing that this is one of the most valuable and important phases of our work, we continue to cheerfully give to every correspondent the latest and best information at our command. Nearly 800 letters of inquiry regarding insects and their injuries were answered during the year; 125 of these answers were prepared for publication and have appeared in the columns of agricultural journals. Several technical articles have also been written for entomological journals.

M. V. SLINGERLAND.

# Report of the Agriculturist.

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*To the Director of the Cornell University Agricultural Experiment Station:*

Sir.—I submit herewith the report of the Agricultural Division of the Cornell University Experiment Station for the year 1896. The larger part of the work has been along the lines of determining the effects of introculture upon the production of farm crops and investigations with reference to the conservation of soil moisture. That there is need for investigation and dissemination of knowledge along these lines is shown by the low average yield of the staple crops throughout the State compared with what might be secured were better methods of tillage more generally practiced.

Interesting and valuable results have been secured with reference to potato culture and the production of forage crops. A comparative study of some leguminous plants to determine their nitrogen storing capacity has been commenced and will be continued during the coming year.

The hay crop and the permanent pastures throughout the State have been so affected by droughts during the past few years that it has become a serious question with many farmers as to what they shall provide in their place or to supplement them. To throw light on this subject experiments have been inaugurated with the view of determining the best crops for green soiling and how silage may best be preserved under different meth-

ods of treatment. Many experiments commenced in former years have been duplicated and results verified. The subject of the leaching of manures has received considerable attention and there is now material at hand for the publication of several bulletins upon the subjects which have been under investigation.

Lime and its action upon acid soils, its value as a conserver of moisture and the beneficial action it exerts on the physical condition of soils are all questions now under investigation and to be investigated during the coming year. It is proposed to commence a series of coöperative culture experiments. Such marked results have been obtained at the Station by improved conditions and by increased tillage of farm crops that in order more fully to verify the results obtained and awaken interest in the work among farmers, an extensive coöperative experiment in potato culture will be inaugurated.

In general, the work of the Division will be largely along the lines of securing increased crop production by better methods of tillage.

L. A. CLINTON.

## Report of the Horticulturist.

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*To the Director of the Cornell University Agricultural Experiment Station:*

Sir.—The past year has been altogether a most prosperous one for the Horticultural Division of the Experiment Station. Its endeavors, however, have been somewhat dismembered, owing to the experiment extension work which has been asked of it by the Legislature. The work might be roughly divided, therefore, into the two categories of home work, or station work proper, and the extension or itinerant work. The later has consumed by far the greater amount of our time and energies during the past year, as, in fact, it did in the two preceding years. In reporting the condition of my Division to yourself early in 1894, I took occasion to suggest that one of the means by which the Experiment Station could help the people was through State aid, which should give us facilities for publishing more information and which should allow us also to hold horticultural meetings or schools for the purpose of popularizing and disseminating the horticultural knowledge of which experimenters are now possessed. At that time I had not anticipated that the recommendation would find such complete and speedy fulfillment. It was in that very year that we were asked to undertake the extension of our horticultural work, and this endeavor has now been prosecuted consecutively for three years. The full results of this work, so far as they can be indicated at the present time,

are set forth in Bulletins 110 and 122. I need, therefore, say nothing more respecting the extension feature of the work of my Division.

At the present time I am as anxious that the Horticultural Division of the Station may return to its original type of labor as I was three years ago that it depart therefrom. My reason for this feeling is the fact that this extension work has now grown to be such a large and responsible enterprise that it should no longer be confined to one division of the Experiment Station. It should be placed under the management of a separate division, and there is every reason to believe that it would be more useful to the State if applied to other branches of rural effort than to horticulture. In the home Station itself, there have been comparatively few changes, and these have not all been for the betterment of the Division. One of the Experiment Station forcing-houses has been entirely rebuilt and is now an ideal house for certain lines of experiment. The orchards have now come to bearing age and have occupied so much of our small area that we have very little left for conducting experiments in vegetables and other annual crops. A year ago, a considerable area of my Division was demolished by changes in the grounds of the University, and the entire collection of grapes, of native plums and many small fruits, to all of which we had given much attention, were entirely obliterated. In order to repair this damage in part, we have, during the past year, fitted up a new piece of land and have set thereon a small experimental vineyard. The loss of the native plum orchard is practically irreparable, however, because it contained many varieties and seedlings which are not in the market; and the same remark will apply to some of the small fruits. Considering the limitation of our area, and the variable

character of the land, we can not make extensive studies of fruit plantations, and we must give increasingly greater attention to subjects of intensive gardening. The greatest needs of the home Division at present are still greater facilities in the forcing of plants and extension of the experiments in ornamental plants and decorative gardening. The extensive commercial fruit plantations of New York State afford ample facilities in which to study the question of fruit-growing in its fullness, with the simple exception of the testing of varieties, an enterprise which, however, we have never undertaken as a leading role in our experiment work. But in some of the finer and intenser kinds of horticultural work, as the forcing-house industry and others, there is a great need, it seems to me, for increased facilities right here. One of the next lines of effort which we must undertake, and which is yet new to the experiment station research of the country, is a line of studies in the forcing of fruits. Our experiments in the forcing of vegetables, whilst not yet concluded, have, nevertheless, reached the point at which we are able to give rather definite advice respecting the commercial aspects of the subject.

It gives me the greatest pleasure to express my gratitude to yourself and to all my associates for the most generous help which has been given the work of my Division during the trying responsibilities of the past three years.

L. H. BAILEY.

# Report of the Assistant Professor of Husbandry and Animal Industry.

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*To the Director of the Cornell University Agricultural Experiment  
Station:*

Sir.—I have the honor to transmit a brief report upon the work of the Dairy Division of the Agricultural Experiment Station for the year 1896.

The work of the Division has progressed along the lines pursued in former years. The most extensive experiments for the past year have been in relation to the quantity of milk as effected by changes in the food of the animal, and in this work I have had the assistance of graduate students in the College of Agriculture. Material is now in hand that will be ready for publication at no very distant date.

The records of the production of our herd that were begun some five years ago have been continued during the year and have added materially to our facilities for work. We have also been able to test the weekly production of several herds of thoroughbred cattle in various parts of the State.

In conclusion I can not refrain from again calling attention to the need for an assistant in this Division who shall give his whole time to the work of the Agricultural Experiment Station.

H. H. WING.



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BULLETIN 106—January, 1896.

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Cornell University—Agricultural Experiment Station,

ITHACA, N. Y.

HORTICULTURAL DIVISION.

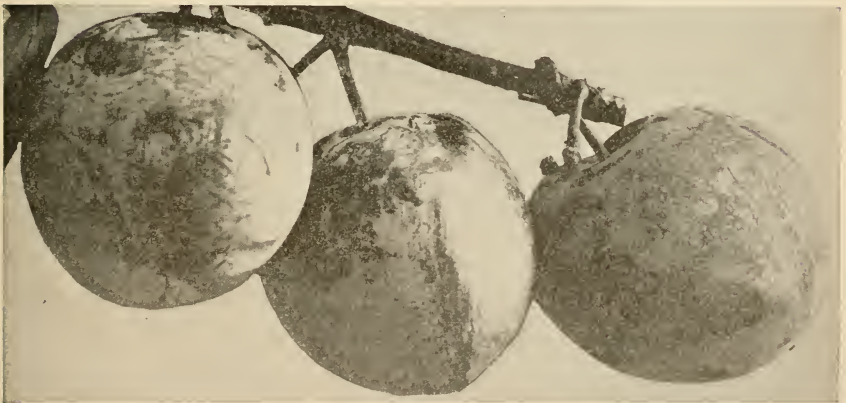
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REVISED OPINIONS

OF THE

# JAPANESE PLUMS.

LIBRARY  
NEW YORK  
BOTANICAL  
GARDEN



Burbank. Page 46.

By L. H. BAILEY.

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Office of the Director, 20 Morrill Hall.

The regular bulletins of the Station are sent free to all who request them.

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In 1895, the following Bulletins were issued:

84. The Recent Apple Failures in Western New York.
85. Whey Butter.
86. Spraying of Orchards.
87. The Dwarf Lima Beans.
88. Early Lamb Raising.
89. Feeding Pigs.
90. The China Asters.
91. Recent Chrysanthemums.
92. Feeding Fat to Cows.
93. The Cigar-Case-Bearer.
94. Damping Off.
95. Winter Muskmelons.
96. Forcing-House Miscellanies.
97. Entomogenous Fungi.
98. Cherries.
99. Blackberries.
100. Evaporated Raspberries in Western New York.
101. The Spraying of Trees; with remarks on The Canker-Worm.
102. General Observations Respecting the Care of Fruit Trees; Weeds.
103. Soil Depletion in Respect to the Care of Fruit Trees.
104. Climbing Cutworms in Western New York.
105. Tests of Cream Separators.

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## BULLETINS OF 1896.

106. Revised Opinions of the Japanese Plums.

CORNELL UNIVERSITY, }  
ITHACA, N. Y., *January 1, 1896.* }

*Honorable Commissioner of Agriculture, Albany :*

SIR.—The following account of the Japanese plums is submitted for publication under the Experiment Station Extension bill (chapter 230, Laws of 1895). There is a universal interest in the Japanese plums amongst the fruit growers of western New York and it, therefore, seems to be wise to publish this bulletin, as a sort of report of progress, even though the subject is very much confused. It is hoped that the bulletin may tend to check further confusion, by bringing into one report an account of all the varieties which are now before the public. In making these studies of Japanese plums, I have depended quite as much upon the information which I have gathered in many plantations about the State as I have upon our own tests.

L. H. BAILEY.

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NOTE.—The illustrations in this bulletin show the fruits full size, but the reader must bear in mind the fact that pictures always look smaller, to the untrained eye, than the objects which they represent.



1.—Abundance, from Daniel Roberts, Keyport, N. J. (See page 41.)



## Revised Opinions of the Japanese Plums.

Two years ago this station published an account (Bulletin 62, "The Japanese Plum in North America") of the Japanese plums as they were then known in this country. Our knowledge was very fragmentary and imperfect at the time, and it was not expected that final conclusions could be reached respecting most of the questions which were uppermost in the public mind. Yet the confusion in which the whole subject lay was so great that it was thought better to publish such conclusions and facts as we possessed rather than to allow the perplexities and the entanglements of nomenclature to increase. Many of the varieties which were passing under indefinite class names were renamed, and the new nomenclature has been widely adopted by nurserymen.

The interest in Japanese plums is unabated, and it now seems to be wise to again report upon the subject, adding the experiences of the two past seasons. It will be many years yet before the difficulties of nomenclature can be wholly cleared up, but an occasional report of progress may be expected to hasten the final outcome. A few varieties are now fairly well understood, and descriptions of these are printed in large type in this paper. I have attempted to add descriptions of all other varieties, in smaller type, for the purpose of bringing our scattered knowledge together for convenient reference; but many of these varieties I have not yet seen in fruit and I cannot, therefore, vouch for the accuracy of the descriptions.

In my former report, I said that "altogether, the Japanese plums constitute the most important type of fruit introduced into North America during the last quarter of a century, and they should receive careful tests in all parts of the country." I am now more fully convinced of the truth of this statement than I was at that time; but some persons seem to have read it so carelessly as to have obtained the idea that I recommend the Japanese plums as superior to the old domestica or European types and to the

natives. The latter classes were already well established a quarter century ago, when the Japanese sorts first came into the country, and their value is not lessened by the introduction of the Japanese type. Wherever the common domestica plums will succeed, they are still the most valuable types, but some of the Japanese sorts can be added for variety with profit. The Japanese type is adapted to a much wider range of our country than the domestica plums are, and they introduce certain features which are invaluable everywhere. The peculiarly desirable features presented by many of the Japanese plums, in various degrees, are earliness, great productiveness, almost complete freedom, so far, from black-knot and leaf-blight, long-keeping qualities and beauty of fruit. In quality they are generally inferior to the domesticas, although several of them compare favorably in this respect with the Lombard. The only other foreign species of fruit which has been lately introduced into this country and which approaches the Japanese plums in importance, is the kaki or Japanese persimmon; but this fruit is confined to the fig belt, whilst the plum thrives from Canada to the Gulf. A third Japanese fruit — introduced over a quarter century ago — the Japanese pear, is also important, and a report on it may be expected from this station within the present year.

It is yet too early, in my judgment, to recommend the extensive planting of the Japanese plums in this State, yet such varieties as Red June, Abundance, Burbank, and Chase seem to be safe to plant: and to this lot may no doubt be added, as a second-choice list, Georgeson, Maru, Chabot, Ogon, Berckmans, Satsuma. For very early, we might add Berger and Yosebe, and Willard. The first two are very small, and the last is very poor in quality. The experiences of one or two more seasons may modify this list considerably, but it represents the best information which I possess at the present moment, for New York.

Those who desire a fuller exposition of the history and characteristics of the Japanese plums, may consult our Bulletin 62.\*

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\*The following additional historical notes may be added: D. E. Hough, who first received the Japanese plums in this country, had a small nursery in Vacaville, California, about 1870 to 1875. Professor Wickson writes: "Mr. Hough was a very expert budder and budded stock for others as well as on his own account. He was quite given to roving from place to

It may be said that the fear expressed in that bulletin that these plums may be found to bloom too early for safe cultivation in western New York, has proved to be unfounded. Farther south, however, and even in Ohio and Indiana, the habitual early bloom of some varieties renders them unsafe. The winters are more uniform in character here than they are farther south, and the "warm spells" of early spring are rarely pronounced enough to start the blossoms. It is probable, also, that the many large bodies of water in and about western New York exert a considerable influence in retarding the fitful variations of early spring. I have yet to hear of any serious loss of Japanese plums through late spring frosts. There was an abundant crop of them in many parts of western New York in 1895, notwithstanding the hard frosts of May.

ABUNDANCE (*Lovett, Catalogue, 1888*). Figs. 1, 2.

Botan, of some.

Medium to large, globular to globular-oblong, generally with a distinct but minute point at the apex, often unequal-sided; stem  $\frac{3}{4}$  in. long; under-color yellow, overlaid with coppery red or with very bright pink-red on the exposed side, in well-colored specimens the entire surface reddened and the under-color almost completely obscured or showing through only in dots and small flaky patches; flesh firm, yet rather elastic and very juicy, sometimes slightly stringy, light amber-yellow, sweet and fully as good as

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place and turned over his acquisitions to other parties. He seems to have pulled up stakes in Vaca valley between his enlistment of the United States officer in Japan in getting the trees, and the arrival of the trees in San Francisco, and therefore he turned over the stock to John Kelsey. D. E. Hough died about twelve years ago."

Mr. Burbank wrote me as follows, in 1894, respecting his first importation: "My collector whom I sent to southern Japan about ten years ago for the Satsuma—of which, two years before, I had found a description in a book in the Mercantile Library of San Francisco, written by a sailor—sent me about half or more of the Japan plums now in general cultivation. All collectors inform me that there were no nurseries until lately, and when an order was given, the collector secured a few here and there, wherever they could be found. This accounts for the confusion of the names."

Lombard when well ripened, although sometimes having a slight musky flavor, the skin rather sour; cling.

The above description is drawn from specimens received from Daniel Roberts, Keyport, New Jersey, and from many New York samples which were indistinguishable from Roberts' specimens. I wrote to Mr. Lovett for fruits from the original tree of Abundance; he replied that the tree is not standing, but referred me to Mr. Roberts, whose trees were propagated from the original stock.



2.—Abundance tree, 6 years old.

Mr. Roberts sent me excellent samples, some of which I then sent to Mr. Lovett, who wrote that the fruit "arrived in perfect condition, and is the true Abundance." I was thus particular about the matter, because there appear to be two if not three things sold in the country as Abundance; or else the variety is wonderfully modified by climate and local conditions. This exact type of Abundance is much planted in western New York. It is the same variety which I described and figured in Bulletin 62.

The Abundance makes a hardy, thrifty, upright-spreading tree, (Fig. 2). It is very productive, and the fruit generally needs



thinning to bring it to perfection. Abundance ripened at Ithaca in 1895 the first week in August, over two weeks ahead of Lombard, a week ahead of Burbank, three weeks later than Yosebe, two weeks later than Willard, and a week to ten days later than Red June.

I do not know if the Yellow-fleshed Botan is identical with Abundance. This name was given by P. J. Berckmans to distinguish a variety received by him from Luther Burbank under the name of Botan. There were two varieties in the batch, and the other, with a lighter-colored and sweeter flesh was named, by Mr. Berckmans, Sweet Botan. This latter is now called Berckmans. When Mr. Lovett sent out his Abundance, it was pronounced to be identical with Yellow-fleshed Botan by Mr. Berckmans. "I have seen trees that were received from Lovett," Mr. Berckman writes, "whose fruit was identical with Yellow-fleshed Botan." The Yellow-fleshed Botan fruits which Mr. Berckmans has sent me several times, seem to differ from the Abundance, as grown here, in the yellower color, less prominent point at the apex, and shorter stem, but these differences may all be due to climate or other local environments. I often notice that plums may be shorter-stemmed when grown in the south than when grown in the north. In specimens which I have received from Berckmans, the Yellow-fleshed Botan has a lighter-colored flesh than the Berckmans. We have trees of the Yellow-fleshed Botan growing, and shall soon be able to determine its relationship to Abundance.

BABCOCK (*Bailey, Cornell Bull.* 62, p. 19, 1894).

Botankio and Botan, of some.

"Medium to large ( $1\frac{1}{2}$ – $1\frac{3}{4}$  in. diam.), round-conical; skin yellow overlaid with purplish red, rather thick; flesh deep orange and solid, a little coarse, sweet, of good flavor and quality; cling; rather late, ripening about with the Burbank, or about a week earlier than Chabot in the south.

"Imported in 1885 by Luther Burbank. Now named for Col. E. F. Babcock, a well-known nurseryman of Little Rock, Arkansas, and among the first to grow and recommend the variety."—*Bulletin* 62.

I have never seen a fruit which I could refer to this variety. I substituted the name Babcock for the loosely applied Botankio,

drawing my description very largely from notes furnished me by Colonel Babcock. Our own variety bought as Botankio turns out to be Abundance.

BAILEY (*J. L. Normand, Catalogue, 1891*).

“Large, nearly globular, with only a slight tendency to become conical; ground-color rich orange, overspread with light and bright cherry red, and showing many minute orange dots; flesh thick and melting, yellow, of excellent quality; cling. Tree strong and upright, productive. Closely related to Burbank, but rounder and mostly larger, and a week or more later.

“Imported by J. L. Normand, Marksville, Louisiana, and by him named and introduced in 1891. Figured in *American Gardening*, xiii. (1892), p. 700. There appears to be another Bailey plum of the domestica type. I know it only from a plate made by Dewey of Rochester, and who declares that it ‘has not failed to bear for twenty-five successive years.’ The Rochester Lithographing Co., successors to Dewey, write me that this plate was in Dewey’s stock before 1886, but that they know nothing further about it.”—*Bulletin 62*.

I have not yet fruited this variety, but I have received it from several sources. Mr. Berckmans regards it as identical with Chabot. It is also remarkably like the Chase and Hoyo Smomo. It is possible that all these four names belong to the same plum. It is evidently a good plum, whatever its proper name may be found to be.

BERCKMANS (*Bailey, Cornell Bull. 62, p. 20, 1894*).

True Sweet Botan.

Sweet Botan.

White-fleshed Botan.

Botan, of some.

Medium (or slightly above if thinned), broadly and obtusely conical and somewhat angular in cross-section; dull deep blood red if ripened in the sun, sometimes with yellowish patches on the shaded side; flesh very sweet, moderately juicy or dry; cling or semi-cling; ripens with Abundance or just ahead of it. Becomes too dry when very ripe.

Introduced by Luther Burbank in 1887, from imported stock. The variety does not appear to be a true Botan, and its nomenclature is so confused and indefinite that I renamed it for Mr. Berckmans, who, to distinguish it from another variety which was also received under the name of Botan (see remarks on Yellow-fleshed Botan, under Abundance), called it White-fleshed Botan. Mr. Berckmans considers it poor in quality, but as it is grown in the north it compares well with Abundance; and even the specimens which Mr. Berckmans has sent me seem to me to be superior in quality to the Abundance which he has sent. Deeper and duller red than Abundance, lacks the point characteristic of that variety, and the flesh is much drier. Very productive. Figured in Bulletin 62.

BERGER (*Munson ; Bailey, Cornell Bull. 62, p. 20, 1894*).

Fruit very small and globular, bright uniform red, with a firm, meaty and sweet yellow flesh and a very small free stone, ripening the middle of July in New York.

There has been much confusion respecting this plum. Mr. Berckmans once sent it to me without a name, saying that it came from H. H. Berger & Co., of San Francisco, as Red Nagate. N. S. Platt sent it from Connecticut as Satsuma, the name under which it was received from Berger. It came from the south (also originally from Berger) as Shiro Smomo. I also have it from western New York, unnamed. T. V. Munson, Texas, sent specimens which he called the Berger, and I adopted his name and published it in Bulletin 62. He writes as follows of it: "The Berger plum is an upright, cherry-like tree. It bears a purple fruit about the size of the Black Tartarian cherry, with meaty flesh, nearly free stone which is as small as the pit of the common Black Morello cherry and much the same shape." It falls from the tree as soon as ripe, leaving the stem on the tree. An interesting little fruit for the home garden, but too small for market. There is a picture of it in Bulletin 62. See Yosebe.

BLOOD: See Satsuma.

BLOOD PLUM No. 3.

"Fruit somewhat smaller than Satsuma, flesh very deep red and juicy, sweet; middle of July; tree of very open straggling growth."  
—*P. J. Berckmans, Catalogue, 1895.*

## BLOOD PLUM No. 4.

“This corresponds with the description of *Honsmomo* of the Agricultural Bureau of Tokio. Fruit medium, dark red flesh; July 10th to 25th; tree of erect growth.”—*P. J. Berckmans, Catalogue, 1895.*

BOTAN: See Abundance, Babcock, Berckmans, Willard.

BOTANKIO: See Abundance and Babcock.

BURBANK (*Van Deman, Rept. Dept. Agric., 1891, p. 392.*)

Fig. on title page and Nos. 3 and 4.

Medium, to rather large upon thinned trees, conical to oblong in form, the point generally blunt; ground-color orange-yellow mostly



3.—Burbank From Luther Burbank, Santa Rosa, Cal.

rather thinly overlaid with red and showing many yellow dots, often more or less marbled, in the sun becoming rather dense red; flesh firm and meaty, yellow, not stringy, rich and sugary; cling. As compared with Abundance, it is a week or two later, more oblong and lacking the peculiar point of Abundance, flesh firmer and not inclined to be stringy, and sweeter, lacking the slight muskiness of Abundance. Burbank is shaded and splashed with dull maroon-red and is much spotted, the yellow under-color being conspicuous. Abundance is a vivid pink-red, the yellow ground conspicuous only on the shaded side. In 1895, the Burbank on our grounds was less than a week later than Abundance, but the very dry season may have ripened it ahead of its usual season.

A specimen of the Burbank sent by Luther Burbank, Santa Rosa, Cal., is shown natural size in Fig. 3. It is very unlike the Burbank

as grown in the east. The size is greater, and the color a deep claret red with minute golden dots. The flesh was very thick, firm and meaty, and of excellent quality.

The variety is a most sprawling, flat-topped or even drooping grower (Fig. 4); and this habit distinguishes the variety from all other Japanese plums which we have grown. The tree should probably be headed-in when young, to keep it within bounds. The fruit generally needs thinning, for the tree is enormously productive.

The Burbank was imported by Luther Burbank, Santa Rosa, California, late in 1885, and named for him by H. E. Van Deman.



4.—Burbank tree, 6 years old.

See Rept. Dept. Agr. 1891, p. 392, where it is also given a good colored plate. Generally introduced in 1890.

The Russian plum 20 M, sent me by Professor Budd, is indistinguishable from Burbank. We have two trees of it, and they bore two or three bushels of plums this year.

#### BURBANK No. 1.

Said to resemble Berekmans. I do not know it.

#### BURBANK No. 2.

“Described as of medium size, regular and globular in shape, yellow over-spread with purplish carmine, with a yellow very juicy flesh which is fine-grained and of good quality; pit nearly free. Very early. This variety is not reported in any recent tests.”—*Bulletin 62.*

“Burbank No. 2, from Berckmans, fruited in 1892 and since; no apparent difference between it and our Abundance.”—*Stark Bros.*, 1895.

BURBANK No. 3: See Late Blood.

BURBANK No. 4: See Heikes.

BURBANK No. 11.

I know this only from specimens received the past summer from Stark Bros., Louisiana, Missouri. It looks very much like Willard.



5.—Chabot.

Freestone or very nearly so. Drops easily: Season of Red June, and said by Stark Bros. to be not worth propagating.

CHABOT (*Burbank*). Fig. 5.

Medium to large (size of Burbank), oblong-conical; under-color orange, deeply overlaid with light cherry-red, the sunny side dark red, and many minute golden dots showing through the red over-color; flesh yellow, rather soft, not stringy, sweet and of excellent quality, with no almond flavor; skin scarcely sour; cling. An excellent plum, ripening early in September in this latitude.

Imported from Japan by Mr. Chabot, of Berkeley, California, but introduced to the trade by Luther Burbank in 1886. See Chase.

## . CHABOT BLOOD.

“A novel and remarkable addition to our fruits. The size is medium, stem very short, and of a brick red or cinnabar color; flesh firm, fine brick red color; very juicy and sweet, and with a peculiar aromatic flavor.”—*Catalogue California Nursery Co., Fourth Edition (recent: no date).*

CHASE (*R. G. Chase Co., Catalogue, 1893*). Fig. 6.

Hattonkin, of some.

Yellow Japan, of some.

Medium to large, heart-shaped; under-color yellow (like Abundance), deeply overlaid with dull red and showing many golden dots, finally becoming uniformly dull red all over; bloom thick; flesh yellow, firm, rather juicy, sweet and good; skin rather tough; cling. The coloring is that of the Burbank, but the plum is more pointed and it is two or three weeks later, ripening in this latitude the first or second week in September.

This very excellent plum was bought by the Chases for Abundance, but is about a month later than that variety. It is of the Chabot type and may not be distinct (see remarks under Bailey). The tree is a strong upright-spreading grower, and productive. It is considerably disseminated in New York under the name of Yellow Japan, although it is a red plum. Chase Co. speaks of the tree as “a good grower” and blooming “two weeks later than Abundance, thus escaping the spring frosts.”

DELAWARE (*Burbank, Catalogue, 1893*).

“Roundish, conical, medium in size, purplish bronze in color with a white bloom; flesh wine-color, juicy, combining many flavors. Trees semi-dwarf, very productive. Catalogued amongst Luther Burbank’s novelties, 1893. Said to be a cross of Satsuma and Kelsey.”—*Bulletin 62*.

DOUGLAS (*R. H. Price, Bull. 32, Texas Exp. Sta., p. 488, 1894*).

Munson, of Bailey, Bull. 62, p. 27.

Hytankayo, of Whitaker.

Hattankio, of some.

“Size rather large, conical, yellow with purple tinge; skin tough; flesh firm, flavor very good. Tree upright vigorous grower,

hardy and very productive. Nearly free from attacks of insects and fungi."—*Dr. Whitaker, Tyler, Texas, in Bull. 32, Texas Exp. Sta.*

Imported and introduced by Dr. Whitaker. The name Munson which I proposed for this plum in Bulletin 62, is antedated by another Munson plum of the Chickasaw type.

#### EARLIEST OF ALL (*Stark Bros.*).

Yosebe, of some.

"Small to medium, globular; color a solid dark red; quality good; pit small, free. Fully ten days earlier than Red June. It drops as soon as colored. Our idea in growing this variety for market would be to shake the fruit on a sheet and market in quart berry boxes. Very productive. Leaf very narrow, conduplicated and somewhat smaller than the Red June."—*Stark Bros.* See Uchi-Beni.

#### ENGRE.

Fruit small, globular, red, almost exactly like Willard and of same season; poor. It seems to differ from Willard in foliage, however. The leaves are short and elliptic, whilst those of Willard are long and obovate. Little known. Two varieties seem to be passing under this name.

#### EXCELSIOR (*Cherokee Nursery Co.*).

"A seedling of the Kelsey. Fruit large, round,  $1\frac{1}{2}$  inches in diameter; color reddish purple, with heavy blue bloom, flesh sweet, juicy, melting and of excellent quality. Ripens early in June. The trees of this variety had more fruit last year than any other variety, either native or foreign. It is undoubtedly a cross between the Kelsey and some variety of the Chickasaw type. The tree is a very strong grower, symmetrical and handsome; a valuable variety."—*Catalogue, Cherokee Nursery Co., Waycross, Ga.*

The fruits which I have seen were an inch and a half in diameter, round-conical, with a distinct small sharp point; stem slender; color very bright dark red with many minute gold dots; flesh soft and watery, sweet; cling. The fruit and foliage suggest only the Wild Goose type (*Prunus hortulana*), but the pit suggests Kelsey.



## FURUGIYA.

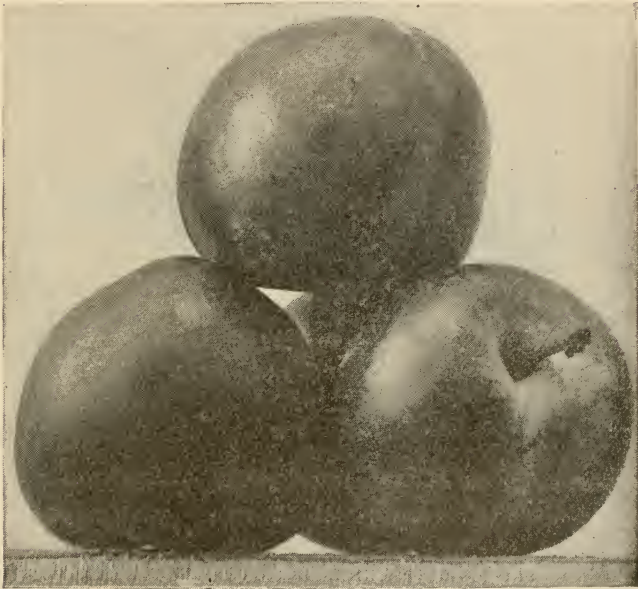
Name given, without description or comment, by J. L. Normand, Marksville, La., in "Special Circular of New Japan Plums and Rare Novelties," 1895-6.

GEORGESON (*Bailey, Cornell Bulletin 62, p. 23*), Figs. 7 and 8.

Hattonkin, No. 1.

Hattonkin, of some.

Hattankio, of some.



7.—Georgeson.

Medium in size, or fairly large when thinned, variable in shape but usually irregularly globular with a flattened apex but sometimes obscurely conical; color a clear rich uniform yellow, with a thin white bloom and minute whitish dots in the skin; flesh very firm, not juicy nor stringy, sweet and good; skin sour; strong clingstone. Ripe at Ithaca in 1895 the last days of August and first days of September, one or two weeks later than Burbank. I had it from Niagara county, New York, however, early in August. A very long keeper. Fairly productive.

Tree (Fig. 8) a sprawling, forked grower, intermediate in form between Abundance and Burbank. The variety is well distributed in Western New York, under a variety of names. Imported by H. H. Berger & Co., San Francisco, and brought to notice chiefly by J. L. Normand, Marksville, La.

GOLDEN (*Burbank Catalogue*, 1893).

Said to be a cross of Robinson (a Chickasaw) and Kelsey.

HALE (*G. H. and J. H. Hale*, 1895).

“J,” of Burbank.

Prolific, of Burbank.



8—Georgeson, 6 years old.

A very handsome, large round-cordate plum, usually lop-sided; orange, thinly overlaid with mottled red, so as to have a yellowish red appearance, or, in well-colored specimens, deep cherry-red with yellow specks; flesh yellow, soft and juicy (not a good keeper), not stringy, with a very delicious, slightly acid, peachy flavor; skin somewhat sour; cling. Very late. I know the fruit only from specimens sent at two or three different times by Luther Burbank. To my taste, these specimens have been the best in quality of all Japanese plums, although Mr. Burbank regards it as inferior in this respect to Wickson (which see). Seedling of Satsuma.

HATTANKIO: See Douglas, Georgeson, Kerr.

HATTONKIN No. 1: See Georgeson.

HATTONKIN No. 2: See Kerr.

HEIKES (*Bailey, Cornell Bulletin* 62, p. 23, 1894).

Burbank No. 4.

Much like Late Blood, but rather more flattened on the ends, or oblate, mostly darker in color, the flesh acid. Little known.

Named for W. F. Heikes, of the Huntsville Nurseries, Huntsville, Ala.

HOUSMOMO.

Name inserted in "Special Circular" (1895-6) by J. L. Normand, without note or comment. (Misprint for Honsmomo? See Blood No. 4).

HOYO SMOMO.

Apparently identical with Bailey, which see.

HYTANKAYO: See Douglas.

JUICY (*Burbank, Catalogue*, 1893).

Cross of Robinson (a Chickasaw plum) and Kelsey.

KELSEY (*W. P. Hammon & Co., Oakland, Cal.*).

Very large (2-3 in. diam.) and long-pointed, tapering gradually from a heart-shaped base, usually somewhat lop-sided, with a deep furrow-shaped suture; color, bright red-purple on a yellow ground, more or less marked with dots, very showy; flesh light yellow and rather firm, rich and pleasant in flavor, free or only slightly clinging to the small stone, more or less hollow above the pit.

The first Japanese plum introduced into this country, but it did not attract much attention outside of California, until ten or twelve years ago. It was figured by Mr. Van Deman in Department of Agriculture Report for 1886, plate X., and again (colored) in report for 1887, plate I.; in Wickson's California Fruits, p. 351; and in my Bulletin 62. Its behavior is not uniform in different years. F. M. Ramsay, of Lampasas, Texas, writes me that in 1888 his Kelsey ripened in September, in 1889 in July, and in 1890 in June. L. A. Berckmans, Georgia, says\* that in 1887 the Kelsey did not mature until October 1; in 1889 it ripened in July; in 1890 it "began to ripen the latter part of July and continued for eight weeks," and on October 1 perfectly green specimens were on the trees. It has a more or less prolonged indefinite season of bloom.

\*Proc. 14th meeting, Ga. Hort. Soc. (1889) 52.

Luther Burbank (Santa Rosa, Cal.) writes: "Kelsey blooms here all winter, from December to March." In California the tree is said to be nearly evergreen.

There are still the most conflicting reports respecting the hardiness of Kelsey. Some persons declare that it fruits in New York; but every report, when run down, shows that the party is mistaken in the variety. The furthest north that I have known Kelsey to fruit is in extreme southern Delaware. J. Van Lindley says\* that in 1893 in North Carolina his Kelsey trees "were loaded with fruit, large and fine, quality of the very best." It ripened from the first to the last of August. "The Kelsey," he continues, "stands at the head for canning and preserving, and sells in any market at fancy prices, but it comes into competition with other fruits grown north." Kelsey has been killed by cold in northern Texas; on the other hand, the trees are said to have come through the winter with little injury in Iowa. My first experience with the Kelsey was at Lansing, Michigan, where the trees killed to the snow line the first winter. Professor Tamari, of Tokio, says that the variety is too tender for the northern plum sections of Japan. Mr. H. E. Van Deman, formerly pomologist of the Department of Agriculture, wrote me upon the hardiness of Kelsey, in 1892, as follows: "My present opinion is that it is about as hardy as the fig. All reliable information that has come to this office up to this date is to the effect that it is not suitable to the northern states because of its tenderness. I know from personal observation that between here [Washington] and Baltimore trees have been seriously injured by winter-killing. Occasionally I have heard of Kelsey plum trees withstanding severe cold, but in every case yet followed up, it has been found that the trees were not correctly named." I am inclined to think, however, that the Kelsey will sometimes endure a New York winter if the wood has been well ripened; but I doubt if it will ever bear in this state.

The following correspondence to the *California Fruit Grower* (Sept. 14, 1885) still further explains the vagaries of the Kelsey:

"The Kelsey Japan plum is surely erratic in disposition, — more or less reliable.

"My experience teaches me, however, that it bears much more regularly when in close proximity to some other variety of plum.

---

\*Thirteenth Rep. N. Car. Hort. Soc. (1893) 20.

"This is very marked, not only in outside rows, but in the center of the block. Wherever I have an old tree of Satsuma, immediately surrounding that tree the Kelseys bear well.

"It does better with very little pruning.

"It must be sprayed with a good fungicide once or twice a year to keep in check the shot-hole fungus.

"It succeeds best in heavy, moist land, and preferably in the coast or bay counties.

"In marketing it, great care must be taken as to when the fruit is picked. Some seasons it colors much more than others, hence the danger of waiting for color.

"I pick mine the very hour (if possible) that the slightest color is apparent. They will color up afterwards in the boxes before they reach destination — referring, of course, to the eastern markets.

"My trees are picked over seven or eight times.

"When the fruit sets very thickly it must be well thinned.

"The prices have been very satisfactory to me. I am well repaid for the extra labor, the fruit netting me four cents to eight cents per pound.

"Conditions and surroundings vary so much that I would not advise one way or the other. Almost any variety of plum or prune could be grafted on Kelseys, where they are not profitable. Why not use Robe de Sargent, especially if the root is peach?

"A double-worked Robe de Sargent tree is best, as it makes a larger tree, and larger fruit as well as more of it.

"It will not unite directly on the peach, as is generally known, hence the suggestion to double work, using the Kelsey on peach root.

‘LEONARD COATES.

“NAPA, Cal., September 9, 1895.”

George S. Higby, Poway, San Diego Co., California, writes as follows of the Kelsey: "I had the honor, I believe, of exhibiting the first specimens of Kelsey in San Diego county. The Kelsey is fast becoming a popular fruit in this county, and is adapted both to the sea-coast and inland valleys. I think that in the near future it may take a position equal to the French or California prune as a dried fruit. A well ripened Kelsey has very few superiors."

KERR (*Bailey, Cornell Bulletin* 62, p. 25, 1894).

Hattonkin No. 2.

Hattonkin, of Berckmans and others.

"Medium to large, generally very strongly conical with a deep suture; color orange-yellow, with a creamy bloom; flesh juicy and sweet, good in quality; cling; early.

“An excellent variety, but not tested in the north. It varies considerably in shape, even on the same tree, occasional specimens occurring without the point. Mr. Berckmans writes me that in 1890 the round form seemed to predominate, while in 1892 the pointed or normal form alone was produced. Imported from Japan by Frost & Burgess, Riverside, California. Named for J. W. Kerr, of Denton, Maryland, one of the most intelligent plum growers of the central states.” — *Bulletin* 62.

“Kerr is not the earliest of the large-sized plums, but most excellent in quality. It partakes more of the Green Gage flavor than any other of the group.” — *P. J. Berckmans*, 1895.

Figured in *Bulletin* 62.

LATE BLOOD (*Burbank, in early lists*).

Hale, of Bailey, *Bulletin* 62.

Burbank, No. 3.

Medium in size, globular or slightly flattened, scarcely if at all pointed, rather light bright uniform red; flesh red, firm and sweet, tightly clinging to the pit.

Imported by Luther Burbank in 1885, together with Heikes, which see. Mr. Burbank writes me that he disposed of this and No. 4 after they had fruited in the nursery row, and that he now has no knowledge of them. Very much like Satsuma, but a few days later and appears to bloom earlier; also less pointed, and somewhat different in leaf. Little known.

LATE HATTANKIO (*Cherokee Nursery Co., Waycross, Ga., in letter, 1894*).

“Color pale orange yellow, heavily covered with a white bloom. Suture very slight. Flesh dark yellow, very firm and somewhat dry with a slight astringency. Generally of poor quality and irregular shape. Ripe with us June 15th to 20th.”

LONG FRUIT (*Burbank*).

Very small, roundish in shape, red, early and said to be a shy bearer. Thought by some to be the same as Engre. Others say that it is the same as Red June. Possibly two things are propa-

gated under this name. Stark Bros. write of it: "Equally small or smaller than your cut of Berger [in Bull. 62], and very acid." Imported by Luther Burbank in 1885, but very little known.

MARU (*Burbank*). Fig. 9.

Masu and Massu.

Medium in size, depressed globular with an obtuse point; very dark uniform maroon-red with numberless minute golden dots;



9.—Maru.

flesh deep yellow, rather soft, with a musky flavor which is not disagreeable, sweet, but quality only medium, skin sour; cling to half cling. Often acid in flavor. Season of Abundance. Said to be very hardy in bud.

Imported by Luther Burbank in 1885. Maru is Japanese for *round*.

## MIKADO.

“It is a large, golden yellow plum when ripe, and samples measured seven and one-quarter inches in circumference. It is considered now as the most profitable variety that is propagated in the valley, ripening early, the trees good bearers and the fruit bringing very high prices. Last season they brought as high as \$11 per box in the eastern markets, or over fifty cents a pound, and this season bringing from \$5 to \$7 per box.”—*Vacaville (Cal.) Reporter*, quoted in *California Fruit Grower*, xiii. 198 (Sept. 2, 1893).

“A very large plum, of greenish yellow color, nearly round, very little suture, a very rapid grower, more so than any other. This is the most remarkable of all plums for its enormous size, beauty and good quality. It is probably the largest plum in existence; ripens fifteen days after Yeddo. I have had specimens of it larger than any Kelsey, or as large as any common-size Elberta peach.”—*J. L. Normand, Marksville, La., Special Circular*, 1895-6.

MUNSON: See Douglas.

NAGATE NO BOTANKYO.

“Early.”—*J. L. Normand, Special Circular*, 1895-6.

NORMAND (*J. L. Normand, Catalogue*, 1891).

Normand Yellow.

Normand's Japan.

Medium to large, obtusely conical with a heart-like base and short stem; color clear golden yellow; flesh firm and meaty, yellow, of high quality; the small pit free. Very prolific, and ripens just after Berkman and Abundance. Allied to Georgeson and Kerr; less conical than the latter.

Imported by J. L. Normand, Marksville, La., and by him disseminated under the name of Normand's Japan in 1891. Figured in Bull. 62.

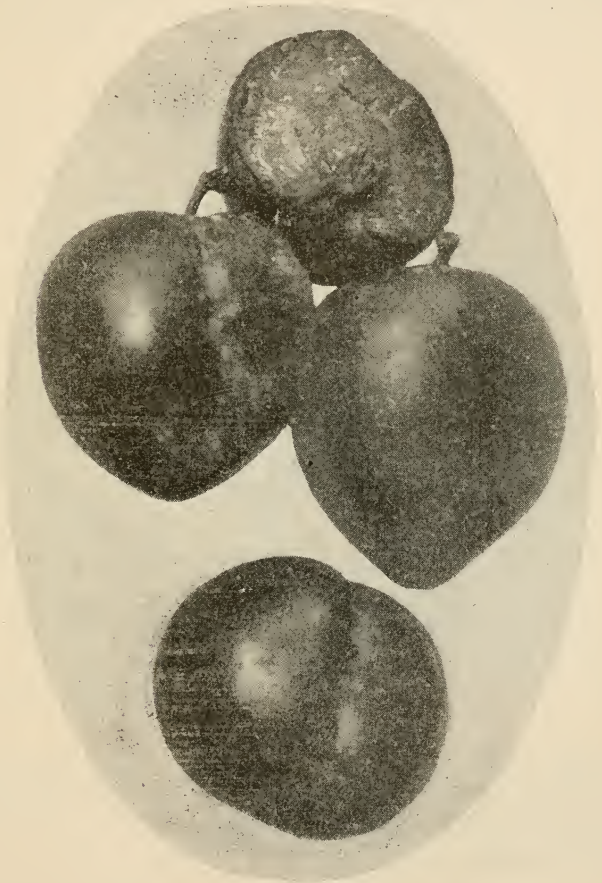
OCTOBER PURPLE (*Burbank*).

A very large black-purple heart-like plum, with no splashes of lighter color; flesh amber-yellow, red beneath the skin, very juicy, but yet firm, somewhat stringy, very sweet and good; skin sour; cling. Very late.



## OGON.

Fruits medium in size, flattened at the ends or tomato shaped, not at all conical, the suture prominent; color clear lemon with a light creamy bloom giving the fruit a whitish appearance; flesh thick and very meaty, not juicy, firm and keeping long, of second or third quality, entirely free from the stone. Tree only moder-



10.—Red June.

ately productive in New York, or in some regions even shy. Early, ripening in New York from late July to the middle of August. Excellent for canning.

Imported by H. H. Berger & Co., San Francisco. One of the best known varieties, but evidently not increasing in popularity in this state. Figured in Bulletin 62.

O-HATANKYO.

“Said to be early.”—*J. L. Normand*, “*Special Circular*,” 1895–6.

ORIENT (*Stark Bros., Catalogue*, 1893).

Red Nagate, of some.

“Large, broadly conical; red, very highly colored; flesh yellow, of high quality. Ripens soon after Burbank. Introduced in the



11.—Red June, 6 years old.

fall of 1893 by Stark Bros. Louisiana, Mo. Figured in *American Gardening* xiv. (1893), p. 363.”—*Bulletin* 62.

Possibly the same as Chabot.

RED JUNE (*Stark Bros., Catalogue*, 1893). Figs. 10 and 11.

Red Nagate, of some.

Shiro-Smomo, of some.

Medium to nearly large size, cordate and very prominently elongated at the apex, the suture deep, generally lop-sided, deep vermilion-red all over, with a handsome bloom, very showy; flesh light

lemon-color or whitish, firm and moderately juicy, not stringy ; very slightly subacid to sweetish, the skin slightly sour, of good pleasant quality although not so rich as some ; cling to half cling ; pit small.

A very handsome plum, ripened at Ithaca in 1895 from July 28 to August 1, nearly a week later than Willard, and a week earlier than Abundance. By all odds the best Japanese plum ripening before the Abundance which I have yet tested. Tree (Fig. 11) upright-spreading, vigorous and hardy, about as productive with us, so far, as Abundance. I thought that the quality of our specimens last season were nearly or quite equal to that of Abundance.

Imported by H. H. Berger & Co., San Francisco. The nomenclature of the variety here described is much confused. H. H. Berger & Co. write me that the true Japanese Red Nagate has red flesh, which this has not. The name Red Nagate is applied to such different varieties, and there is such an absence of opinion as to what the true Red Nagate is, that I have adopted Red June as the only tenable name.

This is the variety to which the name Shiro Smomo is oftenest applied, but it is neither a Smomo plum nor is it white (Shiro means *white*), thus affording a curious instance of the utter confusion of the American application of the names of the Japanese plums. Professor Georgeson tells me that the Shiro Smomo of the Japanese is a small white early plum with yellow flesh, somewhat cling and of medium season. I do not know if it occurs in this country ; and it is probably not worth while to endeavor to fit the name to any variety. The Ogon is probably the nearest to it of any variety in this list.

#### SAGETSUNA.

Name given in J. L. Normand's "Special Circular," 1895-6, without comment.

#### SATSUMA.

Blood.

Yonemomo.

Size medium to rather large, broadly conical with a blunt, short point, suture very deep ; color very dark and dull red all over, with greenish dots and an under-color of brown-red ; flesh blood-red, rather coarse and acid, fair to good in quality, tightly clinging to the pit ; midseason ; productive.

Imported by Luther Burbank in 1886. Figured in Pomologist's Report, Rept. Dept. Agr. 1887, Plate I. (colored), and also in Wickson's California Fruits, 351, the latter copied from the former. I have never seen a Satsuma with such a small pit as represented in these cuts, nor of the same shape. The fruit appears to be uniform in shape and markings, and it is figured from life in Bulletin 62. The Satsuma is hardy in the northern states. Stark Bros., Louisiana, Mo., write that it blooms too early with them and is not so hardy as some others. This belongs to the Beni-Smomo group of Japanese, which is characterized by red flesh. Season about with Burbank. Usually too sour to be agreeable, and the color is such that the market will probably object to it. Very long keeper.

SEA-EGG (*Burbank*).

Mr. Burbank sends me a very handsome and well-marked Japanese plum under this name, which is globular heart-shape in outline, and mottled-red; flesh very thick and meaty, orange-yellow, sweet and excellent, with a slight muskiness; cling.

SHIRO SMOMO: see Red Nagate and Berger.

SHIPPER (*Burbank*).

Fruit oval, light red with a white bloom; flesh very firm, yellow, sweet and juicy; long keeper. Tree sturdy, but a moderate grower. Described with Burbank's Novelties, 1893. Seedling of Satsuma.

SHIRA TA BENE.

"Similar to Satsuma, but much earlier, ripening in July; fruit blood-red through."—*J. H. Haynes (Indiana) in Prairie Farmer*, Dec. 21, 1895, 8.

STRAWBERRY: see Uchi-Beni.

SWEET BOTAN: see Berckmans.

TRUE SWEET BOTAN: See Berckmans.

UCHI-BENI.

Ura-Beni.

Honsmomo.

Strawberry.

Medium in size, heart-shape and somewhat pointed, bright carmine red; flesh red and fine-grained, somewhat acid, rather poor in

quality; cling; rather early. Little known. Uchi-Beni means *inside red*.

Stark Bros. write me as follows, under date of August 12, 1895  
 "This is a small plum, similar to the variety you describe as Berger, and is the variety we called Strawberry when we propagated it; but we discarded it two years ago. Ripens a few days after the Earliest of All, but is not so large nor so good quality and is not at all productive, while the Earliest of All is remarkably productive."

WHITE-FLESHED Botan : See Berckmans.

WASSE BOTONKYO.

Name given, without comment, in J. L. Normand's "Special Circular," 1895-6.

WASSE SMOMO.

"Said to be very early."—*J. L. Normand*, "*Special Circular*," 1895-6.

WASSU.

Name only, in J. L. Normand's "Special Circular," 1895-6.

WEeping BLOOD.

"This is a valuable acquisition, said to produce a blood-red plum of good quality. The tree must be seen to be appreciated. I have them here on my experimental grounds, growing finely; I budded them at different heights on straight peach stock four to eight feet from the ground, with slender limbs curving down gracefully like the Tea's Weeping mulberry. Single trees set out on the lawn look grand."—*J. L. Normand*, "*Special Circular*," 1895-6.

WHITE KELSEY.

"This is a duplicate in size and shape of the common Kelsey, except it is of a pale, creamy color, almost white when ripe; does not rot before maturity like the Kelsey, and much earlier to ripen and later to bloom than it; delicious in flavor."—*J. L. Normand*, "*Special Circular*," 1895-6.

WICKSON (*Burbank, Catalogue*, 1894).

Perfection, of Burbank.

A remarkably handsome and very large, deep maroon-red plum of the Kelsey type. Long cordate or oblong pointed; flesh firm,

deep amber-yellow, clinging to the small pit. There is apt to be a hollow space about the pit, as there is in Kelsey. I have had the plums from Burbank three times, all of them in good condition, and have tested them when in prime condition; but each time the fruit has had such a pronounced musky-almond flavor that I could not enjoy it. Mr. Burbank, however, regards it as superior to Hale in quality. Excellent keeper. Cross of Burbank with Kelsey, Burbank furnishing the seed.

Stark Bros. report that nursery stock of this variety has stood 22° below zero at their place without injury.

WILLARD (*W. F. Heikes*, 1893). Fig. 12.

Botan No. 26.

Medium in size, spherical to oblong in general outline, but prominently cornered or angled, never pointed, the sinus very slight but stem cavity deep; color bright claret-red with many minute yellow dots; flesh rather firm, whitish, of poor quality; freestone. A strong, vigorous and hardy tree, productive and one of the earliest plums yet tested in the north, ripening in Central New York late in July. In appearance the fruit is remarkably like some of the improved types of *Prunus Americana*. The fruit is handsome when well ripened, and keeps two to three weeks if picked when it begins to color, but the quality is almond-like and poor—so poor that I can not recommend it. Fruit picked in 1895 on July 16, when it just began to color, kept until August 6, the specimens shriveling rather than rotting.

Cions procured from California six or seven years ago by S. D. Willard, Geneva, N. Y., and named for him by W. F. Heikes in *Practical Nurseryman*, June, 1893. It was undoubtedly imported from Japan, but the history of it is lost. Mr. Burbank writes: "I had the Willard sixteen years ago. Not valuing it very highly, I discarded it many years ago, although it may prove valuable as an early variety; but I would prefer Stark Bros.' Red June, which ripens at the same time, but even that variety, though handsome, is poor in quality."

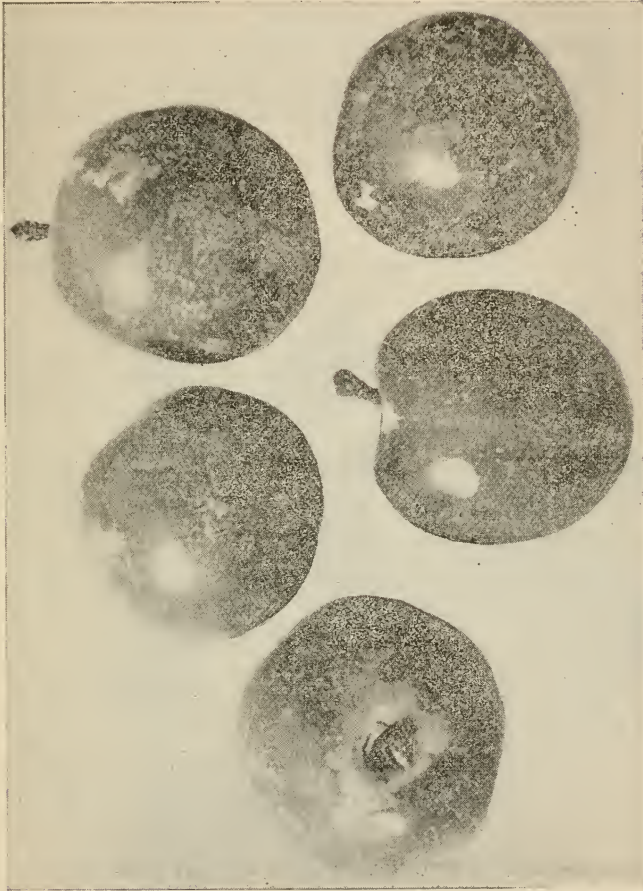
YEDDO.

"Much like White Kelsey, which it resembles in some respects, but it is of a deeper yellow color and ten days later to ripen, and

very attractive and fine-flavored plum."—*J. L. Normand*, "*Special Circular*," 1895-6.

YELLOW JAPAN: See Chase.

YONEMOMO: See Satsuma.

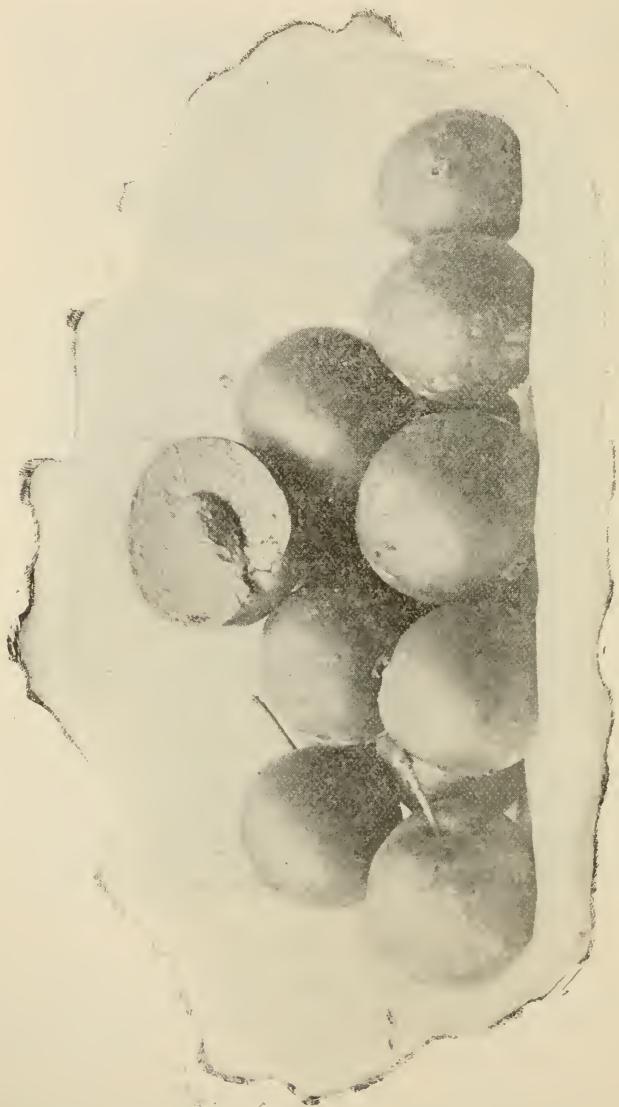


12.—Willard. Grown by S. D. Willard, Geneva, N. Y.

YOSEBE. Fig. 13.

A small short-oblong-pointed fruit, with slender stem and almost no suture; deep purple-red all over; flesh dark yellow, soft, sub-acid, with a pronounced almond flavor; pit small and free. A handsome very early plum, but the quality poor. Falls from the tree as soon as ripe, leaving the stem on the tree. Ripe here a week earlier than Willard.

Tree an upright grower, with reddish twigs and light-colored foliage. Leaves comparatively small and rugose, somewhat concuplicate, very prominently serrate, yellowish green. Stipules conspicuous. Tree very unlike other Japanese plums, when in leaf.



13.—Yosebe. One of the Somomo or cherry-like type.

There are two or three varieties passing as Yosebe, and nobody knows which one is entitled to the name. Neither do I know



whether the proper orthography of the name is Yosebe or Yosobe. It is probable that all the varieties have been given separate names, which can be used as soon as the characteristics of the varieties are understood.

Apt to be confounded with Berger. The Berger is small and nearly or quite globular, with a smooth circular cherry-like pit; Yosebe is distinctly cordiform and a half to twice larger, with a roughish and lenticular pit. The two are also very unlike in foliage.

L. H. BAILEY.



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BULLETIN 107—January, 1896.

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Cornell University—Agricultural Experiment Station,  
ITHACA, N. Y.

ENTOMOLOGICAL DIVISION.

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WIREWORMS

AND

THE BUD MOTH.

LIBRARY  
NEW YORK  
BOTANICAL  
GARDEN



By M. V. SLINGERLAND.

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Office of the Director, 20 Morrill Hall.

The regular bulletins of the Station are sent free to all who request them.

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## BULLETINS OF 1896.

106. Revised Opinions of the Japanese Plums.
107. Wireworms and The Bud Moth.

## EXPLANATORY NOTE.

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In Bulletin 33, issued in November, 1891, Professor J. H. Comstock and the writer gave a detailed account, occupying 80 pages, of nearly three years of experimentation with *wireworms*. The bulletin embodied the results of our efforts to discover a practicable method of preventing the ravages of these pests, and a study of the life-history of several common species.

In Bulletin 50, issued in March, 1893, the writer devoted 26 pages to a detailed discussion of the *bud moth*, one of the most destructive insect pests in the orchards of western New York. Our two years' study of the insect enabled us to correct several erroneous statements regarding its habits and life-history which had a very practical bearing on the method of combating it.

Wireworms had long ranked among the worst insects pests of the general farmer; the bud moth threatened to "nip in the bud" many a prospective crop of fruit; and unfortunately what little definite and accurate knowledge has been published regarding these insects was widely scattered and inaccessible to the farmer or fruit grower. Therefore, as our bulletins combined these previously ascertained facts with many new ones, the results of much original investigation, the demand for the bulletins was so great that the entire edition of each was exhausted in less than a year. So that during the past two or three years that these bulletins have been "out of print," the information they contain has been inaccessible to the hundreds of correspondents who have desired information regarding wireworms and the bud moth.

Although but few observations have since been made on these insects, it seems advisable, in consideration of the above facts, to again discuss them. In the following pages we, therefore, give, in a condensed form, the information contained in Bulletins 33 and 50; what few new facts we have seen recorded are also included in their proper connection, thus bringing the information up to date. Several new figures enliven the pages.

M. V. SLINGERLAND.

## CONTENTS.

### WIREWORMS. Pages 73-91.

- I. Introduction. Page 73.
- II. Methods of experimentation. Page 75.
- III. Experiments. Pages 75-85.
  - A. Protection of seeds. Pages 76-78.
    1. By a coating of Paris green and flour. Page 76.
    2. By a coating of tar. Page 76.
    3. By soaking it in a solution of salt. Page 77.
    4. By soaking it in a copperas solution. Page 77.
    5. By soaking it in a chloride of lime and copperas solution. Page 77.
    6. By soaking it in kerosene oil. Page 77.
    7. By soaking it in turpentine. Page 78.
    8. By soaking it in a strychnine solution. Page 78.
    9. By soaking it in other poisonous substances. Page 78.
  - B. Destruction of the larvæ. Pages 78-83.
    1. By starvation. Page 79.
      - a. By clean fallow.
      - b. By supposed immune crops, like buckwheat, mustard and rape.
    2. By insecticides, as kerosene, crude petroleum, poisoned dough, bisulphide of carbon, salt, kainit, muriate of potash, lime, chloride of lime, and gas lime. Page 80.
  - C. Destruction of pupæ and adults. Pages 83-85.
    1. Fall plowing. Page 83.
    2. Trapping. Page 84.
- General summary of the methods of combating Wireworms. Page 85.
- IV. The transformation of several species of Wireworms. Pages 85-91.
  1. The wheat wireworm (*Agriotes mancus*). Page 86.
  2. *Asaphes decoloratus*. Page 87.
  3. *Melanotus communis*. Page 88.
  4. *Drasterias elegans*. Page 89.
  5. *Cryptohypnus abbreviatus*. Page 90.

### THE BUD MOTH (*Tmetocera ocellana*). Pages 92-101.

- Its history and distribution. Page 93.  
How it is spread. Page 93.  
Its name and classification. Page 93.  
How its presence is indicated. Page 94.  
Its appearance. Page 94.  
Its life history. Page 95.  
Its appearance and habits in the spring. Page 95.  
Pupation. Page 97.  
Habits of the moth. Page 97.  
Egg-laying. Page 97.  
Summer habits of the caterpillar. Page 98.  
Hibernation. Page 98.  
Number of broods. Page 99.  
Its natural enemies. Page 99.  
Methods of preventing its ravages. Page 100.

# Wireworms.

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## RESULTS OF EFFORTS TO DISCOVER A PRACTICABLE METHOD OF PREVENTING THE RAVAGES OF THESE PESTS, AND A STUDY OF THE LIFE HISTORY OF SEVERAL COMMON SPECIES.

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### I. Introduction.

Among the most prominent of the pests that infest field crops are the insects commonly known as wireworms. These are long slender grubs of a yellowish-white color and with unusually hard bodies. Their wire-like form and the hardness of the body has suggested the common name. Two wireworms are shown, natural size, among the roots in figure 16; one is represented enlarged in figure 14. Unfortunately the term wireworm has been misapplied to certain animals—the millipedes—which are not true insects but belong to a different class in the animal kingdom. Figure 15 represents a millipede. The following pages do not treat of millipedes.



14.—A wireworm, twice natural size.

The true wireworms are the young of click-beetles, or snapping-bugs as they are more commonly termed. Our common kinds of click-beetles are mostly small or of medium size; a few are larger. Two are shown on the corn plant in figure 16, and figures 17 and 18 represent others. They are usually of a uniform brownish color; some are conspicuously spotted. More than five hundred kinds of click-beetles have been described from North America. "There is hardly a country child that has not been entertained by the acrobatic performances of these long, tidy-appearing beetles. Touch one of them and it at once curls up its legs and drops as if shot; it usually lands on its back, and lies there



15.—A millipede.

figures 17 and 18 represent others. They are usually of a uniform brownish color; some are conspicuously spotted. More than five hundred kinds of click-beetles have been described from North America. "There is hardly a country child that has not been entertained by the acrobatic performances of these long, tidy-appearing beetles. Touch one of them and it at once curls up its legs and drops as if shot; it usually lands on its back, and lies there

for a time as if dead. Suddenly there is a click, and the insect pops up into the air several inches. If it comes down on its back, it tries again and again until it succeeds in striking on its feet, and then runs off. We remember well carrying these creatures into the old district schoolhouse, where all lessons had to be learned from books, and where nature was never given a chance to teach us anything. Here with one eye on the teacher and one on this interesting jumper



17.—A click-beetle.

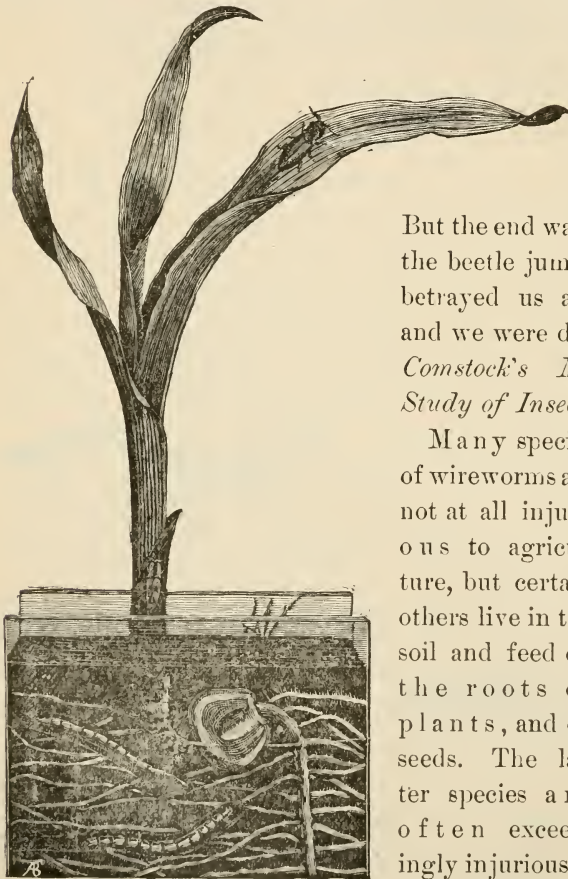
laid on our book behind the desk, we found a most fascinating occupation for the tedious moments.

But the end was always the same; the beetle jumped so high that it betrayed us and was liberated, and we were disgraced." (*From Comstock's Manual for the Study of Insects, p. 543*).

Many species of wireworms are not at all injurious to agriculture, but certain others live in the soil and feed on the roots of plants, and on seeds. The latter species are often exceedingly injurious; and as they work



18.—The Eyed Elater (*Alaus oculatus*).



16.—A corn-plant growing in a root-cage infested by wireworms and click-beetles (from a specimen in the Cornell Insectary).

in the ground out of sight, they are very difficult to combat.

During three years (1889, 1890 and 1891) we made numerous experiments to ascertain a practical method of preventing the ravages of these pests. Unfortunately our efforts were not attended



with that degree of success for which we had hoped, and thus the chief object of our investigations was not accomplished. But we did succeed in proving the futility of many methods that have been very generally recommended for the destruction of these pests; and it seemed worth while to publish the detailed results of our experiments, as given in Bulletin 33, for they might save farmers from making expensive efforts that would surely bring no adequate returns.

Much has been written upon how to combat wireworms. And yet, at the time Bulletin 33 was written (November, 1891), there had not been published the results of a single extensive series of carefully conducted experiments. Professor Forbes has recently published some results he obtained in 1888 and 1891 (Seventh Report, p. 48-49), and these will be noted in connection with the discussion of our experiments. Most writers on this subject have reasoned and written, but have not tested their theories.

## II. Methods of Experimentation.

Under this heading in Bulletin 33, we described and figured the different kinds of cages used in our experiments. As they are of general interest to the working entomologist only, we will not again discuss them. Suffice it to say in this connection that every precaution was taken to keep the wireworms under as nearly natural conditions as possible, and the experiments were conducted in a systematic and careful manner. To eliminate possible sources of error, comparative or check cages were used in each experiment; in these check experiments the cages were the same as the others, only they remained untreated. So far as practicable, every method was applied as it would be in the field.

## III. Experiments.

Both defensive and offensive measures were used in our experiments. Thus we tried to protect seed from the ravages of the wireworms, and we also tried to destroy the insects in each of three different stages of their existence — as wireworm or larva, pupa, and adult; no eggs were obtained upon which to experiment. The scope of our experiments was necessarily large as they embraced nearly all the methods that we found recommended in the literature of these insects. Only the general results can be given here; they

were published in much detail in Bulletin 33. Most of them were made in 1890 and 1891, while some were begun in 1889. The results of Professor Forbes' recently published experiments will also be included in their proper connection in this discussion.

### A. PROTECTION OF SEEDS.

The most conspicuous of the injuries caused by wireworms, and the one most keenly appreciated by the farmer, is the destruction of the seed. Thus farmers have given more attention to protecting their seeds than to any other method of combating wireworms. Seeds have been coated with various substances in the effort to render them distasteful or poisonous to the insects, and several methods are strongly recommended. But as none of the recommendations were based on carefully ascertained facts, we tested each one.

#### 1. PROTECTION OF SEED BY A COATING OF PARIS GREEN AND FLOUR.

This method promised to be a most desirable one; for, if it resulted as we confidently expected, not only would the seed be protected but the wireworms would also be killed.

We coated kernels of corn with varying amounts of Paris green and flour (in one case sugar was added), and carried on a large number of experiments covering a period of nearly two years. The only apparent result of the coating was to retard the sprouting of the seeds. We saw wireworms destroy several of the coated seeds without apparent injury to themselves.

In 1888, Professor Forbes found that corn which "was covered with a coating of the green poison, was eaten freely by some of the wireworms without killing them." In 1885, he also mixed Paris green with the soil in which the corn was planted without any injurious effect on the wireworms, but the corn failed to grow.

It is thus evident that it is useless to try to protect seed from the attacks of wireworms by coating it with a Paris green mixture.

#### 2. PROTECTION OF SEED BY A COATING OF TAR.

It has long been a common practice among farmers to coat their seed corn with tar to prevent its being attacked by wireworms. However, no one has demonstrated that they will not attack corn thus coated.

Our results from two years of experimentation show that sometimes larvæ will attack seed corn even when it is completely coated with tar. In actual practice, but few of the kernels would get a complete coat; it requires considerable disagreeable labor to apply the coating; germination is considerably retarded, even when the kernel has been previously soaked in water; and corn thus treated cannot be readily used in a planter. From these considerations it can be seen that this method of protection does not afford that degree of certainty and practicability which is desired.

### 3. PROTECTION OF SEED BY SOAKING IT IN A SOLUTION OF SALT.

This method was quite commonly practiced many years ago among farmers in western New York. Our series of experiments, extending over a period of nearly a year, made it evident that corn soaked in a saturated salt solution is as readily eaten by wireworms as if not thus soaked, and no injury results to the wireworms.

### 4. PROTECTION OF SEED BY SOAKING IT IN A COPPERAS SOLUTION.

In 1876 an Illinois farmer reported favorable results from soaking his seed corn before planting in a solution of copperas (sulphate of iron), to protect it from the attacks of wireworms.

After two seasons of experimentation with the solution, we got no results which indicated that wireworms would not eat and destroy seed soaked in it as readily as any other, and receive no injury therefrom.

### 5. PROTECTION OF SEED BY SOAKING IT IN A CHLORIDE OF LIME AND COPPERAS SOLUTION.

Our experiments during two seasons gave conclusive evidence that a solution of chloride of lime and copperas will not protect seed corn which has been soaked in it from the attacks of wireworms.

### 6. PROTECTION OF SEED BY SOAKING IT IN KEROSENE OIL.

In our experiments with this substance made in the spring of 1891 the wireworms destroyed nearly every kernel of corn we planted; there were no indications that this food disagreed with them.

## 7. PROTECTION OF SEED BY SOAKING IT IN SPIRITS OF TURPENTINE.

The soaking of seed corn in turpentine has been frequently recommended as a preventive against attack from wireworms. All of the kernels of corn we thus soaked were destroyed, before germination began, by the wireworms and they were unaffected by the meal.

## 8. PROTECTION OF SEED BY SOAKING IT IN A STRYCHNINE SOLUTION.

The idea of soaking seed corn in a solution of strychnine was suggested to us by the fact that seed thus soaked is used to poison sparrows and gophers. Our results from experiments made in 1891 showed that although seed corn be soaked in a very strong solution of strychnine, it is rendered neither distasteful nor destructive to wireworms. Prof. Forbes has recently reported similar results from experiments made in Illinois in 1888 and 1891.

## 9. PROTECTION OF SEED BY SOAKING IT IN OTHER POISONOUS SUBSTANCES.

In 1888 and 1891, Professor Forbes fed to wireworms corn that had been soaked in the following:

A mixture of Paris green and water.

Fowler's solution, diluted with an equal quantity of water.

An alcoholic solution of arsenic.

A solution of arsenic in boiling water.

An alcoholic solution of corrosive sublimate.

A saturated solution of potassium cyanide.

In almost every case the wireworms fed upon the kernels without injury to themselves. Thus, Professor Forbes says, "that it is not practicable to protect corn by means of these substances, even were it possible to use them without retarding or preventing the germination of the seed."

## B. DESTRUCTION OF THE LARVÆ.

The various methods that have been proposed for the destruction of wireworms fall under two heads: First, destruction by starvation; second, destruction by the use of insecticides.

## 1. DESTRUCTION OF WIREWORMS BY STARVATION.

*a. Starvation by Clean Fallow.*

It has been the general belief that the wireworms which infest our fields could live but a short time in soil in which no vegetation was allowed to grow. No experiments were recorded, however, to show how long the worms could live in such soil.

We kept several experiment cages in "clean fallow" for nearly a year, and more wireworms remained alive (many of them passed through the transformations to the beetle stage) in these cages than in similar cages in which grass was kept growing. Therefore, we would not advise the farmer to lose the use of his land for a season and the labor necessary to keep it free from all vegetation in the hope that he may thus starve out the wireworms.

*b. Starvation by the Growth of Supposed Immune Crops.*

It is supposed there are certain crops so distasteful to wireworms that when these crops are grown the worms will either perish from hunger or leave the field, and thus the succeeding crops be spared from the ravages of these pests. The crops usually recommended for starving out the wireworms are buckwheat, mustard and rape.

## BUCKWHEAT.

In this country more attention has been directed to buckwheat as a supposed immune crop than to any other.

By a series of experiments extending over a period of two years, we proved that wireworms will attack and cut off roots of buckwheat; and that they can live for many months and undergo the transformations necessary for the continuance of the species, in soil in which only buckwheat is growing. Therefore as wireworms have lived as long and thrived as well in cages of buckwheat as they have in cages of timothy and clover, we cannot regard buckwheat as an immune crop.

## MUSTARD.

In Europe, mustard has long been regarded as a crop that clears the soil of wireworms by starving them out. We experimented with both the Chinese and brown mustard, and wireworms lived in cages containing no other vegetation but these plants for from one to two years; we have never been able to keep them alive so long

in cages containing clover and timothy. Thus our experiments do not indicate that a crop of mustard will render the soil so free from wireworms that the succeeding crop will escape their ravages.

#### RAPE.

Another crop, upon which it is said wireworms will not feed, is rape. It is but little grown in America, but is considerably grown in England to provide pasture that will fatten sheep readily.

Wireworms lived as long and thrived as well in our breeding cages on roots of rape as in soil in which clover and timothy were grown. Thus, it would seem that rape can no more be regarded as an immune crop than any other crop cultivated at the same time.

#### 2. DESTRUCTION OF WIREWORMS BY MEANS OF INSECTICIDES.

As the species of wireworms which infest growing crops live during their whole larval life beneath the surface among the roots, it is a more difficult matter to reach them with insecticides than those pests which feed exposed on the plants. A substance must have great penetrating and killing power to be of any value. Most of the substances that have been recommended were first applied merely as fertilizers, but in later years their insecticidal properties also have been much discussed.

##### (a) *Substances that act merely as Insecticides.*

Most of the insecticides which we used are well known and have been used successfully against other underground insects.

##### KEROSENE, PURE AND AS AN EMULSION.

In 1885, Professor Forbes found that "applications of these substances made to wireworms in the earth were found practically ineffective, any strength sufficient to kill them killing vegetation also." Our experiments corroborate Professor Forbes' conclusion. We found that wireworms could be killed by using either substance in sufficient quantities, but this amount would destroy all vegetation and would be too expensive an application.

##### CRUDE PETROLEUM, PURE AND AS AN EMULSION.

On the whole our results with the crude petroleum emulsion and with the crude petroleum were not as promising as those obtained with the kerosene oil emulsion.

## POISONED DOUGH.

In our experiments in 1888, poisoned sweetened dough was used with some success to attract and destroy the click-beetles. (See Bulletin No. 3, Nov. 1888, p. 38). As the wireworms in our breeding cages readily came to the surface to eat wheat scattered thereon, it was thought that many might be attracted by sweetened dough placed on the surface.

A few experiments soon made it evident that the wireworms could not be thus attracted to the poisoned dough.

## BISULPHIDE OF CARBON.

This substance has been quite extensively used against certain subterranean insects. Our experiments showed that it would kill wireworms when poured into a hole near infested plants; but as it had to be used at the rate of about 150 gallons per acre, its cost would be excessive.

*(b) Substances that act also as Fertilizers.*

There are several substances now in common use as fertilizers which possess some insecticidal properties. Dealers in the potash fertilizers, especially kainit and muriate of potash, claim that the ravages of wireworms are effectually checked by the use of their fertilizers. In 1890 and 1891 we carried on a large series of experiments with salt, kainit, muriate of potash, lime, chloride of lime, and gas-lime to determine whether they might be effectually used against wireworms.

## SALT.

Many farmers assert that salt either destroys wireworms, drives them deeper into the soil beyond the roots, or renders the soil so obnoxious that the worms leave.

1. *Will salt kill wireworms?* From a large series of experiments we found that to destroy wireworms, salt must be used at the rate of about eight tons to the acre, or over one per cent. of the soil to a depth of four inches must be salt. This amount would be very destructive to vegetation.

2. *Will salt drive wireworms deeper into the soil?*—In 1891 we thoroughly tested this supposed action of salt upon wireworms by

means of special apparatus devised for the purpose (see Bulletin 33, p. 230, for detailed description and figures).

The results of this experiment indicated that salt applied at the rate of 1000 pounds per acre (a heavy dressing) interfered with the germination of wheat, and neither drove the wireworms deeper into the soil, nor caused them to migrate any appreciable distance.

#### KAINIT.

This is a German potash salt which is now much used as a fertilizer in this country. We made many and varied experiments with kainit on wireworms. The results obtained indicate that kainit has but little, if any, effect on wireworms in the soil even when applied in very large quantities, as from four to nine tons per acre.

It should be noted that these results are diametrically opposed to those obtained by Professor J. B. Smith of the New Jersey Experiment Station (*Insect Life*, Vol. 4, Nos. 1 and 2, p. 45; Bull. 85, N. J. Exp. Sta., p. 5; An. Rept. N. J. Exp. Sta. for 1891, p. 42). However, none of the statements yet made by Professor Smith are supported by sufficient evidence to lead us to modify the conclusions derived from the results of our experiments. Professor Forbes says of the experiment upon which most of Professor Smith's evidence is based: "It is evident from the context that this experiment had been made some years before, apparently not under the inspection of an entomologist." Mr. F. M. Webster, entomologist of the Ohio Experiment Station, in discussing the methods of fighting the wireworms, says (Bull. 51, Ohio Expt. Sta., p. 137): "There may be some virtue in the application of kainit, although this has not as yet been thoroughly and clearly demonstrated."

#### MURIATE OF POTASH.

This is a product of German mines, and is our principal potash fertilizer.

After many experiments extending over a period of more than nine months, we were forced to conclude that it has to be used at the rate of from four to six tons per acre to have any effect on the larvæ, and then it is not so effective as the cheaper kainit or the much cheaper common salt. Its use in such large quantities would



also be very destructive to vegetation. Although a valuable fertilizer, it is too expensive an insecticide to use against wireworms.

#### LIME.

Lime has long been used as a fertilizer, and many report good results from its use on fields infested by wireworms. However, our experiments covering a period of over seven months showed that lime applied at the rate of even 200 bushels per acre, either slaked or unslaked, or as lime water, had no effect upon the wireworms.

#### CHLORIDE OF LIME.

Several experiments made with this substance showed that it will kill wireworms in the soil, but must be used at the rate of nearly six tons per acre. It is thus impracticable and too expensive.

#### GAS LIME.

This is the refuse lime thrown out at gas works. When fresh it smells strongly of ammonia and sulphur, but becomes nearly odorless after exposure to the air for a few days. We thoroughly tested it; and our experiments indicate that the killing properties of the gas lime soon pass away, and it has to be used fresh in such great quantities (twenty to forty tons per acre) to be even partially effective that, notwithstanding its cheapness, it is hardly practicable on large areas.

### C. DESTRUCTION OF PUPÆ AND ADULTS.

#### (CLICK-BEETLES).

##### 1. FALL PLOWING.

It is with pleasure that we turn from the discussion of measures that give little or no promise of practical use to one that we believe is of great importance. For the results of our experiments convince us that much can be done towards checking the increase of wireworms by fall plowing.

The explanation of the beneficial results that will follow fall plowing we believe to be found in the following facts, which were brought out in our studies of the life history of our more common species of wireworms: Wireworms live for at least three years in the worm or larval state. In this state they cease feeding about

November 1st, and hibernate until spring. When the worms are fully grown they change to soft white pupæ which resemble the beetle in form. This change takes place in the species that commonly infests field crops during the month of July. The pupa state lasts only about three weeks, the insect assuming the adult form in August. But, strange to say, although the adult state is reached at this time, the insect remains in the cell in the ground in which it has undergone its transformations till the following April or May, nearly an entire year.

We found that in every case where we disturbed the soil so as to break these earthen cells, the insects within perished.

This experience clearly indicates that if infested fields are plowed after July 20th and thoroughly pulverized and kept stirred up, many of the little earthen cells may be broken and the tender pupæ or beetles within destroyed. After three or four weeks of this thorough cultivation, wheat or rye may be sown.

In connection with this fall plowing and cultivation we earnestly recommend the method of short rotation of crops to farmers having land badly infested with wireworms. Do not keep fields in sod for more than a year or two at a time. No doubt it will require several, at least three years by this method, to render the soil comparatively free from the pests as only the pupæ and adults are killed each fall, while most of the one and two-year-old wireworms will escape injury. Those farmers who practice the method are not troubled with wireworms.

## 2. TRAPPING.

Our experiments on preventing the ravages of wireworms by trapping were carried on in 1888 and 1889. Two methods were employed, trapping by baits, and by lanterns.

*On trapping by baits.*—This method has been discussed in detail in Bulletins 3 and 33 of this Station, so that only the general results will be given here. The baits, which consisted of sliced potatoes, wads of green clover, and sweetened and unsweetened cornmeal dough were placed under boards in various parts of a badly infested corn field. Instead of attracting the wireworms, as was expected, their parents—the click-beetles—came to the baits in large numbers; the clover attracted by far the larger number (65 per cent).

It was found that the beetles were the most active at night, and that they seek their food chiefly by running over the surface of the ground.

When it was found that they were so readily attracted to the baits, poisoned clover baits were used with the result that most of the click-beetles were destroyed, proving that they fed upon the baits and thus suggesting a practical method of combating them. Where the insects are very numerous over a limited area, many of the beetles can be killed with the expenditure of a very little labor in distributing these poisoned baits.

*On trapping by lanterns.*—A series of six trap-lanterns were kept lighted every night here on the University farm from May 1st to October 1st, 1889. During the whole five months only eighty click-beetles were captured. Thus the method has no practical value in fighting wireworms.

#### GENERAL SUMMARY OF THE METHODS OF COMBATING WIREWORMS.

When we began our experiments in 1889, we confidently expected to be able in a short time to tell farmers how to protect their seed and their growing crops from these pests. We thought that the greatest part of our work would be to determine which of several ways is the most practicable, the easiest used, or involved the least labor or expense. For three years we did our best; and we failed to discover a single satisfactory method of protecting seed, or of destroying immature wireworms in the soil.

We did learn, however, why fall cultivation will destroy the wireworms ready to pupate, the pupae, and the beetles; the beetles can also be trapped and killed in large numbers with poisoned clover baits. We also learned that many commonly recommended plans are useless.

Such a short rotation of crops as will include a period of thorough cultivation in the fall will prove the best method of fighting these pests yet suggested.

#### IV. Notes on the Transformations of Several Species of Wireworms.

We used nearly 10,000 wireworms in our experiments. They were collected by correspondents in Lewis county and forwarded to

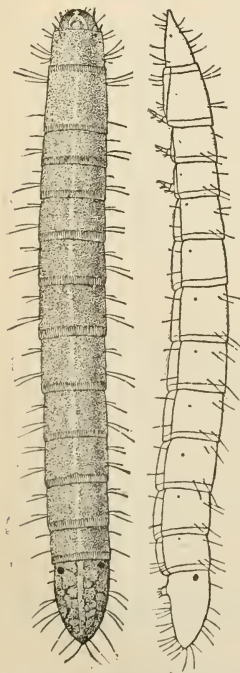
us in invoices of a thousand or more at a time. We were easily able to distinguish five different species among those sent. The species were kept in separate cages, thus enabling us to make many observations on the habits, etc., of each during the course of our experiments upon them.

## 1. THE WHEAT WIREWORM.

*Agriotes mancus*, Say.

This species is probably the most numerous and most destructive kind of wireworm in our State; it constituted 91 per cent. of the 10,000 with which we experimented.

The beetle (Fig. 21) was described in 1823, but nothing was known of its life until 1867 when Dr. Fitch described the wireworm (Fig. 19) and added a few other notes. It is widely distributed and has been reported as destructive in Canada and some of the Western States.



19.—The wheat wireworm, back and side view, enlarged five diameters (after Forbes).

*Its life-history.*—It is not known where any species of click-beetle lays its eggs. It is the general opinion that they are laid in the spring in the earth close to the roots of the plants.

We never found any of the wheat wireworms less than 4 mm. in length; they measure when full grown from 16 to 19 mm. They are of a waxy-yellow color; their general appearance is well represented in figure 19 (a detailed description was given in Bulletin 33, p. 257). The eye-like depressions (Fig. 20, *e*) on the sides of the last segment render it easily distinguished from most other wireworms. How long this insect remains in the wireworm state, we failed to learn. We found that one cannot draw accurate conclusions as to their age from their size. Our observations indicated that this wheat wireworm may trouble the farmer at least three years

before assuming the beetle state; it grew only about 2 mm. during six months.

The wireworms cease feeding in the fall before November 1st, and descend into the soil for several inches where they remain in a torpid condition all winter. With appetites sharpened by their long fast, they come toward the surface in the spring and do more damage than at any other time.

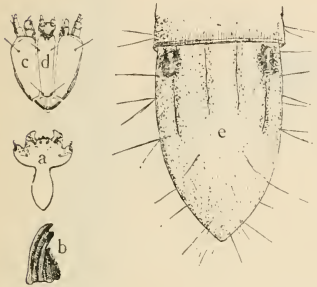
When they become full grown, which occurs about July 1st, these wheat wireworms prepare for pupation by forming a little earthen cell in the soil, usually less than six inches from the surface. The pupa is of a pure white color, very soft, and about one-fourth longer than the beetle which it resembles in general appearance. The pupal stage lasts about three weeks, and by September 1st all

have transformed to beetles.

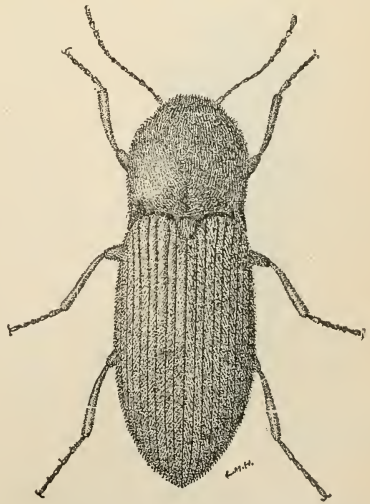
The beetles (one is shown, enlarged seven times, in figure 21, and natural size on the upper part of the corn plant in figure 16) are of a dark brown color. They remain in the little earthen cells, made by the wireworms, all winter, and work their way to the surface during April. They fly well and can run quite rapidly; when disturbed they "play possum" for a time. They will eat clover leaves and we saw one at work on a kernel of wheat. They lived but a few days after emerging in our cages. When and where they lay their eggs still remains one of nature's secrets.

## 2. *Asaphes decoloratus*, Say.

This click-beetle is widely distributed over the northern states east of the Mississippi river, and occurs in both cultivated and grass



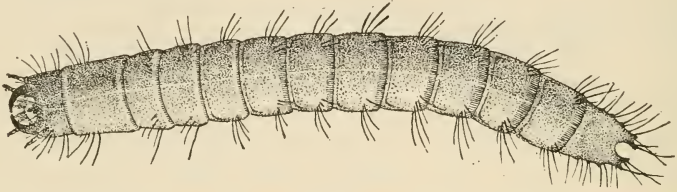
20.—The wheat wireworm. a, b, c, d, details of mouth parts, enlarged; e, caudal segment, enlarged.



21.—*Agriotes mancus*, the adult, enlarged 7 diameters (after Forbes).

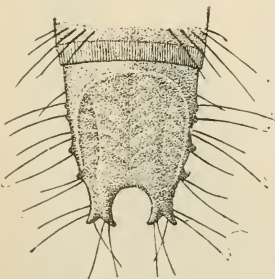
lands. It has not yet occurred in sufficient numbers to be injurious; only about five per cent. of the wireworms we have examined belonged to this species.

*Its life-history.*—Our specimens of the wireworms ranged in length from 7 mm. to 25 mm. They are of a dark, waxy-yellow color; their form and characteristic features are well shown in figures 22 and 23 (a detailed description is given in Bulletin 33, p. 261). What little data we have indicates that the duration of the wireworm period is at least three years.



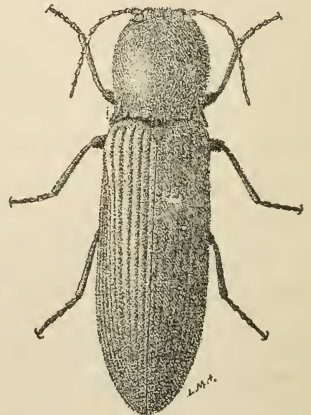
22.—The wireworm of *Asaphes decoloratus*, enlarged three and three-fourths diameters (after Forbes).

Unlike the wheat wireworm, this wireworm matures in May. The change to a pupa takes place in little earthen cells in the soil. We have not seen the pupa; this stage lasts about three weeks. Most of the beetles emerged in our cages in June. In Professor Forbes' experiments in Illinois they emerged as early as May 25th.



23.—Caudal segment of the wireworm of *Asaphes decoloratus*, much enlarged (after Forbes).

The beetle varies from 9 mm. to 15 mm. in length, and is of a shining blackish color with brown legs. Its characteristic features are well shown in figure 24. All the beetles emerge before fall, but



24.—*Asaphes decoloratus*, the adult, enlarged four and one-fifth diameters (after Forbes).

of the further life of this insect we know nothing.

### 3. *Melanotus communis*, Gyll.

This species of wireworm is very common in cultivated lands, especially in corn

fields, in our State; Professor Forbes found an allied species (*M. cribulosus*) much more common in Illinois corn fields. The insect is widely distributed, ranging at least from Nebraska to New Jersey and Canada.

*Its life-history.*—The mature wireworms vary in length from 25 mm. to 30 mm. They are of a light brown color, with the head, thorax and last segment considerably darker. (They are described in detail in Bulletin 33, p 265). Figure 25 shows the characteristics of the caudal segment of this

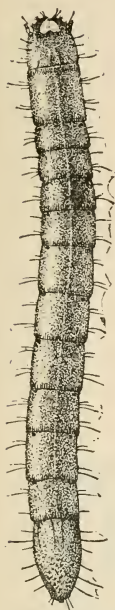
will serve equally well to show the principal features of the whole worm.

The insect spends at least three years as a wireworm; one specimen lived in our cages for nearly two years. The change to a pupa takes place in earthen cells during July. The pupa is white and tender, and changes to a beetle in about a month. The principal characteristics of the slender, glossy, dark brown beetle are well shown in figure 27. They remain in earthen cells in the soil all winter, emerging in May. The secret of the rest of their life remains with nature.

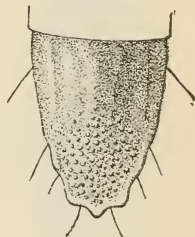
#### 4. *Drasterias elegans*, Fabr.

This species of wireworm is widely distributed over the country, and has been reported as exceedingly abundant and injurious to young wheat in Indiana. We have found it quite abundant in sod land here.

*Its life-history.*—Notwithstanding its abundance, comparatively little is known of the life of this insect. It is one of the smallest of



26.—The corn wireworm (*Melanotus cribulosus*), enlarged  $4\frac{1}{2}$  diameters (after Forbes).

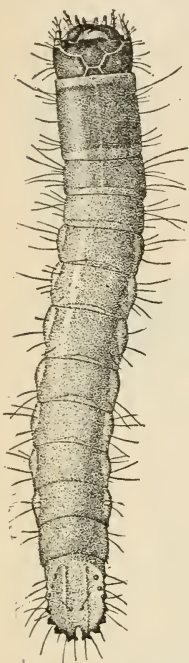


25.—Caudal segment of the wireworm of *Melanotus communis*, greatly enlarged (after Forbes).

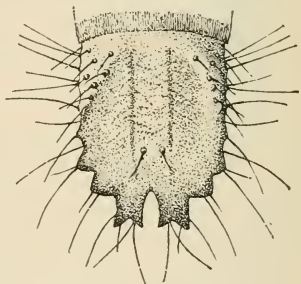


27.—*Melanotus communis*, the adult, enlarged four diameters (after Forbes).

the wireworms, measuring from 9 mm. to 12 mm. in length when full grown. Its body is considerably flattened and of a light waxy-yellow color. Figures 28 and 29 well illustrate its characteristic features.



(It is described in detail in Bulletin 33, p. 268). They undergo their transformations in earthen cells in the soil, the change to a beetle taking place about July 1st. The beetle is of a general rusty-brown color with black markings; it is shown natural size and enlarged in figure 30. We were unable to determine whether they emerged in the fall or passed the winter in the earthen cells. Professor Forbes has recorded considerable data on this point which leads him to conclude that it seems probable that they emerge in the summer and early fall, probably laying their eggs in part the same season; that it hibernates in sheltered places and continues abundant until June of the following year, doubtless breeding meanwhile; and that it lives two seasons in the earth as a wireworm.



28. — The wireworm of *Drasterias elegans*, enlarged seven diameters (after Forbes).

29. — Caudal segment of the wireworm of *Drasterias elegans*, much enlarged (after Forbes).

5. *Cryptohypnus abbreviatus*, Say.

We met with a few wireworms of this species in old sod land. The beetle has been known since 1823, and it is not uncommon throughout North America. It is a robust beetle, about one-fourth of an inch in length and of a brownish-black color with a greenish-bronze lustre. (For detailed descriptions see Bulletin 33, p. 270, of Trans. Am. Ent. Soc., 1891, p. 7).

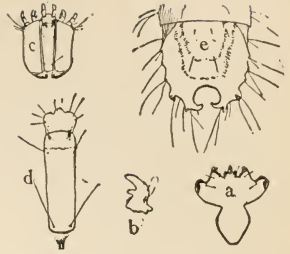


30. — *Drasterias elegans*, the adult natural size and enlarged.

The wireworms are from 7 mm. to 9 mm. in length when mature, and closely resemble the young worms of *Asaphes decoloratus* (Fig. 22). They are of a dark waxy-yellow color and consid-



erably flattened in form. The caudal segment and some details of the mouth parts are shown in figure 31. (For a detailed description see Bulletin 33, p. 271).



31. — Wireworm of *Cryptohypnus abbreviatus*. a, b, c, details of the mouth-parts; e, the caudal segment — all enlarged.

## The Bud Moth.

*Tmetocera ocellana.*

This bud moth has come to be recognized by many of the most extensive apple growers of western New York as the most injurious and hardest to fight of any insect now present in their orchards. It works in the opening leaf (Fig. 32) and flower buds



32—Work of the bud moth in opening leaf buds.

(see frontispiece), and often nearly the whole crop on many trees is destroyed while yet in the bud. It is also especially destructive when it attacks recently budded or grafted trees and nursery stock. Besides apple, it also feeds upon pear, plum, cherry, quince and peach trees and blackberry buds.

Thus, fruit growers have to fear in the bud moth a pest which is capable of literally “nipping in the bud” a prospective crop of fruit, a graft, or a budded stock.

## ITS HISTORY AND DISTRIBUTION.

As the insect has been known in Europe for more than half a century before it was recorded in this country, it is, therefore, no doubt an imported species. It attained economic importance in Europe about 1840, and was first discovered in this country in 1841 in Massachusetts, where it was doing considerable damage; by 1869 it had become to be "the most injurious enemy of the apple-tree, next to the canker-worm, in the State." The same year it did some damage in Pennsylvania, and in 1870, plum trees were attacked by it in Canada. The first record of the occurrence of the insect in New York State is, in 1880 in a Union Springs nursery. The previous year it was found at Washington, D. C., and by 1885, it had reached Nova Scotia. In 1887, it was quite injurious near Rochester, N. Y., and in 1888 and 1890, apple and blackberry buds were injured in Maine. Throughout Massachusetts, New York and Canada the insect appeared in very destructive numbers in 1891, and in Michigan in 1892. It has been found in Missouri, and two or three years ago was introduced into Idaho.

The bud moth is thus widely distributed over the New England and Middle States and Canada; it occurs as far south as Washington, D. C., and as far west as Idaho.

## HOW IT IS SPREAD.

The active moths doubtless fly readily from orchard to orchard and thus the pest may slowly spread. But a much more fruitful source of infestation is to be found in nursery stock. We have seen the insect at work in several nurseries, and it is claimed that it was introduced into Idaho on stock received from one of our New York nurseries. Its manner of hibernating makes its distribution very easy on nursery stock.

## ITS NAME AND CLASSIFICATION.

The bud moth is closely allied to the codlin moth, and resembles the latter in size and form, but differs in structure, in coloring and in its habits and life-history.

A spot, somewhat eye-like in appearance, on each front wing of the moth suggested its name—*ocellana*—which was given to it in

Austria in 1776. The popular name—eye-spotted bud moth—first used by Dr. Harris in 1841, is now in common use. The moth has been described under five different names, and has been placed in six different genera. The genus *Tmetocera* (“cut-horned,” from the notched appearance of the base of the antennæ of the male moth) was established in 1859 for the reception of this insect which still remains its only representative.

#### HOW ITS PRESENCE IS INDICATED.

The caterpillars of the bud moth are astir early in the spring, usually about May 1st, and soon begin their destructive work on the swelling and opening fruit and leaf buds. They eat into the buds, and often so check and disfigure a small tree as to spoil its symmetry. More often the caterpillar does not begin its work until the buds are nearly half opened. It then feeds upon the central expanding leaves or flowers, tying them together with silken threads (see the frontispiece, and figure 32). Some of the partly eaten leaves soon turn brown and thus render the work of the insect quite conspicuous; one correspondent wrote that his trees looked as though a fire had swept quickly through them, as so many leaves had turned brown. This tying together of the opening leaves and flowers and the brown appearance of many of them, are the most characteristic indications of the presence of the insect.

#### ITS APPEARANCE.

*The caterpillar.*—It is in this stage that this insect is familiar to fruit-growers. It appears on the buds in the spring as a little



33.—Caterpillar of the bud moth about three times natural size.

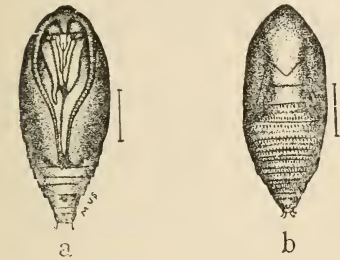
brown caterpillar, about .16 of an inch long, with a black head and thoracic shield. In June, when the caterpillars are full-grown (Fig. 33) they are about half an inch in length and are of a cinnamon brown color; the head, thoracic shield, and true legs are black. The body is sparsely hairy, and bears five pairs of pro-legs.

*The pupa.*—This quiescent stage of the insect is passed in the nests in the latter part of June in a tube of dead leaves. Two

views of a pupa are shown in figure 34. It is about .27 of an inch in length and of a light brown color; the dorsum of each abdominal segment bears two transverse rows of small tooth-like processes directed caudad.

*The moth.*—The moth (Fig. 35) measures about three-fifths of an inch across its expanded wings.

It is of a general dark ash-grey color with a broad cream white band across the front wings. Dr. Harris saw the resemblance to two eye-like spots in the arrangement of two short horizontal black dashes followed by a vertical streak of lead blue



34.—Pupa of the bud moth; a, ventral view; b, dorsal view—enlarged.

near the anal angle of the front wings, and in the three or four similar black dashes, also followed by a streak of lead blue, near the apex of these wings.



35.—The bud moth—the adult insect, twice natural size.

#### ITS LIFE-HISTORY.

Although the caterpillar and pupa of the bud moth were known more than eighty years ago, its true life-history, as observed by Mr. J. Fletcher, the Canadian Government entomologist, and the writer, was not recorded until 1892 (Report of Entomologist for Dept. Agr. Canada, 1891, p. 195).

*Its appearance and habits in the spring.*—The date of the emergence of the little brown caterpillars from their winter retreats varies considerably in this state. They seem to time their appearance by the date at which the buds begin to open. Thus the earliness or lateness of the season or of the variety of the tree infested will vary the time from two to four weeks, ranging from April 15 to May 15.

In some cases the caterpillar appears before the bud has opened sufficiently for it to readily enter. It is then forced to eat its way into the bud. Once within the bud it revels in the very ten-

der growing leaves or flower buds, tying them together with its silken threads, and thus forming for itself a well protected nest within which its destructive work goes on (Figs. 32 and 36). It does not confine its work to one or two leaves or flowers, but seems to delight in devouring a part of a leaf here or one side of a developing flower there. So that nearly every leaf or flower in the opening bud is forced to contribute to the greed of the little creature, thus greatly increasing its destructiveness.

It is especially destructive on young trees or nursery stock as it then most often attacks the terminal buds, sometimes burrowing down the shoot for two or three inches causing it to die, and thus greatly marring the symmetry of the tree.

The later work of the caterpillars in the opening leaves has been well described by Professor Comstock as follows:

“The larva settles on one of the more advanced leaves, of which it cuts the petiole half through either near its base or close to the leaf so that it wilts. Of this half dead leaf it forms a sort of tube by rolling the edge of one side more or less down and fastening it with silken



36.—Characteristic nest of the bull moth caterpillar; and several of the curious eggs, greatly enlarged, laid by the moth.

threads and then lining the inside sparsely with silk. If the leaf which it has selected as its final home should become too weak at the place where it has been cut so that there may be danger of its falling to the ground; then the larva goes to work and either strengthens it with silk which is fastened to the twig and petiole or ties the apical portion of the tube to another leaf or cuts that part

of the leaf which contains its tube from the rest of the leaf, so that either the whole or only that portion which contains the tube hangs suspended from another leaf." The larva lives in this tube most of the time, only coming forth to feed; when disturbed it retreats into the tube out of sight. In feeding it draws other leaves, one after another, toward it and fastens them with threads of silk, thus forming a nest (Fig. 36). Some of these partially devoured leaves soon turn brown and die, thus rendering the nest quite conspicuous.

The caterpillars continue to feed in the spring, mostly at night, for six or seven weeks, and probably shed their skin three times during this time.

*Pupation.*—Within a tube, usually formed in the nest by rolling up one side of a leaf or by bringing together two or three half devoured leaves and securely fastening everything with silken threads, the full-grown caterpillar retreats and lines the interior with [a thin closely woven layer of silk. This forms the cocoon within which the caterpillar is soon to undergo its wonderful change to a pupa. The date of this change varies in this State from June 1st to 25th. About ten days are spent as a pupa, then by the aid of the tooth-like hooks on its back, it works its way nearly out of the cocoon, and its skin splits open to allow the pretty little moth to emerge.

*Habits of the moth.*—The moths begin to appear as early as June 5th in our State, and often all have not emerged by July 10th. They are most active during the night, remaining quiet during the day on the trunk and limbs of the tree, with wings folded roof-wise; in this position they closely mimic the bark. They probably live about two or three weeks.

*Egg-laying.*—Three or four days after emerging, the moths begin to lay eggs, working mostly at night. They are laid on the leaves singly or in small clusters slightly overlapping each other. They are curious objects (Figs. 36 and 37). In fact they so closely resemble minute drops of water or a fish's scale on the leaf as to necessitate the use of a lens to determine the egg characteristics. They are very transparent and will reflect the prismatic colors like a drop of water.

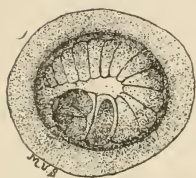
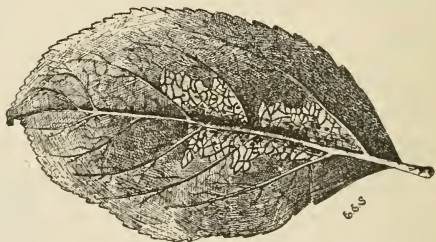


FIG. 37.—Egg of bud moth showing the developing caterpillar within—greatly enlarged.

They are disc-like, very much flattened, usually oval in outline, a few are circular, and measure .8 mm. by .7 mm. A flat outer rim .2 mm. wide adheres closely to the leaf, leaving a central slightly elevated rounded disc in which the larva develops. About nine days after the eggs are laid the developing greenish caterpillar lying curled up in the central portion can be plainly seen through the shell. The egg-stage lasts from seven to ten days.

*Summer habits of the caterpillar.*—Soon after emerging through a hole near the edge of the central portion of the egg-shell, the little greenish caterpillar begins to feed upon the skin of the leaf, usually upon the underside. A few hours later it makes for itself a tube of silk open at both ends and usually made alongside the mid-rib. From these silken homes the caterpillars sally forth to feed upon the surrounding tissues, protecting themselves as they go by a thin layer of silk spun over their feeding grounds (Fig. 38). They feed upon one epidermis and the inner tissues of the leaf, leaving the net-work of veinlets; the opposite epidermis forms the floor of its feeding grounds. The veinlets and the epidermis soon turn brown, thus rendering the summer work of the insect quite conspicuous. Rarely more than one caterpillar works on a leaf.



38.—Leaf showing the work of a young caterpillar during the summer.

The caterpillars continue to feed in this manner during July and August, and a part of September. Soon after the third or fourth moulting of the skin, they cease feeding and seem to know instinctively that they have reached that point in their development when it is necessary for them to make preparations to go into winter quarters, even though it be several weeks yet before the leaves become unfit for food, or fall from the trees.

*Hibernation.*—Our observations in 1891 and 1892 definitely showed that the bud moth passes the winter as a half-grown caterpillar



snugly hidden in a silken case on the tree. Figure 39 represents a twig, natural size, bearing three of these hibernacula at *a*, *a*, and *b*. These little winter homes are very inconspicuous objects as they are scarcely more than an eighth of an inch in length, and are covered with bits of dirt from the bark or are sometimes made under some convenient piece of dead leaf or bud-scale. One must be very familiar with these hibernacula to be able to find them, even on a badly infested tree. The caterpillars begin to go into winter quarters early in August and all are snugly tucked away before the leaves fall. They instinctively build their winter homes near the winter buds on the twigs so they may be at hand to nip the bud upon its showing any signs of opening in the spring. The life-cycle is completed with the opening of spring and the appearance of the little brown caterpillars on the buds.



39.—Twig showing the position of the winter homes of the caterpillar at *a*, *a*, and *b*, natural size.

*Number of broods.*—There is but one generation of the insect in a year in this and more northern latitudes. The moth appears and lays her eggs in June or July, and the caterpillars feed upon the leaves until half-grown, in which stage they hibernate. Possibly two broods may occur further south.

#### ITS NATURAL ENEMIES.

In Europe, five parasites are recorded at work upon this insect. Three parasites (*Phytodictus vulgaris*, *Pimpla* sp. and *Microdus laticinctus*) have been reared from it in this country; the latter species seems to be quite common in some localities.

Besides these parasitic enemies, the bud moth is sometimes eaten by birds in Canada, and we also found a large wasp (*Odynerus catskillensis*) storing its cell with the caterpillars which must furnish delicious morsels for the grub of the wasp when it hatches.

Doubtless all of these foes aid considerably in keeping the pest in check, but it has now become so numerous and wide spread that its enemies are insufficient and the devices of man must be called into action.

## METHODS OF PREVENTING ITS RAVAGES.

This insect is proving an exceedingly hard one to combat. It cannot be effectively and practicably fought while in the adult or egg stages, and there is but little hopes of reaching the caterpillars in their hibernacula during the winter. Although the caterpillars work under a silken covering on the undersides of the leaves during the early part of the summer, it may be possible to kill some of them with a Paris green spray, but we doubt it. The pupæ can be reached only by hand-picking the nests during the ten days in June which the insect passes in this stage. Thus, so far as we now know, the most vulnerable period in the life-cycle of the bud moth is during the last half of its caterpillar life when it is at work upon the opening buds, leaves and flowers.

We once saw a case where hand-picking could have been profitably practiced. A block of young pear trees had become badly infested and each caterpillar's nest was rendered conspicuous by one or two brown dead leaves. All of the then nearly full-grown caterpillars could have been quickly killed by collecting and burning their nests; this would have effectually prevented the appearance of the insect another year. One man could have thus exterminated the pest in that block of a thousand or more young trees in a very short time. This method may prove practicable in many cases where nursery stock becomes infested. The nests should be gathered before June 1st.

Although hand-picking is the surest method of checking the insect, it is impracticable on large trees, and besides, by the time the work of the caterpillar has progressed far enough to render its nest conspicuous, it has done most of its damage. Fruit growers cannot afford to wait until after the developing fruit and new growth are "nipped in the bud" before placing any obstacles in the way of this insect.

We believe the pest can be reached with an arsenical spray applied *frequently* and *thoroughly*. It will necessitate at least two thorough applications *before the flowers open*. If possible keep the swelling and opening buds coated with Paris green so that the little caterpillar's first meal in the spring will be a poisonous one. In order that the spraying should be thoroughly done at this time, fruit growers should realize that if the insect is not killed before

the blossoms open they will not have another chance to do it nearly so effectively until the next spring.

If the trees are usually badly infested with the apple scab or other fungi it would be well to combine the Paris green with the Bordeaux mixture, and in this case using about one pound of the poison to one hundred gallons of the fungicide; the poison will adhere longer if applied with the fungicide. If Paris green only is applied, use about one pound to two hundred gallons and always add two or three pounds of freshly slaked lime to prevent the burning effects of the free arsenic in the Paris green. Take especial pains to thoroughly wet the buds on the smallest twigs. With at least two thorough applications of Paris green before the flowers open we believe this insect can be effectively checked for the season. Do not spray when the trees are in bloom as many honey-bees may be killed.

The limited time during which this bud moth can be reached by sprays renders it an especially hard insect to fight. It will require thoughtful, intelligent, and persistent work early in the spring to hold it in check.

MARK VERNON SLINGERLAND.



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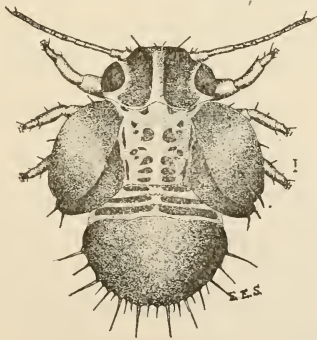
BULLETIN 108—January, 1896.

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Cornell University—Agricultural Experiment Station,  
ITHACA, N. Y.  
ENTOMOLOGICAL DIVISION.

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THE PEAR PSYLLA  
AND  
THE NEW YORK PLUM SCALE.



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## BULLETINS OF 1896.

106. Revised Opinions of the Japanese Plums.
107. Wireworms and the Bud Moth.
108. The Pear Psylla and the New York Plum Scale.

# I. The Pear Psylla.\*

*Psylla pyricola* Förster.

During the past five years this minute insect has inflicted such severe losses upon pear growers in various parts of the country that it threatens to seriously interfere with the successful cultivation of this fruit.

## ITS HISTORY, DISTRIBUTION AND DESTRUCTIVENESS.

The insect is an old offender, and like most of our other imported insect pests, it has wrought much more destruction here than in Europe, its native home. It was probably first introduced into this country upon young pear trees imported from Europe in 1832 by Dr. Ovid Plumb, of Salisbury, Conn.; † during the next five years he lost several hundred trees from its ravages. By 1848, it had spread into Massachusetts and into Dutchess and Columbia counties in New York. It is not again recorded as injurious until 1871, and then in Illinois; this State seems yet to be the western limit of its range. In 1879, it was destructive at Ithaca and at Saratoga, N. Y. A dozen years passed without any record of its injury. Then, in 1891, it suddenly appeared in enormous numbers in restricted localities in quite widely separated portions of this and other States, and thousands of dollars worth of fruit and many valuable trees were ruined by its ravages. Pear orchards at Fitch-

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\* This insect was discussed in detail in Bulletin 44, issued in October, 1892. There was so great a demand for the bulletin that the issue was exhausted in about a year. While this discussion includes an abstract of Bulletin 44, it also contains much new material, especially in regard to the distribution of the insect, its natural enemies, and to the methods of fighting it.

† The evidence submitted by Dr. Lintner (Ninth Rept. p. 319) to show that this insect, "may have been operating in the State of New York as early as in 1824, if not in the preceding century," is far from conclusive.

burg, Mass., Meriden, Conn. and Pomona, Md., were devastated. In this State, it was especially destructive, orchards in the eastern, central and western portions suffering severely; many trees ultimately dying. One orchard near Ithaca promised 600 bushels of fruit, but less than 50 matured; and, Mr. G. T. Powell, at Ghent, had an estimated yield of 1,200 barrels reduced to less than 100 barrels of marketable fruit.

At the time we wrote Bulletin 44 (1892), the insect was known to occur only in Connecticut, Massachusetts, New York, Illinois and possibly in Michigan; its occurrence in Maryland, noted above, was not recorded until 1894.

In 1892, it was found abundant in Ohio. In 1893, it was discovered in New Jersey, and we also received it from Thomaston, Me. In 1894, it was found to be quite generally distributed over New Jersey, and had appeared in Canada (Freeman, Ont.) and Virginia for the first time. The same year it invaded a Maryland orchard (Chestertown, Md.) of over 20,000 trees in overwhelming numbers, and was quite destructive to several orchards in western New York. This year (1895) we have learned of no serious outbreaks of the pest. We have, however, received it from Clinton, Mich., where it did considerable damage in 1894.

We believe the insect is now present in alarming numbers in most of the pear orchards in New York State. We have not failed to find it in any orchard examined for this purpose in western New York, especially in Niagara county and in the vicinity of Rochester. Specimens have been sent us from Coxsackie, Pavilion, Milton, Carlton and Dansville, N. Y.; and it has been recorded from Athens, Menands, Catskill and Baltimore, N. Y.

Thus, the range of the insect has been greatly increased since 1892. It now ranges from Maine southward through Massachusetts, Connecticut, New Jersey, Maryland and into Virginia, and westward through New York, Canada, Ohio and Illinois to the Mississippi river, beyond which it has not yet been recorded.

#### HOW IT SPREADS.

In spite of its wide distribution, it seems to be rather a local insect, and its spread from orchard to orchard rather slow. Some of Coe Brothers' orchards at Meriden, Conn., have been badly



infested for 15 years, and, yet, it had not appeared (in 1892) in one orchard set in 1881 only half a mile distant.

Our New York nurserymen are reported to be responsible for its introduction into Maryland, Virginia, New Jersey and Canada. In nearly every case it is claimed the source of infestation can be directly traced to pear stocks bought of New York nurserymen in 1890 or 1891, or about the time the pest was so numerous in this State. It is supposed that the hibernating form of the insect is thus distributed.

#### ITS CLASSIFICATION AND NAME.

This pear pest is one of the true bugs and belongs to the family *Psyllidae*, commonly known as jumping plant-lice from the leaping habit of the adult insects. Thirty-four species of Psyllids have thus far been described from the United States.

*Psylla pyricola*, although it was observed in this country in 1833, received its name in Europe fifteen years later. Previous to 1848, European writers had referred to the species as *Psylla pyri*, not distinguishing it from that species. *Psylla pyricola* sometimes attacks the apple tree in Europe, but it seems to confine its attacks to the pear in this country.

#### INDICATIONS OF ITS PRESENCE.

During severe attacks of this pest, old trees put forth but little new growth, new shoots often droop and wither in May, the leaves turn yellow and the fruit grows but little, and in midsummer the leaves and half-formed fruit often fall from the trees. The insect also indicates its presence by secreting large quantities of a sweet, water-like, sticky liquid called "honey dew" which often covers all parts of the tree; it has literally rained from the leaves in some cases and smeared the backs of horses during cultivation\*. A black fungus soon grows all through this honey-dew and thus gives the tree a disgusting blackish appearance as if treated with a thin

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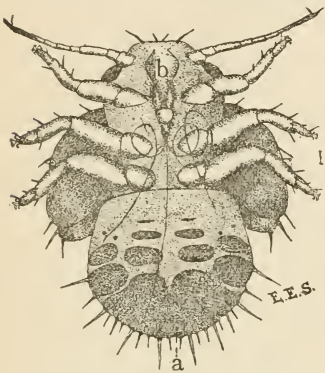
\* During the severe attack in Maryland in 1894, "the leaves were scarcely at all yellowed, but were covered with dead and dry patches or spots, sometimes invading almost the entire leaf." It seemed to be due "to the sun-scalding resulting from the collection of the honey-dew on the leaves in large drops."

coat of black paint or soot. Pear trees of all varieties and ages are attacked in this State.

Although the indications of the presence of some enemy is so conspicuous, the depredator is so small as to be easily overlooked.

ITS APPEARANCE.

*The immature insect.*—These curious, minute, oval, immature forms are called nymphs.



40.—Full-grown nymph of the pear psylla, ventral view, greatly enlarged.

The newly-hatched ones (Fig. 43) are yellow in color, with crimson eyes, and can scarcely be seen with the unaided eye. During their growth they gradually acquire the black markings, shown in the frontispiece and in figure 40, and become tinged with red. A very conspicuous feature in the full-grown nymph is the large black wing-pads on each side of the body.

*The adult insect.*—In this form (Fig. 41) the insect strikingly resembles a cicada or dog-day harvest-fly in miniature. Its general color is crimson, with broad black bands across the abdomen. Its thickened femora enable it to jump like a flea. In the male insect the abdomen terminates in a large trough-shaped segment from which project upward three narrow copulating organs; the end of the abdomen of the female resembles a bird's beak.

(Fig. 41) the insect strikingly resembles a cicada or dog-day harvest-fly in miniature.



41.—*Psylla pyricola*, the adult insect, much enlarged.

ITS LIFE-HISTORY.

But little was known of the life-history of the pear psylla, either in Europe or in this country, previous to the publication of our Bulletin No. 44 in 1892.

*How it passes the winter.*—The insect hibernates in the adult stage, hidden in the crevices under the loosened bark on the trunk and large limbs of the pear trees; a favorite hiding place on some trees is in the cavity formed by the bark growing about the scar of a severed limb. During warm days they often crawl about on the

branches and trunk. They are not easily seen as they are so small and their color so closely imitates the bark.

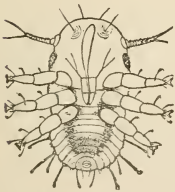
*Egg-laying of the winter brood.*—During the first warm spring weather the adults come from their hiding places, copulate, and egg-laying soon begins. In this State, most of the eggs are usually laid before April 25. They are placed in the creases of the bark or in old leaf scars, about the bases of the terminal buds of the preceding year's growth; some occur about the side buds, near the terminal ones. They are usually laid singly, but rows of eight or ten sometimes occur. The eggs (Fig. 42) are scarcely visible to the unaided eye; it would take eighty of them placed end to end to measure an inch. They are elongate pyriform in shape, smooth and shining, and of a light orange-yellow color when first laid, becoming darker before hatching. A short stalk on the larger end attaches the egg to the bark, and a long thread-like process projects from the smaller end.



42.—Egg of pear psylla, greatly enlarged.

The temperature conditions in the spring influence the time of oviposition and the duration of the egg-state. In 1892, the eggs were from seventeen days to three weeks in hatching. Hatching usually begins about May 10. By the 18th most of the nymphs are out and their parents have disappeared.

*Habits of the nymphs.*—Immediately after emerging, which usually happens about the time the leaves are expanding, the minute nymph (Fig. 43) seeks its favorite feeding place, the axils of the leaf petioles, and later on stems of the forming fruit. When these axils become full they gather on the leaves. Their food consists entirely of the sap of the tree, which they suck through a short, sharp beak. Unless disturbed, they move about but very little, sometimes becoming covered with their own honey-dew. They stop feeding only when their skin gets too small, and they cast it off for a new elastic one that they grow just beneath the old one.



43.—Newly-hatched nymph of pear psylla, ventral view, greatly enlarged. (Reduced from figure by U. S. Dept. of Agr.)

*Habits of the adult.*—The strong legs and wings of the adult enable it to spring up and fly away with surprising quickness upon the slightest unnatural jar. The hibernating forms are not as

active and are readily captured. The adults also feed upon the sap by means of a sharp beak, but seem to have no favorite feeding place.

*Egg-laying and habits during the summer.*—In about a month after emerging from the egg in the spring, the nymphs become full grown and at the last casting of the skin the adult insects appear.

This first brood, appearing about June 10, and all subsequent summer broods of the adults, differ strikingly from those that hibernate. The winter forms differ in size, being nearly one-third larger, in their much darker coloring, and especially in the darker coloration of the front wings. Thus, in this pear psylla, we have a case of true dimorphism; the winter form had been described as a distinct species, *Psylla simulans*.

In about a week after their transformation from the nymph stage, the summer adults copulate and begin laying eggs for another brood. These eggs do not differ from those laid by the winter forms, but they are laid singly or in groups, not on the bark of the twigs, but on both sides of the leaves, tucked in among the hairs along the midrib or adroitly placed in the notches of the toothed edge of the leaf. They hatch in from eight to ten days.

A careful study was made of one generation of the insect in 1892 and the many interesting details then learned have been recorded in Bulletin 44. It was found that the nymphs cast their skin five times, at intervals of from three to seven days, the adult insect appearing at the fifth or last moult. So life-like were some of the cast skins as they were left on the leaves by the nymphs that it often required close examination with a lens to determine if the object was alive or only a nymph's cast-off garment. In each stage the nymphs secreted globules of honey-dew several times larger than themselves. Although the adults feed, they do not grow nor do they seem to secrete any honey-dew, but void considerable quantities of a whitish excrement. The summer adults probably live for less than a month, while those that hibernate remain alive for at least six months.

*Number of broods.*—Our observations indicate at least four broods in this State; the adults were the most numerous on or about June 15, July 20, August 20 and September 25, or a brood

appeared about once a month. Apparently a fifth brood appeared in Maryland in 1894. The adults emerging in September and later were the hibernating form.

*Honey-dew and excrement.*—The honey-dew occurs in such immense quantities that it seems almost impossible that it is all secreted by the nymphs, and yet such is the fact. We found that one nymph secreted at least four drops (i. e. four minims) before it became an adult. In the case of the nymphs most of the food is elaborated into honey-dew ; some is assimilated, and the waste matter voided as excrement. The adults, however, seem to secrete no honey-dew, and consequently they void considerable quantities of excrement.

The honey-dew and excrement are very different substances. The former is a clear water-like liquid and forms into globules when secreted. The excrement, however, is a whitish semi-solid substance which is voided in long cylindrical strings, or minute whitish balls which roll from the anus like quicksilver globules. The honey-dew seems to be secreted from the anus with the excrement.

#### ITS NATURAL ENEMIES.

When we wrote in 1892, no enemies of the pear psylla had been recorded ; we had heard rumors that a lady-bug beetle was destroying them in some localities, but there was nothing definite.

However, during the outbreak in Maryland in 1894, at least two predaceous insects were found feeding on the psyllas, one of which did very efficient work. As both of the insects are common in our State, pear-growers should learn to know them. One is a common lace-winged fly, *Chrysopa oculata*. Its various stages are well illustrated in figure 44. It is such an interesting creature and proved such an efficient foe of the psylla in Maryland that we give a brief sketch of its life.

The adult (Fig. 44, *b*) is a beautiful dainty creature with its wings and body of a pea-green color, and with a pair of large eyes that shine like melted gold. It is a very helpless creature, does not feed at all, and remains concealed in low grass during the day, becoming active and depositing its eggs in the evening. It emits a very disgusting odor when handled. "The lace-wing is a prudent mother ; she knows that if she lays her eggs together on a leaf the

first aphid-lion (as the young are called) that hatches will eat for its first meal all his unhatched brothers and sisters. She guards against this fratricide by laying each egg on the top of a stiff stalk of hard silk about half an inch high (Fig. 44, *a*). Groups of these eggs are very pretty, looking like a tiny forest of white stems bearing on their summits round glistening fruit. When the first of the brood hatches, he scrambles down as best he can from his egg perch to the surface of the leaf, and runs off, quite unconscious that the rest of the family are reposing in peace high above his head." (*Comstock's Manual for the Study of Insects*, p. 181).

Mr. Marlatt, who observed its work in Maryland, says of the young aphid-lion: "On approaching the egg or young psylla nymph, it immediately grasps it between its long, curved, mandible-like organs, which amount to two sucking tubes, between the tips of which the egg or young nymph is held and rolled one way and the other, as between thumb and finger, the juicy contents being in the meantime rapidly extracted; the dry shell is cast aside, the whole operation frequently taking less than a minute. The aphid-lion is an extremely hungry one and is always feeding. It eats anything that comes in its way, is totally fear-



44.—*Chrysopa oculata*. a, eggs; b, full-grown larva or aphid-lion; d, larva devouring an adult psylla; e, cocoon; f, adult insect; g, front view of the head of the adult—all enlarged. (Reduced from figure by U. S. Dept. of Agr.)

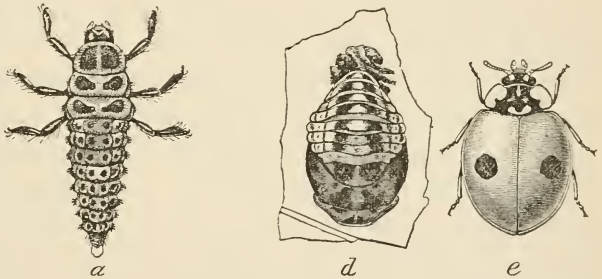
less, and is also, unfortunately, cannibalistic, eating its own kind with great readiness. It is a safe estimate to say that one aphid-lion will destroy several hundred eggs and nymphs of the psylla in addition to the adults which it will destroy (see *d* in figure 44) in its later larval growth." In about ten days the aphid-lion becomes

fully grown (Fig. 44, *b*) and rolls itself up into a tiny ball and weaves around it a glistening, white cocoon (*e* in figure 44), which looks like a seed-pearl. Possibly while secluded in this pearly cell the aphid repents its greedy, murderous ways, and changes in spirit. In from ten to fourteen days, a neat lid is cut from the upper end of the cocoon (see *e* in figure 44) and an active pupa\* wriggles out, from which in an hour or so the dainty lace-wing emerges. There are several broods of this predaceous enemy of the psylla during the year.

It is to be hoped that this lace-wing may see fit to include the pear psylla in its menu in New York State, where there is abundant opportunity for it to do our pear growers as efficient service as it has rendered in Maryland.

The other insect enemy of the pear psylla is the very common red lady-bug (*Adalia bipunctata*) with a black spot on each wing-cover (Fig. 45

*e*). It is so common that if it can be induced to feed freely upon the pear psylla it will prove a very efficient aid in the warfare against the pest. It is predaceous in both its larval



45. — *Adalia bipunctata*. a, larvæ; d, pupa; e, adult—all enlarged. (Reduced from figure by U. S. Dept. of Agr.)

(Fig. 45, *a*) and adult stages. Mr. Marlatt saw a beetle with an adult psylla in its mandibles in the Maryland orchard; and he says one of the beetles cleaned the eggs from the leaves of a young pear tree in his breeding cage about as fast as upwards of 50 to 75 psyllas laid them. He reared from the egg state a brood of the lady-bug

\* Most writers state that the *adult* emerges from the cocoon, but, as was pointed out by Dr. Shimer in 1865 and by Dr. Riley in 1869, what they have called the *pseudo-imago* or *sub-imago* comes from the cocoon. The names given this stage of the insect are misleading, as they properly apply to a *winged* stage preceding the *imago* stage of may flies. In the case of the lace-winged flies, their *pupae* are sufficiently active to force their way out of the cocoon.

beetles on the eggs and nymphs of the pear psylla. Our correspondent in Clinton, Mich., writes that he has "noticed the common lady-bug feeding on the nymphs of the psylla."

Birds have been seen picking the adult psyllas out of their winter retreats in Niagara county; so industrious were the birds that but few psyllas were left on some trees.

#### HOW TO COMBAT PEAR PSYLLA.

*The eggs.*—Although the eggs laid early in the spring are freely exposed on the bark to the action of insecticides, yet we were surprised to find that many of them hatched after they had been dipped in kerosene oil, turpentine, benzine, and several of the washes used for killing scale insects. Mr. Marlatt reports that in July he killed many of the eggs laid on the leaves, by spraying with a kerosene or whale-oil soap emulsion diluted with from seven to nine parts of water. However, as many of the eggs cannot be killed in this way and as the insect can be combated much more effectively in another stage, we do not consider it advisable to fight it in the egg-stage.

*The nymphs.*—Our experiments in 1892, showed that the nymphs in all stages were quickly killed by kerosene emulsion.\* Others who have tested it thoroughly report success.

Usually most of the damage is done in this State by the first brood of nymphs before June 15. It is therefore very important that the insect should be checked early in the season. We now advise using the emulsion diluted with about fifteen parts of water, instead of with twenty-five, as it is more effective against the nymphs, and it will also kill the adult insects. As the nymphs begin to hatch just as the leaves are expanding, then is the time to

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\* The formula is  $\frac{1}{2}$  pound hard or soft soap, 1 gallon water, 2 gallons kerosene.

First, thoroughly dissolve the soap in boiling water. While this solution is still very hot add the kerosene; if the whole is then left over the fire for a few moments to raise the temperature of the kerosene slightly, it will facilitate the emulsifying process. Remove from the fire and quickly begin to agitate the whole mass through a syringe or force pump of some kind; draw the liquid into the pump and force it back into the dish. Continue this operation for five minutes or until the whole mass assumes a creamy color and consistency which will adhere to the sides of the vessel, and not glide off like oil. If desired for use immediately, it may



begin spraying; about May 15 is usually the time in this State. Where they are numerous, a second or third spraying will be necessary. *The emulsion must be applied liberally and thoroughly;* it will not injure the tree in the least. It is much more difficult to fight the insect later in the summer, when the tree is in full foliage and many of the nymphs are covered with honey-dew. Watch for their appearance on the unfolding leaves in the spring and act promptly. Spray two or three times in a week if necessary; make every effort to prevent the development of a second brood.

*The adults.*—In Bulletin 44 we suggested that a thorough washing of the trunks and larger branches of the trees in winter with kerosene emulsion (at least five per cent. kerosene), or a strong soap solution, would destroy many of the adults in hibernation in the crevices of the bark. It is reported that a whale-oil soap solution has been thus used very effectively in New Jersey. We believe it is a practical method, and should be practiced in infested orchards.

We once saw hundreds of the hibernating adults congregated on the smooth trunks of a large block of young standard pear trees. There were twenty-five or more on each tree, and all of them on the same sides of the trees. It was a short job with a rag or mitten to grasp the tree at the base, draw the hand up the trunk and thus crush the psyllas.

Is it practicable to fight the adults in summer? They are then often very numerous but are very shy and active, and fly from the tree the moment the spray strikes it. It would thus seem that "spraying has practically no value against the adults during their active summer existence" (Mr. Marlatt). However, several of our

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now be readily diluted with cold water, preferably with rain water. Or the whole mass may be allowed to cool when it has a semi-solid form, not unlike loppered milk. This stock if covered and placed in a cool dark place will keep for a long time. In making a dilution from this cold stock emulsion, it is necessary to measure out the amount of the emulsion required and first dissolve it in three or four parts of boiling water; if cold water be used a large quantity of a white flocculent mass rises to the surface and does not dissolve. After the stock emulsion is dissolved, cold water may be added in the required quantities. If all the utensils are clean, and the directions followed closely, no free oil will rise to the surface of the dilution.

New York pear growers have demonstrated the practicability of fighting the adult insect. In 1894, the presence of the pest in destructive numbers was not suspected in one Niagara county orchard until the leaves began to drop off in July. The kerosene emulsion spray was at once directed against the enemy with the result that it at once brought down millions of the adults, their dead bodies being thickly strewn about the spraying apparatus. Although the insect had gotten such a start in the orchard, it was so effectively checked with the emulsion that but few psyllas were found in 1895. Mr. Geo. T. Powell, who has had more practical experience with this insect than any other fruit grower in the State, also sends us the following brief, yet graphic, account of his fight with the insect in 1894:

“May 10th. Eggs began to hatch and we sprayed with kerosene emulsion, diluted 1 to 20.

May 15th. The nymphs began to get out in full force, when we began spraying with great thoroughness. When the wind blows hard, the spraying is not done so effectively, especially in the tops of quite tall trees.

May 16th. Sprayed a second orchard. The day is clear and still. The work is very much more effective, killing the young psyllas quickly and in all parts of the tree.

May 17th. Sprayed the first orchard again. Many insects alive, the emulsion not having hit them thoroughly on account of high winds. Unless the insect is destroyed the fruit will be worthless.

June 5th. After several rainy days, sprayed pear trees again and for the last time as the psylla seems to be pretty well knocked out by this time; only a few nymphs are feeding, but quite a number of adults about the tree.

June 11th. Finding a few nymphs still coming out and working, we sprayed again and at the same time bringing down millions of the adults that escaped former sprayings. The day is very still and warm. The greatest possible force is given the spray, which goes over the tops of the highest trees. The stones on the ground and the platform of the machine are covered with dead adults. A sheet is placed under a small tree, and after spraying but ten seconds, 150 adults fell upon the sheet and in five minutes 90 per cent of them were dead.

After discovering the extent to which the adults were being destroyed, the entire orchards were gone over, extra force being given to the spray to bring down as many adults as possible, thereby lessening largely the number to multiply next year.

We used a hand-pump on the Phillip's sprayer and stopped at each tree, spraying very thoroughly before leaving it. There is no power machine that will do this work thoroughly enough as yet;

for pressure on the pump cannot be kept on strong enough or long enough to do the work effectually.

Results.—Notwithstanding a very long and severe drouth, we brought through a very good crop of pears of excellent quality, the first good crop in four years. The trees made growth and have quite rallied from an almost hopeless condition of decline.

June 18, 1890. I very thoroughly annihilated the psylla last year. My pear orchard is improving remarkably. Sprayed only once this season, they were so few.”

*Geo. J. Powell.*

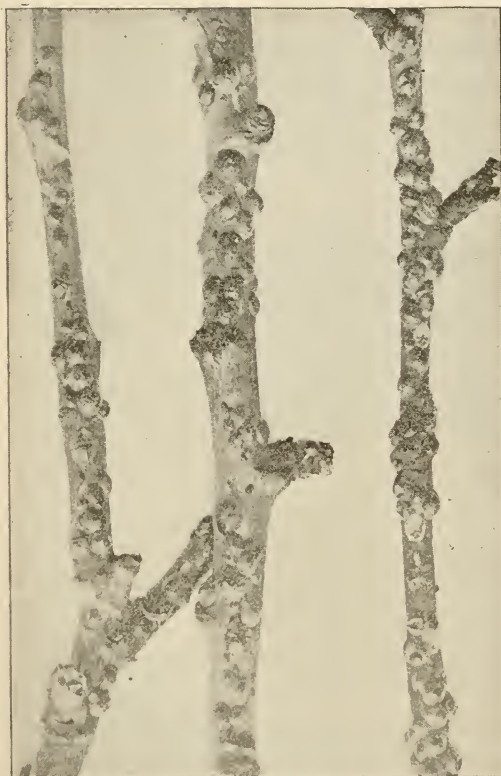
Disheartened pear growers cannot fail to find much encouragement in the above account of how the ravages of this pear psylla were checked in one of the worst afflicted orchards in our State.

## II. The New York Plum Scale.

*Lecanium juglandis?* Bouché.

This insect (Fig. 46), which suddenly appeared in overwhelming numbers in many of the largest plum orchards in western New

York in 1894, was discussed in detail in our Bulletin No. 83, December, 1894. The bulletin is not yet out of print and can be obtained by addressing the Director of the Experiment Station. Several new and important facts have been learned about the insect since the bulletin was published, and these are included in the following notes which aim to give fruit-growers the latest news about this serious pest.



46.—Plum branches badly infested with the full-grown scales, natural size.

*Extent of its damage in 1894.*—The serious picture we drew in Bulletin 83 of the ravages of the insect did not tell half the truth. Before the winter was far advanced, it was found that the strain

on many trees from so many millions of little pumps sucking out their vital fluid—the sap—had been too great. In one orchard three hundred of the oldest bearing trees had succumbed in January, and three hundred more died before spring.

*Effect of the winter of 1894-'95 on the scales.*—When winter set in, each one of the 50,000 of the best plums trees in western New York harbored millions of the little scales, thus threatening the entire destruction of thousands of these trees in 1895. The situation was exceedingly serious. However, in January it was reported at the meeting of the Western New York Horticultural Society that “a large percentage of the insects were being killed by the winter.” We at once made a careful examination of many infested branches sent in by correspondents in different localities, and found that the report was well founded; the good news was fortunately true. From 50 to 75 per cent. of the scales were then dead, and evidently more succumbed later for we believe that in most orchards less than 25 per cent. of those that went into hibernation in the fall were alive in April, 1895. Apparently those most exposed died first, indicating that weather conditions of some sort may have caused their death. But whether it was due solely to low temperature, or to the sharp, dry, chilling winds that prevailed, we cannot say.

*Extent of damage in 1895.*—So far as we have learned, all those who suffered so severely from the insect in 1894, are unanimous in their opinion that but very little damage has been done by it in their orchards this year; and it has not been numerous enough to attract particular attention except on a few trees. This general exemption from injury this year was due to three principal causes. First, a majority of the scales died from some cause during the winter, thus greatly checking the future development of the insect. Second, most of those having infested trees carried on a vigorous warfare against the pest with the kerosene emulsion, both in the fall and early spring. Third, thousands of the scales were killed by minute parasites in the spring, and the lady-bug beetles which feed upon the scales were unusually numerous and active during the summer.

However, a few orchards suffered considerably from the insect this year; we learned of one apple orchard in Niagara county that was

quite badly injured. On the whole, the insect did very little damage in 1895 compared with the destruction wrought in 1894.

*The future outlook.*—What little information we have indicates that the insect is going into hibernation in considerable numbers on some trees, but the outlook for 1896 is encouraging. Nevertheless, it will not do to be too sanguine. Every tree known to harbor the pest should be carefully examined this fall, during the winter, and especially early in the spring.

Previous to last year, New York orchards had never suffered from the attacks of this or any other *Lecanium* scale, and they may not be threatened so seriously again for many years to come. But we can never tell when to expect most of our insect foes to appear in alarming numbers, so that our fruit growers must be continually on the alert and watch this plum pest closely every year.

*Its name.*—Experts are not yet agreed upon the name this *Lecanium* should bear. It has lately been decided by Mr. Newstead, of England, that it is identical with the European insect—*Lecanium prunastri*. Messrs. Cockerell and Maskell conclude that it is probably identical with *Lecanium juglandis* which Bouché found on black walnut in Germany over fifty years ago.\*

*Its history and distribution.*—The fact that isolated specimens of this insect can be found on almost any large plum tree in certain portions of the State, indicates that it has been with us for many years. The few years preceding 1894, happened to offer the conditions most favorable for its multiplication in excessive numbers in western New York; and it then forced itself upon our attention by its destructive work.

Mr. L. O. Howard, U. S. Entomologist, reports (Yearbook of U. S. Dept. of Agr. for 1894, p. 272) that there are two other distinct kinds of *Lecaniums* affecting plum trees in the United States. One of these passes the winter in the same stage as does our New York species, while the other hibernates as a nearly full-grown, rounded female. Our New York species has

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\* Mr. Maskell writes us on October 6, 1895: "I have examined your insects, and agree with Mr. Cockerell that on the whole they are nearest to *Lecanium juglandis*. I don't quite see how your insect can be *L. prunastri* which has very marked epidermal puncta. I don't think you will go far wrong in calling it *L. juglandis*."

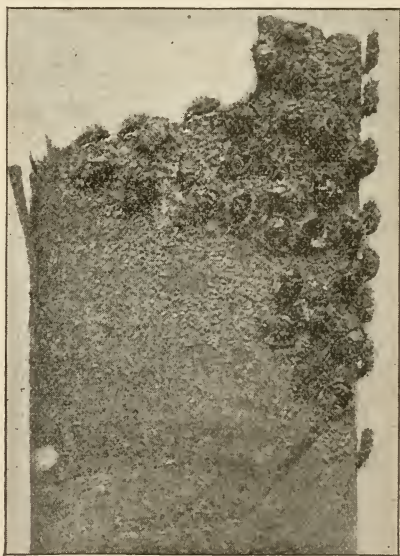
recently appeared in destructive numbers in Canada. It is also more generally distributed over our state than was suspected when we wrote Bulletin 83. We have received it from Aquetuck, Hector, Schoharie (on *Prunus simoni*), Eastwood and Penn Yan, N. Y.

*Its food-plants.*—The insect still remains par excellence a plum pest, yet several quince and apple trees have been seriously injured by it. A possible source of infestation for some of the orchards near Geneva was found to be an ash grove which was very badly injured in 1894 by a Lecanium which is apparently the same as the one working on the plum trees. The grove was also badly injured this year, the leaves all dropping off during the summer.

Probably the Lecaniums found in such large numbers on maple and other forest trees in different parts of the State are distinct from the plum Lecanium.

*Its natural enemies.*—The small, black, elevated, smooth, parasitized scales described in Bulletin 83, p. 693, were very numerous last spring, and we bred many of the minute four-winged flies. Mr. L. O. Howard has determined them as *Coccophagus lecanii* Fitch, a Chalcid which is common in many parts of the country and attacks several different kinds of Lecaniums. This little foe proved a valuable ally of the fruit-grower last spring, as we found a considerable percentage of the scales parasitized.

From several different sources we have learned that the twice-stabbed lady-bug beetle was very numerous in



47.—Spiny larval skins of lady-bug beetles, natural size.

the infested plum trees this year. Several groups of the spring skins (Fig. 47) shed by their larvæ when they pupate, have been sent in by plum growers. Protect these little lady-bugs, as they are doing valiant service in the extermination of this pest.

*Results of spraying.*—All who sprayed with the kerosene emulsion (diluted with 4 parts of water) according to the directions given in Bulletin 83, report general success. There is no longer any question about its killing the scales hit by it.

During the summer we saw infested trees that had been sprayed with different substances to kill the young scales then on the leaves. Some of the scales had been killed, but as it was evident that a great majority, over 75 per cent., were uninjured, the applications were far from a success. The liquids had also injured the bloom on what little fruit there was. What results we saw fully confirmed our opinion, expressed in Bulletin 83, that the insect cannot be effectually and practicably checked by sprays while it is on the leaves during the summer and early fall.

Spray infested trees once after the leaves fall in autumn, and at least twice in the spring before the buds open. Use kerosene emulsion diluted four times, and the application cannot be done too thoroughly; each little scale must be hit.

MARK VERNON SLINGERLAND.



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BULLETIN 109—January, 1896.

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Cornell University—Agricultural Experiment Station,  
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106. Revised Opinions of the Japanese Plums.
107. Wireworms and The Bud Moth.
108. The Pear Psylla and the New York Plum Scale.
109. Geological History of the Chautauqua Grape Belt.

*The Honorable Commissioner of Agriculture, Albany.*

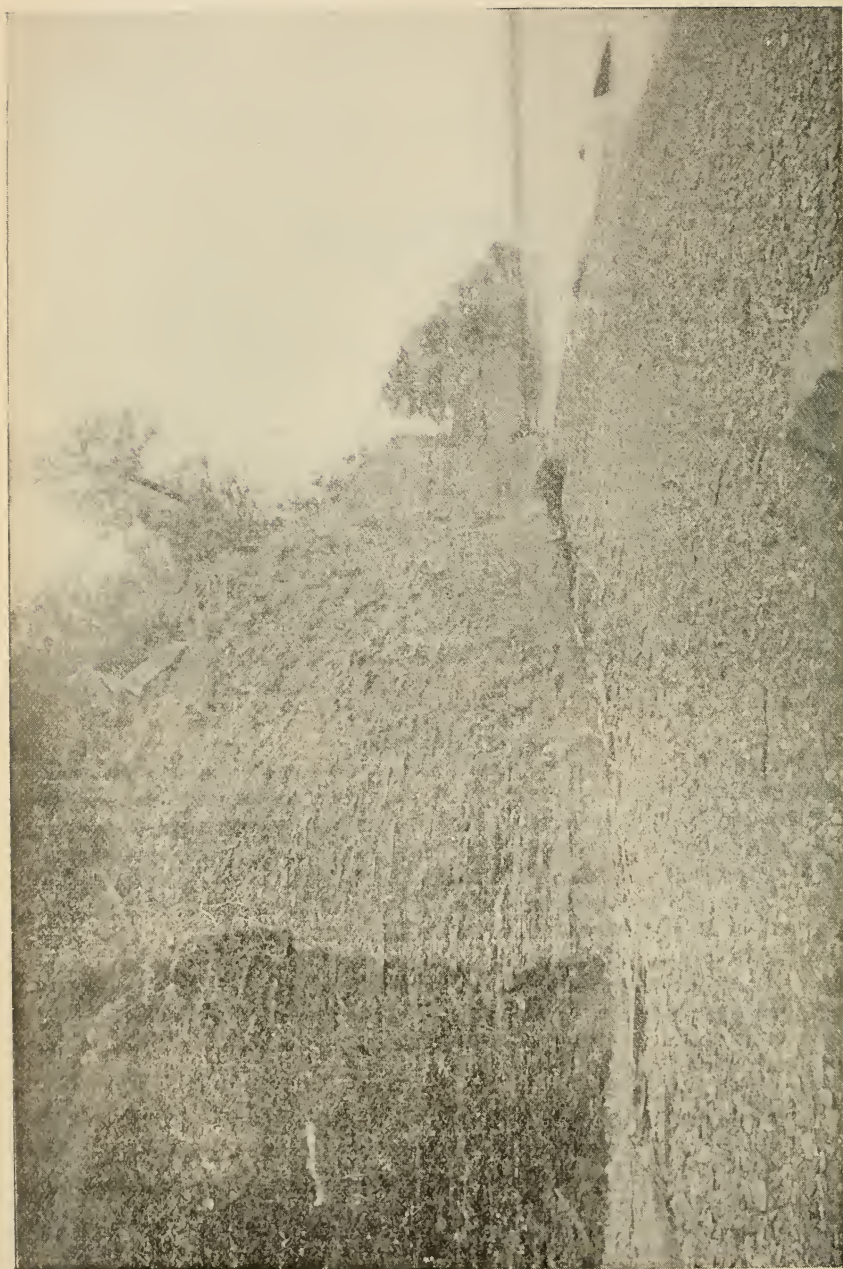
SIR: One of the most obvious circumstances connected with the cultivation of many fruits is the fact that the most successful plantations of them are confined within somewhat narrow areas or in well marked geographic regions. This circumstance is emphatic in the grape belt of Chautauqua county. It becomes a matter of great importance to determine the reasons for the existence of these fruit belts, and to ascertain how far their limits may probably be extended with profit. A study of the surface geology and topography of any of these belts may be expected to afford most interesting and valuable facts for the pomologist, for this type of investigation is yet practically untouched by scientific inquiry. In Chautauqua county there is a particular reason for such an inquiry because of the fact that the entire Erie slope is not equally adapted to the grape, although vineyards have been almost promiscuously planted upon it. It is necessary that the true grape belt be delimited and charted. In seeking to take up this investigation, we have been fortunate to secure the services of R. S. Tarr, Professor of Geology in Cornell University. It is a happy circumstance that Chautauqua county, which originated and matured the movement for Experiment Station extension work, should now be the scene of the first specific attempt in this country, on the part of an Experiment Station, to analyze the physical geography of a fruit belt.

L. H. BAILEY.

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CONTENTS.

	PAGE.
Introduction .....	127
Topography .....	128
The Bed Rock .....	129
The Soils.....	130
General Description of the Soils.....	130
The Hillside Soils .....	132
The Gravel Ridges .....	134
The Lake Clay Soils .....	136
Shale Gravel.....	138
The Relative Value of the Soils .....	138
The Modern Beaches.....	139
The Ancient Beaches.....	144
The Gravel Ridges .....	145
Variations in the Gravel Ridges.....	147
Irregularities and Level of Gravel Ridges.....	148
Interpretation.....	149
Résumé of the Geological History .....	150
Climatic Conditions.....	155
Most Favorable Places for the Location of Vineyards .....	156
Influence of the Gravel Ridges .....	157



48.—Wave-cut cliff and beach of Lake Erie, north of Ripley.

# Geological History of the Chautauqua Grape Belt.

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## INTRODUCTION.

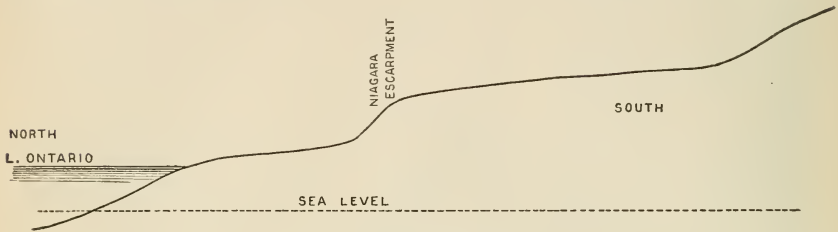
This study was made primarily for the purpose of ascertaining the natural conditions which favor fruit growing in the grape belt of the Erie shore of New York. It became immediately evident that these conditions had to do both with the soil and the climate. Concerning the latter, little detailed information of value could be obtained; for in order to gain this information, meteorological observations must be carried on for a series of years at stations located in different places. In order to find out how the soil varies, a rather careful study of characteristics and distribution was made, and the satisfactory study of these involved the question of origin. Since the origin is a question of some interest, it will be included in this paper.

In general, it may be said that the two factors of soil and climate have conspired to make the grape belt a district admirably adapted to fruit raising. While each is of importance, it is evident that the climatic peculiarities are of more importance than the soil. Both the characteristics of climate and soil are due to the topographic peculiarities and the geological history of the region included within the grape belt and in its immediate neighborhood.

The time occupied in the field study has amounted to only about three weeks—two in June, one in September and two days in November—and therefore a great amount of detail can not be expected. Although a little work was done east of Silver Creek, the study was practically limited to the region between this town and the state line. During the study, I have received many courtesies from the residents of the grape belt, and I am particularly indebted to Mr. J. W. Spencer, of Westfield. In September I was aided by Mr. T. L. Watson, of Cornell University. In running the three lines of levels, Mr. M. D. Tennant, of Westfield, did the leveling and the writer acted as rodman.

## TOPOGRAPHY.

The situation of the grape belt is peculiar. From Lake Ontario southward, toward Niagara Falls or Lockport, there is a nearly level plain extending to the base of the Niagara escarpment, known



49.—Profile of the Niagara escarpment.

locally as “the mountain” (Fig. 49), which raises quite abruptly to a height of two or three hundred feet. This escarpment is well seen at Lewiston, where the basal plain stretches away toward the lake with scarcely any diversity to break the monotony. All of this plain is less than 500 feet in elevation above the sea, and it borders the entire southern shore of Ontario.

South of the Niagara escarpment, toward Batavia or Buffalo, there is another plain, which beyond Buffalo narrows down to a width of only one or two miles as the state line is approached. It is nowhere below 500 feet, nor above 800 feet in elevation. This narrow strip which borders the Erie shore is the true grape belt. Everywhere the southern margin of this plain is backed by an



50.—Location of the grape belt.

escarpment or ridge (Fig. 50), which quickly raises to a height of 500 or 600 feet above the plain, and in some places is over 1,000 feet above the lake. Therefore, the grape belt (in New York) is a narrow plain extending north-eastward from the Pennsylvania state line, and bounded on the north by the lake, on the south by a high range of hills. East of Silver Creek the plain widens and the bounding escarpment loses in elevation. This narrow plain is only a small fragment of the real plain; for the waters of Lake Erie cover the greater part of it. As is shown in the profile (Fig. 50), the plain descends beneath the lake waters

and ascends on the Canadian side. Not merely is a part of the plain now submerged, but at a recent geological period more of it, and that part now occupied by the most flourishing vineyards, was covered by the lake waters. Lake Erie now plays an important part in modifying the climate of the grape belt; it formerly did important service in modifying the soils.

#### THE BED ROCK.

As revealed along the lake shore, and in the remarkable gorges which cut the escarpment and the plain, the bed rock is entirely upper Devonian shales and sandstones above the horizon of the Hamilton, which does not extend farther west than Evans. Both plain and escarpment are made of these; but it is probable that the latter owes its elevation to the protective effect of some harder layers of upper Devonian rock now removed.

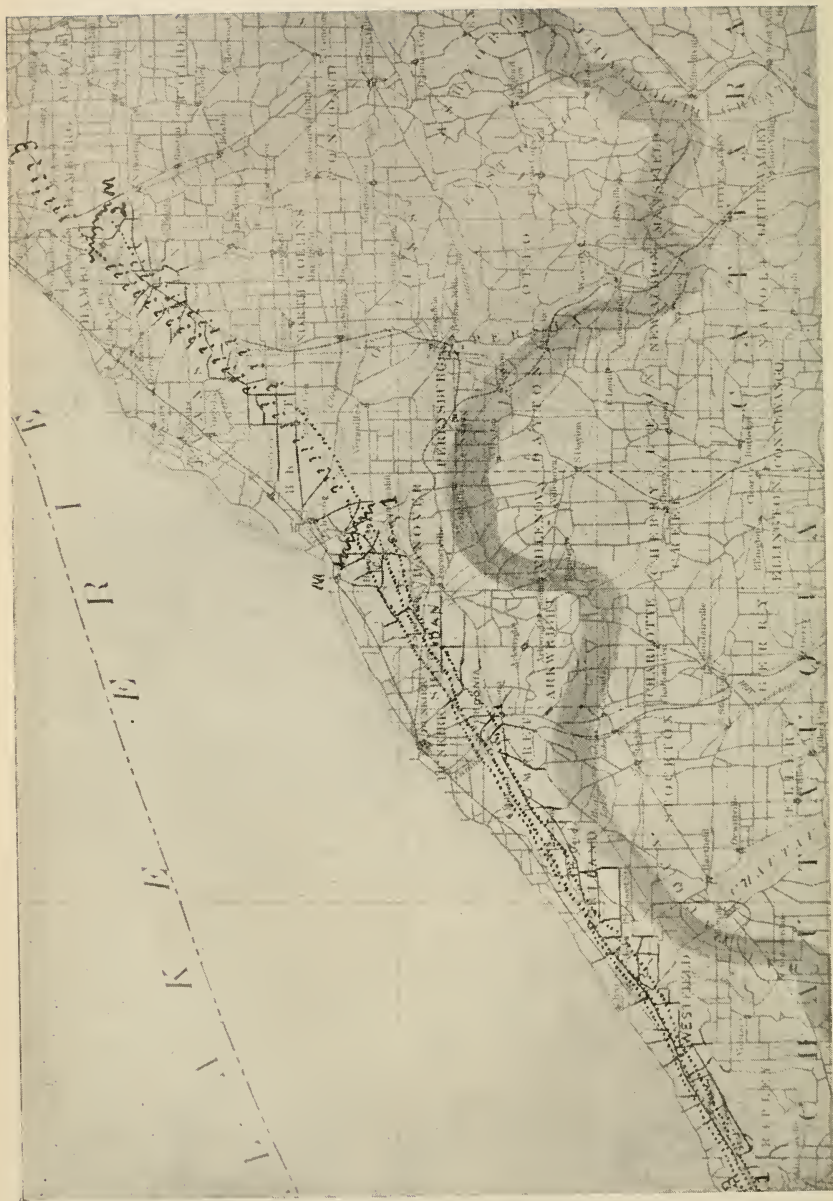


51.—Section of the grape belt.

On the northern face of the escarpment the soil is prevailingly thin and the plough frequently reaches the bed rock; but on the plain, the bed rock is rarely seen at the surface, excepting in the stream beds and in the shale ridges, which are found mainly east of Dunkirk. Still the bed rock plays an important part in the soils; for fragments of shale are commonly present in all the soils of the district.

#### THE SOILS.

*General description of the soils.*— If we should make several north and south sections across the grape belt, from the middle of the escarpment to the lake shore, they would be found to vary in details according to the location of the line, but to be quite the same in general features. The average condition would be as follows (Fig. 51). Commencing on the hillside with a thin soil of clayey nature, and with an abundance of pebbles, (Fig. 53) and perhaps boulders, at the base of the hill, when at the elevation of about 250



52. — Map of the region in the vicinity of the Grape Belt. Showing the approximate location of the three beaches and the moraines (M).



feet above the lake, we come to a gravelly soil in which the pebbles are well rounded (Fig. 57) as if by water action. North of this there is a steep slope of twenty or thirty feet, at the base of which the soil becomes clayey, and this continues usually for several hundred feet, or possibly as many yards, when gravelly conditions are again encountered, somewhere in the vicinity of the main Buffalo and Erie turnpike. One or two gravel terraces are found here, and at the base of the northernmost of these clay again appears. Here, as in the case of the first gravel ridge, there are springs at the junction of the gravel and clay, so that, where not artificially drained, this place is continuously indicated by swampy conditions. From the top of the upper (southernmost) gravel ridge to the spring line at the base of the lowest the descent is about ninety feet, and the distance anywhere between two and three hundred yards and a mile or even more, though usually not far from a quarter of a mile.

From this point lakeward, a distance of one or two, and in some places even three miles, the plain is somewhat irregular, with a general descent toward the lake, which is some 150 to 160 feet below the gravel ridges. The soil is usually a clay, though it is often of a sandy nature. The immediate shore line is commonly a bluff, either of shale or of clay (Figs. 48, 59 and 61), though at times it is in the form of a beach, without any well-developed bluff (Fig. 58).

As has been said, this will hold in general for *any* north and south line, whether at the state line, Fredonia, Silver Creek or any intermediate point. If, however, we make our section nearly parallel to the lake shore, remaining at the same elevation above its surface, we find a remarkable uniformity of conditions. Thus we may pass from Erie, Pa. (and indeed from far to the west of this), to Hamburg, N. Y., without leaving a belt of gravel, excepting where the road crosses a stream; or, if on the hillsides, one may pass over the same distance upon a boulder-bearing clay; or, if near the lake, upon a fine clay soil, usually free from boulders. These differences are constant and they are due to definite causes. Since the result is of importance to the fruit grower, the cause must at least be of interest. Before considering the cause, we will examine the conditions in a little more detail.

*The hillside soils.*—Above the upper gravel (see map, Fig. 52), which usually lies but a short distance south of the main road, the ground generally commences to rise more rapidly and the escarpment is soon reached. On this hillside there is considerable grape raising, but the soil is altogether different from that in the region to the lakeward, which is the main grape belt. The base of this soil is a clay of very fine texture; but there are some local variations from this. In some cases the soil is a loam and in places it is even sandy, while on the other extreme it is often a dense hardpan; but nearly everywhere the bulk of the soil is clay, whether it is



53.—Section in the boulder clay on Mayville and Westfield road.

hard and compacted into hardpan or is a loose and relatively friable loam. When fresh, the color is blue; but since the soil is generally somewhat disintegrated, the color ordinarily seen is a yellow, which is due to iron rust leached from the soil fragments.

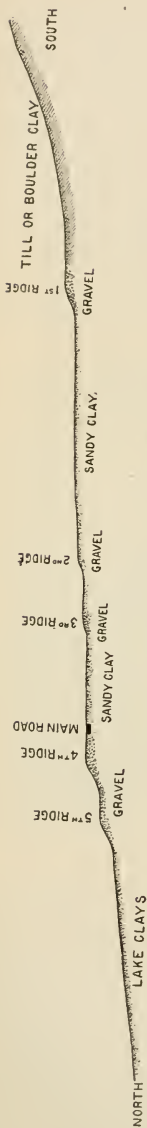
Next in importance to the clay is the presence of pebbles. These are very numerous, and at times they are of considerable size. It is important to note the form of these. They are angular, and if rounded at all, this is usually on only one or two of the sides, so that angular corners are almost invariably to be found. Moreover, the sides of these often bear numerous grooves and scratches. While many of the pebbles are fragments of shale rock,

like that which forms the bed rock of the region, a careful examination shows that there are many which are foreign to this part of New York. Thus granites, sandstones and limestones are found in a region which from the bed rock yields only shales and sandy shales. If we could examine the soil particles with a microscope, we should find them to be composed of minute rock particles, fresh and unchanged, as if worn or ground from the rock by some strong force. The entire mass is put together without arrangement, and there are no distinct layers such as those found in the lower gravel soils. We say it is unstratified, though sometimes (as in figure 53) there is a partial stratification, never very distinct.

This soil varies greatly in thickness, being usually several feet deep; but while sometimes, particularly in the stream valleys, it attains a depth of several hundred feet, in other places on the hillsides it forms a very thin veneer over the shale rock. Near the crest of the escarpment there is another belt of soil of morainic origin; but as this is not in the true grape belt, it need not be considered here.

This clay soil is the same as that which covers the greater part of the area of New York and New England, and of Canada to the north of these districts. Its characteristics and origin are well understood by geologists, to whom it is known as *till* or *boulder clay*. In the first half of this century its origin was in dispute; but we now know that it is a deposit from a great continental glacier which occupied northeastern North America, and extended outward in all directions from a center near Hudson Bay or Labrador, behaving like the present ice sheet of Greenland, or the Antarctic. Slowly moving across New York State toward the south, with a depth certainly as great as a mile (for it covered the highest mountains of the east), it ground down the rocks, reducing them to a fine clay, which is often called rock flour, and caused a mingling of pebbles from various sources. Thus the granite from the Canadian highlands is stranded on the hillsides of Chautauqua county and is there mingled with the shale. The grooved and scratched pebbles show that this process of grinding was in operation.

Much of this material was dragged beneath the ice; and owing to variations in the topography of the land, in currents or in supply,



54.—Section to show the relative position of the gravel ridges and the other classes of soil.

in some places it accumulated to a depth of several hundred feet, while in other places it was not so extensively deposited, just as in some places a river scours its channel clear, while elsewhere it is building a bar. Finally the ice disappeared from these hillsides and all of the material that was in or under it was left to form the present hillside soils.

The hillside soils are somewhat difficult to work, partly because of the roughness of the surface, partly because of the irregularities of the texture and composition, which, even in the same field, may very differently affect capillarity and drainage. Moreover, it is often a dense hardpan which is difficult to till. Still it is a strong, sturdy soil, which, when properly cultivated, furnishes good crops. However, it is not so well adapted to grapes as the more sandy soils of the valley.

*The gravel ridges.*—Throughout the entire grape belt (Fig. 54), there are three distinct gravel areas, extending approximately parallel to the Erie shore. On one of the two northernmost of these the main road to Buffalo is generally located, while the third is south of this, at distances generally varying from one or two hundred yards to more than a half mile. Between these distinct ridges there are sometimes one or two less distinct gravel beds; but most of the space between them is occupied by a clayey soil. In some places, particularly near the larger streams, the entire belt is gravelly.

The surface of the gravel ridge is typical. Each one is remarkably level-topped (Fig. 55), and the roads that follow them often extend for miles almost on a dead level. There are distinct terraces, and when viewed from the north they present a bold face which rises quite abruptly to a height of from fifteen to thirty feet (Fig. 56), beyond which a nearly level plain is usually encountered (Figs. 54 and 55). Near the streams the terrace is broader than elsewhere; and in some cases it is a true

ridge with a nearly level top but with a slope both to the north and the south (Fig. 65).

The soil of these gravel ridges is peculiar, and it is upon them that many of the best vineyards are located. Wells and natural sections show that the gravel soil varies in depth from one or two feet near the edge, to ten or fifteen feet. Beneath the gravel is found clay or shale. The gravel soil consists of pebbles and sand



55.—Round the crest of a gravel ridge just east of Fredonia.

with scarcely any clay, excepting that which has come from the disintegration of some of the fragments. After plowing it does not form clotted bunches, but is loose, friable and porous. Water readily passes through it, and for this reason, forms of vegetation whose roots do not extend deep into the soil are in danger of suffering in times of drought.

When examined in a fresh section, it is found that the gravel is often very pebbly, and that the pebbles are sometimes very large.

Compared with those of the hillside, the pebbles are found to be well rounded and smoothed (Figs. 57 and 66), as if by water action. There are few if any angular corners, and no grooves or scratches. The clay element is practically absent, and the pebbles are bound together by sand instead. The pebbles and sand are in layers, or are stratified (Fig. 57), so that there are several important differences between the soils of the two zones.

A comparison with the beaches of the present lake shore shows a striking resemblance, not only in texture but in the surface outline. In both cases there are many rounded pebbles and much sand; and in both cases, also, the surface form is that of a flat-topped



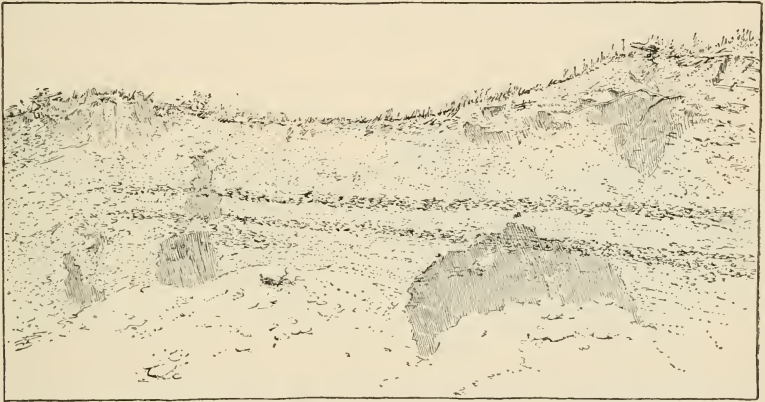
56. — Upper terrace southeast of Sheridan.

terrace. However, in the beach there is almost no clay, while in the gravel ridges the decay of some of the pebbles and sand particles has furnished some clay; and also the action of vegetation and cultivation has somewhat modified the gravel ridge soil. The meaning of this resemblance will soon be shown to be similarity of origin. As many who have tilled the gravel soil have conjectured, the ridges are true lake beaches now stranded on dry land.

*The lake clay soils.*—In the present lake, gravel beaches are being formed along the shore line; and each time that there are strong waves, the washing action of the water moves the pebbles backward and forward, rounding them by grinding off tiny particles of clay. The force of the waves and currents is capable of carrying

the beach sand and gravel only to a very short distance from the shore line; but the clay that is worn away by the waves passes in suspension for a considerable distance from the shore line before settling to the bottom. During windy days the waters immediately off shore are clouded with sediment. Fishermen know that at a distance of only a few yards from the shore the lake bottom is almost everywhere covered with clay or sandy clay. The soundings made by the United States Engineers, who have surveyed the bottom of Lake Erie, show that a muddy bottom is the prevailing feature.

When the lake waters reached to the height of the gravel ridges, the region below this was naturally a place for the deposit of clay.



57.—Section through the upper beach at Westfield, showing stratification of pebbles and sand.

While some pebbles may have been drifted away by the ice, and dropped to the bottom away from the shore, the clay was in most places free from large fragments. In some places, particularly opposite the mouths of streams, the clay might be replaced by sand for a considerable distance from the coast. An examination of the soil between the northernmost gravel ridge and the lake shore, shows that these features exist.

A layer of clay, varying in depth from a few inches to several feet, is spread over most of the region west of Silver Creek and north of the gravel ridges. Oftentimes it rests on the bed rock, barely covering it: in other cases it is found above the true boulder clay, and in some stream cuts one may often see a bed of dense boulder clay upon which rests a foot or two of clay, which

is often quite sandy. In such places, one has the opportunity of studying the differences between the two kinds of clay soil, one of which is characteristic of the hillsides. The lake clays are found to be in layers, as if deposited in water, and the clay is usually less dense than the boulder clay, while pebbles are relatively scarce.

*Shale gravel.*—Between the lake shore and the true gravel ridges, in some places there are low ridges of shale, on which the soil is so thin that deep plowing reaches the friable shale bed rock. The soil is then made up of a mixture of fragments of shale and clay, forming what is known as shale gravel. These deposits are not



58.—Modern beach at Barcelona, showing the crest in the background.

very extensive, and they merely represent rock hills which have not been deeply covered by glacial or lake deposits. They are less common west of Silver Creek than they are east of that town.

*The relative value of the soils.*—Of the three important kinds of soil in the grape belt, the gravel is distinctly the best for fruit raising, and the hillside soils of the least value. That the fruit growers have generally recognized this, is shown by the fact that in the belt of gravel there is a much greater percentage of vineyard than in either of the other belts. While it is so readily permeable to water that plants whose roots do not extend deep into the ground may suffer from droughts, it rests upon a much less permeable rock or clay, over which water is constantly percolating; and those forms of vegetation whose roots are able to reach down to this zone are



not endangered. The depth of this permanent water zone is variable, but it is usually several feet.

The width of this gravel belt is very variable, as indeed are the details of its composition. Near the mouths of large streams, as at Silver Creek, Fredonia, Westfield and the state line, the zone broadens so that a sandy soil extends from the base of the true gravel ridge across the plain, nearly, if not quite, to the lake. Between the streams the gravel ridges become narrower terraces, and the lake clay soil commences at their very base. Therefore, in different parts of the grape belt, the area in which the soil features are especially adapted to grape raising is somewhat variable; but there is a certain uniformity, and the importance of this to the question of origin is sufficient to call for a more detailed statement of the features of the gravel ridges, or, as we may now call them, the ancient beaches.

#### THE MODERN BEACHES.

Let us first take a glimpse at the present shore line features of Lake Erie. There are two separate kinds of shores, the rock or clay bluffs (Fig. 48) and the gravelly or sandy beaches (Fig. 61). Oftentimes the bluff is faced by a beach (Figs. 48 and 61). Where the larger streams enter the lake, the width of the beach is increased, and the waves are not cutting at the base of the shale bluffs. The cliffs need not delay us, for it is the beaches with which we have to do in particular. The beaches consist of sand and gravel thrown by the storm waves to a height of several feet above the reach of the ordinary waves. In time of strong waves the water dashes over the top of the beach, moving the pebbles to and fro, although they are situated fully ten feet above the present lake surface (measured at Barcelona) (Fig. 58). This is the crest of a terrace whose width varies, sometimes being a narrow strip at the base of a bluff (Fig. 59), sometimes, especially near the mouth of a stream, broadening out to quite an extensive plain. At Silver Creek and at the mouth of Cattaraugus Creek, the beach deposits are very extensive; and in the latter, the action of the wind by building sand dune hills has raised the level above the reach of the highest waves. In these places also, bars are being built opposite the mouth of streams (Fig. 60).



The reason why these beaches are being built is that the supply of gravel is greater than the waves are able to remove. In some cases the supply comes mainly from the rocky headlands, in others



60.— Present bar formation at Silver Creek.

from streams. Where it can not all be ground down to a fine clay, that can be carried off shore and dropped to the bottom, it accumulates as beach gravel; and so, year by year, the beaches encroach



61.— Present beach of Lake Erie, north of Dunkirk.

upon the lake. The crest of the beach, which may be ten feet above the lake level, represents the highest point to which the lake waves can reach and bear gravel: in other words it represents the

height reached by the violent storm waves. Since this varies with the exposure, the crest of the beach may vary in height, as we have seen that it varies in width. This variation amounts to only a few feet, the beach being higher on exposed than on sheltered coasts.

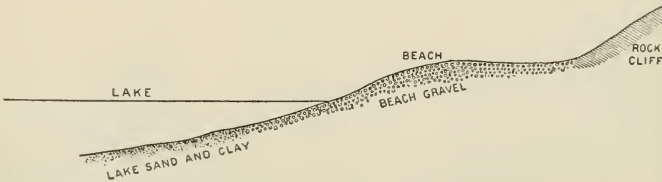
Generally the top of the beach is nearly level (Figs. 59 and 61);



62.—Cross section of bar: ancient A ; modern B.

but where accumulations are made off shore, as they sometimes are where streams bring considerably more gravel than the waves can dispose of, a bar is built, and this slopes both ways (see Figs. 60 and 62B. Also compare with Figs. 62A and 65).

Therefore the top of the true beach is a plain of varying width, whose elevation is nearly uniform, both along the shore and at



63.—Cross section of beach.

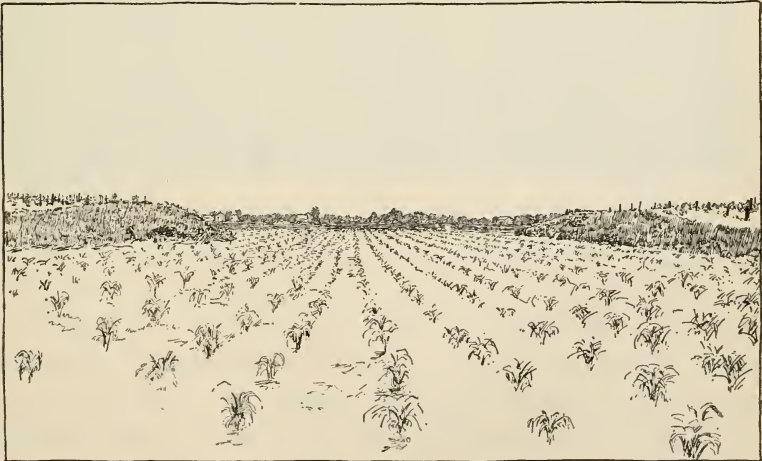
right angles to it. If it is in the form of a bar, the elevation remains nearly uniform in the direction of the length of the bar, but at right angles to this it rapidly descends in both directions. In the beach, the flat topped plain is faced on the lakeward side by a rapidly sloping front; and this descent continues beneath the lake waters. (Fig. 63).

Therefore on the shore of the present lake we have a terrace plain of a nearly uniform level, and the terrace slope (Figs. 58, 59 and 61), the whole being composed of well rounded and water-worn



64.—Pebbles of the modern beach at Barcelona.

gravel and sand (Figs. 58 and 64). We also find numerous wave-cut cliffs either in the clay (Fig. 61) or in the rock (Fig. 48); and opposite the mouths of the streams there are often formed bars (Fig.



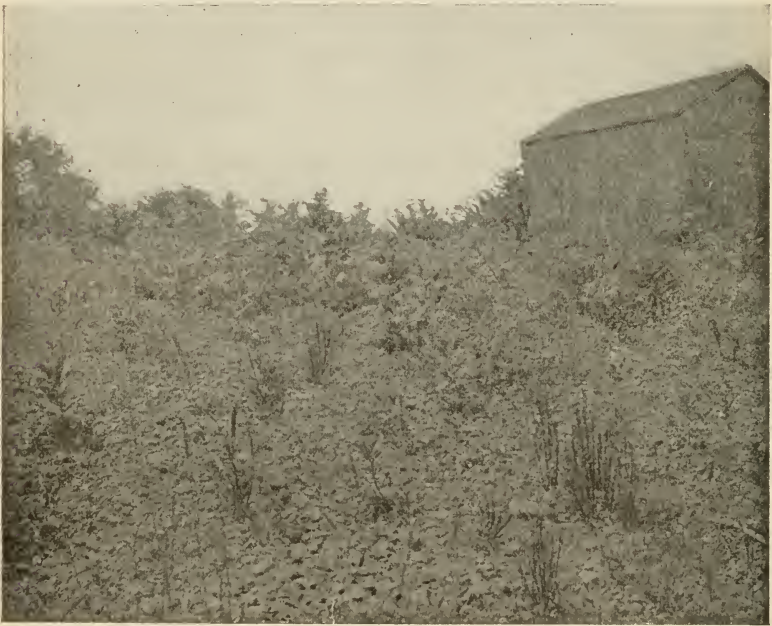
65—Section through a bar. Midway between Sheridan and Fredonia. Beach to be seen in the background in the gap cut through the bar.

60) which are welded at their base to the beach, and stretch more or less completely across the stream mouth. Sometimes there are

spits of gravel; and there are numerous other minor details of shore line features.

#### THE ANCIENT BEACHES.

Most of the features just described are found also in the gravel ridges. They usually have all of the characteristics of beaches (Figs. 56 and 66), and near the streams they are often transformed to bars (Fig. 65). The resemblance is so close that even the most casual observers have noticed it and formed the theory that the ridges



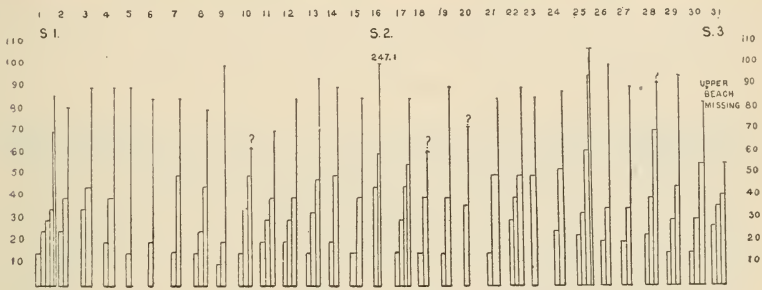
66.—Photograph showing pebbly nature of old beach terrace near Sheridan.

were made by the lake waters. So far no fossils of lake shells have been found in the gravels, though some have been reported by residents of the region. It would be of great importance to find these\* for they would determine beyond question whether the gravel ridges are lake or ocean beaches. There is little reason for believing the latter, although this explanation has been suggested by some.

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\* If any reader should know of the existence of fossil shells like those now living in the lake, I should be very glad to be informed of the occurrence.

*The gravel ridges.*—In passing from one end of the district to the other, numerous differences are found in the gravel ridges. Perhaps the most important change is in the number of beaches (Fig. 67). From the base of the lowest to the crest of the highest, there is a vertical range of from 85 to 100 feet\* in a distance which is often less than a half mile. In this distance there are always two distinct ridges or beach terraces and usually several. There seem to be five beaches, though it is rare to find all developed in the same section. In thirty-one sections whose elevations were measured with the aneroid barometer, only one (Number 17) clearly exhibited five ridges. In section 1 there are six gravel ridges, but one or two of these may have been bars opposite the stream mouth.



67.—Diagram to show the elevation of the different terraces (in thirty-one sections) above the base of the lowest terrace. 1, at State Line; 30, just east of Silver Creek.

There are four beaches in section 10, in which the upper beach was not measured; and there are also four in Section 31 where the upper beach is absent. In several places (nine sections, 8, 11, 12, 13, 22, 25, 28, 29 and 30) four beaches appear in the same north and south line. On the other hand there are places where the three lower beaches are merged into one terrace, or in which one or two of the beaches are so indistinct as to be scarcely noticeable (notably section 16).

From State Line to Sheridan the upper beach is quite distinct; but east of that place this beach begins to lose distinctness and it disappears just east of Silver Creek. The lower beaches extend eastward, one

\* The elevation of the lake is 573 feet above sea level; and of the base above the lake, as determined by a line of levels run at Portland, 147 feet. Therefore at this point the base of the lowest beach ridge is 720 feet above sea level.

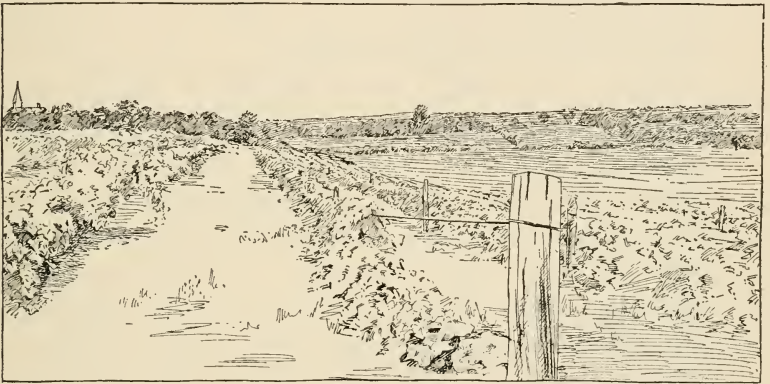
disappearing just south of Hamburg, the others extending to the vicinity of Crittenden where they also die out. Without analyzing my measurements here, it may be said that the crest of the first or lowest beach ranges from 15–20 feet above the base of the terrace; the second beach ranges between 10–15 feet above this; the third from 10–15 feet higher; the fourth also 10–15 feet higher; and the fifth between 30–40 feet above this. As one drives along the main road to Buffalo, the face of the upper terrace is frequently visible, while the road itself is usually upon either the lowest, or, more commonly on the second level. From just west of Silver Creek to within three miles of Fredonia, it follows the lowest; but west of this is more commonly on the upper level, though at times descending to the lower. When visible, the third and fourth beaches (measured from the base) are indicated by slight gravel ridges. There is so much variability in these respects that to make the feature entirely clear it would be necessary to describe the region in much detail. From figure 67 one will obtain an idea of the irregularity of level, throughout which, however, there is considerable uniformity.

Below the upper terrace there is usually a bench or plain which slopes quite uniformly up to the base of the terrace and on the northern margin ends in a steep descent; but in a number of places this plain is diversified by slight benches of gravel, marking some of the intermediate beaches. From the crest of the upper terrace toward the south there is also a plain, which is usually very narrow, but is sometimes gradually merged into a broad till-covered plain (Fig. 54).

From the lake shore to the base of the first gravel ridge, near the main road, there are no beaches of a distinct character, although in one or two places there are indications of wave action. Over this plain, which is often one or two miles in width, the soil is mostly of clay, as has already been noted. However, north of the town of Portland there is an ancient sand dune region, in which the sand is no longer in movement, having probably had its features introduced immediately after the lake water left the land. The sand is fine in texture, quite like moulders' sand, and it is heaped into the typical conical peaks with enclosed craters, which characterize sand dune belts. Here the topography is very rough; but elsewhere the prevailing condition is that of a plain, sloping lake-ward.



*Variations in the gravel ridges.*—Not only do the number of the gravel ridges vary, but there is a considerable difference in their characteristics from one point to another. Generally the slope of the terrace front is abrupt (Fig. 68), and the top quite level; but, as has already been noted, it may be in the form of a ridge or bar instead of a beach. There is also a variation in width, which in some cases is very marked. Notably opposite the mouths of streams the width of the gravel is greatly increased, the deposit there being in the nature of a delta. Here the steep front of the terrace disappears and is replaced by a gravel slope, crossed by numerous gullies and traversed by ridges of gravel; and this gravel extends for a considerable distance toward the



68.—Front face of lower beach terrace just west of Portland. East of section line No. 2, Fig. 67.

lake, gradually becoming a sand, and then, near the lake, a clay. The best delta in the area studied is that upon which the town of Fredonia is situated; but there are other similar deposits near the mouth of nearly every stream of considerable size.

Just as in the modern beach, there is also a variation in texture in any single gravel ridge. But quite unlike the modern beach, the material is always a gravel. In the entire region studied I have found no considerable part of either terrace made of sand. In small areas there is often much sand; but nearly everywhere there are layers of rounded pebbles in close association.

On the present shore there are many wave-cut cliffs of shale; but in the entire region occupied by the gravel ridges, from State

Line to Hamburg, I have not found a single rock cliff. In some cases wells have reached rock near the front edge of the gravel terrace, suggesting the possibility of such cliffs veneered over with gravel which has slipped down from above. This would be possible only with low rock cliffs; and we may therefore conclude that in this part of the shore line there are no wave-cut cliffs which are at all comparable in size to those of the present lake shore. Whether there are any wave-cut cliffs of gravel I am not so certain. There are places where the lowest terrace may be of this nature; but this could not be proved, for beach gravel covers the face and base.

In any event, it may be concluded that the prevailing feature of these ancient shore lines is the wave-built, instead of the wave-cut terrace. In this respect there is a marked difference in the features of the present lake shore, and a resemblance to such coasts as the sandy shores of New Jersey and the Carolinas. This is a feature which needs to be explained and will be discussed in later pages.

*Irregularities of level of gravel ridges.*—When formed by the lake waters, these ridges were essentially horizontal. That is to say, leaving out of question certain minor variations from place to place, such as we see on any beach at present, the average crest of each beach from one end of the region to the other, was a horizontal line, just as is the case on the present lake shore. Still, at present, these ridges are not horizontal. As determined by careful lines of levels, and by numerous elevations obtained by other means, they are tilted so that the eastern end is higher than the western. This necessarily records a change in the level of the land since the beaches were deposited. Along the line of beaches from Cleveland to Silver Creek the change amounts to over 90 feet. Therefore, since the distance is about 150 miles, the change in level amounts on the average to about three-fifths of a foot per mile. The levels made in the grape belt are not of decisive value for the distance between them is not great. Still in the profiles (Fig. 69) one sees that very nearly the same change is recorded.\*

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\* From Section 1 to Section 3 the distance is 36 miles. The crest of the second beach is 185 feet above lake level at State Line, 195 feet at Portland and 221 feet just east of Silver Creek. In other words, the beach increases in elevation at the rate of about 1 foot a mile. There is little doubt that the uplift is greater in the east than in the west.



ficiently complete to allow of any full statement of their meaning. Indeed, one of the needs of North American geology is to have some one person follow this subject to an end by tracing the beaches not only to the States, but also through Canada. There is much yet to be learned, though we are in a position to state the more general facts of the history.

It cannot be doubted that these ridges were formed in water. Their resemblance to the shore lines of the lake is so perfect, in almost every particular, that the conclusion is almost forced upon us that the water in which they were formed was lake water; and this conclusion scarcely admits of a reasonable doubt. No other explanation than beach origin can be admitted, for no other possible cause can be found, and if of beach origin, then the beaches were formed either in lake or ocean. In support of the latter hypothesis no single fact can be found which does not equally apply to the theory of origin in lake waters; and against the ocean theory there are facts which seem to entirely exclude it. If these were formed in the ocean they should be continuous; but the beaches end quite abruptly, the upper one just south of the town of Silver Creek, the next south of the town of Hamburg, and the others and lower ones near Crittenden. There is no known reason why ocean beaches should thus terminate, while, as we shall see, there is an excellent reason why lakes should cease to build beaches at these points.

Everything then points to lake origin, and all the observed facts may be accounted for by this theory, while no known fact opposes it. Therefore we may consider it more than a theory; it is a proved fact. There remains to be explained (1) why Lake Erie should have been so much higher than now; (2) why the beaches end so abruptly, and (3) why they are no longer horizontal. These facts can best be explained in the course of a brief statement of the geological history of the region.

#### RÉSUMÉ OF THE GEOLOGICAL HISTORY.

Before the last geological period, the northern part of New York had valleys and hills, plains and escarpments, very much as at present, though the details of topography were quite different. Among the more important differences was the absence of the great lakes, which occupy valleys that have been transformed to lakes largely

by the action of the glacier. Over this country the glacier ice slowly advanced until practically the whole of New York was covered, and for a time this ice sheet ground its way over the rocks, carrying fragments southward and wearing down the valleys and the hills as it passed. All life was of course exterminated from the region and the land was transformed to a dreary icy plateau like that of central Greenland. Why it came or how long it remained are questions which the geologists of the future must answer, if we ever learn. That it came and worked, performing certain tasks we of the present century have determined.

At last, by some change in the condition of the climate, the ice sheet began to melt away and to uncover the buried land. It seems to have done this quite rapidly, though somewhat intermittently. That is, it would stand for awhile with its front along a certain line, then quite rapidly melt away and transfer its front to a distance of a dozen or so miles to the north, where it would again take a stand. This is indicated by the moraines, which are irregular hills of glacial deposits that were accumulated at the front of the ice. The glacier was carrying a load of rock materials, and when these reached the front they were dropped from the melting ice and therefore accumulated. If the ice stood long enough a moraine was built along the margin; if its stand was brief no morainic accumulations were made. One of these moraines passes through Janestown, another past the northern end of Lakes Chautauqua, Bear and Cassadaga, and in a general east and west line back of the crest of the escarpment. Another line passes just east of Silver Creek, one near Hamburg, and another through Crittenden.

Beneath and in the ice was a load of rock fragments which were moving southward. They were being ground over one another and over the bed rock, so that they were being reduced to clay by the scouring action of the ice, which worked somewhat like a great sandpaper. When the glacier disappeared, this material was left where it happened to be, and so a soil was deposited which was composed of clay and pebbles derived from various sources to the north. This till or boulder clay was dragged into many of the old valleys, either wholly or partially filling them, so that the streams have often been obliged to cut new channels in the shale. Sometimes these rock gorges end abruptly where the stream crosses or

flows in the old drift-filled valleys and then the shale wall is changed to one of till, in which the boulder clay is sometimes one or two hundred feet deep, as is the case in parts of the gulf near Westfield.

As the ice withdrew, with a south-facing front, it naturally interfered with all north-flowing streams. It formed a dam and caused many reversals of drainage. The St. Lawrence valley was occupied by the ice when the front had retreated north of the escarpment which partly encloses the grape belt. Therefore these north-flowing streams could not drain by the present outlet, but were pounded back and forced to take another place of outflow, and this was of course the lowest point in the enclosing hills, a point which was naturally higher than the present outlet. While the lake was held at its upper place of outflow it was building the upper beach, which has been called Sheridan beach. The outflow of this lake was then at Fort Wayne, Ind., into the Wabash, and the beach may be traced continuously to this outlet. However, in the east this beach comes to an end just south-east of Silver Creek; and near its eastern end there is a tract of moraine.\*

To the southward of the town of Hamburg, on the road to New Boston, there is another morainic belt, and a second beach, which can be quite continuously traced from west of Silver Creek nearly to Hamburg, begins to disappear as this town is neared. The last place at which it could be distinctly determined is near Eden Church, southwest of Hamburg; but a third beach from the top passes directly through Hamburg, and has been found to disappear near Crittenden. In each case, as the moraine is approached, the beach becomes less distinct and finally can be traced no farther.

This shows that while these beaches were being built at their respective levels, the ice was standing at different places and was bringing materials which were being laid down at its front in the form of moraines. At first the ice front passed near Silver Creek and then the upper beach was made, while the outflow of the lake was past Fort Wayne. Then the edge of the ice withdrew for a distance until some lower outlet was formed, and again to a still lower, more northern point, when another and still lower outlet was

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\*This moraine has not been traced, so that nothing can be stated concerning its extension; but it appears in quite distinct development about two miles east of Silver Creek, extending nearly to the town.

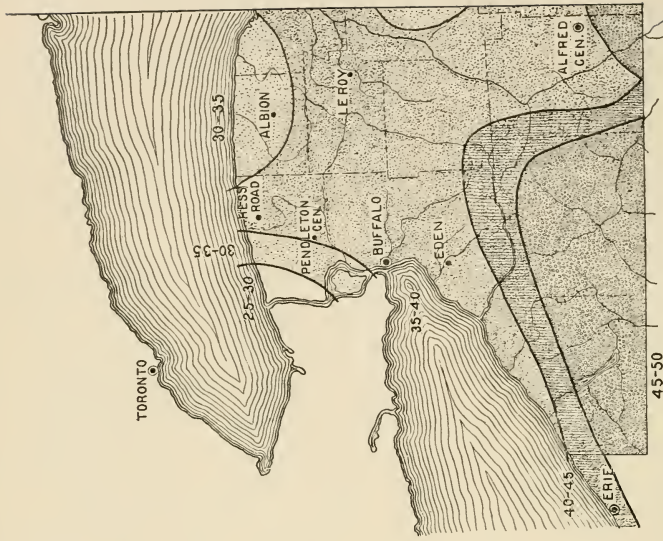
established. One of these last two outlets was past Chicago; but we know too little about the subject to state which one represents this stage, or to tell where the third outlet was.

At last the ice retreated far enough for the Erie basin to take its present outflow past Buffalo; but the valley of the St. Lawrence was still ice dammed, and Ontario was raised to the level of the overflow of the Mohawk valley. Thus temporarily the several Great Lakes had their level raised by ice dams: and during this time distinct shore lines were formed.

There are some differences from the present shore lines still to be accounted for. Why, for instance, are there no rock cliffs, but everywhere a series of beach gravels, a condition of so much importance to the grape grower? It would have been a serious disadvantage to have had the vineyards traversed by two or three rock escarpments like that of the present lake shore. In the first place, the question whether the waves and currents shall cut or build depends upon whether they are able to remove all of the material that they obtain by one cause or another. That is the reason why beaches are not built on some of the exposed head lands of the lake, while they are commonly present in the enclosed bays, and why the gravel accumulations opposite the mouths of the streams are more extensive than elsewhere.

There are various reasons why the waters of the ancient lake were less able to remove the materials furnished them than is the case with the present lake. As the ice was leaving the land, there was at first a time when no vegetation covered the clay soil, and when the whole surface was attacked by the rain just as a plowed field is to-day. Therefore the streams were given more materials to carry to the lake. In the second place, the rains must also have been heavier when the cold ice wall was melting and furnishing vapor to the air. Besides this, the streams entered the lake at the base of the hill, while now they flow for a mile or two over a plain. Another important reason is the fact that the shores were gradually rising. Therefore, for various reasons, the lake was given more materials than the waves and currents could dispose of, and hence they accumulated in the gravel ridges which we find.

A second important difference between the old shores and the present ones, is the fact that they are no longer horizontal. This is



70.—Rainfall in inches, giving total for the year. From report of the State Weather Bureau.



71.—Average temperature for the year in degrees Fahrenheit. From report of the State Weather Bureau.



due to a tilting of the land since the beaches were formed. There is abundant evidence that the land is now and has been in the past in a state of motion. Actual historic record proves this in several places, and geological study proves it in many more. Since the glacial period the movement in this part of the land has been that of tilting, with greater elevation in the northeast. Therefore these beaches do not show so great a change as they would if they extended in a more nearly north and south direction. The amount of tilting varies from place to place, but in the Chautauqua grape belt averages not far from one foot per mile.

A final question that we may ask, is how long ago this happened. To this no definite answer can be returned. A study of Niagara gorge, which has been formed since Lake Erie fell below the lowest gravel ridge, seems to show a period between 4,000 and 15,000 years. There is some reason for believing that the first is nearer to the truth than the last, and that it may even be a shorter period than this. Otherwise it would be difficult to account for the fact that these gravel ridges have resisted destruction so well. Nor can we state any more definitely how long it took the lake waters to build the beaches. They probably do not represent a great length of time, for materials were apparently rapidly supplied.

#### CLIMATIC CONDITIONS.

While the soil is a very important element in the value of the grape land, the climate is of even greater importance. Hence, while this study was not made primarily with the object of determining the climatic peculiarities of the belt, some features of a general nature were so pronounced that they attracted attention. The lake is a great modifier of climate. In the spring, by reason of the low temperature of its waters, it holds back the vegetation and this tends to keep it behind the ordinary frosts. Its very presence checks frost by moderating the temperature of the neighboring air. In the summer, the water tends to cool the air of the day and to keep the nocturnal temperature fairly high. During the fall, the water has been warmed by the summer sun, and the influence of this warm body of water lengthens the growing season and tends to keep off the early autumn frosts.

There are many other influences, but nothing of importance

can be stated excepting on the basis of a careful study extending over several years. The lake breeze of the day must moderate the daytime temperature; and the land breeze of the night may in some cases so keep the air in motion as to prevent frosts. That there is a marked influence upon climate as a result of the peculiar conditions of topography and neighborhood of water, is evident at the very first. The sketch maps (Figs. 70 and 71) show that the mean annual rainfall is greater on the escarpment than on the lake plain, and that the mean annual temperature of the hills is lower than that near the lake. During the disastrous frost of May, 1895, the vineyards in the grape belt, taken as an average, suffered less near the lake, while those farthest from the water were most injured. Still there were cases of vineyards near the lake that suffered considerably, while some on the escarpment were scarcely touched.\*

#### MOST FAVORABLE PLACES FOR THE LOCATION OF VINEYARDS.

As has been said, there are two factors in the problem which deals with the reason for the conditions in the grape belt, one climatic the other geologic. The climatic features are dependent upon the location near a large lake, and the presence of the bounding escarpment, which confines this influence to a narrow limit. In the eastern part, where the escarpment is relatively low and far from the lake, the influence of the lake is much less distinct.†

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\*The behavior of this frost was altogether remarkable, leaving some districts or vineyards almost unharmed, and nearly ruining the crop in others, while even in the same vineyard these extremes were sometimes noticed. This was probably chiefly due to eddies of the air, for even though air is almost quiet, it is still in uneven motion. One may see this illustrated on a calm day by noticing the movements of a column of smoke. The air, being invisible does not reveal these movements, and we become aware of them only when the conditions are exceptional, as when a frost is dealing out destruction to vegetation. The condition of the ground also affects the frost, and the question whether it is dry or moist, freshly plowed or turf covered, whether there are trees or pastures or plowed ground in the neighborhood, all have their influence; but this subject has never been properly studied, and it is not possible to state just how these differences affect frost action.

†This was well illustrated during a frost in the middle of September, 1895. At Westfield there was no indication of a frost, east of Silver Creek signs of its effect began to appear, and at Hamburg, the frost had done considerable damage to the more delicate forms of vegetation.

This is the main reason why the grape belt does not extend far east of Silver Creek. Even in the distance of a few miles, from the lake to the crest of the hill, where grape raising practically ceases, there is much variation in climate, as has already been pointed out.

Considering the three belts of soil from the standpoint of their adaptability to grape raising, the hillside soils are of least value, the climate is least favorable, and the surface configuration of the land is least adapted to this industry. The lake clay soils are of poorer grade than the gravel soils, but the climate is in favor of this belt. The defect of soil texture, which is against most of the lake clay soils, can be readily overcome by a very little intelligent study of the conditions; and so there seems to be no reason why the vineyards should not extend from the base of the hill to the lake. Indeed, the favorable climatic conditions make this industry possible even on the hillsides for a considerable elevation above the plain.

#### INFLUENCE OF THE GRAVEL RIDGES.

One of the most striking influences of the gravel ridges is upon the roads. For the greater part of the distance, each of the two main gravel strips is occupied by a road which is remarkable for its levelness and for the gravelly material which makes the excellent roadbed. Travelling is therefore extremely easy, and it is very probable that this natural roadway was the site of an Indian trail. Even the position of the towns is often determined by the gravel ridges. Several of the villages and towns, east of Silver Creek, are (including Hamburg) on the gravel; and west of this town, in New York, every place of any size on the Erie shore (excepting Dunkirk, which is so situated because of its port) is located on the gravel ridges. This is true of Sheridan, Fredonia, Brockton, Portland, Westfield and Ripley.

Another important influence is upon the water supply. The gravel furnishes a reservoir through which the water percolates along the junction with the clay; and at the base of the gravel ridges, springs occur where the line of junction nears or reaches the surface. So important is this underground reservoir that not only are the houses on the ridges easily supplied with water, but houses below the beaches are in some cases furnished with water from this source.

Of course the most important influence is upon the fruit industry, and this has already been discussed in sufficient detail. Two or three suggestions may, however, be in place. There is no reason why the fruit district should not extend beyond Silver Creek. For several miles beyond that town the conditions are favorable, though they become less and less so as the distance increases. Another point is the feasibility of increasing the range of crops. The climate and soil are well adapted to all kinds of fruits which are common to this latitude; and one would suppose that even the tobacco plant might be profitably grown in a region so peculiarly favored. Almost all conditions have conspired to make this one of the most favored spots in the state.

R. S. TARR.

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BULLETIN 110—January, 1896.

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Cornell University—Agricultural Experiment Station,

ITHACA, N. Y.

HORTICULTURAL DIVISION.

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# Extension Work in Horticulture.



By L. H. BAILEY.

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## BULLETINS OF 1896.

106. Revised Opinions of the Japanese Plums.
107. Wireworms and the Bud Moth.
108. The Pear Psylla and the New York Plum Scale.
109. Geological History of the Chautauqua Grape Belt.
110. Extension Work in Horticulture.

## Extension Work in Horticulture.

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*The Honorable Commissioner of Agriculture, Albany:*

SIR.—A report of progress of the work which has been undertaken by the Cornell University Agricultural Experiment Station in pursuance of the requirements of the Experiment Station Extension bill, is herewith submitted.

At the outset, it is proper to say that this bill originated entirely with the people. The beginnings of it occurred in 1893, when certain Chautauqua county persons asked the Station to undertake some experiment work in their vineyards. We replied that while we should like to take up the investigations, our funds were insufficient to meet the expense without endangering work in which we were already engaged; and this lack of funds would be keenly felt if other sections of the State should also, following the Chautauqua example, ask for help. We suggested to them, therefore, that if their local horticultural society could raise sufficient funds to meet the expense of fertilizers, traveling and incidentals, we should try to detail a man to look after the work. The matter dropped here; but the next winter we heard of a movement on foot amongst the Chautauqua people to obtain a small State appropriation to pay for experiment work in their vineyards. The movement was placed in the hands of S. F. Nixon, assemblyman from Chautauqua county, who early in 1894, obtained a grant of \$16,000, one-half of which was to be expended by the Cornell Experiment Station in work in horticulture in the Fifth Judicial Department of the State, an area comprising sixteen counties of western New York. This is the only instance, so far as I know, of a movement for experiment station work which has been initiated and pushed to a final passage wholly by a farming community. The laws upon which our land-grant colleges and the agricultural experiment stations are founded were conceived and completed almost wholly by a comparatively small body of educators and experimenters, aided by persons in the

various professions. But at last, the people themselves, whom these foundations are intended to benefit, have felt the touch of the new spirit and the quickened life, and have demanded additional funds to be expended more immediately under their own direction. It must be gratifying to every citizen of New York to know that this State is the pioneer in this experiment station extension movement.

The clause in the law of 1894 which appropriated money to the Cornell Experiment Station, is as follows: "The sum of eight thousand dollars, or so much thereof as may be necessary, is hereby appropriated out of any moneys in the treasury, not otherwise appropriated, to be paid to the agricultural experiment station at Cornell university for the purpose of horticultural experiments, investigations, instruction and information, in the fifth judicial department, pursuant to section eighty-seven of the agricultural law." The law also provided that "such experiment station may, with the consent and approval of the commissioner of agriculture, appoint horticultural experts to assist such experiment station in the fifth judicial department, in conducting investigations and experiments in horticulture; in discovering and remedying the diseases of plants, vines and fruit trees; in ascertaining the best means of fertilizing vineyard, fruit and garden plantations, and of making orchards, vineyards and gardens prolific; in disseminating horticultural knowledge by means of lectures or otherwise; and in preparing and printing, for free distribution, the results of such investigations and experiments, and such other information as may be deemed desirable and profitable in promoting the horticultural interests of the State. \* \* \* \* All of such work by such experiment station and by such experts shall be under the general supervision and direction of the commissioner of agriculture." This bill became a law by the Governor's signature, May 12, 1894. In the Legislature of 1895, Mr. Nixon introduced a bill to continue the work, but increasing the amount given to Cornell Experiment Station to \$16,000. This second bill became a law on the 4th of April, 1895.

Upon taking up the work asked for by the bill, in the early summer of 1894, the Cornell Experiment Station placed the immediate prosecution of the enterprise in the hands of a chief



“horticultural expert,” in the language of the law, and the present writer was elected to that office, with the expectation that most or all of the work should be completed during the summer vacation. In entering upon his duties, this officer laid out three general lines of work, as specified in the law,—“conducting investigations and experiments,” “disseminating horticultural knowledge by means of lectures or otherwise,” and “preparing and printing” the results of the work. In other words, the work was to be divided between research, teaching, and publication. The enterprise was new and untried; the territory to be covered is large, the interests varied, and the demands numerous; and the promotors of the bill had large expectations of the results. The responsibility of inaugurating the enterprise was keenly felt, for a mistake in the beginning might be expected to exert a serious and baneful influence upon future legislation designed to improve the conditions of rural life. The officer in charge has been extremely fortunate, however, in having the hearty support of his colleagues, the free coöperation of the commissioner of agriculture, and, above all, the kindly and intelligent interest of scores of horticulturists in his territory. It was conceived that, in the beginning, a comparatively small and well digested enterprise prosecuted by a few carefully chosen men would be productive of better results than any bold attempt, with a large force, to carry the work into every part of the fifth judicial department. Inasmuch as the original grant was obtained through the exertions of the grape-growers of Chautauqua county, it was designed to undertake careful studies of the vineyard interests at the outset. The immediate charge of this work was placed in the hands of my assistant, E. G. Lodeman, who, to fit himself more specifically for certain problems which were presenting themselves, went to Europe (at his own expense) and visited the vineyards of the Rhine, of Italy and Southern France. The entomological inquiries were placed in the hands of M. V. Slingerland, assistant entomologist of the Experiment Station. Certain lines of investigation made at Ithaca were placed in immediate charge of Michael Barker, who was secured from the Botanic Gardens of Harvard University. We also associated with us for a time in certain field work, Mr. Harold G. Powell, a senior in agriculture in Cornell University, and one who has had much experience in pomological matters.

In 1895 the work was placed in the hands of the director of the station (who was absent the previous year) and the writer, but the immediate charge of it was given, as the year before, to the latter officer. Some additional help was secured because of the larger work which was demanded by the larger appropriation; but in general the enterprise went forward upon the same lines as in 1894.

### 1. RESEARCH OR EXPERIMENT.

There are two types of experiment work which the people seemed to require of us. One type is a demand for more exact knowledge upon many rural problems; and in order to obtain this knowledge it was thought best to prosecute the inquiries at the Station at Ithaca where there are facilities for scientific work and where the experiments can be given that personal attention which is absolutely essential to truthful results. The other type of experiment is a demand for actual tests of fertilizers, spraying, methods of tillage, and the like, which shall be made upon the farms in various parts of the territory, and where they may be seen by the farmers themselves. These experiments are rather more object lessons than scientific research for they are largely concerned with problems which are already well understood, and their results are not capable of such exact analysis as are those which are obtained from painstaking and long continued experiments at the home station. This latter category comes rather more directly under the head of teaching than of experiment.

Arrangements were at once made to take up certain lines of experiment at Ithaca which the fifth judicial department seems to need; and several lines of inquiry which had been already undertaken by the station and had been discontinued because of lack of funds, were again taken up, since they were capable of yielding quicker results, and with much less expenditure of money, than experiments which should be newly started. Some of the inquiries which were completed and published from this state fund in this way are: Apricot Growing in western New York; The Cultivation of Orchards; The Grafting of Grapes; The Native Dwarf Cherries; Black-Knot of Plums and Cherries, and Methods of Treatment; The Spraying of Orchards; Winter Muskmelons; Forcing-House Miscellanies (comprising accounts of

heating glass houses, lettuce growing under glass, celery under glass, cress, forcing egg-plants, winter peas, bees in greenhouses, methods of controlling greenhouse pests, treatment of carnation rust); Revised Opinions of Japanese Plums. Several other lines of experiment, touching the horticultural interests of our territory and which had already been carried to a certain point by our own funds, are now going forward at the home station, and the results may be expected in bulletin form, as they mature.

Certain wholly new investigations have also been undertaken at the home station for the benefit of western New York, most of which, however, are not yet ready for publication. Certain of these studies have been prosecuted in part upon the farms in western New York, particularly those relating to insects. The bulletins of this type which have already been published are as follows: A Plum Scale in Western New York; The Climbing Cutworms in Western New York; The Cigar-Case-Bearer in Western New York; The Dwarf Lima Beans; Recent Chrysanthemums; The China Asters, with remarks upon Flower Beds; The Spraying of Trees, with remarks upon the Canker-Worm; Soil Depletion in Respect to the Care of Fruit Trees. A half dozen other investigations of this type are already completed and awaiting publication.

Another type of research work which we have undertaken under the auspices of this bill is the investigation of the conditions of certain horticultural interests in western New York. In the interest of these particular inquiries, we have traveled no less than 25,000 miles in western New York and have visited and examined many hundreds, if not thousands, of plantations. We have attempted in these investigations to learn the actual state of the industries and to suggest means for their improvement. They are really the beginning of a horticultural survey which can be much extended with great profit. Some of these inquiries have already matured, and the results are published in the following bulletins: Hints on the Planting of Orchards; The Peach Industry in Western New York; Peach Yellows; Some Grape Troubles in Western New York (with a particular account of the "rattling" of grapes in Chautauqua county); Varieties and Leaf-Blight of the Strawberry; The Quince in Western New York; The Recent Apple Failures of Western New York; Cherries; Blackberries; Evaporated Raspberries in

Western New York; General Observations Respecting the Care of Fruit Trees; Geological History of the Chautauqua Grape Belt. Various other investigations of this type have been completed, for the time, and the reports may be expected soon. Some of these are currant growing, gooseberries, the Japanese pears, and dwarf apples. Other inquiries which have been under way for the past two seasons still need one or two more years' work before they are ready for publication. Some of the most promising of these are the bean industry, dwarf pears, standard pears, plums, strawberries, raspberries. Many other horticultural industries, some of which are sadly in need of investigation, we have not yet been able to touch. Some of the most pressing of these untouched problems are connected with the growing of various vegetable crops for the canning trade, some of the forcing-house industries, and the nursery business.

The experiments which are now in progress in western New York are chiefly concerned with the fertilizing of fruit lands. There are, for example, experiments under way in fertilizing peach lands at Youngstown, Niagara county, and near Morton, Monroe county; in fertilizing apple orchards near Lockport, and in Wayne county; in fertilizing and managing nursery lands at Dansville; and several tests upon grape lands in Chautauqua county. Aside from these definite experiments, we are keeping close run of the experiments which are making by various farmers in our territory.

At the present time every intelligent farmer is an experimenter. We are in a transition period as respects the methods and objects of farming. But the greater part of all this experiment is lost unless it is carefully studied and collated by a specialist, and the summary results of it given to the world. Much of this cumulative body of experience of the best farmers is capable of yielding better results than similar work which might be undertaken at an experiment station. In fact, there are many lines of investigation touching rural economy, or farm management, which can be undertaken in no other way than by a study of actual farm conditions. An experiment station, which is necessarily constituted for scientific research, cannot touch many of the most vital problems of farming. The only ideal station is that which adds the farm of every one of its constituents to its own resources.

## 2. TEACHING.

One of the distinctive marks of the last decade, in educational lines, is the extension of university teaching to the people. Probably no movement of the latter part of the century is destined to exert a greater influence upon the form of our institutions and civilization than this attempt to leaven the entire lump of citizenship with the inspiration of higher motives. The agricultural experiment station movement is itself a part of this general desire to carry the new life to every person, whether college-bred or not. But this movement, beneficent as it is, still lacks some of the means of making itself felt. It must have a closer vital connection with the people. The people must be made to hear, even though they desire to be deaf. Good citizenship has a right to demand that every person live up to the full stature of his opportunities. The establishment of the experiment stations upon a federal grant ensures stability and removes them beyond the reach of petty and local jealousies and criticisms; but the addition of a state grant to the federal grant brings them home to the people and awakens a personal interest in them in the rural communities which can be obtained in no other way. If this state aid asks for extension teaching, still more will be gained towards spreading the influence of the stations. The results of the experiment station work must be carried to every farmer's door; and if he shuts the door, they must be thrown in at the window.

The greatest good to be derived from this experiment station extension bill was conceived, therefore, to be teaching. So meetings have been held and attended — nearly fifty of them in the last two years — in which something has been said of the new teaching of science and the new demands of the times. This teaching has not only been cordially met by the rural communities, but it has been eagerly sought by them. The rural population is ready for instruction, and by far the greater part of those who receive it endeavor to profit by it. The derision of "book-farming," of which we have heard so much, has all gone, because the teaching is now worth being received. In the light of our present knowledge it is easy to see that most of the agricultural teaching of a generation ago was wholly unsuited to the conditions which it desired to reach, and it had, for the most part, a most meager foundation both of

fact and of inspiration. If "book-farming" came to be a by-word, it was because the epithet was deserved. It is true that the agricultural industries are the most difficult to all industries to reach with the educational motive, but this is because of the inherent difficulties of the subjects and not because farmers are unwilling to learn.

The truth of these remarks is attested by the large attendance at many of the meetings which have been held under the auspices of the bill, by the eager questioning of the attendants, and by the enormous correspondence which pours into the Experiment Station offices. An instance of the awakening interest may be cited. The writer met about twenty fruit growers at Hotel Richmond, Batavia, in early spring. The work of the year in Genesee county was talked over. On the 14th day of May an orchard meeting was held at South Bethany at which 300 to 400 people were present; on the 18th of July, at a potato-spraying contest at Stafford, 500 or 600 people were in attendance; on the 22d of August, at Nelson Bogue's, near Batavia, the turnout was estimated at 1,500 to 2,000. Yet, large as this number is, the writer has addressed a western New York farmers' audience of twice this size during the past season! Surely the time is ripe for sowing the seed of the new agriculture!

Some of the teaching under the auspices of this bill has been done by sending a man to attend horticultural and grange meetings, when such a favor was requested. Last spring we inaugurated a series of "spring rallies," which were brisk, active meetings of one or two days' duration. For the most part, two or three persons took part in these meetings—the officer in charge of the work, Mr. Lodeman and Mr. Slingerland. It was the purpose of these meetings to send the farmer into the season's work with such an initial velocity that he could not stop himself before the harvest time. There were plain direct talks about the philosophy of tillage, fertilizing the land, conservation of moisture, and the like, instructions about spraying, and sometimes talks about insects. An orchard was generally sprayed for the purpose of explaining the operation. These meetings were uniformly well attended. Some of the best of them were held at Morton, Clyde, Dundee and Youngstown.

The most exact work which has been done in extension teaching, however, is in the holding of certain meetings which we have called "horticultural schools." These are designed to carry the most useful features of university extension methods to the aid of the rural communities. The instruction is designed to be somewhat fundamental in character, of such a nature that it interests the listener in the subject because of its intellectual relish, and thereby sets him to thinking. If the farmer thinks correctly, he then does correctly. In the treatment of insects, for example, the listener is asked to consider the anatomy, physiology, natural history, and habits of insects, and little is said about the means of destroying noxious kinds. He can read current literature the more intelligently and with keener interest, for having even a little of the fundamental knowledge, and he is very likely to carry the new habit of thought directly into the field with him. Another feature of these schools which has met with much favor is the training of the powers of observation by placing specimens of twigs, fruits, flowers, or other objects, in the hands of the participants, asking that they explain what they see. It is true that most persons do not see what they look at, and still fewer persons draw correct conclusions from what they see. It has been our habit to enroll those persons who signify a desire to attend all the sessions of a school, in order that they may feel themselves to be intimately identified with the movement; and the roll is generally called at the opening of each session. An average attendance of forty or fifty persons is sufficient for a successful school. The first school was held at Fredonia in the holidays of 1894. The enrollment was about 60; but the effect of the teaching was felt throughout a wide constituency. It is generally only the most influential persons who attend such schools, and they spread the instruction far and wide; and the teaching is perhaps all the better for being second-hand and for being worked over into more assimilable shape. The high-water mark in these schools was reached at Jamestown, where over 100 persons were enrolled, and where the interest was at high tension from start till finish. Other persons than those enrolled attend the exercises, and the evening lectures draw a larger audience.

The instructors in these schools were mostly teachers in Cornell University, and each one provided printed synopses of his lectures

for the use of his hearers. At the first Fredonia school, the last day, by request of the promoters in that vicinity, was given over to local speakers upon "practical" questions; but we were requested, in arranging the program for the second school, to omit all local talent in order that the exercises might "not fall below the university standard." Five of these schools have been held. The character of them can best be understood by a display of the announcements and the synopses:

## CONSPECTUS

OF A

## SCHOOL OF HORTICULTURE

TO BE HELD AT

FREDONIA, CHAUTAUQUA CO., N. Y.,

Dec. 26-29, 1894,

Under the auspices of

THE EXPERIMENT STATION EXTENSION, OR NIXON, BILL.

Conducted by L. H. Bailey, and a committee of Chautauqua Horticulturists, consisting of John W. Spencer, S. S. Crissey, I. A. Wilcox, G. Shoefeld, U. E. Dodge, E. K. Hough, F. W. Howard, L. Roesch, F. M. Southwick, G. Jaarda, J. C. Thies, S. G. Bartlett.

Day sessions will be held in Temple of Honor Hall and evening sessions in the large Normal Hall.

WEDNESDAY, DECEMBER 26.

2.00 P. M.

1. Announcements.
2. Observation upon *Twigs*.
3. *How Plants Live and Grow*. With demonstrations with the microscope. W. W. ROWLEE, Assistant Professor of Botany in Cornell University.

7.00 P. M.

4. *An Analysis of Landscapes*, with stereopticon views.  
L. H. BAILEY.



## THURSDAY, DECEMBER 27.

9.30 A. M.

5. Observations upon *Fruit Buds*.
6. *The Nursery*. Discussion upon the propagation of plants, illustrated with the operations and nursery-grown specimens. NELSON C. SMITH, Geneva.

2.00 P. M.

7. Observation upon *Seeds*.
8. *A Brief of the Evolution of Plants*. Origination of varieties. Philosophy of domestication and pruning. L. H. BAILEY.

7.00 P. M.

9. *The Geological History of Soils*. With stereopticon views. R. S. TARR, Assistant Professor of Dynamic Geology and Physical Geography in Cornell University.

## FRIDAY, DECEMBER 28.

9.30 A. M.

10. Observation upon *Leaves*.
11. *Chemistry of the Grape and of Soil*. G. C. CALDWELL, Professor of Chemistry in Cornell University.

2.00 P. M.

12. Observation upon *Flowers*.
13. *Theory of Tillage and Productivity of Land*. I. P. ROBERTS, Director of the College of Agriculture, Cornell University.

7.00 P. M.

14. *What are Fungi?* Considered with special reference to the grape, with stereopticon views. E. G. LODEMAN, Instructor in Horticulture in Cornell University.

## SATURDAY, DECEMBER 29.

9.30 A. M.

15. Observation upon *Fruits*.
16. *Commercial Grape Culture in Chautauqua County*. Considered in various aspects, by S. S. CRISSEY, Fredonia; G. SCHENFELD, Westfield; J. A. TENNANT, Ripley.

2.00 P. M.

17. Observation upon *The Apple*.
18. Continuation of No. 16.
19. General Question Box.
20. Final exercises.

This is probably the first school of its kind devoted to horticulture in this country. With no precedents to guide us, we shall probably make mistakes, but we shall all do our best. It will always be a pleasant memory that we have participated in a pioneer movement.

The day exercises will aim at specific instruction in particular subjects. The evening exercises will be popular illustrated lectures.

Everyone is invited to attend the various exercises. Persons have the privilege of enrolling themselves as students for the purpose of receiving personal aid upon the points under discussion. At the close of each day's exercise the students will be questioned upon the subject. This questioning is not pursued for the purpose of ascertaining the student's knowledge of the exercise, but to elucidate the subject under discussion. During this exercise, also, the student has the privilege of freely asking questions upon the topic under consideration. It is expected that the instructors will not be interrupted with questions during the course of the exercise.

Each day session will be opened with a *lesson upon observation*. Students will be given specimens, as indicated in the program, and ten minutes will be allowed for examination of them. The students will then be questioned as to what they have seen.

Students should provide themselves with note-book and pencil.

Roll will be called immediately upon the hour set for meeting.

Printed synopses of all the day lectures will be distributed to students.

While most of the instruction deals with fundamental principles, special applications will be made to the grape whenever possible.

Roster of the first Fredonia School:

J. R. Adams, Fredonia.	Newell Cheney, Poland Center.
L. S. Allnott, Fredonia.	Mrs. Newel Cheney, Poland Center.
S. G. Bartlett, Fredonia.	H. B. Clothier, Forestville.
F. A. Beckwith, Fredonia.	T. W. Clute, Fredonia.
A. J. Blodgett, Fredonia.	

E. L. Colvin, Fredonia.	J. J. Parker Fredonia.
I. E. Cowden, Fredonia.	J. M. Pettit, Fredonia.
S. S. Crissey, Fredonia.	Dr. A. P. Phillips, Fredonia.
U. E. Dodge, Fredonia.	J. A. Powers, Portland.
M. M. Fenner, Fredonia.	Dr. N. Y. Richmond, Fredonia.
G. H. Green, Fredonia.	L. Roesch, Fredonia.
E. A. Guest, Fredonia.	P. L. Saxon, Fredonia.
G. C. Guthrie, Fredonia.	G. Schœnfeld, Westfield.
Sam'l Hall, Fredonia.	J. W. Skinner, Laona.
Geo. T. Hammond, Fredonia.	C. L. Snow, Forestville.
F. D. Hardenburg, Brocton.	F. M. Southwick, Dunkirk.
W. W. Harris, Brocton.	J. W. Spencer, Westfield.
Mrs. W. W. Harris, Brocton.	A. M. Tenuant, Westfield.
E. K. Hough, Fredonia.	J. A. Tennant, Ripley.
F. W. Howard, Fredonia.	Carl Thatcher, Fredonia.
G. Jaarda, Fredonia.	D. M. Thayer, Fredonia.
F. M. Kidder, Fredonia.	Mrs. D. M. Thayer, Fredonia.
C. I. Mason, Fredonia.	John C. Theis, Fredonia.
A. Matthews, Portland.	M. J. Tooke, Sheridan.
J. A. Miller, Fredonia.	E. I. Wilcox, Fredonia.
R. E. Morris, Brocton.	I. A. Wilcox, Portland.
A. F. Newton, Fredonia.	C. W. Wilson, Fredonia.
O. Ostrander, Fredonia.	E. P. Wilson, Fredonia.
J. N. Palmer, Fredonia.	H. M. Wolbur, Fredonia.
Dr. William Parks, Fredonia.	—58 Students.

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## CONSPECTUS

OF A

## SCHOOL OF HORTICULTURE

TO BE HELD AT

YOUNGSTOWN, NIAGARA CO., N. Y.,

Friday and Saturday, August 16 and 17, 1895,

Under the auspices of the

EXPERIMENT STATION EXTENSION, OR NIXON, BILL.

FRIDAY, AUGUST 16.

Morning Session—10 A. M.

1. Music.
2. Observations on Buds and Branches.
3. The Soil—Its resources and management.

I. P. ROBERTS,

*Professor of Agriculture,  
Cornell University.*

Afternoon Session—2 P. M.

4. Music.
5. Observations on the Peach.
6. The Orchard.—Management of land and trees.

L. H. BAILEY,

*Professor of Horticulture,  
Cornell University.*

Evening Session—7.30.

7. Music.
8. The Science of the Weather.—Illustrated by charts and diagrams.

R. S. TARR,

*Professor of Geology and Physiography,  
Cornell University.*

SATURDAY, AUGUST 17.

Morning Session—10 A. M.

9. Music.
10. Observations on the Apple.
11. Insects Injurious to the Peach.—Illustrated by actual specimens.

M. V. SLINGERLAND,

*Entomologist in the Experiment Station,  
Cornell University.*

Afternoon Session—2 P. M.

12. Music.
13. Observations on the Apple-scab.
14. The Spraying of Orchards.—Lessons of the year.

E. G. LODFMAN,

*Assistant Horticulturist,  
Cornell University.*

The meeting will be held in the Opera House.

The school is free to everybody, and every one interested in horticulture is invited to attend.

Come with note-book and pencil.

Be on hand promptly at the opening hour. The observations will be the most interesting exercises.

Bring in specimens of fruits, flowers, insects, and whatever else interests you.

Come with the determination to learn all you can about the subjects under discussion.

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## A SCHOOL OF HORTICULTURE

WILL BE HELD IN

UNION GRANGE HALL, JAMESTOWN, N. Y.,

October 31, November 1 and 2, 1895,

Under the auspices of

THE NIXON, OR EXPERIMENT STATION EXTENSION, BILL.

Conducted by L. H. Bailey, Cornell University.

FREE TO ALL.

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THURSDAY, OCTOBER 31.

- 2.00 P. M. Lesson in observation upon *Bark*.  
Outline of the Nutrition of Plants. With Examples.  
E. J. Durand, Instructor in Botany, Cornell University.
- 7.30 P. M. Address on Evolution in the Vegetable Kingdom.  
L. H. Bailey, Professor of Horticulture, Cornell University.

FRIDAY, NOVEMBER 1.

- 10.00 A. M. Observation on *Insects*.  
Insects and Insect Enemies. M. V. Slingerland,  
Entomologist in the Experiment Station, Cornell University.

2.00 P. M. Observation on *Flowers*.

Plows and Plowing. I. P. Roberts, Director of the College of Agriculture, Cornell University.

7.30 P. M. The Geological History of Jamestown Region. With lantern slides. R. S. Tarr, Professor of Geology, Cornell University.

SATURDAY, NOVEMBER 2.

10.00 A. M. Observation on the *Apple*.

How can the Farmer tell what Fertilizer his Soil Needs? G. C. Caldwell, Professor of Chemistry, Cornell University.

2.00 P. M. Observation on *Fungi*.

Fungi and Fungous Enemies. E. G. Lodeman, Instructor in Horticulture, Cornell University.

Let every one who is interested in agriculture and horticulture come and take part in the sessions.

Bring in all specimens of plants, insects, fruit, and the like, concerning which you wish to ask questions.

Come with note-book and pencil.

Read up on the subject under discussion before you come. You will then get more out of the instruction.

Be on hand *promptly* at the opening hour.

This is an opportunity for every one to renew his school days.

Roster of the Jamestown school:

R. Adams, Jamestown.	Simeon Brownell, Dewittville.
James S. Aiken, Fluvanna.	Mrs. Simeon Brownell, Dewittville.
Mrs. Geo. L. Ames, Gerry.	W. O. Brownell, Bemus Point.
Miss Nettie J. Armstrong, Jamestown.	Miss Callahane, Jamestown.
B. B. Bissell, Gerry.	A. M. Cheney, Jamestown.
Mrs. R. M. Bissell, Gerry.	Mrs. A. M. Cheney, Jamestown.
Flint Blanchard, Jamestown.	Asa Cheney, Bemus Point.
Mrs. Flint Blanchard, Jamestown.	J. Cheney, Jamestown.
L. G. Brainard, Ellington.	Mrs. J. Cheney, Jamestown.
Mrs. Mary Brainard, Ellington.	Mrs. Kate Cheney, Bemus Point.
Miss Ellen A. Breed, Jamestown.	Lewis Cheney, Kaintone.
	Miss Martha Cheney, Bemus Point.

- Newel Cheney, Poland Center. R. T. Hazelton, Frewsburg.  
 Mrs. Newel Cheney, Poland Jared Hewes, Stedman.  
 Center. W. L. Hyde, Jamestown.  
 Amos Colburn, Ellington. Miss Lottie C. Landon, Jamestown.  
 Miss Minnie Comstock, James- Miss E. E. Leet, Jamestown.  
 town. G. F. Leet, Point Chautauqua.  
 F. A. Crandall, Falconer. C. H. Love, Frewsburg.  
 J. W. Creal, Kaintone. N. D. Lewis, Jamestown.  
 Thos. W. Crouch, Jamestown. R. R. Lord, St. Clairville.  
 Chas. M. Dow, Jamestown. S. A. Markham, Ellington.  
 Edwin Durand, Frewsburg. Mrs. S. A. Markham, Ellington.  
 F. E. Durand, Frewsburg. O. D. Mitchell, Busti.  
 Mrs. F. E. Durand, Frewsburg. Mrs. Anna A. Mills, Jamestown.  
 Mrs. O. J. Felton, Falconer. S. M. Morley, Stow.  
 C. C. Fisher, Stow. Mrs. L. Morgan, Jamestown.  
 F. A. Fitch, Randolph. Mrs. Florence Morton, Stow.  
 L. D. Gale, Steadman. W. Palmeter, Jamestown.  
 Miss Louise E. Geer, James- V. E. Peckham, Jamestown.  
 town. Mrs. V. E. Peckham, Jamestown.  
 C. D. Gifford, Jamestown. Miss Clara Phillips, Bemus Pt.  
 Mrs. C. D. Gifford, Jamestown. George A. Phillips, Bemus Pt.  
 T. H. Gifford, Jamestown. Mrs. J. Phillips, Bemus Point.  
 W. C. Gifford, Jamestown. Mrs. Mary Phillips, Jamestown.  
 Mrs. W. C. Gifford, Jamestown. Mrs. L. J. Pierce, Jamestown.  
 G. A. Gladden, Napoli. H. Pike, Jamestown.  
 Mrs. G. A. Gladden, Napoli. Mrs. Josephine Price, Jamestown.  
 A. L. Gleason, Open Meadow. David Rider, Levant.  
 Miss Gertrude Green, Ashville. Mrs. David Rider, Levant.  
 Miss Ophelia Griffith, James- Mrs. L. S. Robertson, Ashville.  
 town. D. F. Rose, Jamestown.  
 Mrs. Daniel Griswold, James- Mrs. D. F. Rose, Jamestown.  
 town. E. H. Sample, Kennedy.  
 Miss Bertha Gron, Jamestown. S. J. Sample, Jamestown.  
 E. A. Harvey, Fluvanna. Mrs. S. J. Sample, Jamestown.  
 Mrs. E. A. Harvey, Fluvanna. W. H. Seymour, Kennedy.  
 W. Haskin, Ellery. Miss Laura F. Sheldon, Jamestown.  
 A. Hazeltine, Jamestown. D. Sherman, Jamestown.

Mrs. D. Sherman, Jamestown.	S. W. Thompson, Jamestown.
S. O. Smith, Busti.	Samuel Townsend, Frewsburg.
Mrs. L. T. Stafford, Kennedy.	A. A. VanVleck, Jamestown.
W. J. Staples, Frewsburg.	Mrs. A. A. Van Vleck, Jamestown.
Mrs. S. M. Stewart, Ashville.	M. B. Wample, Jamestown.
E. A. Stone, Poland.	Mrs. M. B. Wample, Jamestown.
Mrs. E. A. Stone, Poland.	T. H. Welch, Stow.
C. N. Taylor, Frewsburg.	R. I. Weld, Sugar Grove, Pa.
Lawrence Taylor, Frewsburg.	Mrs. Mary Wheeler, Ellington.
F. D. Thompson, Boomertown.	J. W. Whitford, Stow.
Mrs. N. R. Thompson, Jamestown.	—————113 students.

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## A SCHOOL OF HORTICULTURE

WILL BE HELD IN

THE COURT HOUSE, LOCKPORT, N. Y.,

November 29 and 30, 1895,

Under the auspices of

THE NIXON, OR EXPERIMENT STATION EXTENSION, BILL.

Conducted by L. H. Bailey, Cornell University.

FREE TO ALL.

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FRIDAY, NOVEMBER 29.

2.00 P. M. Lesson in observation upon *Seeds*.

The Soil. What there is in it and how to get it out.

I. P. Roberts, Director of the College of Agriculture, Cornell University.

7.30 P. M. Address, Landscape Art. With lantern views. L. H. Bailey, Professor of Horticulture, Cornell University.



## SATURDAY, NOVEMBER 30.

- 9.30 A. M. Observation on *Insects*.  
Insects and Insect Enemies, with specimens and models. M. V. Slingerland, Entomologist in the Experiment Station, Cornell University.
- 11.00 A. M. Black-Knot and Potato Blight, with drawings and specimens. E. G. Lodeman, Instructor in Horticulture, Cornell University.
- 2.00 P. M. A session with the growers. "How Science-teaching Looks to a Farmer." John W. Spencer, Westfield, Chautauqua Co.  
"Is Orchard Culture Going to Supplant Mixed Husbandry?" Albert Wood, Carlton, Orleans Co.

## Roster of the Lockport school:

Asa Baldwin, Lockport.	Wm. Scism, Lockport.
E. M. Baldwin, Lockport.	W. E. Shafer, Lockport.
R. A. Barnes, Lockport.	E. Ashley Smith, Lockport.
George Bebe, Lockport.	John W. Spencer, Westfield.
Lewis T. Bell, Lockport.	H. L. Taylor, Cambria.
F. M. Bradley, Lake Road.	E. Terry, Ridge Road.
Jones W. Brown, Lockport.	Geo. P. Tower, Youngstown.
H. H. Bugbee, Gasport.	H. B. Tower, Ransomville.
Wm. Bugbee, Gasport.	Mrs. H. B. Tower, Ransomville.
Ellis S. Button, Gasport.	A. G. Eighme, Lockport.
Fernando Capen, Warren's Cor's.	A. Flanders, Lockport.
Merritt H. Carl, Lockport.	E. G. Gafla, North Ridge.
W. B. Cook, Lockport.	Almon Gallup, Lockport.
E. E. Crosby, Lockport.	C. Gaylord, Lockport.
I. N. Crosby, Pekin.	T. Greiner, La Salle.
J. R. Crosby, Lockport.	W. T. Hall, Lockport.
F. Day, Hartland.	T. J. Hastings, Ridge Road.
L. S. DeWolf, Gasport.	Geo. W. Haynes, Lockport.
Ralph G. DeWolf, Gasport.	Geo. W. Hildreth, Lockport.
Wm. L. Dysinger, Lockport.	T. Hough, Lockport.
Chas. Oedes, Lockport.	Orman S. Jaques, Wright's Cor's.
Wm. H. Outwater, Olcott.	W. T. Mann, Barker.
M. B. Reed, Medina.	G. E. Manning, Ransomville.

Daniel McCarthy, Lockport.	A. E. Van Dusen, Hickory Cor's.
Chas. H. McClem, Newfane.	John Walker, Ridge Road.
A. Merlen, Gasport.	A. J. Wheeler, Cheboygan, Mich.
F. R. Montgomery, Johnson's Creek.	E. V. Wheeler, Lockport.
Franklin Moore, Ransomville.	P. B. Wilson, Kuckville.
Luke Tower, Youngstown.	Albert Wood, Carlton.
B. Treadwell, Lockport.	Miss E. A. Wood, Pekin.
A. D. Tripp, North Ridgeway.	J. S. Woodward, Lockport.
	———— 62 students.

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## PROGRAM

OF A

### SCHOOL OF HORTICULTURE,

TO BE HELD AT

FREDONIA, CHAUTAUQUA CO., N. Y.,

December 30 and 31, 1895, and January 1 and 2, 1896.

Under the auspices of

THE EXPERIMENT STATION EXTENSION, OR NIXON, BILL.

Conducted by L. H. Bailey.

Day Sessions will be held in Temple of Honor Hall and  
Evening Sessions in the Large Normal Hall.

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MONDAY, DECEMBER 30.

2.00 P. M.

1. *Observation upon Pollen.*
2. Pollen: What it is and what it does. By E. J. Durand, Instructor of Botany in Cornell University. Illustrated by charts, and pollen under the microscope.

7.30 P. M.

3. Address: How Plants Obtain their Nitrogen. By George F. Atkinson, Professor of Cryptogamic Botany, Cornell University. With lantern views.

## TUESDAY, DECEMBER 31.

10.00 A. M.

4. *Observation of Insects.*

5. Insects: How they live, grow and multiply. By M. V. Slingerland, Assistant Entomologist to the Experiment Station, Cornell University. Illustrated by specimens, charts and *papier maché* models.

2.00 P. M.

6. *Observation upon Soils.*

7. Stock, Silos and Soiling for Fruit Growers. By I. P. Roberts, Director of the College of Agriculture, Cornell University.

7.30 P. M.

8. Address: The American Boy. By Professor Roberts.

## NEW YEAR'S DAY.

10.00 A. M.

9. *Observation upon "Knot-holes."*

10. The Philosophy and Practice of Pruning. By L. H. Bailey.

2.00 P. M.

11. *Observation upon Black Currants of the Shops.*

12. Flower-Growing for Amateurs. By Ernest Walker, Florist, New Albany, Indiana.

7.30 P. M.

13. Address: History of Grape-Growing in America. By L. H. Bailey. With lantern views.

## THURSDAY, JANUARY 2.

10.00 A. M.

14. *Observation upon Figs.*

15. Vegetable Gardens under Glass. By W. M. Munson, Professor of Horticulture, Agricultural College of Maine. With photographs and samples of the vegetables.

2.00 P. M.

16. *Observation upon Potatoes.*

17. Potato Blight and Potato Rot. By E. G. Lodeman, Instructor in Horticulture, Cornell University. With specimens.

Everyone is invited to attend the various exercises. Persons have the privilege of enrolling themselves as students for the purpose of identifying themselves intimately with the extension movement. At the close of each day's exercise the students will be questioned upon the subject. This questioning is not pursued for the purpose of ascertaining the student's knowledge of the exercise, but to elucidate the subject under discussion. During the exercise, also, the student has the privilege of freely asking questions upon the topic under consideration. It is expected that the instructors will not be interrupted with questions during the course of the exercise. Discussion and questions asked for the purpose of eliciting information are always welcome; but there is no time for mere argument and contention.

The day exercises will aim at specific instruction in particular subjects. The evening exercises will be popular illustrated lectures.

Each day session will be opened with a *lesson upon observation*. Students will be given specimens, as indicated in the program, and ten minutes will be allowed for the examination of them. The students will then be questioned as to what they have seen.

Students should provide themselves with note-book and pencil.

Roll will be called immediately upon the hour set for meeting.

Printed synopses of all the day lectures will be distributed to students.

Read up on the subject under discussion before you come to the meeting. You will then get more out of the instruction.

Roster of the second Fredonia School:

(On account of the bad weather and the interruption of New Year's Day, the attendance was smaller than it otherwise would have been.)

S. M. Aldrich, Fredonia.	S. S. Crissey, Fredonia.
F. Baldwin, Fredonia.	Eliza Denton, Fredonia.
W. T. Benjamin, Fredonia.	U. E. Dodge, Fredonia.
P. G. Cate, Fredonia.	Elbert A. Guest, Fredonia.
H. B. Clothier, Forestville.	George Hammond, Fredonia.
R. C. Clothier, Silver Creek.	F. W. Howard, Fredonia.
T. W. Clute, Fredonia.	G. Jaarda, Fredonia.
E. L. Colvin, Fredonia.	F. M. Kidder, Fredonia.
L. E. Cowden, Fredonia.	J. N. Larder, Fredonia.

John C. Theis, Fredonia.	Mrs. M. H. Sackett, Fredonia.
A. W. Tuttle, Fredonia.	David Scott, Fredonia.
W. H. Van Scoter, Fredonia.	Henry Smith, Fredonia.
H. F. Weaver, Fredonia.	Miss L. Smith, Fredonia.
E. I. Wilcox, Fredonia.	Mrs. L. E. Southwick, Fredonia.
R. D. Luther, Fredonia.	John W. Spencer, Westfield.
S. T. Lyne, Fredonia.	J. Spink, Fredonia.
C. J. Mason, Fredonia.	N. A. Tambling, Fredonia.
Thos. Moran, Fredonia.	Karl A. Thatcher, Fredonia.
E. J. Oakes, Fredonia.	I. A. Wilcox, Portland.
Dr. Wm. Parks, Fredonia.	Mrs. I. A. Wilcox, Portland.
Dr. A. P. Phillips, Fredonia.	E. P. Wilson, Fredonia.
Dr. N. Y. Richmond, Fredonia.	L. I. Young, Fredonia.
Lewis Roesch, Fredonia.	————— 45 students.

The synopses which have been used in the various meetings are as follows :

*Theory of Tillage and Productivity of Land.*

(Given at first Fredonia School.)

(By PROFESSOR ROBERTS.)

- I. Plant food in the soil.
- II. Its availability. Objects of cultivation :
  1. To promote capillarity.
  2. To bring fertility to the plant.
  3. To set free the mineral plant food.
  4. To hasten nitrification.
  5. To aerate the soil, or to prevent too free aeration.
  6. To present new surfaces to the rootlets.
  7. To induce new root growth.
  8. To conserve moisture.
  9. To facilitate the drying of the land.
  10. To form a mulch.
- III. Treatment of the land.
  - How to cultivate.
  - When to cultivate.
  - Crimson clover.
  - Phosphoric acid.
  - Potash.

(Students should consult Bulletin 72, Cornell Experiment Station.)

*Plows and Plowing.*

(Given at Jamestown School.)

(By I. P. ROBERTS.)

I. Why we plow.

Effects of plowing on moisture.

Drying and warming the land.

Conservation of moisture.

Preventing hard-pan.

Increased storage capacity.

Aeration of soil.

To promote nitrification.

To bury trash.

To prepare a home for plants.

II. When to Plow.

III. How to Plow.

IV. When and How not to Plow.

*Stock, Silos and Soiling for Fruit-Growers.*

(Given at the Second Fredonia School.)

(By I. P. ROBERTS.)

1. Importance of the animal in the rotation. Manure. The animal enforces a change of cropping. The ideal farm is self-sustaining, making its own fertility. Gives continuous employment. Value of the stock itself.
2. How stock may be kept without permanent pastures or meadows.
  - a. *Silage*. The value of silage, and how to use it. Crops which may be made into silage. Silage rations for various animals,—horses, milch cows, steers, sheep, hogs, poultry.
 

How to make the silo.

How to fill it.
  - b. *Soiling*. What it is, and what are its uses. Crops which may be grown for soiling purposes. Yield of soilage crops. Soiling in catch crops. Soiling in the rotation. Can soiling be substituted for pasturage?

3. What stock, and how many, can the fruit-grower with 80 acres of land keep with profit? How to procure good stock.

*Chemistry of the Soil and of the Grape.*

(Given at first Fredonia School.)

(BY PROFESSOR CALDWELL.)

I. *The Chemistry of the Soil.*

- (a) An arable soil in its best condition for producing crops contains seven essential parts:
- (1) Clay; (2) sand; (3) assimilable plant food; (4) moisture; (5) humus; (6) air; (7) micro-organisms.
- (b) Clay furnishes the substantial medium required by the plant as a root-hold, and is also a storehouse for preserving some of its food from waste.
- (c) Sand is required to make more friable and porous the too stiff and compact soil that clay alone would yield.
- (d) The most important part of the food of the plant that is in the soil consists of nitrogen, lime, potash and phosphoric acid forming a very small part of the soil, and mostly insoluble, or unassimilable.
- (e) Plant growth involves unceasing chemical change in the soil as well as in the plant itself, and this cannot go on without water, nor can plant food be taken up without it.
- (f) Humus or decaying vegetable and animal matter is, as it decays, a source of carbonic acid, which is an important solvent of plant food; humus also itself contains plant food, and it is a loosener of the soil.
- (g) Air is necessary in the soil for its oxygen, without which the humus is not formed, and cannot decay.
- (h) An important feature of this decay is the progress of nitrification; this does not go on without the assistance of micro-organisms.

II. *The Chemistry of the grape.*

- (a) The vine as a whole is composed of three parts: Water, combustible matter, and incombustible matter.
- (b) The largest part of the *dry* plant is combustible, consists of what is called carbonaceous matter, and is derived from the air.

- (c) The rest of the combustible matter, forming but a small portion of it, contains nitrogen, and is called nitrogenous matter or proteids. Though small in proportion it is very important. The nitrogen for it must come from the soil.
- (d) The production of starch, sugar, cell-walls and acids is the chief work accomplished in the growth of the vine and its fruit.
- (e) The quality of the grape for eating depends largely on the relative proportions of sugar and acid. The ripening of the grape consists largely in changes in these proportions.
- (f) Can the grape grower modify these proportions by fertilizing or other treatment of the plant?
- (g) The fermenting of the grape juice depends on its sugar, the access of air and the assistance of micro-organisms.

*How can the Farmer tell what Fertilizer his Soil Needs?*

(Given at the Jamestown School.)

(By G. C. CALDWELL.)

Nitrogen, phosphoric acid and potash, are the only plant foods that need any special looking after in the management of manuring the soil.

The old-time management compared with more modern methods. In some respects the modern method better, in others not. Neither method is based on any real knowledge of what any particular crop growing on any particular soil requires. No royal road to this knowledge. The chemical analysis of the soil will not give a reliable answer to the question in hand, because the soil of a field cannot be fairly sampled. A recent striking illustration of the difficulty.

The question must be put to the soil and crops together in each case, by plot experiment. The difficulties of this method discussed.

How the experiment should be conducted,—

- a : Selection and preparation of the field.
- b : Size, shape and arrangement of the plots.
- c : Fertilizers to be used, and when and how to be applied.
- d : Cultivation of the crop.
- e : Harvesting and measurement of the crop.
- f : Corrections that may be made to even up the results.

The use of the results as an answer to the question put. Concerning the repetition of the experiment.



*The Nutrition of Plants.*

(Given at first Fredonia School.)

(BY PROFESSOR ROWLEE.)

1. Nutrition is one of the two primary functions of all organisms. The other is reproduction.

2. There are different methods of taking food. Amoeba absorbs its food through the walls of its body. In higher forms a body cavity is developed and food is absorbed only through its walls. The culmination of complexity of structure is reached in the highly complicated respiratory and digestive systems of the higher animals.

3. To understand the relation of nutrition in plants to nutrition in animals, one must go back to primitive methods of taking food.

4. There are two great operations going on in living beings, one a building up process (constructive), the other a tearing down process (destructive).

5. These processes may be distinguished,—(a) by the materials used as food, (b) by the structure of the operating organs, (c) by the product of the operation.

6. There is no hard and fast line separating animals from plants. The method of nutrition prevailing among plants is one of the most decisive characters.

7. The chlorophyll function (photosynthesis).

8. The content of the vegetable cell is primarily protoplasm. This in active cells is differentiated in two parts,—the nucleus, at the center, and the ectoplasm, the lining membrane of the wall. The former displays greater activity in the process of reproduction, the latter, in those of nutrition.

9. The green pigment, chlorophyll, which gives the green color to plants is fixed in minute differentiated masses of protoplasm, called chlorophyll bodies.

10. Various forms of chlorophyll bodies,—Oscillaria,—Spirogyra,—Chara,—Coleus.

11. Movement of the chlorophyll bodies occurs in all plants so far as known. It is rapid in Elodea and Vallisneria.

12. Conditions best suited to activity of these workers. Importance of sunlight. Pruning to avoid waste of energy.

13. Plants without chlorophyll.

14. General conclusions.

*Outline of the Nutrition of Plants.*

(Given at the Jamestown School.)

(BY E. J. DURAND.)

*All plants built up of cells.*—Various forms of cells in different parts of the plant.

*The green coloring matter of plants (chlorophyll).*

*The essential elements of plant food.*—These are obtained (1) from the soil, (2) from the air. The food of the seedling; of the mature plant.

*What is sap?*—Water and certain soluble portions of plant food are absorbed from the soil by the root hairs. Forced up through the sap-wood or inner bark by root pressure. Most of the water is evaporated from the leaves through the stomates. The constant current of water from the roots to the leaves. Some of the water combined with the carbon dioxide of the air forms starch.

*Assimilation.*—This process can take place only in the presence of chlorophyll and light. Parasitic plants containing no chlorophyll cannot assimilate carbon dioxide.

*The diffusion of the assimilated food.*—It may be used at once; or stored up, usually (1) roots, *e. g.*, carrot, maple, or (2) underground stems, *e. g.* potato—This stored up material forms the food of many plants in spring before the leaves start.

*Respiration,* the breaking down of tissue and its burning up with oxygen.

*Pollen: What it is, and what it does.*

(Given at the second Fredonia School.)

(BY E. J. DURAND.)

1. *Stamens and Pistils.*—The essential part of a flower; their sexual function.

*Pollen.*—The floury mass of minute grains borne in the anther, the sack at the upper end of the stamen.

2. *The pollen-grain* consists of a rounded bit of fluid, *protoplasm*, surrounded by two membranes. Some of the forms of pollen. After being scattered by the anther, the pollen is carried by the wind or by insects, or other agencies, to the pistils of other plants of the same species.

3. *Office of the pollen.*—The pollen-grain germinates by sending out a minute tube, which grows down through the pistil, finally entering the ovary to fertilize the egg-cell. How fecundation takes place.
4. *Close-fertilization and cross-fertilization.*—The most healthy and hardy seed is borne by the plant whose flowers have been fertilized by pollen from a different plant.
5. *Some devices of plants to insure cross-fertilization.*—The stamens and pistils may be borne in different plants, e. g. Maples and Willows. The stamens may mature before the pistils on the same plant, e. g. Sunflower. Pollen may be impotent when applied to the pistil of the same plant, or of the same variety, as in some varieties of fruits. The case of Pears. Special devices to insure fertilization.
6. *The agency of insects in cross-fertilization.*—Why flowers are colored. The office of nectar (honey). Importance of bees in orchards. Some flowers fertilized by special insects, e. g. clover. Some adaptations of insects for carrying pollen.

*Fungi and Fungous Diseases.*

(Given at the Jamestown School.)

(BY E. G. LODEMAN.)

I. Bacteria.

What are they?

Some of their characters.

Effects upon plants. Pear-blight.

Methods of treatment.

Methods of study in the laboratory. Illustrated by specimens and photographs.

II. Fungi Proper.

The principal groups, respecting their habit of life :

1. Feeding upon living tissues (Parasites).
2. Feeding upon injured or dying tissue.
3. Feeding upon dead tissue (Saprophytes).

Consideration of the first group (Parasites).

How they injure plants; 1, by growing on the surface of host plant; 2, by growing within the tissue of the host.

External indications of their presence. Illustrated by examples and photographs.

How they pass the winter.

Conditions favoring their development.

Methods of dissemination.

Methods of study in the laboratory. Illustrated by specimens.

Methods of treatment.

### *Potato Diseases.*

(Given at the second Fredonia School.)

(BY E. G. LODEMAN.)

A. *Scab*.— Due to a fungus (*Oospora scabies*).

Nature of the fungus. It lives both in the tubers and in the soil.

Treatment of the tubers; of the soil.

Where it is worst; effects of much stable manure; often worse where lime or ashes have been used, probably because these materials modify the acidity of the soil.

Clean seed, clean land, and rotation are the sovereign remedies.

There is a scab which is produced by insects.

B. *Early Blight*.— Caused by a fungus (*Macrosporium Solani*).

Features of the disease; appears early in the season, in small spots, and causes the leaf to shrivel as if suffering from drought; spreads slowly; tubers do not rot. It is the commonest disease of potato tops.

The flea-beetle and its relation to the disease.

The remedy. Spraying with Bordeaux mixture.

C. *Late Blight, Rot*.— Caused by a fungus (*Phytophthora infestans*).

This is the potato disease of history, and it once caused a famine in Ireland. Known for a half century.

Usually appears after the middle of July; attacks large areas of the leaf; spreads rapidly, causing vines to wilt down; tubers contract a dry rot.

How it is treated. Bordeaux mixture is a specific. Treatment of tubers in the cellar; lime and plaster; heating.

*Insects and Insect Enemies.*

(Given at the Jamestown, Lockport and the second Fredonia Schools.)

(BY M. V. SLINGERLAND.)

Illustrated by large models, diagrams and specimens.

1. What is an insect?  
Its near relatives.  
How many insects are known?
2. How they are built.  
External features. Appendages of the body and their use.  
Internal structure; muscular system; how they breathe; the blood and its circulation; their nerves.
3. How they feed.  
Striking differences in their mouth parts.
4. Their sensations.  
The five senses, their form, location and range in insects.
5. The story of their life.  
How it begins. How they grow. Their wonderful transformations.
6. Injurious insects.  
Questions answered, and discussion of any specimens which may be brought in.

*The Nursery; from the Seed to the Setting of the Plantation.*

(Given at the first Fredonia School.)

(BY NELSON C. SMITH, Geneva.)

I. *Cuttings*.—The kinds: hardwood, softwood, long, short, single eye, root cuttings. How and when they are taken. How stored and how planted. What plants are thus propagated. Commercial propagation of currants, gooseberries, grapes.

II. *Layers*.—How made and when. Tip layering. The raspberry. Mound or stool layering. The English gooseberry and quince.

III. *Budding*.—The method: the stock, cutting the cions, setting the buds, tying, subsequent treatment. What plants are budded, and when.

IV. *Grafting*.—The kinds: root, top, crown, cleft, whip. Uses of each. What plants are grafted in the nursery, how and when.

V. *General nursery practice*.—Lands and fertilizers. Method of cultivating. Raising the stocks. Importing them. Transplanting. Trimming. Stripping. Double-working.

VI. *Advice to purchasers*.—Age of trees and vines to plant. Points of first-class stock. Trimming the young trees at planting time. How to plant. When to buy and plant.

*The whole to be illustrated with operations and specimens. (Students are referred to Bulletins 69 and 77, Cornell Experiment Station.)*

DEFINITIONS.—*Cutting*.—A severed portion of a plant which is inserted in soil or water with the intention that it shall grow. A softwood or herbaceous cutting is often called a *slip*. *Layer*.—A shoot or portion of a plant bent down and covered with earth with the intention that it shall take root at the covered part, when it can be severed from the parent plant. *Mound layer* (or *stool layer*) is an erect stool or sucker with earth heaped about its base. *Stock*.—A plant or part of a plant upon which a bud or cion is set. *Grafting*.—The operation of inserting a cion in a stock. *Cion*.—A portion of a plant bearing one or more buds and a piece of stem, which is inserted into a plant (the *stock*) with the intention that it shall grow. *Budding*.—The operation of inserting a bud, with little or no wood attached, in a plant with the intention that it shall grow.

### *Vegetable Gardens Under Glass.*

(Given at the second Fredonia School.)

(BY W. M. MUNSON.)

Illustrated with photographs and specimens of vegetables.

1. Why vegetables are grown under glass.
  - The nature and extent of the markets.
  - Who may engage in the business.
  - The profits.
2. What vegetables are grown under glass.
  1. Lettuce. 2. Tomato. 3. Cucumbers (two types). 4. Asparagus. 5. Rhubarb. 6. Beans. 7. Radish. 8. Cauliflower. 9. Melon. 10. Pepper. 11. Eggplant. 12. Miscellaneous, as cress, sweet herbs, etc.

3. The houses which are used for winter gardens.
  - a. The lean-to house.
  - b. The uneven span house.
  - c. The even span house.
  - d. How they are made:—foundations, sides, roof, ventilators, glass.
  - e. How much they cost.
  - f. How they are heated:—flues, steam, water.
  - g. How hot they must be:—the cool house, for lettuce and the like; the warm house, for tomatoes and cucumbers.
  - h. How the sunlight is managed:—clear roofs and shaded ones.
4. Internal arrangement, and general management.
  - a. The beds or benches.
  - b. The soil.
  - c. The water.
  - d. Insects and fungi.
  - e. It all depends upon the gardener.

*Flower-Growing for Amateurs; or Flowers in and Around the House.*

(Given at the second Fredonia School.)

(By ERNEST WALKER.)

1. *Propagation of plants.*
  - (a) By seeds. Seed pans or trays. Soil. The conditions of germination. Soaking seeds. Filing. Depth to sow. Watering. Temperature. Light. "Drawing up." "Damping off."
  - (b) By buds, Tubers, Corms, Scales, Root-cuttings, Budding, Grafting, Layers, Leaf-cuttings, Head-wood cuttings, Soft-wood cuttings, Saucer-system, Close-system.
2. *Transplanting plants.*

Potting soil.

Seedlings and cuttings, potting, boxing, larger plants shifting, "Setting out."

3. *Window Gardening.*

Difficulties, selection of plants, unsuitable plants, preparation for winter bloom. Bulbs, potting, rooting. Watering plants. How roots absorb. Loss of water. How roots behave in pots. How often to water. Leaf surface. Size of pots. Pots in saucers. Sickly plants. Dust. Insects.

4. *The Yard.*

Lawn. Concealing the unsightly objects. Foliage. Flowers. The location and planting of borders, and beds. Vases. Simplicity. Shrubs. Trees. "Come 'round and see my back yard."

*Commercial Grape Culture in Chautauqua County.*

(Given at the first Fredonia School.)

(By S. S. CRISSEY and G. SCHOENFELD.)

I. MODERN METHODS AN OUTGROWTH.—Examples; pruning and training; distances for planting; varieties; culture; extent of acreage.

II. MODIFYING INFLUENCES.—Varieties modified by climate; cultivation modified by extent; the educational work of societies and institutes.

III. PHYSICAL TOPOGRAPHY.—Natural superiority for grapes due to climate; theory of thermal strata; formation of northern Chautauqua; land and lake air currents; freedom from fungi; exemption from frosts; high summer temperature; dryness of the atmosphere.

IV. PRUNING.—Philosophy of; physiological effects; grape vine periodically extends its structure; evil effects of improper methods.

V. GREEN MANURING.—Plant food available by nitrification; green crops in fall and spring prevent loss of nitrogen; improvement of mechanical condition; comparative value of fertilizers furnished by green manuring; effect on cultivation.

*Picking and Packing Grapes.*

(Given at the first Fredonia School.)

(By J. A. TENNANT.)

I. Time to pick; what to pick in; how to pick; how to remove to packing house; how to store; when to pack; how to



pack; what to pack in; how long to keep when packed, before marketing.

Above applying to common methods of marketing.

II. Suggestions as to shipping-crates.

III. New scheme concerning handling and marketing grapes.

*A Brief of the Evolution of Plants.*

(Given at the first Fredonia School.)

(By L. H. BAILEY.)

1. Conception of an organic evolution. Its relation to philosophy, history, sociology, theology.

2. Reasons for the belief in evolution. Struggle for existence. Constant changes in the external world.

3. Explanations of evolution. Lamarekism. Darwinism. Neo-Darwinism or Weismannism. Neo-Larmarekism.

4. Divergence of the animal and plant. Individuality. Theory of the phytomer. Bud variation. Philosophy of pruning.

5. Variants of domestication. Climate. Food supply: (a) character of soil; (b) thin planting; (c) fertilizing; (d) tillage. Change of seed. Greenhouses.

6. Philosophy of sex. It exists for the purpose of making variable off-spring. Crossing and hybridizing amongst plants.

7. Selection as a means of contemporaneous evolution.

DEFINITIONS:—*Family, Order* in botany.—A group of genera and species; as *Cupuliferæ*, the oak family, *Rosaceæ*, the rose family.

*Genus* (plural, *genera*).—A group or kind comprising a greater or less number of closely related species; as *Acer*, the maples, *Fragaria*, the strawberries.

*Species* (plural, *species*).—An indefinite term applied to all individuals of a certain kind which come or are supposed to come from a common parentage. A perennial succession of normal or natural similar individuals perpetuated by means of seedage. "All the descendants from the same stock."—*Gray*.

*Variety*.—A form or series of forms of a species marked by characters of less permanence or less importance than are the species themselves.

*Sport.*—A variety or variation which appears suddenly and unaccountably, either from seeds or buds.

*Cross.*—The offspring of any two flowers which have been cross-fertilized.

*Hybrid.*—A cross between two distinct species.

*Environment.*—The conditions or circumstances in which an organism lives, comprising climate, soil, and all other external conditions.

*The Philosophy and Practice of Pruning.*

(Given at the second Fredonia School.)

(By L. H. BAILEY.)

A. WHY WE PRUNE.

1. To produce larger and better fruit.
2. To keep the plant within manageable shape and limits.
3. To change the habit of the plant from more or less wood-bearing or fruit-bearing.
4. To remove superfluous or injured parts.
5. To facilitate spraying.
6. To facilitate tillage and to improve the convenience of the plantation.

B. THE PHILOSOPHY OF PRUNING.

1. The argument from philosophy.  
The struggle of existence amongst the branches.
2. The argument from physiology.
3. The argument from experience.
4. How nature prunes.

C. HOW AND WHEN TO PRUNE.

1. The position of the fruit bud.
2. How wounds heal.
  - (a) The cork cells and their mission.
  - (b) The cambium and its office. The tension in stems.  
The callus.
  - (c) The form of the wound in relation to the healing process. The wound parallel to the parent branch. The wound at right angles to the severed branch. The shoulder. The direction of the wound. The length of the stub. The edges of the wound.

- (d) The time to prune, with reference to the healing of the wound. More depends upon the position of the wound than upon the season in which it was made.
- (e) Dressing for wounds. The vegetable parasites of the wounds; bacteria; toadstool-fungi; punk-fungi.
3. Pruning for wood and pruning for fruit.
4. Practical considerations. Allow the tree to take its habitual form. How much and how often it is advisable to prune. Heading-in. Tools.

*The Management of Orchard Lands.*

(Given at the Youngstown School; also followed essentially in meetings at Dickensonville, Morton, Dansville, Clyde, Ridgeway, Williamson, Palmyra, Lyndonville, Dundee and other places.)

(BY L. H. BAILEY.)

1. *The soil.*

Its origin. Its mechanical texture and physical characters.

Soil moisture. Its source. Its importance. Movements.

How conserved. Its relation to vegetable covers. Mulches.

Tillage. Spring or fall plowing. The harrow. Management of clay lands.

2. *Fertility.*

Amount of fertility in the soil. Where it comes from. Tillage and fertility. Nitrification. Humus. Loams.

Manuring. Feed the plant rather than the soil. Nitrogen.

Potash. Phosphorus. Stable manures. Green manures.

Commercial fertilizers.

How to tell what the land needs. Ask the plant not the chemist.

At the first Fredonia School, an eight-page folder was printed for the use of the participants, containing extracts and abstracts of various local essays touching the grape-growing of the Chautauqua region. There are so many suggestive things in this circular, not only to Chautauqua County, but also to many other parts of Western New York, that an abstract of it is published here:

*Grapes: Development of Methods on Large Areas.*

(Used at the first Fredonia School.)

## INTRODUCTION.

Modern methods in vineyard management are an outgrowth or development. Consider, for example, pruning and training. We began with stakes ; first one stake per vine, then two stakes per vine, then post and wire trellis. At first, we used posts six and one-half feet and two wires, then posts seven and eight feet and three wires, and now in some instances posts nine and ten feet and four wires. Distances of planting are also an outgrowth. In an early day, Concord vineyards were in some few cases put as close as six feet each way. Thousands of acres have been set eight feet by eight, and later, thousands of acres more at the now commonly received distance of nine feet between the rows. The development in varieties is equally marked. For many years Catawba and Isabella were the standard, then came Clinton and Delaware, then the Concord and its well-known seedlings ; then Brighton, Niagara, Diamond, Moyer, Vergennes, Jessica, and last some new early varieties not yet fully disseminated but from which much is expected. Methods of cultivation are a development. The first cultivation was in small garden plantings, tilled by hand or the one-horse cultivator, and in a slow, laborious and comparatively costly way.

The grape industry has outgrown the garden period and has become a farm crop. Methods of cultivation which are well enough for a quarter acre, are too slow and costly for twenty-five acres. Vineyardists have been obliged to widen the rows, put on two horses, use the gang plows and the latest improved spring tooth harrows and horse hoes. We have introduced this line of thought, which is perfectly familiar to all of you, and which might be extended to many other branches of the industry, for the purpose of calling your attention, in this introductory part of to-day's study, to some of the causes which have led to this rapid development.

As we study the philosophy of vineyard management, we are impressed with the interdependence and modifying influence of one branch or condition upon others. To illustrate : the species and varieties we can profitably grow are determined by our climate. Attempts to raise varieties grown exclusively in Europe and Cali-

ifornia have been repeated failures. Again, the production of grapes on the large scale now demanded, has greatly modified the entire farm economy. As we have said, the grape has become a farm crop. We can with as equal propriety speak of grape farms, as we say dairy farms, stock farms or grain farms, and the question of boarding houses, packing houses, machinery, spraying apparatus, etc., becomes a legitimate and necessary branch of our farm study.

The development of modern methods in grape growing has not been carried forward independently of the principles involved. The men who first began extensive vineyard planting were men who had already had, many of them, years of experience as fruit growers and market gardeners. They had long been members of farmers' clubs and leaders in its discussions. August 23, 1886, the present Horticultural Society was formed. This society had in its beginning a membership from the best fruit growers. Its first president, Ira Porter, deceased, had for years been the president of the Pomfret Farmers' Club. Lincoln Fay, originator of the Fay currant, was a charter member. This society has persistently, and as we think, wisely, adhered to its original mission as stated in section second of article first: "Its object shall be the advancement of its members in a knowledge of the theory and practice of horticulture." From the first, we have kept to the original mission, "talking it out winters and working it out summers," along the line of advancement in the knowledge of the theory and practice of horticulture. We have held our meetings, discussing old questions, and, as fast as they came to the front, new questions, eagerly sending for and reading all the bulletins of the experiment stations, reports of the department at Washington, transactions of horticultural societies, and standard fruit journals. In twenty years there has been rapid progress, here and in other fruit growing centers, not only in making history but in the development of the fundamental principles of scientific management. It has become a broad field. The Chautauqua grape belt has to-day 26,000 acres of vines, and the crop for 1894 was 3,600 cars, or 10,800,000 nine pound baskets. The special papers brought before the class for to-day's study will be one on "Topographical formation and its relation to climate" (reprint), "Conditions of climate favoring the grape" (reprint), "Why I sow rye in the vineyard" (reprint), "Pruning," by Mr.

Shoenfeld, "Picking and packing," by Mr. Tennant, and perhaps other papers. The reprints are made to save time and for the convenience of the class.

*Grape Growing in Northern Chautauqua, by E. S. Bartholomew.*

The question is often asked, why it is that the valley lying along the south shore of Lake Erie, within the border of Chautauqua county, is so much better for grape growing than very many other sections of the United States, for it is a fact that the grape vine is found growing wild in almost every part of the country, and the cultivated varieties have been tried almost everywhere.

I will answer, first, negatively, that it is not in the soil, neither is it in the fact that the valleys of Chautauqua and Bear Lakes lie elevated and south of Lake Erie at a distance of seven to eight miles. Then why do not the vines perfect fruit as well in so many other locations, and as regularly as in this valley? It is the climate. This peculiar condition of the climate is the result of two prominent causes: the great body of water of Erie on the north, furnishing by its evaporation just the necessary hygrometrical condition of the atmosphere; and the lake helps to form a thermal belt, or stratum of warm air, furnishing a more even temperature during the night, thus aiding the early and perfect maturing of the grape, and affording immunity from frost. \* \* \* Thus we have a more uniform temperature during the 24 hours, so essential to the earlier maturing of the fruit.

This thermal stratum is intensified by the peculiar topographical formation of the earth forming the south boundary of the valley. The northern end of the Alleghany mountains forms a ridge of high land of a somewhat circular form, with its highest point nearest the lake, about two miles west of the gorge of Chautauqua creek, at an altitude of about seven hundred feet above the lake and about two miles from it. From this point westward it rounds off from the lake, and begins to break down in its altitude until it is lost in the great plain of the Ohio and Mississippi rivers. Eastward it retains its nearness to the lake to a point about three miles east of the village of Westfield, when it begins to recede from the lake, and to slowly reduce its altitude, until south of Fredonia it is from five to six miles from the lake. In the towns of Sheridan and Hanover

its trend is changed to the east. As soon as its altitude decreases, and the distance from the lake increases, the thermal stratum thins by widening, and much of its benefits are lost to the grape grower.

It will be found by careful observation that the soil of almost the entire United States is as favorable for the growth of the grape vine as is that of this location, and the success in grape culture would be just as remunerative if the same climatic conditions existed as with us. Hence it is found that the peculiar influence we have is worth to us four times as much per acre as the soil is.

### *Conditions of Climate Favoring the Grape.*

[From the Transactions of the Chautauqua Horticultural Society.]

1. Exemptions from frost, especially in the fall months. The vine begins to leaf about May 10th; it is in blossom June 15th to 20th; in 90 days from the blossoming the early, and in 120 days the late grapes are ripe. In southern Chautauqua and in parts of Cattaraugus and Allegany counties the vine will grow, but three years ago in all that section there was a killing frost on September 24. In this lake shore section, with one exception, there has not been a damaging frost before October 20 in twenty-five years. In 1887 the first killing frost did not occur until after the first week in November.

2. The high mean temperature of the summer months. In the fierce heat and drought of mid-summer, the surface vegetation of the garden suffers, the pastures are scorched as by fire, but the vine, sending its roots three, four and even five feet into the earth, is able to withstand the severe trial if the tillage is good.

3. Conditions securing dryness of the atmosphere and perfect circulation of air. Lake Erie is by far the most shallow of the five great lakes, having an average depth of only 70 feet. In consequence, it is sooner affected by the summer heat. In mid-summer we have in the latter part of the day a constant lake breeze blowing inland, and during part of the night a contrary current. Going back from the water, the land gradually rises in a succession of terraces. June, July and August are the dangerous months for disease, and just then is experienced this climatic condition of dryness and high temperature. Bulletin No. 7, Botanical Division, Department of Agriculture, 1888, says: "At Sandusky, on the shore of

Lake Erie, the loss from black rot in 1887 was only four or five per cent.; the same was true at Fredonia, Dunkirk and Brocton in New York, and in all these places the absence of dews or fogs during this year was marked. In Tennessee grape culture is really not remunerative except above the limit of fogs. Thus, upon the plateaus of the Cumberland there is a Swiss colony that cultivates the vine successfully, and upon the lower hills of Ashland county, Ives seedling gives moderately good crops, although black rot is more frequent; but upon the Cumberland river, where thick morning fogs are frequent, and where the temperature is high, vine products amount to almost nothing."

In the discussion which followed, Mr. Christy, of Hanover, said that wherever the lake breeze strikes the inland without any interruption, we do not have serious frosts.

Mr. Rathbun, living near Smith Mills, said he planted a Delaware vineyard in 1863. Delawares have never failed to produce a crop and have never been injured by the frosts.

Mr. Ryckman, of Brocton, said that Hanover is a larger town than Portland, and there is much good land for grapes in it. I should select the land back upon the foot hills, even if it should be, as much of it is, very poor for ordinary farming. On the foot-hills, the Salem does well. In planting, he preferred grass or sod ground to stubble. You need not hesitate to set a vineyard because the land is not broken up.

\* \* \* \* \*

From the address of Hon. R. P. Marvin (late Justice of the Supreme Court in the Eighth District) at the meeting of the society in Brocton :

"In 1850, before grape growing had started much, while holding court in Cattaraugus county, I met young Mr. Deveraux, the son of a prominent Utica man, who to my great surprise told me that we had in northern Chautauqua a great grape country. He had traveled through all the great grape regions of Europe. I asked him why he considered the lake region good for grapes. He said that Lake Erie is a shoal lake and consequently in winter freezes over. The ice in the spring keeps vegetation back and gives a later spring than farther west around deeper lakes. Thus we avoid late spring frosts. During the summer, owing to its shallowness, the lake



becomes warmer than either of the other lakes, and this warm water gives to this section a long, beautiful autumn with plenty of time to ripen the grape to perfection."

*Why I Sow Rye in the Vineyard, by G. Shoenfeld.*

In the months of July and August, when the vineyards should be clean and exposed to the sunlight the organic matter in the soil is broken up, and nitrification proceeds rapidly. Nitrogen being the most valuable and costly as well as the most subtle element of plant food, is then easily lost by leaching during our fall and spring rains. To prevent this, in the latter part of August I sow rye in the rows of the grapes. The rye will thoroughly penetrate the ground with its roots during the wet season, take up and store available plant food for the next season, when the vine will appropriate it, besides putting the land in just that mechanical condition, when plowed under, to make the plants thrive. The plants want organic matter to work upon and plenty of heat, a moderate amount of moisture, just the right conditions in which the vineyard should be during June and July to the middle of August.

By adding potash and phosphoric acid, if not in abundance already in the soil, the plant food for the vines is complete. I consider such a course better and safer than using stable manure instead. The valuable parts of manure are precisely the same as in fertilizers, viz., nitrogen, potash and phosphoric acid. Its value over commercial fertilizers lies in its fiber, or vegetable substance; but this fibre can be added by the rye.

Following this paper Mr. Shoenfeld read a statement of a vineyard of one and one-half acres, which, before being improved by plowing under rye for a term of years, produced a crop hardly worth harvesting. In 1892 the yield was 1,184 nine pound baskets.

### 3. PUBLICATION.

The character of the publication which has been made under the auspices of the Experiment Station Extension Bill has already been discussed. After conferring with the Commissioner of Agriculture, it was decided to number these extension bulletins consecutively in our regular series, thus avoiding the complications which would arise from two independent series. Fifteen bulletins (comprised

between Nos. 69 and 87, inclusive) were published from the first grant (1894). Fifteen bulletins have also been published from the second fund, but several more, for which the work is already completed, are awaiting publication from the unexpended funds now in our hands. The complete list of these bulletins to date is as follows :

No.	Title.	Author.	Engravings.	Pages.
69.	Hints on the Planting of Orchards.....	L. H. Bailey....	7	16
70.	The Native Dwarf Cherries.....	L. H. Bailey....	6	12
71.	Apricot Growing in western New York.....	L. H. Bailey....	12	28
72.	The Cultivation of Orchards.....	L. H. Bailey....	4	22
74.	Impressions of the Peach Industry in western New York.....	L. H. Bailey....	16	30
75.	Peach Yellows.....	L. H. Bailey....	8	20
76.	Some Grape Troubles in western New York....	E. G. Lodeman..	7	46
77.	The Grafting of Grapes..	E. G. Lodeman..	17	22
79.	Varieties and Leaf-Blight of the Strawberry.....	L. H. Bailey....	11	26
80.	The Quince in western New York.....	L. H. Bailey....	13	28
81.	Black-Knot of Plums and Cherries, and Methods of Treatment.....	E. G. Lodeman..	7	24
83.	A Plum Scale in western New York.....	M.V.Slingerland.	6	24
84.	The Recent Apple Failures of western New York..	L. H. Bailey....	11	34
			(1 colored)	
86.	The Spraying of Orchards, Apples, Quinces, Plums.	E. G. Lodeman..	9	34
87.	The Dwarf Lima Bean..	L. H. Bailey....	15	24
90.	The China Asters; with Remarks upon Flower Beds.....	L. H. Bailey....	12	24

No.	Title.	Author.	Engravings.	Pages.
91.	Recent Chrysanthemums.	Michael Barker.	6	32
93.	The Cigar-Case-Bearer in western New York....	M.V. Slingerland.	12	20
95.	Winter Muskmelons.....	L. H. Bailey....	12	20
96.	Forcing-house Miscellanies.	{ L. H. Bailey.... E. G. Lodeman..	11	44
98.	Cherries .....	{ L. H. Bailey.... G. H. Powell...	15	24
99.	Blackberries.. .....	L. H. Bailey....	15	26
100.	Evaporated Raspberries in western New York....	L. H. Bailey....	28	40
101.	Notions about the Spray- ing of trees; with re- marks on the Canker- Worm .....	L. H. Bailey....	8	24
102.	General Observations re- specting the Care of Fruit Trees; with some reflections upon Weeds.	L. H. Bailey....	4	26
103.	Soil Depletion in Respect to the Care of Fruit Trees.....	I. P. Roberts...	3	22
104.	Climbing Cutworms in western New York....	M.V. Slingerland.	21	50
105.	Revised Opinions of the Japanese Plums.....	L. H. Bailey....	14	30
109.	Geological History of the Chautauqua Grape Belt.	R. S. Tarr.....	24	38
110.	Extension work in Horti- culture.....	L. H. Bailey....	1	42
Total .....			335	862

This report is necessarily but the merest outline of the work which has been undertaken in fulfillment of the requirements of the bill. A large part of such work lies in the visiting of farms and communities where some difficulty demands attention, in the

giving of advice everywhere by person and by letter, and of sending an entomologist, botanist, or other expert to investigate such dangers as seem to threaten any horticultural interest. The bill has virtually carried the experiment station to every horticulturist's plantation, and every constituent has been at liberty to call for personal aid whenever his troubles are of such a character that others, as well as himself, are interested therein. All this work does not admit of publication, and its value is all the greater for being done in a quiet, unostentatious way, with no thought of public recognition.

A word should be said respecting the attitude of Cornell University towards this grant of funds for extension work. The reader will already have noticed that the movement originated wholly with the people. If the movement has value to the people of western New York, the advantage must necessarily be in proportion to the public desire and demand for it. It is in every sense a popular movement. Its prosecution has imposed great burdens upon the officers who have had it in charge, and it has demanded important changes and considerable sacrifice in the accustomed work of the university. On the other hand, the university exists to serve the people of the state, and if the people desire that it undertake or continue such an enterprise and are satisfied that it can help them, then the university, on its part, stands ready to lend its men, equipment and influence to assist the rural population, so far as such undertakings do not jeopardize its more legitimate work. But it must be distinctly understood that this is not a grant to Cornell University, but a grant to the people to be administered by Cornell University, and that the university has refused, and must continue to refuse, to take any part, directly or indirectly, in forwarding any legislation connected with the work.

Respectfully submitted,

L. H. BAILEY.

*January 10, 1896.*

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BULLETIN 111—February, 1896.

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Cornell University—Agricultural Experiment Station,

ITHACA, N. Y.

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Office of the Director, 20 Morrill Hall.

The regular bulletins of the Station are sent free to all who request them.

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## BULLETINS OF 1896.

106. Revised Opinions of the Japanese Plum.
107. Wireworms and The Bud Moth.
108. The Pear Psylla and The New York Plum Scale.
109. Geological History of the Chautauqua Grape Belt.
110. Extension Work in Horticulture.
111. Sweet Peas.

CORNELL UNIVERSITY, ITHACA, *February 1, 1896.*

*Honorable Commissioner of Agriculture, Albany:*

Sir.—A good friend once wrote us that it might be well enough to make a bulletin on chrysanthemums for florists, but that what the people really want is a bulletin on cabbages. We replied that if we make a bulletin on cabbages, the florist will write that such literature may be allowable, but that the people want a bulletin on sweet peas. And the florist may add, with much force, that whilst there are bulletins enough on cabbages, there are none whatever on sweet peas. All this simply means that the constituencies of a government experiment station are exceedingly various, and that all, alike, help to support it. There are probably more persons in this state who growsweetpeas than there are who grow cabbages; at least, such ought to be the case. There is a wide-spread feeling that flower-growing is not a commercial occupation, but simply a sentimental one; yet people who buy and sell flower seeds and cut flowers and flower plants, have reason to hold a contrary opinion. Flower-growing, both for home and for market, is rapidly increasing in the east; and of all horticultural occupations, this has received the least scientific attention in this country. We shall be sorry to offend our correspondent a second time, but we shall lay the blame upon the sweet pea. The plant is so attractive that we cannot help it.

In this study of the sweet pea, I have associated with me one of my students, who is fitting himself to be a landscape gardener. Mr. Wyman has made a faithful record of our varieties during the season, and I am convinced that he has good taste in matters of flower-growing. All the detail work in Part II. is his.

The bulletin is submitted for publication under Chapter 230 of the Laws of 1895.

L. H. BAILEY.



72. Countess of Radnor. One of the <sup>most</sup> popular  
sweet peas; lavender-purple. ~~Full~~ Nat-  
ural size:



# Sweet Peas.

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## I. GENERAL SKETCH OF THE SWEET PEA.

The improved sweet peas hold a leading place in the returning tide of the good old flowers. The varieties now number many over a hundred, where but a few years ago they were less than a dozen. The sweet pea has long been a favorite, for it has beauty of form and color, attractive habit, and delightful perfume; it needs only a variety of colors, shapes, sizes and seasons to perfect it for the amateur's and florist's use, and all this has now been added to it. The sweet pea is one of those fortunate flowers which can never be developed into stiffness and formality, for the shape is irregular and the plant is a free and random grower. However much the desire for oddity or formalism may conduce to the popularizing of other flowers, it can effect little with the sweet pea. It is unique and wayward, and if it once loses its old-time freedom, it is no longer a sweet pea.

Yet there is a tendency to develop the sweet pea beyond its characteristic limits of simplicity and daintiness. The most apparent fault with some of the novelties, if one may judge from the pictures of them, is their arrogant size; but, fortunately, I have never seen such peas in the garden. If I were really assured that I should raise such amazing flowers as I see in the catalogues, I should certainly never buy the seed of them. I should still give my affections to the modest Painted Lady, whose presence still graces the unconventional old gardens. But I do not desire to complain of the trade cuts, for I know what a powerful magnifier a silver dollar is when it is placed behind a flower; and I simply "make allowances," and buy. If I get the color and the shape and the texture, the degree of bigness is a trifling matter. Another heresy in sweet peas is the desire for a double flower. The form of the pea flower is its peculiar beauty. The broad trim standard is the most perfect surface for the display of color, and an effective shield and foil for the contrasting pigments of the wings and keel.

When that simple standard is displaced by two or three, and the shield becomes shapeless and contorted and contrary, the flower is no longer the sweet pea of the dear old gardens, but is apt to be a mussy and impudent thing. We want not bigger flowers and more petals, but we want more sweet peas. That is, we want more productive plants—if that is possible—and more flowers in the cluster. We need, also, more very early and more very late varieties, a still greater range in color, and some improvement in the texture of the flowers. But let us keep to the sweet pea type. Those contrary individuals who are always trying to grow tomatoes on potato plants and strawberries on blackberry bushes, would leave the world a better legacy if they were to grow more tomatoes on tomato plants and better strawberries on strawberry plants.

My reader wants to know how these new sweet peas are obtained. The process is simple enough, but, like most simple things, it is hard to learn and harder to perform. The most important part of the process is a well laid plan of action on the part of the operator. He must determine what improvement the plant needs. Then he must study the plant closely to learn its habit of variation, and how it adapts itself to the different conditions in which it is grown. He will then put himself in sympathy with the plant, simply trying to improve or augment the little differences which appear, and not set himself squarely against the line of evolution of the plant by attempting the impossible. He has a picture in his mind of a deep clear pink flower. Very well; he goes through the rows of his pink-flowered varieties and marks those plants whose flowers are nearest his ideal. The seeds of these plants are separately saved, and sown. Amongst the offspring, he again selects, and he again sows, taking care that his stock does not become crossed with some other type. Presently, his new color is obtained, the seeds have got in the habit of "coming true," and the brood is given a new name and introduced to the trade. More often, however, the operator has no distinct ideal in his mind, but he watches his plants carefully and every marked departure or "sport" from the type is saved and sown. From such sports the greater part of our novelties, of all annual plants, have come. The sports are frequent enough, but it requires rare judgment to distinguish those which will likely perpetuate themselves, and to carry on the subsequent selection by

means of which they are freed of their impurities or the tendency still to sport. If desired variations do not appear, then the operator may endeavor to start it off by a radical change of soil or treatment, or possibly by crossing. All this means that the cultivator must become intimately familiar with his subject before he can expect to make much headway in the origination of novelties. So it has come that the modern improved plants owe their development largely to one or two careful and patient persons in each generation.

The sweet pea has had but one genius. He is Henry Eckford, who for twenty years has given his attention to this plant upon his



73.—Henry Eckford.

garden-farm at Wem, in Shropshire, England. He has given us the greater number of our best improved varieties. "When I first took up the sweet pea," he writes, "there were six or eight distinct varieties in cultivation, and experts in the art, as far as I could learn, had come to the conclusion that it could not be further improved, and in the first two or three generations of the work it appeared a fair conclusion; but I should say that I had been for many years working on the improvement of various florist flowers, and which had proved so eminently successful that a first rebuff did not deter me from further attempts." In our own country, the

work has now been taken up by Rev. W. T. Hutchins, of Indian Orchard, Massachusetts; and it has remained for him to make the first important attempt to write any account of the modern sweet pea. His booklet, "All About Sweet Peas," appeared in 1894; and he has been and is still the most devoted grower and champion of sweet peas upon this side of the Atlantic. This is not saying that he is the largest grower, for this honor is held by C. C. Morse & Co., of California, whose crop of sweet peas covered 250 acres in 1895, and this firm has also produced a number of excellent varieties. But Mr. Hutchins is an amateur sweet pea critic, whilst Mr. Morse grows the seeds for market. W. Atlee Burpee & Co., of Philadelphia, were amongst the first retail seedsmen to take up the sweet pea. The first sweet pea show of any note in this country was held under the inspiration of Mr. Hutchins at Springfield, Mass., in 1893.

Although this great improvement in the sweet pea is so recent, the plant has been long in cultivation. It is native to Italy, and was introduced into England about 1700. Its Latin name, *Lathyrus odoratus*, was given by Linnæus in 1753. In 1754, Philip Miller, a famous English garden-botanist, speaks of two distinct varieties in the fourth edition of his "Gardener's Dictionary": "One of these has pale red Flowers, which is commonly called by the Gardeners, Painted-lady Peas; the other hath intire white Flowers: both these may be allowed a Place in the Borders of the Flower-garden, for the sake of Variety." William Curtis had a colored plate of a purple form in his "Botanical Magazine" in 1788, and speaks as follows of the plant: "There is scarcely a plant more generally cultivated than the Sweet Pea, and no wonder, since with the most delicate blossoms it unites an agreeable fragrance. Several varieties of this plant are enumerated by authors, but general cultivation extends to two only, the one with blossoms perfectly white, the other white and rose-colored, commonly called the Painted Lady Pea. \* \* \* They have both been introduced since the time of Parkinson and Evelyn."

In America, M<sup>r</sup> Mahon mentions the sweet pea amongst his "hardy annual flower-seeds," in his "Gardener's Calendar," in 1806. He knew five varieties, as follows:

Var. *albis* (white).

Var. *carneo*, old Painted Lady.

Var. *roseo*, new Painted Lady or Scarlet.

Var. *cæruleis* (blue).

Var. *atropurpureo* (dark purple).

Thomas Bridgeman, in his "Young Gardener's Assistant," 1838, mentions "Sweet Peas, of various descriptions and colors. *Lathyrus odoratus*, var. *alba*, *purpurea*, *rosea*, *striata*, etc." Edward Sayers, in "American Flower Garden Companion," 1838, speaks of sweet peas, "purple, scarlet, white, pink, pink and white or painted lady." Buist, of Philadelphia, writes that they are "well deserving of culture," and says that there are "many varieties," in his "Flower Garden Directory," 1845. Yet they could not have been very widely grown at this time, for Eley's "American Florist," which appeared in the same year at Hartford, does not mention them. In 1851, Breck writes in his "Book of Flowers" that sweet peas are "deservedly one of the most popular annuals which enrich the flower-garden. The varieties are white, rose, scarlet, purple, black and variegated. Every variety should be sown by itself in circles about a foot in diameter, three or four feet from any other plant." The custom of giving designative personal or descriptive names to varieties of annual flowers was scarcely known forty or fifty years ago, and we do not know just what types were then in cultivation. The loose vernacular or Latin names were used rather more for groups or strains of color than for any particular minor variation as the names are in these days, when we have so greatly refined the choice and descriptions of garden plants. The first distinct note of the recent popularizing and diffusion of named sweet peas in this country came in 1889 with the introduction of the *Blanche Ferry*, which is an improvement of the old Painted Lady, and which is still one of our best varieties when grown from carefully selected seeds. This variety was found in a garden in northern New York by W. W. Tracy, of the firm of D. M. Ferry & Co. C. L. Allen writes as follows of its evolution, in "American Agriculturist," for September 7, 1895: "The farmer's wife had for years been in the habit of saving her own seeds, starting with the old and well-known Painted Lady. In the heavy loam of her garden, and with the much shorter season of growth there than in Europe, this made a more rapid growth, and annually became more dwarf in habit. At the same time it became a 'cropper,'

that is, all the flowers, that in other climates would have a much longer period in which to develop, here appeared nearly all at the same time if not cut. Thus in a few years a dwarf and very free



74.—Tangier Scarlet Pea (*Lathyrus Tingitanus*). Half size.

flowering type was established, which remains constant in our country. The success that greeted the introduction of this variety, and the fact of its having been developed here, stimulated our growers to extra exertion, not only to grow sweet peas as a crop,

but to watch for variations which a change of climate is sure to produce. The result is we have found that sweet peas can be about as cheaply grown here as the common field pea. But more important still is the fact that all our well-known sorts are more prolific when the seeds have been grown here. The introduction of new varieties, as well as new types, is one of the marked features of our industry."

Before going further, the reader should be reminded that there are two other closely related species of peas in cultivation for their flowers, and one of them, the Tangier Scarlet, is even called a sweet pea. This Tangier pea is *Lathyrus Tingitanus* (Fig. 74). It has been in cultivation longer than the sweet pea, having been introduced into England as early as 1680. Curtis figures it in the "Botanical Magazine" in 1790, and speaks of it as follows: "The Tangier Pea, a native of Morocco, cannot boast the agreeable scent, or variety of colors of the sweet pea; nor does it continue so long in flower; nevertheless there is a richness in the color of its blossoms, which entitles it to a place in the gardens of the curious." It bears an attractive purple flower, with a large standard and small wings, and blooms earlier than the true sweet peas. It is also known for its very narrow and long leaflets, generally 2-flowered peduncles, and long, flat, hairless pods.

The other pea to which I wish to refer is *Lathyrus latifolius* (Fig. 75), the perennial or everlasting pea. This plant, a native of Europe, has been long in cultivation, although it appears never to have received special attention, since there are only three



75.—Perennial or Everlasting Pea. (*Lathyrus latifolius*.)

or four well marked varieties of it. Its leading forms are simply known as the red and the white. It is at once distinguished from the sweet pea, aside from its perennial nature, by the many-flowered clusters, the very large standard, the thick and stiff texture of the scentless flowers, the broad and strongly veined leaflets, and the broad hairless pods. It is an excellent hardy plant for a mixed border or for clambering over rocks or other low objects. I have several plants of it growing against a tennis screen, and they bloom most profusely in late spring and early summer. It is a profuse seeder, and the pods should not be allowed to form if continued bloom is desired. It propagates readily by seeds and by cuttings.

*Where and How to Grow Sweet Peas.*

The sweet pea is such an unconventional and domestic flower that it is unsuited to formal beds or to an obtrusive position on the lawn. It is one of those flowers which we enjoy the more if it is somewhat hidden from the public view, and is restricted to the more private and personal parts of the grounds. It is preëminently a flower for the back yard. A rear or side border, against a fence or other background, is a good position for it. The plant is always attractive when seen clambering over bushes, but it rarely thrives well when planted close under shrubbery unless it is grown in a box or large pot of rich earth plunged into the ground, to remove it from the competition of the roots. If one is to raise a considerable quantity of sweet peas, they may be planted in rows and allowed to run up a screen of chicken-wire; or, if one can take the pains to tie them occasionally, a trellis may be made of four or five strands of fence-wire, like a half-size grape trellis. On good soil most varieties will reach a height of four or five feet.

If sweet peas are to continue to bloom throughout the season, the soil must be rich and capable of holding moisture. A thin, dry soil will not grow good peas. In light soils it is well to apply a liberal dressing of manure to the soil in the fall, plowing it under very early in the spring; and in addition to this, a dressing of some concentrated fertilizer in the spring will be useful. But the chief thing is moisture. The land must be well and deeply fitted, to increase its water-holding capacity. It is ordinarily advised to till the soil frequently after the peas are planted until they



begin to bloom, at which time all cultivation should cease. I do not believe that this is safe advice. The land becomes hard by constant tramping of visitors when the plants are in bloom, and the evaporation from the soil is thereby greatly increased. A heavy mulch of straw or litter may be placed on the soil when the plants begin to bloom, to conserve the moisture; but if the rows are far enough apart to allow of it, a frequent stirring of the soil all through the season with a horse or hand cultivator will be found to be the most efficient conservator of moisture. The plants also endure dry weather better when thinly planted. We like to have the plants six or seven inches apart in the row. Our own test in 1895 comprised four rows each 150 feet long, and three feet asunder, in heavy clay loam. The vines were trained on five horizontal wires, making a trellis three or four feet high. The land was stirred with a horse and cultivator about every week all summer long. The result was, that although we had a prolonged drought, we had sweet peas in abundance from early July until October.

Deep planting also enables the sweet pea to resist dry weather. It is a good plan to make furrows four or six inches deep, drop the peas in the bottom and cover an inch or so. Then, as the plants grow, the earth is gradually filled in about the plants, until the furrow is full. If there is danger that these furrows will fill with water, and hold it for some time, the peas should be planted more shallow and the furrows filled at once. Early planting is also desirable. In this latitude we can plant as early as the first of April, on warm soil,—that is, a month before hard frosts have ceased. The sweet pea is a hardy plant, and the seed is not injured by much cold weather. I have known good results from planting seeds in the fall, but this practice is unreliable in the northern states. I doubt if it can be recommended with full confidence north of Norfolk. But even if the seeds are got in late and shallow, the plants may be carried through by a little extra attention to tillage. Our test of 1895, of which I have spoken, was inaugurated so late that we thought it inadvisable to delay matters by deep planting. So we planted the seed about two to three inches deep, on the last day of April, and our sweet peas were the admiration of the community. If there are any secrets in the growing of sweet peas, they are these: A rich, well-prepared

soil, early and rather deep planting, picking of the pods as soon as they form, and the judicious selecting of seed and varieties.

There is some inquiry as to the forcing of sweet peas. Our experience in this matter is very limited. It is generally thought to be best to sow the peas early in winter in a cool house amongst other things — as carnations — and let them take their time for growing. When the sunny days come in March and April, they may be expected to bloom.

### *The Varieties of Sweet Peas.*

All the foregoing requirements are easy enough to meet save the last — the selection of varieties. The kinds are now so numerous and so various that the amateur may be perplexed in the choice. Of course much depends upon the taste of the grower. One should always be sure, also, to have enough. The beauty of flowers lies largely in the generosity and profusion of them.

The grower should also have a good variety in color and shape, and this is best obtained by purchasing the best named varieties, and making the mixture to suit. If I were confined to six varieties, I think that I should choose the Improved Painted Lady or a pure type of Blanche Ferry, Apple Blossom, Emily Henderson, Mrs. Gladstone, Butterfly and Countess of Radnor. But there are twenty varieties which even the average flower-lover may grow with great satisfaction. F. Schuyler Mathews, in his "Beautiful Flower Garden" (1894), speaks as follows of his method of growing sweet peas and his choice of varieties. I am glad to transcribe his account, because Mr. Mathews regards the subject from the artist's standpoint. "My own method of arranging sweet pea vines is confined to a fence or hedge row, which I create out of chicken-yard wire and rustic posts. This fence serves the double purpose of a thing of beauty, and a barrier against the roaming cow, who by the way, frequently takes toll in the shape of a fine bunch of my favorite Boreattons. The varieties which are most attractive in color are:

Boreatton, red-purple and violet.

Mrs. Sanky, white.

Lottie Eckford, white, blue-edged.

Orange Prince, scarlet pink and rose pink.

Blanche Ferry, pink and white.

Cardinal, red-crimson and red-scarlet.

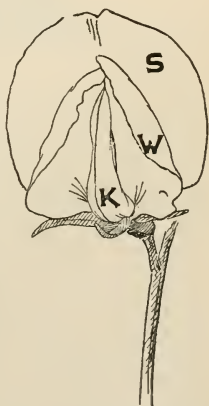
Grand Blue, ultramarine-purple and purple crimson.

Primrose, cream-yellow.

. . . . . With all deference to a perfect harmony of color, I may add that there is really very little discord to be found in an indiscriminate mixture of all varieties."

A more detailed account of the merits of the various sweet peas which we have grown will be found in the descriptive list in Part II. But, after all, it does not matter so much, as I have said, what varieties one plants as it does that he plants, and plants generously. One can scarcely obtain such a profusion of color and fragrance throughout the season from any other flower. Mr. W. N. Craig contributes to "Garden and Forest," the following record of the productiveness of sweet peas: "We have never tested individual plants, but last year we kept a record of the spikes cut from a row sixty feet long, partly composed of the Eckford varieties and partly of good mixed sorts. The first flowers were cut on June 11th, and the last on October the 20th. The number gathered for each month was as follows: June, 2,000; July, 17,600; August, 18,000; September, 6,400; October, 3,500; total, 47,500. Besides this, large numbers went to seed, and probably the row would have yielded 60,000 spikes if it had been carefully picked over."

The varieties of sweet peas with which Mr. Eckford began his work, as given by Mr. Hutchins, are seven, as follows: Light Blue and Purple, Painted Lady, Common White, Scarlet, Scarlet Striped, Dark Striped, Black. Most or all of these Mr. Hutchins would now discard; and he also adds (1894) the following to the list of those which are superseded by better varieties: Adonis, Crown Prince of Prussia, Vesuvius, The Queen, Carmen Sylva, Queen of England, Empress of India, Isa Eckford, Bronze Prince, Black, Purple Brown Striped, Scarlet Invincible. Yet several of these varieties are still favorites with us; and for myself, I should place Empress of India in a list of my second or third half-dozen. This simply illustrates the old aphorism that there is no accounting for tastes. So long as one likes the varieties which he grows it does not matter what names they bear.



76.—The Sweet Pea flower.

Before going further the reader should stop long enough to notice the architecture of the sweet pea flower (Fig. 76). The broad orbicular upper petal, *s*, is the standard, banner, vexillum, or shield; the two mid-sized pieces, *w*, are the wings, and these close over the smallest central portion, comprised of two connivent parts, called the keel, *k*. When the sweet pea attempts to become double the duplication usually appears in the standard, which, instead of comprising but a single piece, may be formed of two or three or four petals. This is well shown in Fig. 77, in which the expanded flower is seen to have three standards. There is no double variety



77.—Double pea. The Splendor.

of sweet pea, but most of the improved types tend to duplicate the standard, and some varieties will give from 20 to 50 per cent. of these monstrosities, when grown upon strong soil. In other words, there is a general and cumulative tendency towards doubling, as the species is improved, but the seeds of double flowers of any particular variety do not necessarily produce double flowers. There is every reason to expect, however, that the time will soon come when double peas will reproduce themselves as reliably as many other annual flowers do; but unless the product is more shapely than any thing which I have yet seen, I shall be ready to quit sweet peas when I am obliged to grow double ones.

Another word may be said upon the size of the sweet pea flower. The accompanying engraving (Fig. 78) shows three types of peas, exactly natural size. All illustrations of objects which have depth and rotundity in them, look smaller than the objects which they represent, until the eye becomes trained to see the perspective and the solidity in the picture. The small flower, on the left, is the Rising Sun. It is about the size of the sweet peas of the last generation. The flower on the right is Etna, and is of good size, as sweet peas go. The middle flower is Dorothy Tennant, and is one of the modern grandiflora type. The flower is large enough for a good sweet pea, in my opinion, although it might be somewhat enlarged without losing its daintiness. Yet this flower measures only an inch and a quarter across, whilst a catalogue illustration before



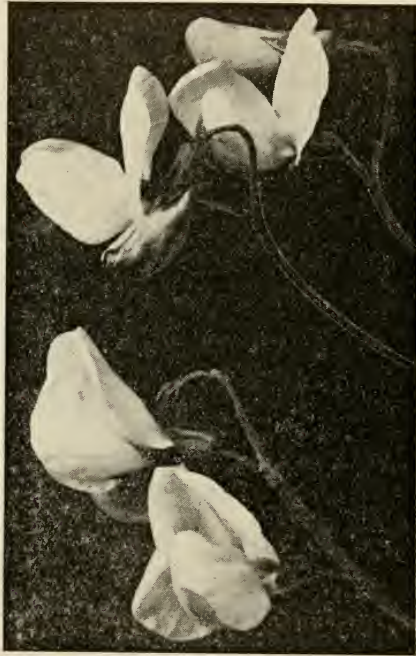
78.—Three typical sizes of sweet pea flowers.

me has them two inches across. I do not deny that such peas are possible, with high culture and pruning, but it is a fair question if they are desirable. The Apple Blossom, Fig. 80, is one of the grandiflora type, a development from the old Painted Lady, but the illustration is the merest trifle oversize. All the other pictures of varieties in this bulletin, except Fig. 74, are exactly natural size, and are made from flowers grown in ordinary conditions, in too thick planting.

Along with the increasing tendency towards doubling of the flowers, the sweet pea has also developed a tendency to enlarge the flower cluster. This often comes as a result of fasciation or abnormal broadening of the stem. As many as eight perfect flowers were developed in some clusters of Apple Blossom in our planta-

tion last year, with no diminution in the size of the flowers, whilst the normal number is only three. Fig. 80 shows this augmentation of the flower cluster. Like the doubling, this enlargement of the cluster is not perpetuated by seeds, but it is not too much to expect that a permanent modification in this direction may come in the future.

Another interesting development of the sweet pea is the recent appearing of dwarf or non-climbing forms. These have appeared



79—Two types of flowers. *Alba magnifica* (above), and *Emily Henderson* (below).

in Germany, England and California. This is one of those peculiar accumulative effects of domestication which is apt to appear somewhat simultaneously in widely separated regions, evidently largely because an equal degree of domestication tends to produce similar effects in any number of regions. The same thing is illustrated in the dwarf Lima beans (see our Bulletin 87), and it transpired long ago in the common garden beans. The California dwarf, which is introduced this spring (1896) by Burpee as Cupid, was found in a field of peas in C. C. Morse & Co.'s plantation in 1893. There was a single plant of it. This original plant was

strong and apparently normal in every way except in its diminished size. In 1895, Morse & Co. grew seven acres of this Cupid, and all the plants came true to seed. We have not grown the plant, but Burpee pulled up two entire full-grown plants and sent them to us last year. One of them measured seven inches high, and the other eight inches. The flowers were of medium size, pure white, and of good form.

It is difficult to construct any classification of the varieties of sweet peas. The best scheme for popular use is thought to be one founded on the color of the flowers. Yet there are various well-marked types of form in the sweet pea flower, which should be recognized in classifying them. The old-time type has a broad plane standard, as in Apple Blossom (Fig. 80), and Countess of Radnor (Fig. 72). In many of the recent varieties, the standard is variously curled or rolled. One of the best of these newer forms is that in which the standard is inrolled or hooded. This is shown to perfection in the dainty and exquisite Butterfly (Fig. 82, best seen in the central flower and in the uppermost flower at the right). An opposite form of standard is the reversed or revolute, well shown in Imperial Blue (Fig. 83). The form of the flower also varies when seen sidewise. Consider Fig. 79. The upper flowers are Alba Magnifica, in which the standard and wings stand nearly at right angles to each other, and, therefore, present a want of connection and homogeneity which is displeasing to many persons. In the lower spray, which is Emily Henderson, this fault does not exist, and the flowers present a more united and shapely effect.

#### *A Seedman's Account.*

The reader will be interested to know something of the methods and trials of seed-growers in growing and breeding varieties. The following account is written by Mr. Waldo Rohnert, one of my former students, who is associated with C. C. Moore & Co., of California:

“Eight or nine years ago the sweet pea was little known as a garden flower. It then had little merit to attract public attention. At that time, Mr. Eckford had done considerable work and his efforts and perseverance were becoming apparent. From the ordinary type and colors he has improved the flower to its

present high standard. Cross-fertilization and selection, keeping the size, form, substance and color constantly in mind, have had a wonderful effect. We depend somewhat upon sports for new varieties, however. As each variety is brought up to the grandiflora type, its liability to sport is also increased.

“As the six new varieties of C. C. Morse & Co. have resulted from sporting and selections, you may be interested in their history. America is a sport of Queen of the Isles. It was selected to a deep crimson-scarlet upon a white ground, large size, good substance, bold and upright standard. It runs about ninety-five per cent true. Its deep and contrasting color gives it a striking appearance. Ramona is a selection out of Blushing Beauty. It is a delicate pink stripe upon creamy-white ground, perfectly hooded form, good substance and grandiflora size; very effective. Oddity was found in a mixed lot, so its parentage is unknown. It is odd because wings and standard are peculiarly hooded, a feature new in the sweet pea. It comes perfectly true from seed. Juanita is a selection out of Countess of Radnor. It has a delicate appearance and as its parent is a back-slider, only a part of it comes true. Grey Friar also adds a departure. Both wings and standard are peculiarly shaded or marbled-purplish mauve. It is a selection out of Senator and has taken some time and critical selection to bring it to its present standard. The vine is vigorous, and, as a rule, has four flowers to the truss.

“The professional growers of sweet pea seed have a good deal of trouble to contend with in the matter of keeping their stock pure. Some varieties are very hard to keep true to type, while other varieties almost take care of themselves. As a rule, nearly all small-flowered varieties come true, while the grandiflora types run off more or less.

“Countess of Radnor and Dorothy Tennant are very hard to keep true. Two years of careless work in growing these varieties will run them into stripes and poor forms. Her Majesty reverts to Princess Victoria; Duke of Clarence runs into Her Majesty and Dorothy Tennant; Mrs. Eckford runs into Primrose and poor whites, while Primrose will lose its primrose effect; Mrs. Sankey runs into poor Lemon Queen; Mrs. Joseph Chamberlain passes into Ovid and weak stripes; Stanley goes into Boreatton and to



Boreatton with purple wings; Peach Blossom varies into Isa Eckford; Blanche Burpee into Mrs. Eckford; Mrs. Gladstone into pink stripes; Emily Henderson has strong light blue and purple and Blanche Ferry tendencies; Apple Blossom runs into Splendor; Royal Robe into Ovid and delicate pinks; Captain of the Blues into Monarch and stripes; Monarch into Duke of Clarence and stripes; Waverly into Apple Blossom.

“There are now about one hundred distinct varieties of sweet peas, and the question arises if the limit of improvement in color and form is not already reached. In what direction are the growers working to keep the public interested in this flower? In the first place, all the present varieties could be improved by having four flowers on each truss. The clear blue, lemon-yellow and fiery scarlet varieties are still to come. A flower having a blue standard with white wings, to correspond with Blanche Ferry, would be a decided acquisition. Such varieties as Meteor, Lady Beaconsfield and Blanche Ferry should be brought up to the grandiflora type. New ranges of colors, as the apricot shades, are not out of the question. Even the size of the present grandiflora type could be increased to a larger and bolder flower. Our work with the sweet pea is really only fairly begun.

“One feature which should be impressed upon the public is that there are types of form in the sweet pea. We should classify the varieties into forms, not into colors. When we speak of a certain color we convey but a vague meaning. From a description of color, no two persons receive the same impression.

“In my experience, crossing has produced some unlooked for results. Cupid on Venus produced a weak Painted Lady of no value. Penzance on Venus has produced an exceptionally fine pink of solid color and good form. It corresponds with Royal Robe, but is larger and holds form and color better. Ovid on Venus had the same result, except that the color was a trifle stronger. Stanley on Venus produced a Boreatton; Ignea on Venus produced something close to Princess Victoria; Bronze King and Primrose on Venus made a weak pink or no value; Beaconsfield on Venus produced Beaconsfield. The conclusion from these crosses is that the stronger color predominates in the cross. We cannot foresee what the result will be.

“Of Eckford’s 1895 novelties, Blanche Burpee certainly takes the lead. It is the finest white to date. While Emily Henderson may be considered a little purer in color, and, on account of its free blooming habits, a better variety for florists, yet it does not possess the size or gracefulness of the Blanche Burpee. The stiffness or formality has always been against the Emily Henderson. Eliza Eckford comes second in value of Eckford’s 1895 novelties and possesses considerable merit. Mrs. Joseph Chamberlain is also a decided acquisition. Meteor is a decided improvement on Orange Princee, but will not be appreciated until it is brought up to the grandiflora type. Duke of York, Novelty and Duchess of York come next in order of value.”

*A Student’s Opinion of the Sweet Peas.*

Mr. Wyman, who has studied our sweet peas in the field day by day, has given me the following impressions of their merits and adaptabilities: “There is much to interest the careful observer in the different types of sweet peas. In the flower only three colors appear, white, red and blue, or rather purple, although the bud is always yellow. While the habit of the plant is much the same in all varieties, the various colors and forms of the blossoms present a series of transitions throughout the species. One type, represented by the Improved Painted Lady, seemingly the foundation of many of the improved sorts, is widely known. It has pink wings and a peculiar pink-reddish banner, upon both of which numerous changes have been wrought. The pink wings may become whiter and whiter, until only the slightest tinge of pink is apparent, while the banner retains most of its lurid hue. The type, on the other hand, may run to deep colors, the wings passing into purple and the banner also becoming darker. When both banner and wings become strongly purple, another type is obtained, of which Cardinal Wolseley is an example. Here the banner is crimson and the wings maroon. The darkest and purplest flowers belong to this class, and are, also, the least beautiful. In other cases the flower retains the purple, but it assumes a distinctly lighter cast. Still another form of the Painted Lady type is a red-purple, blotched with lavender, like the Countess of Radnor. Going back to our original type of the pink and

red, we may start again in the first direction, towards a loss of color. When both banner and wings become very light, as in the Empress of India, we have a beautiful salmon, one of the softest shades in the species.

“While the greatest variations of the blossoms appear in the color, there is also, though in a lesser degree, a variation in form. One type spreads out a broad, rigid banner; another, more fragile, folds its banner together slightly, while another bends it backward. Still another class, perhaps the most remarkable, folds over the lateral edges of its banner and forms a hood. The student loves to contemplate the flower and attempt to construct some hypothesis of the means by which these variations are brought about. Here a delicate fibre has strengthened itself, and holds a petal rigidly in place. In another flower the fibre is less sturdy, and allows its banner to curl and plait itself. In another a notch is taken from the side of the banner, weakening the rigidity of the structure. Of necessity the edge then curls forward and we have the hooded form. One can imagine a change in color, too, by a cell losing or retaining its characteristic pigment; and even in health there may come the deathly purple which is always sure to appear as the blossom fades.

“There are so many attractive varieties that it is difficult to say which are the leading ones. If a flaming color is wanted, one may choose the Apple Blossom, of the old pink and red type, which surpasses all in brilliancy and uniformity of color. It gives the prettiest mass to be found in all the varieties which we have grown. Another form of the same type, the Improved Painted Lady, combines much of the brilliancy of the Apple Blossom with a softer and much more pleasing finish. It is also earlier and more profuse in its bloom. The Empress of India gives a delightful salmon which, in the beauty of its mass, approaches the Apple Blossom, and at the same time is one of the prettiest varieties for cutting for single specimens. The Countess of Radnor is an expression of a dark lilac color and a hooded form. Notwithstanding its remarkable characteristics, it is by no means a beautiful flower, because the color seems to lack character. The Butterfly, of a much lighter type of azure, is perhaps the most charming of all. It is pale lilac and delicate.

Its single flower is effective, and in mass it gives a shade of which one never tires. It, too, is an early and profuse bloomer. Of the whites, Mrs. Langtry is, perhaps, the most pleasing, but is surpassed in earliness and productiveness by the Fairy Queen. Of the purples, Cardinal Wolseley stands foremost both in richness and harmony of color. Nevertheless, it has a rival in earliness and bearing qualities in the Imperial Black, but it is not equalled in quality. The Orange Prince, while only a moderate bloomer, must not be overlooked. It approaches the Painted Lady type, but is characterized by its orange banner and rose-pink wings. It is pretty, but not the best. It is different from all the rest, and the collection would be incomplete without it. As to which sweet pea is best of all, the Improved Painted Lady seems to me to be most satisfactory, and I am willing to cast our lot with it.

“It is a common practice to show together a number of varieties and to call them mixed, but when one tries it, he finds that it does not give the satisfaction which comes of a single variety. Although the colors may be related, the mixtures do not produce the harmony which is essential to the best effects. If there must be a mixture, it is much better to follow the pattern of a single flower by giving a decided tone to the mass with some one characteristic variety, of a profuse bloom, as the Invincible Scarlet, and then touch it up slightly in the two directions of light and shade,—with a light pink, as Mrs. Gladstone, and a white, as Fairy Queen, and perhaps with a moderately dark pink and purple,—the less purple the better,—as the Captain of the Blues, discarding lilacs—which may be good in themselves,—and also all striped purples, which seem to be inappropriate to any ornamentation whatever.

“The use of the sweet pea in ornamental work can be best understood by considering its natural character and adaptability. It is a common and rather cheap plant. It seems to have something in common with weeds as well as with refined exotics. It is naturally modest and retiring. It is not improved by the society of other flowering plants. It is beautiful when growing by itself in masses in half-secluded places, but does not bear great prominence. I remember to have seen one place where it looked

uncommonly well, and that was on a rough wooden trellis, surrounded by half-grown grass, a few feet from a dingy uninteresting wooden house, on the side where no one ever came. In an ordinary well-kept flower-garden, where the beds are laid out by themselves, it may sometimes appear to advantage, but it seems wholly out of place in a strictly formal bed.



80.—Apple Blossom. An abnormal 4-flowered truss.

“All that has been said refers to the growing plant and flower. More properly, the use of the sweet pea bloom is in the bouquet. No place then is so exalted but that it adds an extra light, and none is so humble that it is not at home.”

## II. VARIETIES GROWN AT CORNELL IN 1895.

An attempt was made the past season to obtain all the sweet peas which were offered by American seedsmen. Nearly all of them were planted April 30th, but a few later arrivals were sown

in the first days of May. The soil was a stiff clay loam. The area was about 150 feet long, and one end of it was naturally more moist than the other, yet this difference in soil did not appear to exercise a great influence upon the season of bloom. The entire area was well tilled throughout the season (as explained on page 219). The vines were tied up as they grew to a trellis of five horizontal wires, and the pods were removed as they formed. The plants continued to bloom throughout September, and even on the 8th of October, when the last notes were taken, several of the varieties were still producing good flowers.

In rating the merits of the flowers in this list, we have called those varieties "good" which rise to the accepted standard of excellence of the modern improved sweet peas. A variety which rises above this level, or has some superlative merit, is designated "very good." Varieties which fall below this level are variously designated, usually as "fairly good." These are varieties of indifferent merit. Below these are the varieties which were distinctly poor. The reader should remember, however, that these opinions are founded solely upon the behavior of the varieties upon our own grounds last year. They are not intended to serve as a general or infallible estimate of the varieties. The accounts of these varieties are all made directly from the plants as they grew on our grounds, uninfluenced by published descriptions.

One who is sensitive to inelegant or pretentious expressions must deplore many of the names of the sweet peas. Ambitious names are always in bad taste, but nowhere more so than in the sweet pea, of which the most pronounced characteristic is modesty and indifference. We cannot expect to control the names which come to us from abroad, but our own originators should exercise a care to give names at least worthy the plant which is to bear them.

The name in parentheses in the following list is that of the dealer who supplied us with the seed. The varieties marked with an asterisk (\*) were originated by Mr. Eckford, and to some of these the date of introduction is added. Several dealers have kindly contributed to this test of varieties, and Mr. Hutchins sent us a good collection of seeds "for the good of the cause."

1. *Adonis*. (Gardiner.)

Very good. Flowers small. Standard convex, apex rounded, base wedge-shaped. Color, rose-pink, soft. Bloom profuse.

Began to bloom July 17.

Continued until September 1.

Profuse July 29.

2. *Alba Magnifica*. (Burpee.) Fig. 79, top.

Good. Flowers small. Standard flat, notched. Color, pure white. Bloom somewhat profuse.

Began to bloom July 17.

Continued throughout the season.

At best August 5.

3. *American Belle*. (Burpee.)

Good. Flowers large. Standard hooded to almost flat. Color, rose-pink. Bloom medium, uniform the whole season.

Began to bloom July 19.

Continued throughout the season.

4. *Apple Blossom*. (Gardiner.) \* Fig. 80.

Very good. One of the best. Flowers above medium size. Standard slightly hooded. Color, rose-pink. Bloom profuse. Beautiful growing in a mass.

Began to bloom July 22.

Continued throughout the season.

At best August 12.

5. *Black and Brown Striped*. (Breck.)

Fairly good. Flowers medium size. Standard flat, notched. Color, standard white striped with pink, wings white striped with rose. Bloom profuse.

Began to bloom July 29.

Continued throughout the season.

At best August 12.

6. *Black Purple*. (Breck.)

Not a success. Flowers medium size. Color, standard dark pink, wings reddish purple. Bloom sparse.

Began to bloom July 23.

Continued throughout the season.

7. *Blanche Burpee*. \*1894.

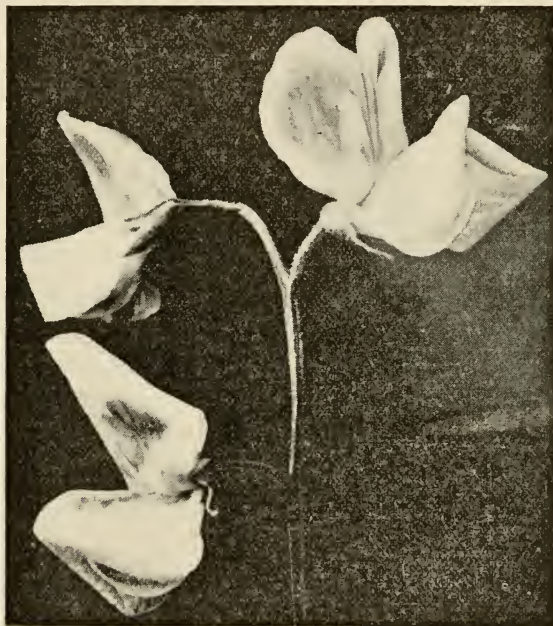
Received from two dealers. The seed from one source did not

grow; that from the other was received so late that the plants failed to bloom.

8. *Blanche Ferry*. (Garliner.) Fig. 81.

Very good. Flowers medium size. Standard convex. Color, scarlet, the wings with large white blotches. Somewhat brilliant. Bloom profuse.

Began to bloom July 13.



81.—*Blanche Ferry*.

Continued throughout the season.

Profuse from July 29.

9. *Blue Bell*. (May & Co.)

Not a success. Flowers small. Standard convex, wedge-shaped. Color, standard pink, wings purple-rose. Bloom sparse.

Began to bloom August 9.

Continued throughout the season.

10. *Blue Bird*. (C. B. Strong.)

Fairly good. Flowers medium size. Standard hooded. Color, dark purple-red. Bloom medium.



Began to bloom July 22.

Continued throughout the season.

At best August 12.

11. *Blue Edged*. (Vick's Sons.)

Good. Flowers large. Standard hooded, with two sinuses at the sides. Color, purple lilac. Bloom profuse. Evidently the same as Butterfly.

Began to bloom July 15.

Continued throughout the season.

At best July 29.

12. *Blue Invincible*. (Childs.)

Same as Imperial Blue.

13. *Blushing Beauty*. (Hutchins.) \*1893.

Good. Flowers small. Standard convex, notched. Color, soft, pure salmon. Bloom always sparse.

Began to bloom August 12.

Continued throughout the season.

14. *Blushing Bride*. (Childs.)

Fairly good. Flowers large. Standard flat. Color, standard pink, wings white blotched with purple-rose. Cheap. Bloom profuse. Evidently a strain of Painted Lady.

Began to bloom July 13.

Continued throughout the season.

15. *Boreatton*. (Gardiner.)\*

Very good. Flowers medium size. Standard convex. Color, standard crimson, wings maroon, deep and rich. Bloom profuse.

Began to bloom July 16.

Continued throughout the season.

Profuse from July 22.

16. *Bronze King*. (Burpee.)

Good. Flowers medium size. Standard flat, stiff, notched. Color, standard light pink, wings white. Bloom medium.

Began to Bloom July 16.

Continued until September 15, quite uniformly.

17. *Bronze Prince*. (Burpee.)\*

Good. Flowers large. Standard flat. Color, purple-red, the wings the more purple. Bloom medium.

Began to bloom July 22.

Continued throughout the season.

At best August 12.

18. *Butterfly*. (Burpee.) Fig. 82.

Very good and dainty. Flowers medium size. Standard hooded, with two sinuses at the sides. Color, purple-lilac, one of the prettiest. Bloom profuse.

Began to bloom July 17.

Continued throughout the season.

Profuse from August 5.



82.—*Butterfly*.

19. *Captain Clarke*. (Burpee.)\*

Poor quality, but prolific. Flowers small. Standard flat, stiff. Color, standard white merging into pink and purple, wings white with a purplish cast. Bloom profuse. Far from being beautiful.

Began to bloom July 16.

Continued throughout the season.

At best August 5.

20. *Captain of the Blues*. (Gardiner.)\*

Very good. Flowers large. Standard flat. Color, purple-red, the wings more purple. Bloom profuse.

Began to bloom July 18.

Continued throughout the season.

At best August 12.

21. *Captain Sharkey*. (Breck.)

Flowers small. Standard flat. Color, standard pink, wings dark rose. Bore only one flower. Evidently not a fair test.

Bloomed August 8.

22. *Cardinal Wolseley*. (May & Co.)

Very good. Flowers large. Standard flat, slightly wedged. Color, standard crimson, wings maroon, rich. Bloom somewhat profuse. Same as Cardinal?

Began to bloom July 19.

Continued throughout the season.

At best August 12.

23. *Carmen Sylva*. (Hutchins.)

Not a success. Flowers medium size. Standard convex, notched. Color, standard pink, wings dark rose-purple. Bloom very sparse.

Began to bloom August 5.

Bloom of short duration.

24. *Countess of Radnor*. (Gardiner.)\* Fig. 72.

Very good, unique. Flowers large. Standard hooded. Color, lavender blotched with red-purple. Bloom medium in quantity.

Began to bloom July 17.

Continued throughout the season.

At best August 12.

The same from Hutchins, except that the bloom was profuse, beginning with July 22.

25. *Crown Princess of Prussia*. (Burpee.)

Good. Flowers medium size. Standard convex. Color, standard pink, wings rose-pink. Bloom profuse.

Began to bloom July 15.

Continued throughout the season.

At best August 12.

*Cupid*: See page 182.

26. *Dark Red*. (Childs.)

Same as Painted Lady.

27. *Delight*. (Breck.)\*

Good. Flowers small. Standard concave, stiff. Color, white. Bloom medium.

Began to bloom July 24.

Continued throughout the season.

At best August 12.

Same from Burpee, but bloom very profuse.

28. *Dorothy Tennant*.\* 1892. Fig. 78, center.

Good. Flowers large. Standard hooded. Color, red purple, the wings more purple, somewhat heavy. Bloom medium.

Began to bloom July 22.

Continued throughout the season.

At best August 12.

29. *Duchess of Edinburgh*.\* (Burpee.)\*

Good. Flowers small. Standard flat, stiff. Color, standard pink, wings rose pink. Bloom profuse.

Began to bloom July 19.

Continued throughout the season.

At best August 5.

30. *Duchess of Marlboro*. (May & Co.)

Very good. Flowers small. Standard flat. Color, standard pink, wings rose-pink. Bloom profuse.

Began to bloom July 22.

Continued throughout the season.

At best August 5.

31. *Duke of Clarence*. (Hutchins.)\* 1893.

Fairly good. Flowers large. Standard somewhat hooded, with two sinuses in the sides. Color, purplish red, the wings strongly purple. Bloom profuse.

Began to bloom July 22.

Continued throughout the season.

At best August 12.

32. *Duke of Kent*. (May & Co.)

Good. Flowers small. Standard flat, wedge-shape. Color, rose-pink. Bloom medium.

Began to bloom July 27.

Continued throughout the season.

At best August 5.

33. *Emily Eckford*. (Hutchins.)\* 1893.

Good quality. Flowers medium and large. Standard hooded. Color, red-purple, bright. Bloom always sparse.

Began to bloom July 15.

Continued throughout the season.

34. *Emily Henderson*. (Burpee.) Fig. 79, bottom.

Very good. Flowers medium size. Standard flat, notched. Color, pure white. Bloom profuse, early.

Began to bloom July 13.

Continued throughout the season.

At best July 22.

35. *Empress of India*. (Burpee.)\*

Very good. Flowers large. Standard flat, stiff. Color, salmon, soft, bright, one of the most beautiful. Bloom medium.

Began to bloom July 17.

Continued throughout the season.

Profuse from August 12.

36. *Etna*. (Hutchins.) Fig. 78, right.

Good. Flowers medium size. Standard flat, wedge-shaped. Color, standard pink, wings rose, brilliant. Bloom medium.

Began to bloom July 13.

Continued until September 1.

At best August 5.

37. *Fairy Queen*. (Burpee.)

Rather poor. Flowers small. Standard flat, stiff. Color, white, streaked or shaded with pink, the soft color almost pure. Bloom very profuse.

Began to bloom July 11.

Continued throughout the season.

At best August 5.

38. *Firefly*. (Hutchins.)\* 1893.

Good in quality. Flowers small. Standard flat, stiff, spreading. Color, standard, crimson, wings rose-pink.

Bloom very sparse.

Began to bloom August 7.

Continued throughout the season.

39. *Flesh-Colored*. (Caldwell and Jones.)

Of no great value. Flowers small. Standard flat, notched. Color, standard pink, wings rose-pink. Bloom sparse. Much like Painted Lady.

Began to bloom July 17.

Continued throughout the season.

40. *Gaiety*. (Hutchins.)\* 1893.

Fairly good. Flowers medium size. Standard slightly convex. Color, white, heavily streaked with pink, bright and somewhat fickle. Bloom profuse.

Began to bloom July 20.

Continued throughout the season.

At best August 12.

41. *Grand Blue*. (Gardiner & Co.)

Same as Imperial Blue.

42. *Her Majesty*. (Hutchins.)\* 1892.

Good quality. Flowers medium size. Standard flat. Color, rose-pink. Bloom always sparse.

Began to bloom July 31.

Continued throughout the season.

43. *Ignea*. (Burpee.)\*

Good. Flowers large. Standard flat. Color, standard pink, wings, rose-pink, brilliant, one of the richest colors. Blooms sparse.

Began to bloom July 15.

Continued throughout the season.

At best August 12.

44. *Imperial Black*. (Perry Seed Store.)

Fairly good. Flowers large. Standard hooded with two sinuses at the sides. Color, purplish red. Bloom profuse. Probably same as Imperial Blue.

Began to bloom July 20.

Continued throughout the season.

At best August 5.

45. *Imperial Blue*. (Burpee.)\* Fig. 83.

Not a success. Flowers medium. Standard somewhat rolled. Color, purple-red. Bloom medium.

Began to bloom July 18.

Continued throughout the season.

At best August 12.

46. *Improved Painted Lady*. (Landreth & Sons.)

Very good. Flowers medium size. Standard flat, somewhat wedge-shaped. Color, standard pink, wings light pink, or white blotched with rose-pink. Bloom profuse.

Began to bloom July 13.

Continued profuse from July 22.

47. *Indigo King*. (Burpee.)\*

Fair quality. Flowers large. Standard hooded with two sinuses at the sides. Color, standard, dark purple-red, wings, dark plum. Bloom medium.

Began to bloom July 22.

Continued throughout the season.

At best August 12.

48. *Invincible carmine*. (Burpee.)

Not a success. Flowers small. Standard flat, wedge-shaped.



83.—Imperial Blue.

Color, standard dull pink, wings rose-pink. Bloom always sparse.

Began to bloom July 31.

Continued until September 1.

49. *Invincible Scarlet*. (Gardiner.)

Good. Flowers small. Standard convex, base wedge-shaped. Color, scarlet. Bloom profuse. Brilliant, but somewhat cheap, from becoming white about the edges as it fades.

Began to bloom July 15.

Continued throughout the season.

Profuse from August 5.

50. *Invincible Striped*. (Burpee.)

Fairly good. Flowers medium size. Standard slightly con-

vex, notched. Color, white streaked with pink, rather cheap. Bloom profuse.

Began to bloom July 20.

Continued throughout the season.

At best August 12.

51. *Isa Eckford*. (Burpee.)\*

Very good. Flowers medium size. Standard sometimes hooded. Color, light rose-pink, delicate. Bloom profuse.

Began to bloom July 19.

Continued throughout the season.

At best August 12.

52. *Joanna Theresa*. (Breck.)

Good. Flowers medium size. Standard flat, stiff, notched. Color, standard dark pink, wings reddish purple, rich. Bloom profuse.

Began to bloom July 19.

Continued throughout the season.

At best August 12.

53. *Lady Beaconsfield*. (Hutchins.)\* 1894.

Not a success. Flowers small. Standard convex, wedge-shaped. Color, standard dull pink tinged with lavender, wings lavender and a very light yellow. Bloom medium.

Began to bloom July 13.

Continued until September 1.

At best August 12.

54. *Lady Penzance*. (Hutchins.)\* 1894.

Good. Flowers large. Standard slightly hooded. Color, cherry. Bloom moderately profuse.

Began to bloom July 24.

Continued throughout the season.

At best August 12.

55. *Lemon Queen*. (Burpee.)\* 1892.

Very good. Flowers medium size. Standard flat, stiff. Color, white with a slightly pinkish cast, soft, bright. Bloom medium.

Began to bloom July 13.

Continued throughout the season.

Profuse from August 5.



56. *Light Blue and Purple.* (Burpee.)

Not wholly a success. Flowers small. Standard convex, stiff, notched. Color, standard dark pink, wings purple. Bloom sparse.

Began to bloom August 3.

Continued throughout the season.

57. *Lord Derby.* (May & Co.)

Fairly good. Flowers small. Standard slightly concave, wedge-shaped. Color, standard pink, wings purple-pink. Bloom medium.

Began to bloom July 17.

Continued throughout the season.

At best August 5.

58. *Lottie Eckford.* (Burpee.)\*

Not a success. Flowers medium size. Standard hooded. Color lilac. Bloom sparse.

Began to bloom July 29.

Continued until September 1.

See also New Lottie Eckford.

59. *Madame Carnot.* (Hutchins.)

Same as Imperial Blue.

60. *Minnie Keepers.* (May & Co.)

Good. Flower large. Standard Hooded. Color, standard pinkish lilac, wings lilac. Bloom medium.

Began to bloom July 19.

Continued throughout the season.

At best August 12.

61. *Miss Hunt.* (Burpee.)\*

Good. Flowers medium size. Standard flat, slightly wedged. Color, light cherry. Bloom medium.

Began to bloom July 13.

Continued throughout the season.

At best August 12.

62. *Mixtures*—

*Alneer's Invincible.* (Alneer.)

A fairly good mixture. The lilac and pink do not harmonize any too well. Bloom medium.

Began to bloom July 19.

Continued throughout the season.

At best July 29.

*Boston Beauties.* (Rawson.)

A fairly good mixture. Bloom somewhat profuse.

Began to bloom July 23.

Continued until September 10.

*Breck's Mixture.* (Breck.)

Almost all white, though the combinations are good.  
Bloom medium.

Began to bloom July 20.

Continued throughout the season.

At best July 12.

*Eckford's Gilt Edge or Surpassing.* (Burpee.)

Not a good combination, but better than some others.

Began to bloom July 17.

Continued throughout the season.

At best August 12.

*Eckford's New Mixed.* (Burpee.)

Not a good combination, the contrasts of color too strong. Bloom profuse.

Began to bloom July 13.

At best August 12.

*Fine Mixed.* (Burpee.)

A mixture of the darker colors, giving a heavy effect.  
Bloom very profuse.

Began to bloom July 13.

Continued throughout the season.

At best August 5.

*Huckins' Bouquet.* (Geo. A. Huckins.)

None too good. Bloom profuse.

Began to bloom July 18.

Continued throughout the season.

At best August 5.

*Invincible Mixture.* (Vick's Sons.)

Not a good mixture. Too dark. Bloom profuse.

Began to bloom July 18.

Continued throughout the season.

At best August 5.

*New Varieties Mixed.* (Burpee.)

Combination poor; too great contrasts. Bloom profuse.

Began to bloom July 15.

Continued throughout the season.

Profuse from August 5.

*Special Colored Plate Mixture.* (Burpee.)

Good, but for the presence of an objectionable striped purple.

Profuse August 12. Out of bloom September 1.

*Splendid Hybrid.* (Perry Seed Store.)

Evidently consisted mainly of one pink variety. Bloom profuse.

Began to bloom July 13.

Continued throughout the season.

At best August 5.

63. *Monarch.* (Burpee.)\*

Not a success. Flowers medium size. Standard flat. Color, light rose pink, soft. Bloom always sparse.

Began to bloom July 22.

Continued throughout the season.

64. *Mrs. Eckford.*\* 1892.

Not a success. Flowers small. Standard flat, stiff. Color, white. Bloom always sparse.

Began to bloom August 6.

Continued throughout the season.

65. *Mrs. Gladstone.* (Gardiner.)\* Fig. 84.

Very good. Flowers medium size. Standard convex, rounded apex. Color, a light rose-pink, soft and delicate. Bloom profuse.

Began to bloom July 13.

Continued throughout the season.

Profuse from July 29.

66. *Mrs. Langtry.* (May & Co.)

Fairly good. Flowers medium size. Standard flat, notched. Color, pure white, rich. Bloom medium.

Began to bloom July 30.

Continued until September 15.

At best August 12.

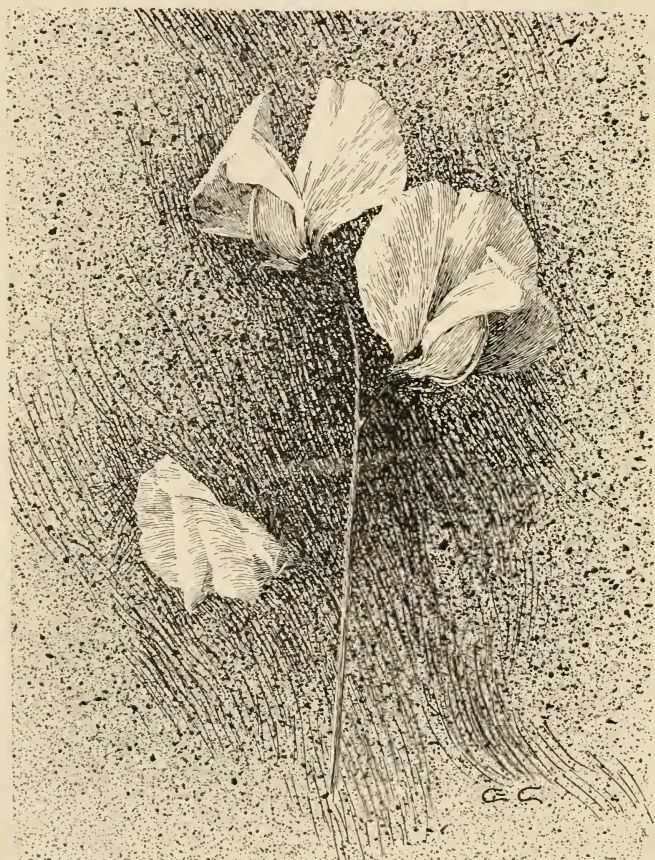
67. *Mrs. Sankey*. (Burpee.)\*

Fairly good. Flowers medium. Standard flat. Color, light pink. Bloom rather sparse.

Began to bloom July 22.

Continued throughout the season.

At best August 12.



84.—*Mrs. Gladstone*. One of the best pinks.

68. *Nellie Jaynes*. (Barteldes & Co.)

Same as *Painted Lady*.

69. *New Lottie Eckford*. (Hutchins.)

Good. Flowers large. Standard hooded. Color, lilac. Bloom medium.

Began to bloom August 3.

Continued until September 1.

At best August 12.

70. *Orange Prince*. (Burpee, Breck.)\*

Good, unique. Flowers small. Standard convex. Color, standard bright orange-pink, wings light rose. Bloom sparse.

Began to bloom July 29.

Continued throughout the season.

71. *Ovid*. (Hutchins.)\*1894.

Good quality. Flowers large. Standard slightly hooded. Color, a bright reddish pink, brilliant, well diffused. Bloom always sparse.

Began to bloom July 20.

Continued throughout the season.

72. *Painted Lady*. (Burpee.)

Good. Flowers medium size. Standard nearly flat, slightly notched. Color, standard rose-pink, wings light pink, or else dark pink blotched with white. Bloom profuse. Bright.

Began to bloom July 13.

Continued until September 15.

At best August 12.

See Improved Painted Lady.

73. *Peach Blossom*. (Hutchins.)\* 1894.

Grew to a height of forty inches, but did not bear a single blossom, although it produced buds at various times throughout the season.

74. *Primrose*. (Gardiner.)\*

Good. Flowers medium size. Standard quite convex, notched, base wedge-shape. Color, white with a slightly yellowish tinge. Bloom sparse throughout the season.

Began to bloom July 22.

Continued throughout the season.

75. *Princess Beatrice*. (Burpee.)

Not a success. Flowers medium size. Standard concave, stiff. Color, soft pink. Bloom sparse.

Began to bloom July 22.

Continued throughout the season.

76. *Princess Louise*. (Burpee.)

Same as Violet Queen.

77. *Princess May*. (Hutchins.)

A failure. One blossom August 5.

78. *Princess of Wales*. (Gardiner.)\*

Good. Flowers large. Standard flat, apex round. Color, drab strongly streaked with purplish red, dull. Bloom profuse.

Began to bloom July 17.

Continued throughout the season.

Profuse from July 29.

79. *Princess Victoria*. (Burpee.)\*

Good. Flowers medium size. Standard flat. Color, standard pink, wings rose-pink. Bloom medium.

Began to bloom July 18.

Continued throughout the season.

At best August 12.

80. *Purple*. (Price & Read.)

Grew thirty-six inches high. First flower August 9. Did not bloom again.

81. *Purple Brown*. (Caldwell and Jones.)

Not a success. Flowers large. Standard somewhat hooded. Color, standard purple-red, wings purple. Bloom sparse.

Began to bloom July 23.

Continued throughout the season.

82. *Purple Prince*. (Burpee.)\*

Not a success. Flowers large. Standard flat, stiff. Color, standard dark pink, wings purple. Bloom sparse.

Began to bloom July 30.

Continued until September 15.

83. *Purple Striped*. (Burpee.)

Good. Flowers medium size. Standard flat. Color, purplish-red streaked with lilac. Bloom medium.

Began to bloom July 13.

Continued throughout the season.

At best August 12.

84. *Purple Striped*. (Caldwell and Jones.)

Not like *Purple Striped* (Burpee), but like *Black and Brown Striped* (Breck).

Of little value. Flowers large. Standard flat. Color, white striped with rose-purple. Bloom scarcely any.

One blossom appeared August 5.

85. *Queen*. (Gardiner.)\*

Good. Flowers medium size. Standard convex, base wedge-shaped. Color, standard light pink, wings a pink-purple. Bloom profuse.

Began to bloom July 17.

Continued throughout the season.

At best August 5.

86. *Queen of England*.\*

Medium quality. Flowers medium size. Standard convex, notched, base wedge-shape. Color, white. Bloom medium.

Began to bloom July 18.

Continued throughout the season.

At best August 12.

87. *Queen of the Isles*. (Burpee.)

Fairly good. Flowers large. Standard flat, stiff, wings at right angles to it. Color, white striped with pink. Bloom somewhat sparse.

Began to bloom July 25.

Continued throughout the season.

At best August 5.

88. *Red and White Striped*. (Breck.)

Poor. Flowers medium size. Standard convex. Color, white strongly streaked with pink. Bloom sparse.

Began to bloom July 23.

Continued until September 15.

89. *Rising Sun*. (Burpee.) Fig. 78, left.

Thrifty but not beautiful. Flowers small. Standard flat, slightly notched. Color, standard white streaked with cherry, wings white and cherry; brilliant. Bloom profuse.

Began to bloom July 13.

Continued throughout the season.

At best August 5.

90. *Royal Robe*. (Hutchins.)\* 1894.

Fair quality. Flowers large. Standard slightly hooded. Color, pink, not well diffused.

Began to bloom July 20.

Continued throughout the season.

Blossoms always sparse.

91. *Senator*. (Burpee.)\*

None too good. Flowers large. Standard flat. Color, lilac streaked with purplish red. Bloom medium.

Began to bloom July 23.

Continued throughout the season.

At best August 12.

92. *Scarlet*. (Vick's Sons.)

Fairly good. Flowers medium size. Standard flat, notched. Color, standard pink, wings purple-rose. Bloom somewhat sparse. Probably same as Invincible Scarlet.

Began to bloom July 24.

Continued throughout the season.

93. *Scarlet Striped*. (Burpee.)

None too good. Flowers large. Standard flat, wedge-shape. Color, white strongly streaked with pink, cheap. Bloom medium.

Began to bloom July 20.

Continued throughout the season.

At best August 12.

94. *Scarlet Winged*. (Vick's Sons.)

Did not grow.

95. *Snowflake*. (C. B. Strong.)

Did not bloom.

96. *Splendid Lilac*. (Burpee.)

Good. Flowers medium. Standard convex, slightly notched. Color, standard pink edged with red purple, wings lilac. Bloom profuse.

Began to bloom July 17.

Continued throughout the season.

At best August 5.

97. *Splendor*. (Burpee.)\* Fig. 77.

Good. Flowers medium size. Standard flat. Color, bright pink.

Bloom sparse.

Began to bloom July 22.



Continued throughout the season.

98. *Stanley*. (Hutchins.)\* 1894.

Good quality. Flowers large. Standard flat. Color, standard, dark pink, wings, rose-purple. Bloom always sparse.

Began to bloom August 2.

Continued throughout the season.

99. *Tangier Scarlet*. (Price & Reed.) Fig. 74.

Very good at a distance from the sweet pea. If both are together, the sweet pea is smothered, this species maturing very much the earlier. Flowers medium size. Standard, sometimes flat, stiff, obcordate, pointed, at others closely hooded so as to overlap itself and enclose the wings. Wings very small. Bloom profuse. A strong grower.

Began to bloom July 1.

Continued through most of the season.

Profuse from July 13.

A variety of *Lathyrus Tingitanus*. See p. 174.

100. *Venus*. (Hutchins.)\* 1893. Fig. 85.

Good to very good. Flowers large. Standard slightly hooded. Color, soft pink, delicate. Bloom rather sparse.

Began to bloom July 19.

Continued throughout the season.

Blossoms always scattered.

101. *Vesuvius*. (Burpee.)

Good. Flowers small. Standard flat, stiff, notched. Color, standard pink with a shade of purple, wings reddish purple. Bloom somewhat profuse.

Began to bloom July 18.

Continued throughout the season.

Profuse from August 5.

102. *Victoria Regina*. (May & Co.)

Not a success. Flowers medium size. Standard flat, broad. Color, standard white heavily blotched with pink, wings blotched with purple-rose, cheap. Bloom medium. Much like *Invincible Striped*.

Began to bloom July 24.

Continued throughout the season.

At best August 12.

103. *Violet Queen*. (Burpee.)

Fairly good. Flowers small. Standard flat, wedge-shaped. Color, standard light pink, wings pink-rose. Bloom medium. (Princess Louise.)

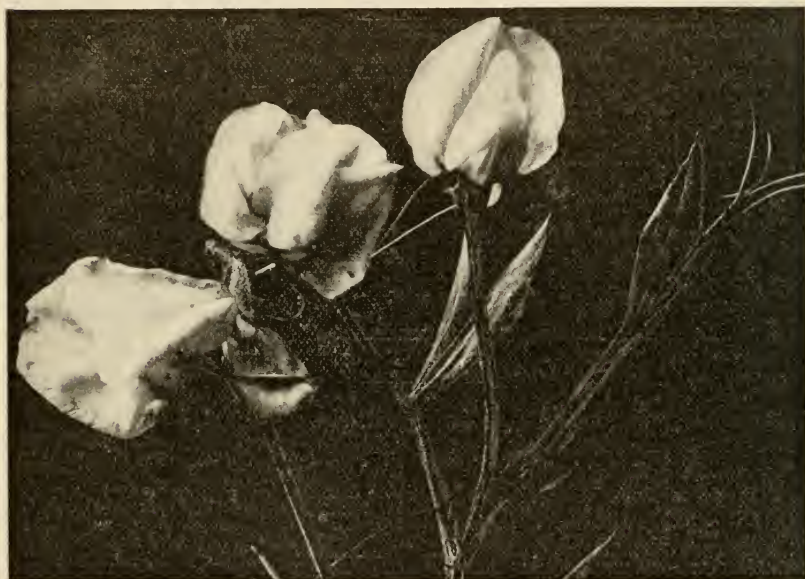
Began to bloom July 26.

Continued throughout the season.

At best August 12.

104. *Waverly*. (Burpee.)\* 1892.

Good. Flowers small. Standard flat, wedge-shape. Color,



85.—Venus. Soft and delicate pink.

standard light pink, wings light purple-pink. Bloom somewhat profuse.

Began to bloom July 22.

Continued throughout the season.

At best August 12.

105. *White*. (Burpee.)

Fair. Flowers medium. Standard, slightly convex, notched. Color, pure white. Bloom always sparse.

Began to bloom July 18.

Continued until September 1.

Same from another dealer. Not a success. Flowers medium size. Standard flat, deeply notched. Color, pure white. Bloom sparse.

Began to bloom July 30.

Continued throughout the season.

At best August 12.

106. *White Invincible*. (Childs.)

Fairly good. Flowers small. Standard flat, stiff. Color, white. Bloom medium.

Began to bloom July 22.

Continued throughout the season.

At best August 5.

The superlative ("very good") varieties in this test are the following:

Adonis,

Apple Blossom,

Blanche Ferry,

Boreatton,

Butterfly,

Captain of the Blues,

Cardinal Wolseley,

Countess of Radnor,

Duchess of Marlboro,

Emily Henderson,

Empress of India,

Improved Painted Lady,

Isa Eckford,

Lemon Queen,

Mrs. Gladstone,

Tangier Scarlet.

A. P. WYMAN.

L. H. BAILEY.



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BULLETIN 112—February, 1896.

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Cornell University—Agricultural Experiment Station,

ITHACA, N. Y.

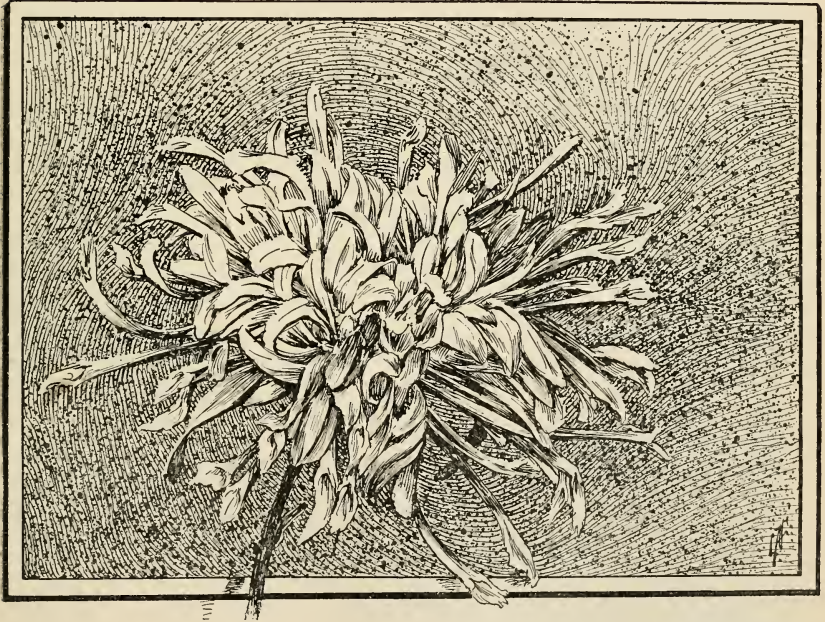
HORTICULTURAL DIVISION.

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J. E. LAGER. See page 282.

By L. H. BAILEY, WILHELM MILLER, and C. E. HUNN.

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## BULLETINS OF 1896.

106. Revised Opinions of the Japanese Plums.
107. Wireworms and The Bud Moth.
108. The Pear Psylla and the New York Plum Scale.
109. Geological History of the Chautauqua Grape Belt.
110. Extension Work in Horticulture.
111. Sweet Peas.
112. The 1895 Chrysanthemums.

CORNELL UNIVERSITY, ITHACA, N. Y., February 8, 1896.

*Honorable Commissioner of Agriculture, Albany :*

Sir.—This account of our cultivation of chrysanthemums in 1895, is submitted for publication under Chapter 230, of the Laws of 1895.

In our former report (Bulletin 91) of chrysanthemums, made nearly a year ago, we took the opportunity of a fly-leaf to explain our position upon the vexed question of the testing of novelties. We made the following statement: "We refuse to test varieties simply because they are new. Our basis of study is the monograph—the investigation of a particular subject, rather than the indiscriminate growing of things which chance to be put upon the market in a given year, and which have no relationship to each other aside from a coincidence in date. When we take up a certain group of plants for study, we endeavor to secure every variety of it, old or new. These varieties are studied not only in the field, but botanical specimens are invariably made of every one, so that the experimenter has specimens before him for leisurely study when the hurry of field work and the excitement of bug-catching are done. We are always glad to receive the seed novelties of any year, but we do not agree to report upon them or even to grow them. If we were to attempt to grow them all, we should simply be making a museum of curiosities, and we should have no time left for investigation and experiment."

This seems to be plain enough to allow of no mistake as to our position, yet we have been half accused of an unwillingness to aid dealers and buyers in the determining of synonyms and the discarding of duplicate and unworthy varieties. This is exactly the opposite of the truth. We are so desirous of aiding in this direction that we have refused to make any effort except when we believed that we could really accomplish the purpose. We are free to say that we have no sympathy with the ordinary "variety test," which simply grows a lot of things and then sets down a few unrelated measurements of them. One must make a comprehensive and detailed and prolonged study of his subject, with all the factors before him, before he is able to judge of such an apparently simple thing as the merits of varieties. All estimates of varieties must be comparative. One can not grow an onion, and then say that it is or is not the same as others, nor can he likely give any accurate measure of its comparative merits, for he has no other varieties with which to compare; and he can not carry even such emphatic subjects as onions in his mind from year to year. One can not file away specimens of all garden varieties, as they grow in all soils and all seasons, as he can dried plants and bugs. If the station officer is to be able to identify and to judge all varieties sent to him, he must attempt to grow every variety of plant every year. And even if he should grow them all, he would likely gain little, save experience, from his effort, for the subject is too large for instant study. In 1896 we expect to make a study of Brussels sprouts, dahlias, sweet corn, chrysanthemums, cannas and tuberous begonias, and any person who has varieties of these things which he wants tested may send them to us. Of these things, especially the ornamentals, we should receive the novelties in advance of their general introduction, if possible.

In this chrysanthemum study, I have been fortunate in my associates. Mr. Miller is a special student in horticulture, a graduate of the University of Michigan, and has given most enthusiastic attention to our chrysanthemum test. Mr. Hunn is a gardener of much experience, well known for his long and earnest connection with experiment station work.

L. H. BAILEY.



86.—Chrysanthemums grown for specimen blooms.



# The 1895 Chrysanthemums.

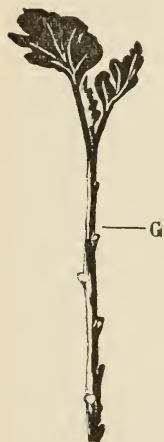
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## I. SUNDRY REMARKS UPON THE SUBJECT.

It is charged that the rapid popularization of the chrysanthemum is mere fashion. It may be so; but if fashion were henceforth always to produce so many beauties as it has in the chrysanthemum, it might be forgiven its endless record of follies. The transcendent merit of the chrysanthemum lies in its almost limitless variety of form, texture and color of flowers. There is no plant known to American gardens which approaches it in these respects, not even the rose. Such variety of form is possible only in compositous flowers, in which each floret is a distinct element and capable of independent development. One cannot feel the truth of these remarks until he has an opportunity to study a large collection of varieties growing together. He will then see that almost every form of compositous flower which the mind can picture has here arisen.

Yet, various as the chrysanthemums are, there are limitations to the development of the species in certain directions. For example, it is idle to look for a blue chrysanthemum. This is not because of any assumed or theoretical incompatibility of the blue and yellow series of colors, but simply because no true blue varieties have ever yet appeared, to our knowledge. The only guide in the breeding for particular characters is experience, or the observed behavior of the species. The chrysanthemum has been cultivated for some thousands of years, but amongst all its departments it has given no blue flowers. It is reasonable to expect that if no hint of such variation has occurred in all this eventful evolution, we can have little hope for its appearing in the future. The same remark will apply to the much-coveted but ever-evasive blue rose. It is a fundamental tenet of plant-breeding that the operator must put himself in line with the natural tendencies of the plant and work harmoniously along

with nature, rather than to set himself against her. Man's power lies more in improving or augmenting tendencies which already exist than in creating new tendencies. There is a tradition, to be sure, that a blue chrysanthemum was once produced, under political pressure, in the orient, but there is no exact knowledge of the matter; and if the King of Japan really did receive such a tribute, I am willing to believe that some one connected with the transaction forestalled the modern flower "artist" and dyed the flower. It is possible, of course, that a blue chrysanthemum may appear, but the probabilities are all against it; and if it does come, it will probably originate as a sport or bud-variety rather than as a definite attempt thereat on the part of the operator.



87.—'Mum cutting.  
Half size.

One must remember, too, in this connection, that the heavy colors of chrysanthemums are nearly always associated with heaviness and gracelessness of habit. We have no pure deep red with the cut of Mrs. Rand, for example. But even the same form, particularly if it inclines strongly to regularity, has a heavier appearance in dark colors than in light ones. There is no more fertile field for the development of new types than in the combining of light and graceful forms with dark colors.

*A word about the culture of chrysanthemums.*—

Our own tests of chrysanthemums have been made for the purpose of obtaining specimen or exhibition blooms. The plants are, therefore, trained to a single stem and a single flower. Fig. 86 shows our house as it looked last November. When so many varieties are grown, the house is not at its best at any one time, but there is a progressing exhibition. The house therefore, lacks the full appearance of an ordinary commercial house. These plants were made from cuttings taken the previous spring, the plants having been grown in pots until late July, when they were taken from the pots and set in the bed.

This growing of the plants to a single bloom does not produce the most decorative or satisfactory results. It simply gives large specimen blooms. I much prefer to grow from three to six

blooms on a plant, and shall do so this year. The plants may be flowered in pots, or in a solid soil bench. Very good small plants may be brought to perfection in 6-inch pots, but the best results, in pot plants, are to be obtained in 8-inch or 10-inch pots. If the plants are to be used for decoration, they should, of course, be grown in pots, but the best results for cut flowers are usually obtained by growing in the earth. In any case, the cuttings are made from the tips of basal or strong lateral shoots, late in February, to May. One form of cutting is shown in Fig. 87. It is inserted in the soil to the point C. If the plants are to be flowered in pots, in which case they usually mature earlier, the cuttings may be started as late as April, or even June; but if they are grown in the soil and large plants are desired, the cuttings should be taken in February or March. The plants which are flowered in the soil are generally grown in pots until July. The grower must decide how many blooms he desires on a plant, and then train the plant accordingly, bringing up the different branches so that they will all bloom at the same time. A well-grown chrysanthemum, in an 8-inch pot and bearing five or six perfect blooms, is one of the most decorative plants which the florist can produce.

*Reflections upon nomenclature, classification and variation (Mr. Miller).*—There is need for reform in three important matters relating to chrysanthemums—nomenclature, synonymy and classification. New varieties of chrysanthemums often bear absurd, bombastic and vulgar names. Many are named after society leaders and prominent persons. There are always practical reasons why novelties are named after popular men and women, and these reasons are often unworthy ones. The poor quality of cigars named after election candidates is notorious. Those who buy new flowers, because of the attractive names, usually feel defrauded of their sympathies. The criticism is often made that our monthly magazines are dealers in attractive titles; that the matter is rarely as spicy as the caption. The disseminators of new horticultural varieties take advantage of waves of popular enthusiasm. They name flowers after actors, base-ball players, barons, saints and society leaders. Almost is realized one of Dean Swift's dissonant combinations, "lords, fiddlers, judges, and dancing

masters." The only consistent course is to abolish the whole system of naming varieties after living persons. So long as this system continues, the element of disappointment and bad taste will persist. It is a constant reproach to horticulture that the art lacks dignity. Need it also be pointed out that we seem to be deficient in imagination?

The reform would be sweeping if made all at once, but there is a preliminary step in this direction that can easily be taken. All such titles as Mr., Mrs., Miss, General, Judge, Count, Baron, etc., should be dropped. These titles cause endless confusion. What makes the case peculiarly hopeless is that the National Chrysanthemum Society of England, in its Official Catalogue, has set the example of indexing varieties according to these titles, in defiance to the established rules adopted by librarians, indexers and cataloguers. It frequently happens that the *pater familias* is not the only popular member of the family. In verifying varieties by English catalogues (whose methods have been tamely copied in America) it is often necessary to remember which is Miss Blank, and what are the first names of the other daughters. Label-writers are usually careless, and their "M" may stand for Mr., Mrs., Miss, Monsieur or a Christian name. According to the trade journals it is not uncommon to order a "Miss" and get a "Mr." The use of titles ought to be discontinued.

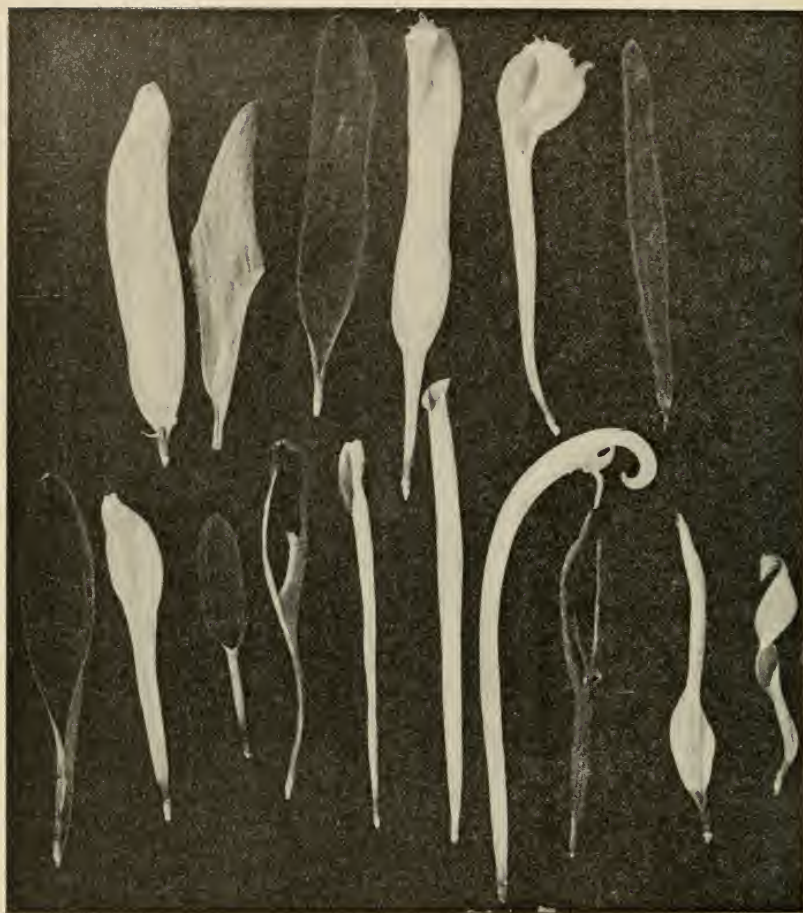
There are other problems of nomenclature which are coming up constantly. Many of them have been considered by societies devoted to other flowers or to fruits. The only real attempts to solve any of these problems have been made by the American Pomological Society, and, for vegetables, by a committee of Experiment Station horticulturists. The Pomological Society has drawn up a set of rules, but, unfortunately, the other societies do not follow them. What is really wanted for progress is a national horticultural society in which professional growers of plants, amateurs and botanists may work together. The societies devoted to the culture of a single flower could coöperate with the national society. Of course, a society, as such, might not deal with problems of synonymy and classification, but its members could do so either as committees or as individual students. Records of hybridization are worth keeping, as well as many other

data for a study of the botany of cultivated plants. It is a pity that we have no horticultural society of the dignity of the Royal Horticultural Society. The American genius for organizing ought to be able to create a better society than this for our own needs. Commercial men could supply materials for history and science, and botanists could instruct plant-breeders at almost every point of their work.

There is this distinction between botanical classification and horticultural classification: The world can wait for the first; the second has a daily practical bearing. Prizes often do harm in this—that they encourage production of flowers that conform to arbitrary and fallacious standards and discourage informality and freedom. This is strongly illustrated in the case of the Mrs. Alpheus Hardy chrysanthemum. The hairiness of that variety was no novelty in the western world. It had repeatedly appeared in England and had been patiently, if not sorrowfully, repressed. The florists did not want a hairy flower, nor was it absolutely new, and the success of the florist who sold it for \$1,500 and the dealer who is supposed to have made \$10,000 out of it in one year, must be explained in some other way. The lesson of this is that conventional standards and horticultural classifications are often tyrannical. It is certain that in 1886 no hairy chrysanthemum could have won a prize before the National Chrysanthemum Society of England. If florists want a good example of the tyranny of classifications they can examine the centenary catalogue of that society and see the ten artificial sections that the English have made and Americans too often follow. The English have more rigid classifications, a more severe system of scoring by points, bigger prizes and less individuality in their flowers.

The danger of suppression of individualism can be averted for the present, so far as the American Chrysanthemum Society is concerned, by a more liberal interpretation of what "incurved" and "Japanese" may mean. The Japanese section should be made broad enough to include most types which do not fit elsewhere. The English "incurved" chrysanthemums are compact, round, formal and regular. The florets are carefully arranged in mathematical order by means of forceps. The "dressing" of

1            2            3            4            5            6



7            8            9            10            11            12            13            14            15            16

88.—Forms of chrysanthemum florets. (See pages 265.)

- |  |   |
|--|---|
| <p>Floret incurved, 13,<br/>         Floret reflexed, 2,<br/>         Margin incurved, 7, 10,<br/>         Margin revolute, 2, 15,<br/>         Ligulate, 1, 6,<br/>         Tubular, 12, 13,<br/>         Various degrees of tubularity, 7-13,<br/>         Doubly curved (<i>i. e.</i>, twice curved, <i>not</i> "recurved"), 3.</p> | <p>Incurved and cupping, 4,<br/>         Incurved and hooded (cucullate), 5,<br/>         Lacinate, or cut, 13, 14,<br/>         Twisted, 15, 16,<br/>         Hairy, 4, 5,<br/>         Quilled, 11,</p> |
|--|---|

petals is unpopular in this country. The guard petals of exhibition carnations in England used to be pasted down on cardboards. There are perfectly estimable people who still take pleasure in the stiffest incurved chrysanthemums. Indeed, it is the wonder and the glory of the chrysanthemum that it can be varied to suit all tastes. This variability is a thing inherent and essential. It is the peculiar genius of the composites. Asters have it, dahlias have it, and chrysanthemums most of all. It is capable of reflecting the fleeting frivolities and fashions of the age as well as certain deeper and dearer things. Chrysanthemums can be formal as well as fanciful, but we have plenty of other formal flowers. Incurved chrysanthemums were popular in a hoop-skirt age, but the Japanese are truly *fin de siècle*. They are informal, fanciful, quaint, odd, individual, and, therefore, a more complete expression of the times than single, incurved, anemone or pompon-flowered sections.

*Descriptions of the florets (Mr. Miller).*—The greatest confusion exists in commercial catalogues as to descriptive terms for chrysanthemums. For example, the word “recurved” is used by some dealers to mean twice curved or doubly curved, *i. e.*, the second curve being in a direction opposite to that of the first. (See No. 3 in the plate illustrating different types of florets, Fig. 88.) Botanists, however, use “recurved” to mean a single curve of greater extent than that expressed by “reflexed.” Descriptive catalogues are hard to write and harder still to order from. Illustrations are preferable in this day of cheap mechanical processes of engraving. A “half-tone” gives one an idea of the bloom which no words can convey. Sometimes, however, the individuality of the floret needs special notice, and it is often impossible to tell from the loose description of florists whether they are describing the blossom or the floret. Illustrations are needed to give general effect, and botanical terms to describe particular effects. No descriptions can convey the idea of the form, compactness or looseness, regularity or irregularity of the blossom so well as a picture does. The floret, however, can sometimes be described by words that are helpful to the imagination. “Ostrich plume” is a fanciful and attractive name, but it has no place in botany. “Hairy” is the proper term. A head of florets

like No. 13 (Fig. 88) gives the general effect of hairiness, and it takes a second look to determine that the individual florets are irregularly cut, but do not have hairs or trichomes, as do florets 4 and 5.

Cataloguers should distinguish between a floret and its margin. For example, a reflexed floret may also have its margins reflexed



89.—W. W. Astor. Four-fifths natural size.

(No. 2); an incurved floret may be ligulate (No. 6), tubular (No. 13), or have its margins incurved (No. 7). Unfortunately, it is impossible to indicate such various degrees of tubularity as are successfully presented by the florets No. 13 to 7. Nos. 12 and 13 are properly called tubular and No. 11 quilled. The ligulate form of petal is conceived to have been originated by the splitting



of a tubular form. This theory is well illustrated by florets 13 to 6. In No. 9, half of the floret shows the tubular origin, and half is ligulate. Whether the opposite tendency for ligulate to produce tubular forms exists, is a question. Possibly Nos. 7, 15 and 16 might be regarded as transitional forms from the ligulate to the tubular. It is often important to distinguish whether a floret is ligulate or whether the margins are incurved. For example, single, intense, vivid colors are probably best displayed by a ligulate floret. *Crimsona* (No. 6) is a case in point. The color of *Miss Helyett* is a similar shade, but the general effect is ruined (for some at least) by a distracting element: the margins of the florets are turned in so much that florists would say, "it shows the under side."

Various types of chrysanthemum florets are shown, natural size, in Fig. 88. No. 1 is a ligulate floret which was incurved in the bloom; No. 2 stood reflexed in the flower, margins revolute; No. 3, floret doubly curved, is cupped at base and top and high in the middle; No. 4, incurved as it stood in the flower, hairy-tipped, cupped, but the character not showing well in the cut (*Mrs. Higinbotham*); No. 5, incurved in the flower, hooded and hairy-tipped; No. 6, ligulate floret (*Crimsona*); No. 7, tubular below, broadly ligulate above, the margin incurved; No. 8, greater part of the floret tubular; No. 9, to be compared with No. 7; No. 10, a partially tubular floret, with very slender base and strongly involute blade; No. 11, quilled floret; No. 12, tubular, straight (*Iora*); No. 13, tubular and curved or hooked, the apex cut or lacinate (*Mrs. R. W. E. Murray*); No. 14, deeply cut or lacinate (*Mrs. W. H. Rand*); No. 15, broad at base, twisted above (*Ezeta*); No. 16, floret twisted throughout (*Shavings*).

*Color problems (Mr. Miller).*—In consulting catalogues of chrysanthemums for the purpose of verifying new varieties, some very perplexing color problems were encountered. Much of this confusion can never be straightened out, because color is a subjective phenomenon. It exists in the minds of men, rather than in nature. But there are certain practical suggestions which can be made to flower dealers, and it is to be hoped that some general principles can be educed. Cataloguers of new varieties should not attempt to make very fine and subtle distinctions, nor should



90.—M. Georges Biron. Natural size.

they use such seductive phrases as "soft dove colored," "fawn colored," etc. Men who write of colors should be examined for color blindness, so that they may know their own limitations. The great practical reason against using words expressing fine shades of color is that these words mean very different things to different persons. It is hard enough to get people to agree on such staple colors as red, blue, green and yellow. What the florists of the country need is a cheap chart of colors, containing simply the common names and the common colors. This matter has been agitated for several years. Mr. F. Schulyer Mathews, a well-known artist and colorer, prepared a chart for the use of florists, which was published as a supplement to the American Florist of August 17, 1895. It is an excellent and worthy attempt, and is a distinct gain to the profession; but it has the fault of containing too many uncommon and unimportant colors and names of colors. "Dull ultramarine (blue, grayish)" is too long for ordinary use. Even if the florist were capable of distinguishing between Mr. Mathews' "salmon," "salmon pink" and "reddish salmon," these names would never be attractive names for the description of flowers. It is very doubtful whether people would care to distinguish lilac and light lilac. Horticulturists ought to agree upon twenty or thirty common names of colors and then secure the preparation of a chart to correspond with these common names. We need colors for the names in common use.

People must not expect too much of color charts. They should realize (as Mr. Mathews does) that pigments cannot compete with the colors of nature. Pigments are dead, petals are alive. Moreover, neither pigments nor petals correspond with the colors of the solar spectrum. It is doubtful if Mr. Mathews is warranted in calling his colors "absolutely true." They may be correct from the pigmental or chemical standpoint, or from the standpoint of technical or trade nomenclature, but it is a question if these are to be the standards of absolutely true colors. The fact is that there is no absolute standard of color. Lapis lazuli and bichromite of potash may furnish very stable and constant pigments, but these materials and all others have decided limitations. These limitations must be understood, or there will al-

ways be disappointment, no standard in common use, and the consequent mutual charges of dishonesty and color blindness.

There are one or two suggestions which I offer in the hope that they may be of some practical help to those selecting varieties. The first suggestion is intended for those who grow chrysanthemums on a small scale, who wish the best of the new



91.—Madame Carnot. Half size.

varieties, and cannot afford to experiment with many. This suggestion is that such growers select of new varieties only those which have a single color. It is early enough to get those varieties containing combinations of two or more colors after they have stood the test of a year's experience with the market. People like strong, vivid and highly individualized single colors in

chrysanthemums. There are only two sides to the question when a single pure color is considered. People either like or dislike it. But when two colors are combined there are infinite possibilities for difference in taste. For example, here is a list of eight recent chrysanthemums, all of which have combinations of only two colors—Fred Walz, Mme. O. Mirabeau, Mrs. Potter Palmer, Genevieve, Sunset Pink, Mrs. C. Harmon Payne, Edith Smith and Burt Eddy. Now, who is to decide which one of these is an inharmonious mixture and which a happy combination? But the problem is even more complicated than this. Let us suppose that the variety Burt Eddy contains seventy per cent. of red (to avoid confusion I shall not attempt to describe the shade) and thirty per cent. of white, on each floret. Do you suppose that this proportion can be maintained year after year? Florists know that combinations of colors are very unstable. I do not mean to condemn these varieties out of hand. Some of them may prove stable as to their proportions, and artistic in effect, but the ordinary florist can afford to wait a year. The point is, that these are typical of a class which it is safer for him not to buy while they are new.

Other mixtures of doubtful value are Gilt Edge, Evening Star, Miss Sylvia Shea and Mrs. Moses Wentworth.

To illustrate how variable the amount of color is, the case of the new variety, Miss M. M. Johnson, may be cited. This is advertised as a pure yellow, but some of the many blossoms grown this year showed varying amounts of red. Radiance is another yellow that should be made "red proof" before being sent out as a pure yellow. Secondary colors appear with age in many new varieties that have only one color at their best. The pink that comes with age to Crystallina (white) is attractive, but that which spreads over Miss Georgiana Pitcher (yellow) makes a melancholy spectacle. Often there is a chance for difference of opinion. In any case, would it not be well for disseminators in their introductory notices to state the fact of secondary color appearing with age? An analogous case is that of varieties which show the center. Mrs. J. M. Parker, Jr., and Mme. Carnot are two of many new examples of this latter class. The center is objectionable in one; not objectionable in the other. It is a mat-

ter of dollars and cents to cut the flowers of the former and sell them before the center shows. But such judgments are essentially personal. What buyers want is the fact. If the center shows, the disseminator should state the fact.

A blue chrysanthemum is not impossible. It was formerly taught that red, yellow, and blue flowers could never be gotten in the same species. Scientists no longer believe in the incompatibility of the cyanic and xanthic series of colors. A blue chrysanthemum may arise either from seeds or "sports." As far as seedlings are concerned, one would naturally be tempted to save the seeds of varieties approaching purple. Blue is perhaps most easily reached through purple, but when the blue is once obtained the difficulty is to keep out the purple. Probably we shall never have an azure-blue chrysanthemum. Even the fringed gentian, which is the standard for azure-blue among wild flowers, is not always free from purple. The tendency among chrysanthemums is to sport towards white, instead of away from it. Of course, sports, like men of genius, have a way of disregarding prophecies, but the tendency is worth pointing out. The story is often repeated that in the year 386 A. D. the King of Corea had to pay to the Japanese Emperor a tribute consisting of red, white, yellow, blue and black chrysanthemums. Even granting that the tribute was actually paid, what proof have we that the Japanese word for blue has meant the same thing for fifteen centuries? Moreover, how does the average person know that the Japanese word is properly translated? If those who are striving to produce a blue chrysanthemum, are also cherishing hopes of selling it for \$1,500, they should be reminded that the public may not care for it when it is obtained. A green chrysanthemum was very rare, but when the two plants of the pink variety Viviani-Morel sported to a green simultaneously in different parts of England, the coincidence was barely mentioned in a British horticultural journal.

*Fragrance (Mr. Miller).*—Can chrysanthemums be made fragrant? Yes and no. *Nymphaea* is fragrant, but it is a small-flowered variety. There are at least half a dozen others. How much these can be developed is a question. At any rate, the large-flowered varieties will certainly never all be fragrant. They are valued for other things. If odor is associated with hereditary constitution, the chances are small for making the genus chrysan-

themum a fragrant one. People are not looking to the chrysanthemums for odor, but simply for form, color, and texture. Fragrance would have to be very emphatic to make any impression beside a flower six or eight inches in diameter. And besides, whatever odor the flower might have would be overpowered by the heavy scent of the foliage. Yet there is nothing really incompatible with the development of odor in the large chrysanthemums. *Nymphaea* has been forced to grow flowers four inches across.

## II. TEST OF NOVELTIES.

In judging new varieties, we have this year divided all the chrysanthemums into very good, good, poor, and intermediate. The word intermediate does not appear in the list, however, because it was thought best not to try to describe the shades of merit between "good" and "poor." When, therefore, there is no comment upon the merit of the variety, it is to be understood that, in our test, the variety seemed to be only intermediate or indifferent in quality. There are so many good and very good chrysanthemums on the market that it is necessary to measure new varieties by a high standard. If the present judgments seem to imply a rigorous standard, it is certainly not so severe as the test of time. It is safe to prophecy that most of the new varieties of 1895 will not be for sale five years from now.

The most complete adaptation to current wants is found among white and yellow chrysanthemums. There is great room for improvement in pinks and dark shades. There are plenty of quilled and hairy pinks, but the Japanese incurved section possesses no pink of the size and beauty of Mrs. Henry Robinson (white) or a dozen yellows that could be named. The trouble with delicate shades of pink is that the color is rarely evenly diffused and it often fades out. The lack of single, pure colors other than white, yellow and pink, is very noticeable. Dark reds are very popular, and yet there is no section in which so little improvement has been made as that represented by Cullingfordii, Geo. W. Childs, John Shrimpton, and Mrs. J. H. White.

In the description of varieties below, the name in the parentheses following the name of the variety signifies the dealer who sent us the cuttings; the name at the end of each description is that of the introducer, so far as we are able to determine from the current

literature. The varieties are arranged alphabetically according to the customary rules of library cataloguing, except that whenever a name consists of two words, the first of which is an adjective, the variety is indexed according to the first letter of the adjective,—*e. g.*, Latest Fad is put under “L” and “Autumn Leaves” under “A.” Varieties named for persons are catalogued under the sur-



92.—Crimsona. Four-fifths natural size.

name. All those varieties which were first introduced to the trade last year are marked “1895.” Those few without dates are such as we have been unable to trace to the introducer; but they are all very recent.

There are several matters of great practical importance which an experiment station cannot determine for the forcing-house industry. Florists must decide amongst themselves the shipping



qualities of different chrysanthemums and the length of time cut flowers will last. These matters are of great practical and momentary value, but of little scientific or permanent importance. The depot for such information should be the trade journals. It is surprising that greenhouse men do not supply these lists to their trade papers with greater frequency instead of going on year after year making avoidable mistakes, and purchasing experience dearly.

The following varieties described in Bulletin 91 have been grown again this year with results similar to those recorded last year. *Elizabeth Bisland*, *Georgienne Bramhall*, *Charlotte*, *Maud Dean*, *Golden Wedding*, *Mrs. Chas. Lanier* (better than we said), *L'Enfant des deux Mondes*, *Mrs. Geo. J. Magee*, *Mayflower*, *Mutual Friend*, *Niveus*, *Mrs. Howard Rinek* (worse than we said) and *Miss Florence Pullman*.

Some of the older varieties, not mentioned in Bulletin 91, have been grown again. Of these the following have done well :

*Callendreau, Dr.*—Similar to *Miss Georgiana Pitcher*.

*Comley, Jas.*—A very good late variety, dark red, changing to carmine and white.

*Iora.*—See Fig. 93, and page 234.

*Lippincott, Mrs. Craig.*

*Queen, The.*—Midseason, white.

*Shrimpton, John.*—Type of *Cullingfordii*, and the best red 'mum.

*Sunderbruch, F. L.*—Early yellow.

*Vivian-Morel.*—The standard pink of its class, and still to be excelled.

The following were intermediate in merit: *John Bunyan*, *Geo. S. Conover*, *Miss Heylett*, *Eva Knowles*, *Sautel's White*.

The following were poor or bad: *Mrs. Jas. Eadie*, *John M. Kupfer*, *Mrs. C. H. Payne*, *Sylvia Shea*, *Yellow Queen*.

The following descriptions and estimates of varieties are made up from notes taken by Mr. Hunn, Mr. Miller and myself.

The dates in the descriptions indicate when the flowers were at their best.

1. *Abbott, Marion* (Smith\*)—Flower 6 inches wide, pink, "color of *La France* rose," incurved, and slightly hairy. Stem 46 inches, long jointed. Nov. 20. (Spaulding.) 1895.

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\* Nathan Smith & Son, Adrian, Mich.

2. *Astor, W. W.* (Smith)—Good. (See Fig. 89.) Flower medium sized. The single row of ray florets white, edged with pink; disk flowers yellow, forming a high compact centre. Stem 36 inches, leaves small, deeply cut. Claimed to be an improvement in size. This belongs to an unpopular class. Considered by gardeners as of no value for commercial purposes. Keeps well. (Rob't Owen, Maidenhead, Eng. Introduced in America by Hill and Smith, 1895.)

3. *Atkins, F. L.* (Smith)—Flower 6 inches. Florets reflexed. Stem 40 inches, close jointed, leaves long and pointed. Considered by our gardener a good midseason white for commercial purposes. November 16. (Pitcher and Manda.) 1895.

4. *Autumn Leaves* (Smith)—Flower 6 inches wide; a combination of white, red and yellow, the yellow being confined to the tips of the florets. Habit half dwarf, stem close jointed, foliage thick and leathery. The combination of color is considered a pleasing one by our gardener. At best December 12. (Spaulding.) 1895.

5. *Bigelow, E. M.* (Dorner\*)—Good. Flowers 5 to 7 inches, with general appearance of a red dahlia. Florets stiff, a few outer ones reflexed. Stem 50 inches, close jointed; leaves large, heavy, deeply cut. Considered by our gardener a fine, showy variety of a color that is scarce among chrysanthemums. Late. (Dorner.) 1895.

6. *Biron, M. Georges* (Beckert†)—Good. (See Fig. 90.) Flower 6 inches in diameter, bizarre, showing chiefly the reverse side of florets which are strongly whorled. Inner sides of florets maroon, reverse amber-colored. Stem 42 inches, habit slender, leaves long and deeply cut. This eccentric appearance may be incident to development or confined to rare cases, as the flower is advertised to belong to the *Vivian-Morel* type. This is recommended chiefly for its oddity and the attention it attracts. November 16. (Calvat.) 1895.

7. *Black, Miss Louise D.* (Beckert)—Flower 4 to 5 inches in diameter, regular and globular, orange-red. Florets small, semi-tubular and tending to incurve. Stem 36 inches, habit slender. A good variety for its type and color. 1895.

8. *Bloodgood, Helen* (Hill‡)—Good. Flower 7 to 8 inches, pink. Florets mostly incurved, the outer ones irregularly reflexed. Stem

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\* Dorner & Son, Lafayette, Indiana.

† Beckert & Bros., Glenfield, Pa.

‡ E. G. Hill & Co., Richmond, Indiana.

52 inches, stout and short jointed; leaves deeply cut. An improvement in pinks. The shade is pure, and the color is quite evenly spread over the florets. November 10. (Spaulding.) 1895.

9. *Borel, Pres.* (Smith)—Flower 8 inches wide, loosely arranged, a striking combination of purple and silver. Stem 56 inches, long jointed, leaves long and narrow. Nov. 18. A French novelty. The colors are either liked or disliked at first sight. (Calvat.) 1895.



93.—*Iora*. Four-fifths natural size.

10. *Brigand* (Smith)—Flower 6 inches wide, deep crimson, slightly reflexed. Florets show yellow reverse. Stem 34 inches, close jointed, foliage large and light green. At best Dec. 12. (Spaulding. Raised by Hill.) 1895.

11. *Bronze Giant* (Smith)—Flowers 6 inches, compactly incurved. Florets yellow, shaded and splashed with dark red. Stem

30 inches, long jointed, foliage scant. At best Dec. 5. (Spaulding.) 1895.

12. *Bryant, Mrs. W. A.* (Pitcher & Manda\*)—Flower 7 inches, yellow. Habit very tall and slender; stem 5 to 6 feet, long jointed, and strong though very thin; leaves small and very unhealthy. The color and form of the flower is similar to that of *II. L. Sunderbruch*. Nov. 27. (Pitcher & Manda.) 1895.

13. *Carnot, Madam* (Smith). Very good. (See Fig. 91.) Flower very large (8 inches wide), loose and free, the florets being very limp and graceful and ligulate, pure white. Outer florets reflexed or hanging, the inner ones variously placed. Very tall (4 ft. or over), the stem long jointed, and foliage rather scant. A long keeper and a most graceful and excellent white. Nov. 10. (Calvat, 1894. Introduced in America by Smith.)

14. *Carnot, Mademoiselle* (Becker). Good. Much like the last, fully as large or larger, but shows the center, although this defect is not greatly objectionable in a flower of this class. White. Stem 40 inches, long jointed, the foliage rather scant. Nov. 27. Variation of No. 13?

*Burt, Eddy.* (See *Eddy, Burt.*)

15. *Chipeta* (Smith)—Flowers 7 inches wide, closely incurved, showing only the reverse side of the florets, the color of which is compared to that of ripened oak leaves. Stem 46 inches, close jointed, leaves large. At best Nov. 16. (Smith.) 1895.

16. *Compton, Miss Georgie* (Spaulding†)—Flower in color and shade suggesting a double yellow tulip. Stem 40 inches, close jointed, leaves deeply cut, held well from stem. Nov. 10. (Spaulding.) 1895.

17. *Crimsona* (Beckert)—Very good. (See fig. 92.) Flowers 6 inches wide, dark crimson, the intense color well displayed by the ligulate florets. Stem 40 inches, close jointed, leaves large and deeply cut. Remarkable for the vividness of its deep color and the velvety finish of the florets. Reverse light colored. At best Nov. 27. (W. Jarvis Smith, Pittsburg.) 1895.

18. *Crosby, Emma N.* (Smith)—Flower 5 inches wide, golden. Florets slightly hairy, the outer ones reflexed back to the stem. Habit dwarf. Nov. 20. (Spaulding.) 1895.

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\* Pitcher & Manda, Short Hills, N. J.

† T. H. Spaulding, Orange, N. J.

19. *Crystallina* (Smith). Very good. Flower 5 inches in diameter, globular and distinct in form, pure white. Florets are crisp, firm, and stand out radially. Stem 36 inches. At best Nov. 10. This is recommended for its earliness, purity of color, distinctness of form and keeping qualities. A secondary color appears with age, the pink being evenly diffused, and not displeasing. (Vaughan.) 1895.

20. *Darville, Camille* (Smith)—Flower 5 inches in diameter, same form as *Ezeta*, pure white. Stem 42 inches, short jointed, foliage light green. At best Nov. 10. (Spaulding.) 1895.

*De Galbert* (see *Galbert*).

21. *Diavola* (Smith)—Flower 6 inches wide, dark red, white and light yellow. Reverse of florets silvery red. Florets very wide and thick. Stem 40 inches, close jointed, foliage very thick, and dark green. At best Dec. 12. (Spaulding.) 1895.

22. *Dinsmore, W. B.* (Pitcher & Manda)—Flower 6 inches in diameter, regularly incurved, golden. Stem 40 inches, close jointed, leaves deeply cut. November 16. Midseason. (Pitcher & Manda.) 1895.

23. *Eddy, Burt* (Smith)—Flower 6 inches wide. Florets ligulate, purple and white. Stem 28 to 30 inches, very close jointed, foliage small. At best Nov. 16. (Vaughan.) 1895.

24. *Egyptian, The* (Hill)—Same as *Nellie Elverson* with us. (Hill.)

25. *Elverson, Miss Nellie* (Hill)—Good. Flowers 6 inches, incurving, showing the reverse. Inner side of florets dark red, reverse bronze. Stem 44 inches, close jointed, leaves large. Nov. 25. A good exhibition flower. (Hill.) 1895.

26. *Evening Star* (Beckert)—Flower large, 6 inches across. Outer florets reflexed, the inner ones spreading and whorled, showing the center, semi-double; color old gold and salmon. Stocky, 30 inches high. Nov. 16. Odd.

27. *Experiment* (Smith.) Flowers 6 inches wide, white, very loose and spreading. Florets narrow and twisted at the apex. Stem 46 inches, leaves small. Advertised "delicate shrimp pink." Dec. 23. (Spaulding.) 1895.

28. *Ezeta* (Smith.) Good. "An improved Rohaillon." Flowers 5 inches in diameter, pure yellow, and distinct in form. Stem 50 inches, close jointed, leaves large and thick. At best Nov. 16. The form of the flower head is globular, the general effect is one of

regularity. (See Fig. 88 floret No. 15.) Recommended for earliness, purity of color, distinctness of form, and lasting qualities. (Smith). 1895.

29. *Falconer, Jennie* (Smith) Flowers 6 inches in diameter, lemon yellow, globular. Florets broad, margins incurved and cupped. Nov. 25. Considered by our gardener a very good mid-season yellow. (Spaulding.) 1895.



94.—Northern Lights. Three-fifths natural size.

30. *Fitzwygram, Lady* (Beckert)—Poor. Flower 4 inches, white. Half dwarf. Not equal to advertised merits. (H. J. Jones.) 1895.

31. *Galbert, Mlle. M. A. de* (Beckert)—Flowers 6 inches, pure white. Florets broad, incurved, a few outer ones reflexed. Stem 40 inches; foliage scant. Nov. 19. (D. Calvat.) 1895.

32. *Gardiner, Mrs. John* (Beckert)—Flowers 5 inches, yellow, incurved. Stem 32 inches, long jointed, leaves small. Early. Nov. 3. (H. J. Jones.) 1895.
33. *Genevieve* (Vaughan)—Flower medium in size, 5 inches across. Florets straight or slightly reflexed, the inner ones white and the outer ones splashed with pink. Stem 30 inches, weak, the foliage small. Nov. 10. (Vaughan.) 1895.
34. *Gilt Edge* (Smith)—Poor. Flowers medium in size, 5 inches across, the florets very narrow. Color yellow tipped bronze. Stem 30 inches, close jointed. Nov. 19. (W. Jarvis Smith, Pittsburgh, Pa.) 1895.
35. *Gold Dust* (Smith)—Flower 8 inches wide, pure yellow. Inner florets incurved, outer ones reflexed, and somewhat hairy. Stem 28 inches, short jointed, leaves deeply cut and of rank growth. Not as hairy as *L'Enfant des deux Mondes*. Nov. 20. (Hill.) 1895.
36. *Haggard, Rider* (Smith)—Good. Large-flowered anemone. Flower 9 to 10½ inches. Ray florets light pink, disk florets a darker pink, the inner ones tipped with yellow. Habit very tall. Stem 60 inches, leaves small. Nov. 10. Recommended for its striking oddity. *Mrs. F. Gordon Dexter*. (Picture on title page of Bulletin 91 gives an idea of the form.) This is not a new variety, but the size has been greatly increased. Attracted universal attention among visitors and much dislike. (H. J. Jones.) 1895.
37. *Hallowe'en* (Smith)—Very good. Flower head 7 inches wide and flat. Florets incurved and quilled, the tubular portion a lighter pink than the ligulate portion. This variety has as much individuality as *Northern Lights*, which has similar colors, but a somewhat different development. Nov. 25. (Hill.) 1895.
38. *Heacock Esther* (Smith)—Flower incurved, yellow. A sport from *Ada Spaulding*. Stem 30 inches, close jointed, foliage good. Nov. 10. (Spaulding.) 1895.
39. *Hersylea* (Sunset Seed and Plant Co.)—Flower large, 6 inches across. Outer florets slightly reflexed, the inner ones upright and cupped. Color good golden yellow. Growth rather slender: foliage oak-leaved. Stem 40 inches. Nov. 16. (Sunset Seed and Plant Co.) 1895.
40. *Higinbotham, Mrs.* (Smith)—Good. Flower 9 inches wide, incurving, showing the center, hairy, pink. Florets incurving, cupping, and even more hairy than those of *Louis Boehmer*. Stem 40

inches, close jointed, leaves large and very dark green. A gain in size over *L. Boehmer*. Nov. 16. (Spaulding. Raised by Hill.) 1895.

41. *Hole, Dean* (Smith)—Flower 8 inches, white and pink. Stem 36 to 40 inches, foliage large, drooping to stem. Nov. 26. (May.) 1895.

42. *Hurley, Mrs. Wm. H.* (Beckert)—Poor. Flower large, 6 inches across; florets slightly reflexed. Color buff. Growth slender, the stem 20 inches high. Nov. 10. (Graham.) 1895.

43. *Iora* (Smith)—Very Good. (See Fig. 93.) Not a new variety. Flower 6 inches in diameter. Florets tubular, pink. The color is a delicate shade evenly diffused throughout. Recommended for exhibition and pot culture. Nov. 16. (Smith.) 1894.

44. *Jayne* (Smith)—Flower 4 inches wide, dark rose color, the shade of *Mrs. Murdock*. Stem 30 inches, long jointed, leaves nearly entire. Nov. 27. (Vaughan.) 1895.

45. *Johnson, Miss M. M.* (Hill)—Very good. Flower 5 inches in diameter, loosely incurved, gobular, golden yellow. Florets wide, incurved. Stem 24 inches, foliage good. Recommended for purity of color, earliness, and dwarf habit. Nov. 5. (Hill.) 1895.

46. *Lager, J. E.* (Smith)—Good. (See title page.) Flower 6 inches wide, bright yellow, irregular in general form, and irregular as to florets, which show varying degrees of tubularity and are irregularly reflexed. Stem 40 to 45 inches and stout, leaves good. Recommended for earliness, and keeping qualities. This is not as good as *Mrs. W. H. Rand* (see Fig. 95), an early yellow of the same class. Nov. 23. (Pitcher & Manda.) 1895.

47. *Latest Fad* (Beckert)—Flower 8 inches wide, yellow. Florets tubular, the outer reflexed. Stem 30 to 36 inches, close jointed, leaves small. Dec. 5. Considered by our gardener a good variety for growing single blooms in pots. (Spaulding.) 1895.

48. *Leech, Katherine* (Beckert)—Good. Flower very large, 7 inches across. Florets loosely reflexed, the central ones erect or spreading. Color clear buff. Strong, short-jointed grower, 25 to 30 inches high. Nov. 16. (Graham.) 1895.

49. *Masse, Marie* (Beckert)—Flower medium in size, the florets reflexed. Color pink, with a purple tinge. Very early and dwarf. Stem 12 inches. Oct. 20. English.

50. *Meige, La* (Beckert)—Flower 5 inches wide, white. Florets



broad, waxy. Stem 28 inches, close jointed, deeply cut. Very late. Dec. 26. (Calvat.) 1895.

51. *Millbrook* (Dorner)—Very good. Flower 7 inches, tubular. The ligulate portion of florets a bright red, tubular portion a salmon bronze. Stem 40 to 55 inches, close jointed, leaves large and held well to flower. The combination of colors is unique and attractive. Nov. 20. (Dorner.) 1895.

52. *Mirabeau, Mme. Octavie* (Beckert)—Good. Flower rather large. Florets long and loose, color a delicate shade of silvery pink. Stem 30 inches high, long jointed. Nov. 28. Very attractive and odd.

53. *Molin, Mme. C.* (Beckert)—Flower 8 inches, loosely arranged, pure white. Outer florets reflexed. Stem 40 inches, close jointed, leaves light green, long. Nov. 25. (Calvat.) 1895.

54. *Mortillet, M. de* (Beckert)—Flower 5 inches wide, incurved. Outer florets red, inner bronze and yellow, reverse buff. Stem 44 inches, foliage unhealthy. (Calvat.) 1895.

55. *Murdock, Mrs. S. T.* (Dorner)—Flower 6 to 7 inches, incurved, pink. Stem 36 to 40 inches, very short jointed, leaves large, deeply cut, dark green. Nov. 25. (Dorner.) 1895.

56. *Murray, Mrs. R. W. E.* (Beckert)—Very good. Flower 5 inches wide, 4 inches deep, white, loosely incurved showing centre. Florets are cut or toothed in such a manner as to give the general effect of hairiness. (See Fig. 88, No. 13.) Stem 46 inches, close jointed, leaves small. A good late exhibition variety. Recommended for purity of color, individuality of form, and lateness. Centre not objectionable. Stands test of close scrutiny as well as that of general effect. Not to be confused with *Mr. R. W. E. Murray*. (*Syn. Mrs. Geo. W. Pullman.*) (H. J. Jones, England.) 1895.

57. *Noisette, Paul* (Vaughan\*)—Flower of medium size, 4 inches across. Outer florets reflexed, the inner ones incurved. Color dull yellow. Dwarf (15 inches high). The foliage small. Nov. 10. (Vaughan.) 1895.

58. *Northern Lights* (Beckert)—Very good. (See Fig. 94.) Flower 8 inches in diameter, quilled, pink. Stem 46 inches, close jointed, foliage very good. Midseason. Nov. 25. Recommended for distinctness of form, and keeping qualities. The spiral condi-

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\* J. C. Vaughan, Chicago.



95.—Mrs. W. H. Rand. Five-eighths natural size.

tion of development shown in Fig. 94 is succeeded by stages of growth that are perhaps even more attractive. (W. Jarvis Smith, Pittsburg.) 1895.

59. *Nyanza* (Smith)—Good. Flower 6 inches in diameter, high built. Florets incurved, cherry red, reverse golden, very broad and strong. Stem 45 inches, close jointed; leaves finely cut. Suitable for cutting Nov. 20. In fine condition Nov. 27. Striking form and color. Keeps well. (Smith.) 1895.

60. *Oakland* (Dorner)—Good. Flower 6 inches in diameter, dark red or terra cotta, very double and spherical. Outer florets reflexed, inner ones slightly incurved, the margins revolute in every case. Stem 50 to 60 inches. At best Nov. 5. Good Nov. 25. Recommended for distinctness of form and color, earliness and keeping qualities. (Dorner.) 1895.

61. *Octoroon* (Smith)—Flower resembles *Nellie Elverson*. Stem 40 inches, close jointed; leaves dark green, thick and stiff. Dec. 5. (Smith.) 1895.

62. *O'Farrel, Miss Elma* (Dorner)—Good. Flower medium sized, very evenly reflexed, magenta red. Stem 36 to 40 inches, close-jointed, leaves deeply cut and drooping to stem, held well up to flower. Dec. 12. Recommended for those who desire a dark red, late in the season. (Dorner.) 1895.

63. *Orange Child* (Beckert)—Poor. Flower medium in size, 4 inches across, zinnia-shaped. Color dull yellow. Half-dwarf; foliage small. Nov. 16. (W. Piercy, Forest Hill, London.)

64. *Palmer, Mrs. Potter* (Hill)—Flower 7 inches wide. Florets incurved of heavy texture, rose pink with silver reverse. Stem 46 inches, long-jointed, foliage dark green. A show variety with good keeping qualities. Nov. 16. (Walz.) 1895.

65. *Parker, Jr., Mrs. J. M.* (Hill)—Flower 6 inches wide, pink, showing the centre. Outer florets somewhat tubular. Stem 30 inches. Must be cut early as the centre is a decided disadvantage. The shade of pink is equal to that of *Viviand-Morel*, but scarcely better. Very early. At best Nov. 8. (Spaulding.) 1895.

66. *Pauckoucke, M.* (Beckert)—Flower 10 inches, lemon colored, loose and sprawling, the outer florets drooping to the stem; inner florets twisting toward centre. Stem 44 inches, very stocky, close-jointed, leaves large. Nov. 10. (Calvat.) 1895.

67. *Pauckoucke, Mlle. Theresa* (Beckert)—Flower 8 inches wide, pure white. Stem 46 inches. Dec. 12. (Calvat.) 1895.

68. *Philadelphia* (Hill)—Good. Flowers 6 to 8 inches in diameter, light yellow, loosely incurved and whorled. <sup>xxx</sup>~~xxx~~The color changes with growth toward creamy white, the tips of florets being somewhat darker. Stem 36 inches, stiff, close-jointed. Nov. 16. Recommended for its class. (Graham.) 1895.

69. *Pitcher, Miss Georgiana* (Pitcher and Manda)—Very good. Flower 6 inches in diameter, globular, loosely incurved, bright yellow. Type of *Golden Dragon*. Stem 36 inches, unusually stout, foliage broad, thick and rank. Nov. 10. (Pitcher and Manda.) 1895.

70. *Radiance* (Hill)—Poor. Flower 6 inches in diameter, golden, loosely incurved. Florets wide. Habit dwarf. Stem 24 inches. Early. Keeps well, but is by no means pure yellow as advertised. Much red is irregularly distributed. Nov. 10. (Hill.) 1895.

71. *Rand, Mrs. W. H.* (Hill)—Very good. (See Fig. 95.) Flowers 8 inches wide, pure yellow, looking like a mass of tangled yellow thread. Florets show much irregularity especially in the degree of laciniation and tubularity. Stem 24 to 30 inches, leaves small. Recommended for earliness, purity of color, individuality of form, and remarkable keeping qualities. Comments on the form ranged from "informal," "free," "pleasing," and "irregular," to "odd," "fantastic" and "eccentric." It is worth noticing that the individual florets are far more irregular than the flower head in its general effect. Compare *J. E. Lager*, title page. Nov. 10. (Vaughan.) 1895.

72. *Reynolds, Maude D.* (Smith)—Flower 9 inches, high built, canary yellow. Outer florets reflexed irregularly. Stem 38 inches, close jointed. Nov. 25. (Spaulding.) 1895.

73. *Robinson, Mrs. Henry* (Beckert, Smith)—Very good. (See Fig. 96.) Flower 7 to 9 inches in diameter, globular, incurved, pure white. Florets wide. Stem 36 inches, foliage good. Nov. 10. Recommended for great size, purity of color, earliness and keeping qualities. A popular vote of visitors would probably have given this the first place over the entire collection. (Pitcher and Manda.) 1895.

74. *Rieman, W. H.* (Hill)—Flower 6 inches in diameter, incurved, very high built, yellow. Outer florets often tubular. Stem 30 inches, close jointed, foliage well up to flower. Nov. 24. (Hill.) 1895.

75. *Shavings* (Smith)—Good. (See Fig. 97.) Flowers small, only 3 inches in diameter, unique in form. Florets twisted and curled, inner side reddish, outer bronze or straw colored. Stem 36 inches, close jointed, foliage good. Midseason. Nov. 16. Recommended solely for its novelty and oddity. (Vaughan.) 1895.

76. *Smith, Mrs. A. W.* (Beckert)—Flower rather large. Florets reflexed. Color shell pink. Of *Viviant-Morel* type of color. Four feet high, close jointed, the foliage deeply cut. Nov. 19. (W. Jarvis Smith, Pittsburg.) 1895.

77. *Spaulding, Mrs. Gladys* (Hill)—Good. Flower 4 to 6 inches in diameter, high built, white, incurved. Stem 32 inches, long jointed, leaves small. At best Nov. 10. Good Nov. 25. (Spaulding.) 1895.

78. *Starin, Mrs. J. H.* (Smith)—Good to very good. Flower large, about 6 inches across and 5 inches high. A few outer florets reflexed, the remainder incurved. White. Stem nearly 4 feet, strong. Nov. 25. One of the best midseason and long-keeping whites. (Pitcher & Manda.) 1894.

79. *Sunrise* (Smith)—Flower 9 inches wide, showing centre. Florets broad, of heavy texture, terra cotta, reverse old gold. Stem 40 inches, close jointed; leaves large and thick. Nov. 10. Same class as *Eva Knowles*. (May.) 1895.

80. *Sunset Pink* (Sunset Seed & Plant Co.)—Flower large, 7 inches across. Outer florets horizontal, the inner incurved and making a high center. Color pink. Stem 40 inches high, short jointed. Nov. 19. 1895.

81. *Thalia* (Smith)—Flowers 6 to 7 inches in diameter. Florets lavender, opening loosely, but incurving to a firm head. Stem 40 inches, very close jointed, foliage large, drooping, completely covering the stem. Nov. 10. (Smith.) 1895.

82. *Trilby* (Smith)—Flower 6 inches wide, pure white. Florets of very heavy texture, the outer reflexed, Stem 36 inches, close jointed, foliage large, dark green, drooping to stem. Dec. 10. (May.) 1895.

83. *Troy, J. H.* (Smith)—Flower 5 inches in diameter, incurved Japanese, pure white. Stem 40 inches, close jointed, foliage scant. (Advertised to be ready for cutting Oct. 5 to 9.) This would rank very high among the early, pure white, incurved varieties if it were not so much exceeded in size and form by *Mrs. Henry Robinson*. Nov. 10. (Pitcher and Manda.) 1895.

84. *Valleau, Marie* (Smith)—Flower 6 inches in diameter, globular, light pink, slightly hairy. Florets broad, heavy texture, the outer reflexed. Stem 40 to 45 inches, short jointed, leaves large, deeply cut, and held well from the stem. Nov. 20. (Spaulding.) 1895.



96.—Mrs. Henry Robinson. Half size.

85. *Wakeley, Dr. A. W.* (Smith)—Flower 6 inches in diameter. Florets wide, incurved, loosely arranged, light red, with light pink reverse. Stem 24 inches; leaves small. At best Nov. 20. (Spaulding.) 1895.

86. *Walz, Fred* (Bock)—Flower 5 inches wide, pink and white. Reverse and tips of inner florets silvery. Stem 30 inches. Nov. 16. (Bock.) 1895.

87. *White, Mrs. J. H.* (Hill) — Flower 6 to 7 inches, reflexed, crimson. Stem 30 to 40 inches, short jointed, foliage very thick. It seems doubtful whether this is any improvement is the much desired dark shades of which *Cullingfordii* in the historic example. There was considerable variation among the specimens as to time and manner of blooming, color and stature. Neither was “extra dwarf.” 1895.

88. *Wynne, Rose* (Smith) — Flower very large, 7 inches across, loose, silvery pink. Stem 3 feet, very stout and close jointed, and of distinct appearance. Nov. 16. (Rob’t Owen, Maidenhead, Eng., 1894. Introduced in America by Hill, 1895.)

89. *Zipangi* (Smith) — Flower 6 inches wide, very high built. Outer florets reflexed showing dark red, inner ones incurved showing buff reverse. Stem 48 inches; leaves large. Nov. 16. (Smith.) 1895.

90. *Zulinda* (Smith) — Flower similar to that of *Hollowe’en*, but smaller. Stem 34 inches, very close jointed; leaves large, very dark green. Dec. 5. (Smith.) 1895.

*Mr. Miller’s synopsis of varieties.*—The names of the varieties in the following selection are not arranged in a fashion that is designed to be complete or systematic, but simply helpful. The arrangement aims to save persons of limited time the labor of reading through a long list of new varieties alphabetically arranged. Florists, gardeners and others who visited our forcing-houses were constantly asking such questions as these: “Where is your biggest blossom?” “Have you any good pink varieties?” “What new colors are there in hairy varieties?” “Will you give me the names of some good quilled sorts?” The following list attempts to answer just such questions:

Varieties of great size.—Mrs. Henry Robinson, Rider Haggard, Mrs. Higinbotham, Helen Bloodgood, Mrs. W. H. Rand, Northern Lights.

Varieties of single, strong colors.—

White.—Mrs. Henry Robinson, Chrystallina, Mrs. R. W. E. Murray.

Yellow.—Mrs. W. H. Rand, Miss Georgiana Pitcher, Ezeta, Miss M. M. Johnson.

Pink.—Helen Bloodgood, Mrs. Higinbotham.

Crimson.—Crimsona.

Dark red.—Miss Elma O’Farrell, Oakland.

Good combinations of colors.— W. W. Astor, Millbrook.

Early varieties.—

White.— Mrs. Henry Robinson, Chrystallina.

Yellow.— Mrs. W. H. Rand, Miss Georgiana Pitcher, Miss  
M. M. Johnson.

Light yellow.— Philadelphia.

Pink.— Mrs. Higinbotham, Marie Masse.

Dark red.— Oakland.



97.—Shavings. Natural size.

Midseason varieties.—

White.— F. L. Atkins.

Yellow.— Ezeta.

Crimson.— Crimsona.

Late varieties.—

White.— Mrs. R. W. E. Murray.

Red.— E. M. Bigelow, Miss Elma O'Farrell.

Tall.— Rider Haggard, Oakland.

Dwarf.— Miss M. M. Johnson, Marie Masse, Paul Noisette.

Hairy.— Mrs. Higinbotham.

Quilled.— Hallowe'en, Northern Lights, Millbrook.



Tubular. — Iora, Mrs. R. W. E. Murray.

Keeping qualities. — Crystallina, Ezeta, Oakland, Mrs. W. H. Rand, Mrs. J. H. Starin.

Good for exhibition blooms. — W. W. Astor, M. Georges Biron, Crimsona, Crystallina, Mrs. Higinbotham, Millbrook, Mrs. R. W. E. Murray, Miss Georgiana Pitcher, Mrs. Henry Robinson, Mrs. W. H. Rand, Northern Lights, Shavings.

Strong individuality of form. — Crystallina, Ezeta, Shavings, Mrs. W. H. Rand, W. W. Astor, Hallowe'en, Northern Lights, Millbrook.

Large Anemone. — Rider Haggard.

Varieties showing the reverse colors. — Miss Nellie Elverson, M. Georges Biron.

Velvety finish of florets. — Crimsona.

Odd, striking, fanciful, eccentric, etc. — W. W. Astor, M. Georges Biron, Rider Haggard, Mme. Octavie Mirabeau, Mrs. W. H. Rand, Shavings.

*Mr. Hunn's choice of varieties.*—It is a difficult matter among so many varieties of exceptional merit to name those possessing the greatest number of valuable points, as different methods of growing and varied soils will often so change the character of a variety that one is compelled to constantly revise his opinion.

The following list is not an arbitrary selection, but it simply gives the results obtained here in 1895 :

WHITE.

*Early.*

*Late.*

Mrs. Henry Robinson,  
Madame Carnot,  
Crystallina,  
Miss Gladys Spaulding,

The Queen,  
Mlle. Carnot,  
F. L. Atkins,  
Mrs. J. H. Starin,  
Mrs. R. W. E. Murray,

PINK.

Iora,  
Helen Bloodgood,  
Mrs. Potter Palmer,  
Mrs. J. M. Parker, Jr.

Northern Lights,  
Mrs. S. T. Murdock,  
Marion Abbott,  
Marie Vallean.

## YELLOW.

Mrs. W. A. Rand,	W. B. Dinsmore,
J. E. Lager,	Jennie Falconer,
Miss Georgiana Pitcher,	Ezeta,
Louise A. Black,	W. H. Rieman.
Mrs. M. M. Johnson.	

## RED.

M. Georges Biron,	E. M. Bigelow,
Mrs. J. H. White.	Nyanza,
	Crimsona,
	Miss Nellie Elverson,
	Millbrook,
	Diavola,
	Hallowe'en.

*Mr. Bailey's choice of six.—*

1. Mrs. Henry Robinson (Fig. 96).
2. Mrs. W. H. Rand (Fig. 95).
3. Crimsona (Fig. 92).
4. Iora (Fig. 93).
5. Madame Carnot (Fig. 91).
6. Miss Georgiana Pitcher.

In this test of 90 novelties, we thought that the following twelve showed superlative ("very good") merits (excluding the varieties which are simply odd or curious). Madame Carnot, Crimsona, Crystallina, Hallowe'en, Iora, Miss M. M. Johnson, Millbrook, Mrs. R. W. E. Murray, Northern Lights, Miss Georgiana Pitcher, Mrs. W. H. Rand, Mrs. Henry Robinson.

L. H. BAILEY,  
WILHELM MILLER,  
C. E. HUNN.

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BULLETIN 113—February, 1896.

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Cornell University—Agricultural Experiment Station,

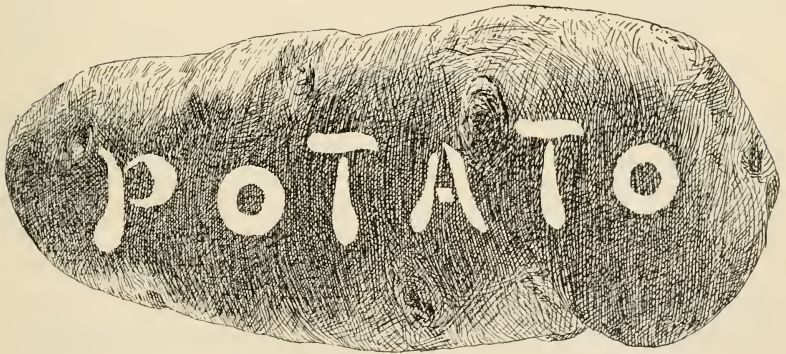
ITHACA, N. Y.

HORTICULTURAL DEPARTMENT.

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# DISEASES OF THE



By E. G. LODEMAN.

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## BULLETINS OF 1896.

106. Revised Opinions of the Japanese Plum.
107. Wireworms and The Bud Moth.
108. The Pear Psylla and The New York Plum Scale.
109. Geological History of the Chautauqua Grape Belt.
110. Extension Work in Horticulture.
111. Sweet Peas.
112. The 1895 Chrysanthemums.
113. Diseases of the Potato.

CORNELL UNIVERSITY, ITHACA, N. Y., *February 20, 1896.*

*Honorable Commissioner of Agriculture, Albany:*

Sir. — For a number of years the farmers of western New York have been asking for light upon the insidious and serious diseases of the potato crop. A special effort has been made during the past season to study these troubles, and although the season was unusually dry and therefore not very productive of some diseases, the results of the investigations seem to be so useful that they are submitted for publication and distribution under Chapter 230 of the Laws of 1895.

L. H. BAILEY.

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### SYNOPSIS.

Part I. Fungi. Pages 297 to 321.

A. Descriptions of the fungous diseases, 297 to 312.

1. Potato rot, late blight, or downy mildew, 297.
2. Early blight, or leaf-blight, 302.
3. Potato scab, 309.

B. Treatments of the fungous diseases, 312 to 321.

1. Potato rot or late blight, 312.
2. Early blight, 312.
3. Potato scab, 318.

Part II. Insects, 322 to 324.

1. Potato beetle, 322.
2. Flea-beetles, 323.

Part III. Machinery for spraying potatoes, 325 to 328.

Summary, 329.

## HISTORICAL NOTES ON THE POTATO DISEASE.

“The most easy way to scourge the land, and force it to yield speedy returns, was by growing crops of potatoes, which are largely productive, but at the same time specially exhaustive of the mineral wealth of the soil. An average crop of potatoes robs the soil of the seed constituents of between three and four average crops of wheat. The tenants were too poor, and if they had been rich had no inducement, by the tenure of their land, to restore to the soil, through adequate manuring, the heavy demands which had been made on its fertility. At the time of the famine in 1846, nearly one-fourth of the land under crops was devoted to potatoes. And even now, out of every 100 acres devoted to green crops in Ireland, 71 are still given to potatoes—a proportion nearly three times greater than that in Scotland, and six times greater than that of England. \* \* \*

“The striking deterioration of the potato produce in Ireland deserves much more attention than it has received, but can only be slightly alluded to in the present essay. From 1601, when Raleigh introduced it into Ireland, the crop grew steadily in favor with the Irish peasantry until 1845, in which year the largest amount of acreage was devoted to it, and fine crops of six and seven tons to the acre were habitually and persistently attained. The famine came, and, as Irish agriculturists assert, the nature of the potato was altered by the disease of 1846, and its productive power was lessened; at least this is given as the explanation of its present low position among Irish crops. It is no longer the potato which is the farmer’s chief source of profit in Ireland.” (“Recess Studies,” edited by Sir Alexander Grant, pp. 250–251.)

“If, then, the loss to Ireland is £3,500,000, we should be glad to know how much the total loss will have been when the destruction in England, Wales and Scotland is taken into account. To place the latter at £1,500,000 is no very extravagant assumption; and if so, this country has lost five millions of money by the potato murrain.” (*Gardeners’ Chronicle*, 1846, pp. 217.)

“*Copper Smoke a Preventive of Potato Disease.*—In the district about Meath and Swansea ‘wherever the copper smoke prevails,’ was the expression of an intelligent inhabitant with whom I fell into conversation, the potatoes are sound, and the same person informed me it was also the case last year. I can verify the fact so far as the present appearance of the crop, as seen from the mail-coach roof can be considered a verification; but I state it with a view of inducing more particular inquiry into it. You are, I dare say, aware the district I speak of is crowded with copper smelting furnaces.”—(*Gardeners’ Chronicle*, 1846, p. 582.)

# Part I. Fungi.

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## A. DESCRIPTION OF FUNGOUS DISEASES.

1. POTATO ROT; LATE BLIGHT; DOWNY MILDEW (*Phytophthora infestans*, DeBary).—The fungus causing the common potato rot is an old offender. It was undoubtedly introduced into Europe with some of the early importations of the potato, and has in certain years proved so destructive that famines have resulted from the entire loss of the potato crop. Such occurrences eventually lead to thorough study of the organism. As early as 1846, the fungus causing the trouble was very carefully described in an English publication,\* and since that time other observers have given the disease much attention. It has spread to all regions in which potatoes are extensively grown, so that both scientists and farmers are very familiar with many of its characteristics.

The most interesting feature connected with the fungus is undoubtedly the wonderful energy which it exhibits, under favorable conditions, in the destruction of the potato plants. It sometimes spreads with such rapidity that a crop may be ruined in one or two days; and unfavorable conditions, or the total destruction of the plants, formerly appeared to be the only effectual agents in preventing or checking the spread of the dreaded disease. This rapid decay of both the foliage and tubers is perhaps the most distinctive of those characters which are commonly brought forward for the identification of the disease. It is almost invariably accompanied by a strong, disagreeable odor which is easily recognized by all who have once experienced it. When large fields have been attacked, the smell is particularly strong; it then arises entirely from the foliage, and is not produced by the tubers.

The conditions which favor such rapid decay are, as a rule, not generally present throughout this state. The fungus makes its

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\* Rev. M. J. Berkeley, *Journal of the Royal Horticultural Society*, Vol. I.

most rapid growth in a temperature of about 70° F. when much moisture is present in the atmosphere. Cloudy days, with occasional showers, and a close damp air are especially favorable to its growth; and if such periods occur during August and September, the disease may appear at any time. But, on the contrary, if the season is dry and hot the fungus is unable to develop, and little or no injury of this nature can appear. It is for this reason that the potato rot is not a regular visitor in most parts of the state, but is more generally confined to certain localities. These are found in the more northern potato districts, in the regions near the sea coast, and in some parts which have a high altitude. In such places the fungus may develop regularly every year, and the severity of the attack will be modified chiefly by abnormal atmospheric conditions.

The fungus causing the late blight of potatoes passes the winter in two forms. The mycelium, or vegetative portion of the parasite, may retain its vitality until the following spring, when growth may again begin and further attacks of the fungus take place. These are followed perhaps by less serious results than those which result from the other form. This second method of surviving the winter is effected by means of a small fruiting body known as an oospore. It is surrounded by a comparatively hard covering and is able to resist considerable extremes of temperature and moisture. The spores are produced in the fall within the tissues of the potato plant, and here they remain until the following spring or summer. By the gradual decay of the surrounding tissues these spores become liberated and when dry may easily be spread over wide areas by means of winds and other natural agencies. Those which eventually rest upon potato foliage soon germinate under proper conditions, and reproduce the fungus at the new point of infection. Here the development of the parasite takes place so fast that in a very short time such places become centers from which the disease is rapidly disseminated.

The manner in which the germ tube of a spore penetrates the tissues is interesting. It is now generally believed that the ends of the tube secrete a ferment which has the power of dissolving the walls of the cells comprising the outer layer of leaf tissue. When such an opening has been made, the small thread of the parasite enters and it then rapidly extends to other cells, and soon



the entire destruction of the leaf may be accomplished. A stoma, or breathing pore may also serve as a point of entrance.

The rapidity with which the fungus advances within the leaf tissues depends very largely upon external conditions, and the appearances of the affected parts is also modified to a very considerable extent. Unfavorable conditions frequently render the identification of the parasite a difficult matter without the aid of a glass, but under such circumstances the disease may be fairly widespread and still cause little injury. In serious attacks, however, many characteristic symptoms may be easily recognized.

The colored plate represents a leaf which has been entered in several places by the fungus causing late blight, or potato rot. The growth of the parasite has been rapid, and the illustration may be considered as a typical example in which the normal development of the disease has taken place. The following points should be noted :

The diseased areas are of considerable extent, and possess a rich brown color. They may be situated in any part of the leaf, but the edges appear to suffer more from new infection than the more central portions of the leaflets. This is probably due to the fact that in case of rains these portions remain moist for a longer period than the center, since the water drains to the lower parts of the leaflets, and collects there in the form of drops of greater or less size. It is to be expected that under such conditions a fungus could gain an entrance more easily than in drier places. The decayed portions are inclined to droop; this is especially true in cases of rapid invasions, for at such times the parts do not dry so fast as the parasite advances. The rapid decay also prevents the edges of the leaflets from curling, although this takes place when the air becomes warm and dry.

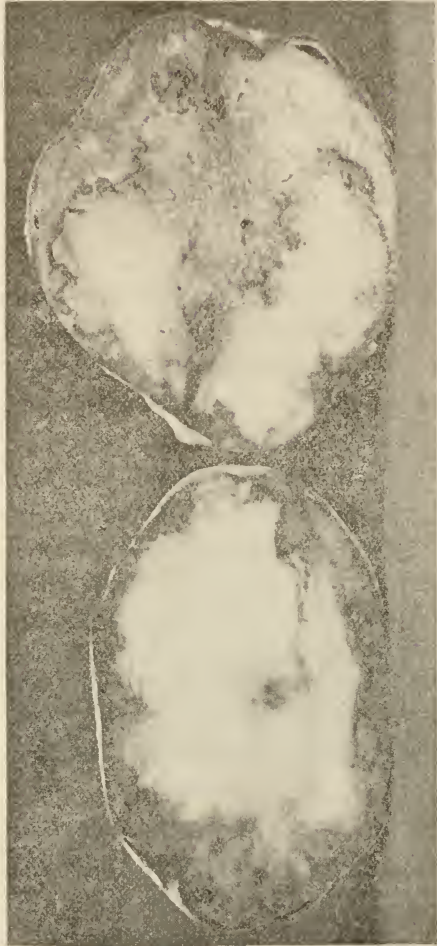
The distribution of colors over the affected leaf is very suggestive. Under normal conditions, the unaffected parts retain a deep green color, while the diseased area may be yellowish-brown, dark brown, or nearly black. But whatever the color, each area is sharply outlined. There is no gradual merging of one into the other, but a distinct change of color marks the progress of the disease. Occasionally another peculiarity may be noticed. If the leaves are closely examined it will be found that the green and the brown areas are not directly in contact with each other; they are

separated by a narrow strip in which the green has been destroyed, and the brown has not yet appeared. It consists of a colorless or at most a very pale yellow line in which the growth of the fungus is probably very active. But during periods which are unfavorable to the development of the parasite this line cannot be discerned, and the green and brown tissues are apparently in contact. Under such circumstances the identification of the disease without the aid of a microscope is an exceedingly difficult matter. Let us suppose that the fungus has succeeded in gaining an entrance, and that it has advanced a limited distance in the leaf tissues. If at this time the weather should turn dry and hot, the development of the parasites would be checked, and the result would be the formation of a small brown spot or area perhaps near the edge of the leaflet, and if several such spots exist the injury might be ascribed, without careful examination, to what is commonly known as the early blight fungus.

The name "downy mildew" has been given to the potato rot disease from the fact that there appears, under favorable circumstances, a downy or mouldy growth upon the under surface of the leaves. This is white in color and may be of considerable density. The upper surface of the foliage does not show it, but whenever this frost-like growth appears on the under side, it is almost certain that the potato rot fungus is present, especially if the other conditions mentioned above are also present. This external growth consists of spores and of the parts bearing them. The spores, or conidia, mature very quickly, and have the power of immediately propagating the fungus. They are small and light, and may be carried long distances by winds. It is largely owing to these bodies that the progress of this potato disease is so rapid. They are produced in countless numbers and are very energetic in attacking healthy tissue. It appears to be very probable, also, that these conidia, or summer spores, are the cause of the rotting of the tubers. After maturing upon the leaf, some fall to the ground and by means of water and other mechanical agents they are brought in contact with the tubers growing underneath the surface of the soil. Here they germinate and effect an entrance in the same manner as occurs above ground. The color of the affected parts also changes, a brown, dry rot taking the place of the normal white color (see Fig. 98). The more slowly the tubers decay, the less is the amount of moisture

present; the contrary is also true. The decay does not take place in a uniform manner, but its progress varies in different tubers. In some it is mostly the parts near the surface that are affected, while in others the disease may advance rapidly towards the center of the tuber, causing the exterior to show a much smaller amount of disease than is actually present. The discoloration, however, generally presents a uniform appearance. Although it is by no means impossible for the mycelium to reach the tubers from the leaves by means of the stems, still it is the generally accepted opinion that infection does not take place in this manner. This belief was held many years ago, for in some of the earlier writings recommendations may be found in which very high hilling is advocated so that the spores may be washed past the tubers and away from them, and not through the soil directly to them.

There is still another feature of the late blight which it is well to bear in mind. The disease generally appears during August and September, although earlier and later attacks are not very rare. Coming so late in the season, all the earlier varieties are comparatively free from attack, but the later ones are especially



98.—Potato tubers affected with dry rot, (*Ptyophthora infestans*.)

subject to the disease. This, however, is not necessarily due to the foliage of such varieties being more susceptible, but rather to the habits of the fungus. I have not observed that the age of the potato plants has a marked influence upon the spread of the disease; nor that the young foliage of the plants is less subject to the disease. It appears as if the parasite is able to thrive upon all potato foliage which is in a healthy condition at the time of the germination of the spores, and that old and young foliage or plants suffer practically to an equal extent. This matter is here emphasized because it will be considered again in connection with the early blight of potatoes.

2. EARLY BLIGHT; LEAF-BLIGHT (*Macrosporium Solani*, E. & M.).—It is only within the past five or six years that the early blight of potatoes has been recognized by scientists and farmers as a distinct disease.\* The trouble has been known during a longer period, and its general character fairly well understood. But the attention which in former years was given to the potato rot fungus caused this second disease to be overlooked, or at least to be regarded as perhaps a peculiar condition resulting from the attacks of late blight, or from certain conditions unfavorable to the growth of the potato plant. But since 1891 the fact has been clearly established that two distinct evils have preyed upon potato foliage, and since that time the second trouble, or, as it has been popularly called, the "early blight," has received considerable study.

The one character which was probably the most valuable in distinguishing the two diseases is the fact that plants having the early blight do not necessarily have rotten tubers, but on the contrary these are almost invariably perfectly sound, although small. The slow progress of the disease, and the peculiar discoloration and shriveling of the plants also made it apparent that there were two distinct diseases affecting the crop.

But the real cause of this trouble has not been found with equal readiness and certainty as was the case with the potato rot. Although at first it appeared as if the entire trouble could be laid at

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\*For bibliographies of the earlier contributions concerning the early blight of potatoes, see Jones, 6th Ann. Rept. Vt. Agric. Exp. Sta. 1892, 66 et seq. Also Sturgis, 18th Ann. Rept. Conn. Agric. Exp. Sta. 1894, 127 et seq.

the door of the fungus *Macrosporium Solani*, yet later investigations have shown that the matter is not so simple as at first appeared. It is true that this fungus is almost invariably found in plants affected by this blight, and that the life of the plants is shortened perhaps to a considerable extent by the fungus, yet it may be doubted whether the whole trouble should be ascribed to the one organism. But, before entering into detailed discussion concerning the cause of the early blight of potatoes, it may be well to define as clearly as possible the trouble which is generally designated by this term.

Upon referring to the plate it will be seen that the leaf upon the right differs considerably from the one which has thus far been considered. This illustration also was made from a typical leaf in order that the more essential features of the trouble might be the more clearly brought out. It will of course be understood that many variations occur, and that these are so great that frequently it is impossible to distinguish with the naked eye whether the phytophthora or the macrosporium is present. Such cases are by no means rare, and I have seen a single leaflet suffering from the attacks of both fungi, as was proved by cultures, yet the two diseased areas were practically indistinguishable. Nevertheless, the following characters will be of assistance in determining which of the two fungi is responsible for the trouble.

Perhaps the most striking differences between the two leaves lie in the size, form and position of the diseased areas. In the leaflets affected with the early blight, it will be seen that these areas are small as a rule, and that they are almost circular in outline except where several have coalesced, in which case the entire area is of irregular outline; but all inequalities have rounded outlines. It appears as if infection occurred at a great number of points, instead of in a few, as shown in the other figure. And it is also interesting to notice that these many points of infection are, with but comparatively very few exceptions, placed along the outer edges or periphery of the leaflets. Although the same is to a certain extent also true with the other disease, still the fungus causing the potato rot does not confine itself nearly so persistently to the edges, but as soon as it is established it extends rapidly to all the softer tissues of the leaflets regardless of whether these are in

one part of the leaflet or in another. It may also be stated of the early blight that frequently the leaf tissue situated along the larger veins succumbs to the disease more slowly than do those portions which are further removed from the veins.

If these diseased areas are very carefully examined, it will be found that it is a very common occurrence to find numbers of slight elevations or ridges arranged in circles about a common center. These may vary slightly in color, but they are perhaps most noticeable on account of their apparent elevation. Since such ridges are absent, so far as my observations go, in areas affected by the late blight, their presence is of considerable value in determining the character of the disease, the more so since the general color of the parts destroyed is very similar in the different cases.

When the colors of the green and apparently unaffected tissues in the figures are compared, another marked difference will instantly appear. The leaf affected with the late blight shows sound healthy tissues up to the region penetrated by the parasite. The leaflets appear to suffer only in those parts actually invaded by the mycelial threads of the fungus. Yet what is the meaning of the yellow color which pervades almost all parts of the other leaf? No parasite appears to have reached these portions, and yet they are manifestly unhealthy. Two explanations might be advanced; first, that the presence of the fungus has an injurious action extending beyond the parts in which it is growing, a supposition which may be said to have but very little support; and second, that the yellow color is due to a natural weakening or maturing of the plant, this in turn being brought about by untoward circumstances or by age. This point will be touched upon more fully under the causes of the early blight.

In the illustration, the edges of the leaflets are shown as having curled to a very marked degree. Such curling is not necessarily an indication of early blight, since whenever the leaf tissue dies, especially at the outer extremities of the leaflets, the tendency seems to be for the leaf to roll upon itself, as shown in the figure. Yet this character possesses a certain significance. In order that a leaflet should assume the position of those here represented, it is necessary that the death of the tissue shall occur more or less

slowly, and that the change shall take place from the outer portions toward the center. As already stated, such conditions may or may not appear during an invasion of the late blight, and for this reason the curling of leaflets affected by early blight is of considerable value in identifying the present disease.

In addition to the characters above mentioned, there are several other factors which appear to be clearly connected with the early blight of potatoes. As the popular name of the disease implies, its appearance may be expected earlier in the year than the late blight; but from this it does not follow that later attacks may not take place as well. The growth of the fungus does not seem to depend so much upon the season as it does upon the condition of the plants exposed to infection. The writer has occasionally seen potatoes of the same variety growing side by side, but which were planted at different times, but were unequally affected by disease. The earlier plantings invariably showed much more injury than the later ones. In some cases the difference was so marked that it would scarcely be exaggerating to say that the younger plants were entirely free from disease, while the older plants, or those first set out, had lost about 50 per cent. of their foliage area. Other modifying conditions were sought, but no other conclusions could be drawn than that in these cases at least, the entrance of the fungus depended upon the plants having reached a certain age.

A similar circumstance has frequently been noted in various parts of the state, with this difference, however, that the plants growing side by side were not of the same varieties. The effect was especially marked when late and early varieties were grown in the same field. The earlier the potato the sooner did it show the effects of disease, the later varieties remaining free for a long time; or, in case of late plantings, the foliage may have escaped the trouble to a marked extent. A large number of fields have been examined with these points in mind, and such observations have led to the conclusion that young, vigorously growing plants are practically free from the disease, while those which have almost completed their growth of foliage, and are rapidly forming tubers, are much more subject to attack.

The time of the appearance of early blight may, therefore, depend upon questions of plant physiology fully as much as upon the season, or even more so. Since fully developed plants, regardless of variety, are more subject to disease than the younger and more vigorously growing ones, it would seem reasonable to conclude that conditions which would cause the plants to ripen prematurely, or that will check the normal growth, will at the same time favor the appearance of the early blight. Facts tend to support this view of the case.

It has been my observation that plants grown upon dry soils, those which are naturally warm and "quick," are more subject to the disease than those grown in moister places in the same field. That is, the early blight appeared first upon the high and dry knolls, and it is here also that the tubers mature the earliest. Seasons of protracted drought, therefore, might be supposed to have a similar effect, and the testimony of all observers bears out the supposition. It is in dry weather that the early blight progresses most rapidly, the late blight requiring a moist atmosphere for its best development. The falling of rain upon a field in which the tops are gradually yielding to the invasion of early blight has a tendency to freshen the plants and apparently to give them a new lease of life. Water seems to be the one thing most needed. Upon lower land the conditions are different, and, as a rule, such lands suffer less from drought, and the potato crops less from the early blight.

A curious exception to the above may here be noted. I have many times seen potatoes growing under trees in dry fields where all the potato plants were suffering severely from the early blight except those protected by the foliage of the trees. As a rule the thicker the foliage upon the tree, and the nearer the branches came to the ground, the less was the injury from blight to the potatoes below. This may be explained by supposing that the spores of the fungus (assuming it to be the sole exciting cause of the trouble) are unable to reach the plants, a scarcely warrantable belief; or, that the spores which do succeed in reaching the potato foliage are unable to germinate on account of lack of moisture. There are several arguments forming the second supposition, for, with the exception of the more or less complete absence



of direct sunlight and rainfall, the plants growing under the trees are in practically the same condition as those growing within the area occupied by the feeding roots of the tree. They have about the same amount of soil moisture and of heat, and they also suffer to nearly the same extent from injury by insects. But they escape the moisture of light showers, and they are also free from dew. It appears probable, therefore, that the secret of their immunity from disease lies in this fact.

Although the character of the season exerts a great influence upon the prevalence of early blight, it is not the only great factor which has the power of seriously reducing the vitality of potato plants. A second agent is a small organism which often appears in countless numbers. It is generally known as the flea-beetle, on account of its quick movements when disturbed. The injury done to the foliage by these little beetles is greater than was formerly supposed. They feed upon the tissues of the leaves, taking out small amounts at different points. Very frequently sufficient material is removed to cause the formation of small holes which extend through the leaf. The diameters of these holes are scarcely larger than that of a pin, yet a leaf is often riddled to such an extent that its vitality is seriously affected. In the plate the leaf affected with early blight shows the results of the work of these insects, yet only the more serious part of the injury could be represented. If a fresh leaf is closely examined it will be found that there are many places in which the beetles have begun to feed, yet when the epidermis of the leaf has been penetrated, and only a few of the cells underneath have been destroyed, the insect changed its base of operations, leaving scarcely a trace to bear witness of its presence. It is true that often when a leaf has been partially pierced, the color of the spot becomes much lighter, but the intensity of the color depends very largely upon the amount of injury done, and in certain cases the change can scarcely be distinguished.

The results of such repeated attacks of the flea-beetle cannot be otherwise than disastrous to potato foliage, and I have heard several growers maintain that the work of the flea-beetle is more to be dreaded than that of any other organism which injures the plants. In localities where these beetles are numerous, such

statements do not exaggerate the matter, for the vigor of the entire plant is frequently much reduced by these insects.

From what has already been said regarding the physiological effect of other injurious influences, it would seem very probable that the work of the flea-beetle may also be considered as being a means of reducing potato plants to a condition which renders the development of the early blight fungus possible. This supposition is supported by facts. If a potato leaf is examined when the first traces of early blight appear, it will probably be found that the first browning of the tissue occurs about the edges of holes made by flea-beetles, or in places in which the tissues have been but partially injured. This is perhaps not always the case, but it has proved to be so in the vast majority of the leaves which I have examined. A reddish-brown zone of varying width is formed about a central point (see plate) and this gradually enlarges until other similar discolorations are met, and the gradual uniting of several of these originally distinct areas, causes the more or less continuous destruction of the tissues at the edges of the leaflets. When the discolorations start nearer the center of the leaf, they generally remain isolated for a longer period.

The later stages of the disease are well known to potato growers. The entire leaves gradually assume the brown and shrivelled appearance, and the stems in turn become yellow, dry and brown, so that nothing remains of a formerly green and flourishing plant except a few withered remnants of foliage and a number of small, partially developed tubers. These do not rot, but owing to the death of the tops they remain small from want of nourishment.

It follows from the preceding remarks on the early blight, that the fungus which is commonly held responsible for the injury is not a true parasite; that is, it will not attack healthy tissue, but only succeeds in obtaining a foothold after the potato foliage has become weakened by age, by unfavorable climatic conditions, or by mechanical injuries chief among which is probably the flea-beetle. This places the most effective lines of treatment upon a different basis from that generally followed with other fungous diseases; instead of preventing the entrance of the organism by means of protective substances, the constitution of the plant



LATE BLIGHT

Drawn and Colored from Nature for  
Cornell University Experiment Station.



EARLY BLIGHT

COLORITYPE CO., N. Y.,

## POTATO-LEAF BLIGHT



itself is to be strengthened, and the removal of as many injurious influences as possible is desired.

There appears to exist another trouble which is generally confounded with the early blight; in fact it is very difficult to distinguish the two without the aid of laboratory methods. This disease, which is entirely of a physiological nature, has been thoroughly discussed by Sturgis.\* It has been found only to a limited extent in New York, for almost invariably cultures made from affected leaves freely developed the early blight fungus. According to Sturgis the same conditions which produce the early blight also bring about the death of certain parts of the leaf tissue in a manner almost identical with that of the macrosporium. He says: "Both classes of injury appeared in connection with the marks of the flea-beetle. Both were exhibited as brown spots and blotches marked with concentric rings; but in specimens characterized by the presence of the fungus, the spots were more sharply defined and darker in color. This difference was sufficiently marked to enable a close observer to distinguish either one in the field after a little practice, but a comparison between the two produced the impression that both classes of injury might have been caused by the same agency, and that the slight difference in appearance might be due to the fact that in the one case a fungus had occupied the injured tissue, and in the other had not done so."

It seems, therefore, that the causes which lead to the appearance of these two diseases are the same, and the same lines of treatment are consequently indicated.

3. POTATO SCAB (*Oospora scabies*, Thaxter).—This disease is one which is well known to potato growers. Figure 99 represents affected tubers. The uneven, warty growths upon the surface of the potatoes are composed of material produced by the tubers in consequence of the irritation of parasitic organisms which live upon the substance of the potatoes. Under favorable circumstances these injuries are very extensive, for the entire surface of the tuber may be affected, and although the affected parts do not always penetrate very deeply, the blemished appearance of the tubers and the actual loss of material may become very serious.

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\*Ann. Rept. Conn. Agric. Exp. Sta. 1894, 127-134.

The causes of potato scab have been discovered only within recent years. The disease was carefully studied in 1889-90 by H. L. Bolley, who was then assistant botanist of the Indiana Experiment Station. The results of his work appeared in *Agricultural Science*, 1890, Nos. 9 and 10.\* He ascribed the cause of the trouble to a certain bacterium which had the power of injuring tubers while they were in active growth, but later caused little injury. The injuries produced by the microbe are generally rather shallow, not extending deeply into the tissues of the tubers.



99.—Scab on potatoes.

Later in the year 1890, Dr. R. Thaxter, of the Connecticut Experiment Station, read a paper upon potato scab in which it was stated that potato scab is due to the work of a fungus.† More recent investigations have verified the work of Thaxter, and it is now the generally accepted belief that practically all the injury which is commonly known as scab is due to a fungus (*Oospora scabies*, Thax.). This frequently enters deeply into the potato, especially if the infection occurs early in the season when

\*See also N. Dak. Agric. Exp. Sta. 1891, Dec. Bull. 4, which contains a record of Bolley's work and a full bibliography of the subject.

† The paper was read Nov. 12, 1890, at Champaign, Ill., before a meeting of the Association of Agricultural Colleges and Experiment Stations. See also a full account in the Ann. Rept. Conn. Agric. Exp. Station. 1890, pp. 80-95.

the tubers are small. When older tubers become affected, the injury generally assumes the form of a corky crust upon the surface.

The conditions which favor the growth of the potato scab fungus are dampness and an alkaline condition of the soil. It is a common experience that scab is more prevalent in soils rich in organic matter, and abundance of air and moisture allow a more vigorous growth of the parasite to take place.

The fact that an alkaline soil causes more severe attacks of potato scab has an important practical bearing. A soil may be made alkaline in a number of ways, especially by the addition of certain fertilizers. Lime has a very strong tendency in this direction, and stable manure exerts a similar influence. This fact has undoubtedly given rise to the popular belief that stable manure will increase the amount of scab upon potatoes. The appearance of the fungus may be favored merely by the alkaline condition of the soil, or it may actually be applied to soil which is free from the disease, and thus an entire field be infected by the fertilizer. If both the soil and the manure are free from disease, no scab will appear, unless it exists upon the tubers used for seed. All fertilizers which have a tendency to produce an acid condition of the soil may check the growth of the fungus, and by the proper selection of fertilizing material sometimes a very marked effect may be produced upon the crop.\*

During 1894, a third cause for the injury generally known as scab was advanced by A. D. Hopkins, entomologist of the West Virginia Experiment Station. The first account of his investigation of this disease was read before the West Virginia State Horticultural Society April 6.† In this paper it was said that the larvæ of one or two species of insects (*Epidapus scabies*, Hopkins, and *Sciara* sp.) disfigure potatoes in a manner very similar to that of the scab fungus. In the more northern states, however, these insects do not appear to be so troublesome, and the methods

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\*An excellent account of the effect of various chemicals and manures upon the amount of scab upon potato tubers has been published by Wheeler and Tucker in Bull. 23, of the R. I. Agric. Exp. Sta. Oct. 1895.

See Special Bull. 2. W. Va. Agric. Exp. Sta. pp. 97-111. Also Proceedings of the Washington Entomological Society, May 3, 1894; Insect Life, vii. p. 147.

of treatment recommended for the destruction of the fungus are generally very effective in controlling the disease.

## B. TREATMENT OF FUNGOUS DISEASES.

1. POTATO ROT OR LATE BLIGHT.—Bordeaux mixture is the sovereign remedy for the rot or late blight. It was first successfully used by the French in 1886 and since that time innumerable experiments have been made with this fungicide in checking the trouble. Success has followed whenever the applications have been properly made, and it is no longer a question whether the mixture will prevent the blight; it is now entirely a matter of judgment and skill on the part of the grower. If the Bordeaux mixture is properly made\*, and thoroughly applied at the right time, scarcely a decayed tuber should appear in the field. It is impossible to state when the first applications should be made, nor how many times the plants should be treated, for the conditions vary so much in different localities. As a rule it is unnecessary to begin spraying before the middle of July, and the first of August will prove none too late in the majority of cases. The character of the season, and the prevalence of the disease in former years must serve as guides as to the best time to begin spraying. In certain localities the late blight appears with considerable regularity, and in such cases it is well to spray about ten days before the period in which the trouble is generally first noticed.

Later applications may be made at intervals of one to three weeks, depending upon the weather. Even in years favorable to blight, three applications should be sufficient to protect the plants almost perfectly. The foliage should be thoroughly covered from above, and if the spray may be conveniently applied from below also, so much the better. A fine and abundant spray will be found most satisfactory (see page 325 for report upon spraying machinery).

2. EARLY BLIGHT. The successful treatment of the early blight is by no means an easy matter, as appeared in the discussion of its probable causes. It was shown that the early blight does not appear

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\* A good mixture for use upon potatoes may be prepared by dissolving six pounds copper sulphate in about twelve gallons of water; slake four pounds quicklime and add to the copper sulphate solution. Dilute to forty gallons. If the ferrocyanide of potassium test is employed, put in about one-fourth more lime than the test solution shows to be necessary.



until the period of active growth is passed, or until the plants have become weakened by some mechanical agency.

The first step towards checking the trouble, therefore, is to maintain the plants in as vigorous condition as possible. Proper fertilization, abundant cultivation, and close attention to the welfare of the plants become matters of prime importance. The selection of suitable land in favorable localities, and its thorough preparation will also prove of material benefit. This disease is an excellent example of the theory that disease in plants is not the prime cause of injury, but rather only an indication or symptom of weakness which existed before the injurious organism could gain an entrance, and which in fact must exist before such an entrance can be effected. The idea, however, does not apply so aptly to all cases of the disease.

The mechanical injuries to potato vines are mostly brought about by insects, and chief among these is the flea-beetle. The methods of treating this pest will be found on page 323.

The bulk of the injury done by the early blight has been ascribed to a fungus (*Macrosporium Solani*) which unduly hastens the destruction of plants that are already on the down-hill side of life. The fungus is widespread and is undoubtedly responsible for much of the injury done to potato crops.

During the summer of 1895 the writer endeavored to control the early blight by means of thorough application of the Bordeaux mixture. Four plots were selected for the work, I and II being upon the University farm where Professor Roberts kindly allowed me the use of certain portions of the potato field, and materially assisted in carrying on the work; plots III and IV were upon the farm of H. R. McNair, Dansville, N. Y. By distributing the plots in this manner it was hoped that more accurate and convincing results might be obtained.

*Plot I.*—The land selected for the experiment was divided into four sections, each covering an area of a little more than three square rods. Burbank potatoes were planted May 16 in rows  $3\frac{1}{2}$  feet apart, the pieces being put in at intervals of 14 inches. At this rate it was estimated that about 10 bushels of seed would be used per acre.

Notes taken July 5 show that the plants were growing vigorously, and were scarcely troubled by flea-beetle. The first application was made at this time, the four sections receiving the following

treatments: 1. Bordeaux mixture made May 18, it having been allowed to stand since that time and receiving only an occasional stirring; 2. Bordeaux mixture freshly prepared;\* 3. No treatment; 4. Copper chloride mixture.† The materials were applied with a knapsack pump and Vermorel nozzle. It was found that the application could be made very satisfactorily in this manner with the exception of section 1, which received the old Bordeaux mixture. The sediment settled so fast that it was mostly applied before one-half of the required amount of liquid had been used, in spite of repeated shaking of the tank by the operator. This necessitated a second treatment immediately after the first, the work being started at the opposite end of the section.

On July 23 the above treatments were repeated with the exception that section 1 received but one application, the distribution being still more uneven than the first time. There was some indication of early blight, yet not enough to distinguish whether the treatments had been of value.

August 28, however, showed a marked difference in the appearance of the sections. The third, which was untreated, had fully 50 per cent of its leaves badly affected; the first was as bad as the check where little of the sediment had been applied, but where the spraying had commenced, and consequently upon that part which received most of the solid contents of the knapsack pump the foliage was much better, scarcely 10 per cent of the leaves showing serious injury. Section 2 also appeared very thrifty, since the foliage averaged fully as well as the best parts of section 1. Section 4, the one which was treated with the copper chloride mixture, appeared to have fully 25 per cent of its leaves seriously attacked. Section 2 was again sprayed with fresh Bordeaux mixture, the other sections remaining untreated.

Other observations were made September 12. At this time the relative amounts of early blight appeared to be about the same as two weeks previous. The part of section 1 which had received most of the sediment was in as thrifty condition as section 2, which

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\*The Bordeaux mixture was made according to the "Normal" formula; copper sulphate, 6 pounds; quicklime, 4 pounds; water, 45 gallons. This mixture contains copper sulphate at the rate of 1.6 per cent of the weight of water used.

† This mixture was made by dissolving 3 ounces copper chloride in 24 gallons of water, and then to this solution was added 6 ounces of slacked quicklime.

had received the extra treatment. From this it would seem that the last application made to section 2 was of minor importance. The vines at that time had practically completed their growth, so that there was little new foliage exposed to the disease. The rainfall had also been slight, and the Bordeaux mixture could still be plainly seen upon all sections treated with it.

The potatoes were dug September 26. Since the sections varied somewhat in size, the yield of each has been estimated upon the proportionate yield per acre, this furnishing a more convenient basis for comparison. The result was as follows:

Section 1. Old Bordeaux mixture,	332 bushels per acre.
“ 2. Fresh Bordeaux mixture,	350 bushels per acre.
“ 3. No treatment,	284 bushels per acre.
“ 4. Copper chloride mixture,	297 bushels per acre.

The apparent gains from the treatments of the sections were accordingly, 1-48 bushels; 2-66 bushels; 4-13 bushels. The advantage derived from the copper chloride mixture is so slight that it promises little practical value. The results obtained with the Bordeaux mixture, however, are more encouraging, and seem to indicate that it may be possible to spray for the early blight, although the margin may at times be close.

To what extent these gains were due to the prevention of injury to the flea-beetle it is difficult to say. The vines which were most thoroughly sprayed with the Bordeaux mixture did not escape the attacks of this insect, as could be seen by the many pits which remained as witnesses of its presence. Untreated plants suffered more severely, as they did also from the early blight. The probable action of the Bordeaux mixture thus appears to be two-fold. In the first place it prevents to a very considerable extent injury from the flea-beetle; in the second place it prevents the entrance of the macrosporium into tissues which have suffered from the work of the insect, and also protects those which are made susceptible to the disease in other ways. It is certain that the fungus was very abundant in the foliage of untreated plants, and it seemed probable that the value of the mixture was just as great in preventing injury from this source as it was in protecting the leaves from the attacks of insects.

*Plot II.* This plot was also upon the University farm. It contained just one-third of an acre, and was planted to several varieties of potatoes, some of which were considerably earlier than others.

The field was divided into two nearly equal parts, the line of division running across the rows so that each part should contain the same proportionate amount of each variety. One portion was sprayed with the Bordeaux mixture, the other part remaining untreated. Applications were made July 13 and August 12, fresh Bordeaux mixture being used each time.

At the time of the second spraying a remarkable difference could be seen between the two parts. The untreated portion showed fully 50 per cent of badly blighted foliage, while that of the sprayed part scarcely exceeded 5 per cent. This difference was especially marked in case of the earlier varieties, and it could be distinguished a considerable distance from the field. The untreated vines perished earlier in the season, and when scarcely a vestige of green could be found in the check section, the other portion was fairly green, at least the tops appeared to possess a decided ability to nourish the tubers which were dependent upon them for support. At this time the very late varieties, such as the Orphan, were all of a deep green color, apparently unaffected either by flea-beetles or by blight. Their turn came later in the fall, although the difference was never so clearly defined as in the case of the earlier varieties.

These potatoes were dug during the last days of September, and yielded at the following rate:

Section 1. Fresh Bordeaux mixture, 311 bushels per acre.

“ 2. No treatment. 272 “

This represents a gain of 49 bushels per acre, a result apparently due more to the prevention of the *macrosporium* than to the destruction of the flea-beetle, for the latter was not conspicuous by its absence. The fungus was very prevalent, and the vines appeared to succumb rapidly when it had once gained a foothold.

*Plot III.* The figures relating to the experiments in plots III and IV were obtained from Mr. McNair, who very kindly looked after the work in such a thorough manner that the results are here published in full. The McNair farm is situated near the head of the famous Genesee Valley, upon the bottom lands. The potato rot is an occasional visitor, but during the summer and fall of 1895 practically no rot was discovered, as was also the case upon the University farm, so that the beneficial results of all applications must be due to the prevention of other troubles, these being commonly summed up in the term early blight.

Mr. McNair grew a number of acres of White Star potatoes, and in his field the plots and sections were laid out so that four rows extended from one end of the plantation to the other. Only the two central rows were considered when the yields were measured. The potatoes were planted May 28, and were sprayed with the Bordeaux mixture July 19 and August 5. This mixture was made of different strengths.

*a.* The most concentrated form contained 6 pounds copper sulphate, 4 pounds quicklime, and 40 gallons of water.

*b.* This mixture contained 5 pounds copper sulphate, with lime in the above proportions, in 40 gallons of water.

*c.* The amount of copper sulphate was reduced to 4.3 pounds in 40 gallons, with lime in proportion.

*d.* Only 3.5 pounds copper sulphate were used to 40 gallons, the amount of lime being likewise reduced.

Five sections were selected, each having four rows and containing 24 square rods. One section remained untreated, but the remainder were sprayed with the different mixtures. This was done by an efficient power sprayer which Mr. McNair had made. Vermorel nozzles were used, and very satisfactory work was done, although the amount of liquid applied might perhaps have been increased to advantage.

When the potatoes were dug in the fall the following yields were obtained, the figures again showing the proportionate amounts per acre:

Section 1, Untreated,	209 bushels.
“ 2, Mixture <i>a</i> ,	227 “
“ 3, “ <i>b</i> ,	234 “
“ 4, “ <i>c</i> ,	221 “
“ 5, “ <i>d</i> ,	191 “

These figures are not altogether encouraging for the sprayer. Sections 2, 3 and 4 on the average yielded an increase of only 18.3 bushels per acre, while section 5 produced 18 bushels less than the untreated one. These figures appear to represent the actual gains, yet no apparent reason exists for the decreased yield of section 5. Probably local conditions of the soil exerted this influence.

*Plot IV.* This plot was situated in another part of the field. Only two sections were made, these being still larger than in the preceding experiment. The most concentrated Bordeaux mixture above mentioned was applied to one, the other remaining untreated.

The plants were sprayed at the same time as in the preceding case, and the same machinery was used. When the crop was harvested it was found that

Section 1, untreated, yielded 252 bushels per acre.

“ 2, Bordeaux mixture, yielded 298 bushels per acre.

In this plot, the gain was 46 bushels per acre. Apparently the conditions were exactly the same, and as this result corresponded fairly well with the results obtained in Ithaca it may be stated that spraying for the early blight is of advantage, and if the applications are properly made, the operation should be profitable.

In summing up the gains obtained by spraying with fresh Bordeaux mixture for the early blight, omitting section 5 in plot III in which an actual loss occurred, it is found that the average increase in the four plots is 44.8 bushels, by no means an insignificant amount. In order that such results may be obtained, it is essential that very thorough work shall be done, and that the operation shall take place at the proper time.

Mr. McNair also kindly furnished me with some interesting data regarding the value of having plants sufficiently thrifty to withstand early blight, a subject already discussed upon page 260. He found that in a certain portion of his field the addition of 10 loads of barnyard manure per acre produced an increased yield of 19 bushels. When there were also added 100 pounds of sulphate of potash and 100 pounds of Carolina rock, and the plants were in addition well cultivated and sprayed, the actual increase in yield was 100 bushels per acre, as was shown by an adjoining plot.

The early blight, therefore, should be treated by growing vigorous plants, and by protecting the foliage against the work of insects and fungi by the use of the Bordeaux mixture.

The early blight may also be avoided to a certain extent by planting early varieties, as these frequently mature before the blight does much harm; and also by planting late, for in this case the plants will be in active growth during the season when the blight is most prevalent, and it has already been shown that such plants are practically free from the disease. During the fall, when the plants are maturing, there is less danger of attack.

3. POTATO SCAB.—The remedy proposed by Bolley\* may be considered as almost a specific for this disease. His first recommenda-

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\*N. Dak. Agric. Exp. Sta. Bull. 4, p. 14.

tion was to soak the seed in a solution of corrosive sublimate for one and one-half hours. The solution was made by dissolving 2 ounces of the poison in 15 gallons of water. Potatoes treated in this manner are practically free from the scab fungus, as the latter is usually destroyed, unless the potatoes used for seed are very badly injured. In such cases it appears that some of the germs of the disease may escape and serve as sources of infection in the field. In order to overcome this defect the use of stronger solutions have been recommended, or the immersion of the tubers during a longer time. Bolley's latest recommendation is to dissolve 10 ounces of corrosive sublimate in 60 gallons of water, and the general tendency among experimenters is to use stronger solutions than the ones first recommended. The period of immersion also varies from one and one-half to three hours. Probably the period of treatment may vary with the amount of scab upon the tubers, and with the depth to which the tissues are diseased. The germinating power of potatoes is sometimes impaired if they are treated with the strong solutions for the long periods recommended. It is advisable, therefore, to get as clean seed as possible, but if the potatoes are scabby, to treat them with solutions whose strength increases with severity of the disease on the tuber, at the same time lengthening the period of immersion.

It has been my experience that it is fully as important to have clean land as it is to have clean seed. The fungus causing the trouble appeared upon potatoes which were grown from clean seed upon land that had not been used for this crop during five years, although two crops of beets had been grown upon it during this period. How long the disease may persist is not known, but it was sufficiently severe during the comparatively dry season of 1895 to obscure the results of several experiments designed to show the value of various treatments of Burbank potatoes for the destruction of the scab fungus. The soil selected is a moderately moist gravel loam.

Another portion of the field had not grown potatoes for eighteen years, and the land proved to be entirely free from the disease. The portion selected for the experiments is a comparatively dry gravel loam in a high state of cultivation. The attempt was here made to lessen the disease by means of copper and brass shavings, these being mixed with the soil in the drills. No beneficial results from the treatment were observed, however, even when enormous

quantities of the shavings were used. It was evident that too small an amount of the metals entered in solution to affect the growth of the scab fungus, although the spores of other fungi are unable to germinate in water which has passed through a copper pipe only a few feet in length.

An attempt to increase the amount of scab was, however, entirely successful. A small handful of air-slaked lime was scattered in the drills where the pieces of potato were planted, and when these potatoes were dug it was found that the number of scabby potatoes was more than twice as great as in the rows which received no treatment; the individual tubers were also more seriously affected. Air-slaked lime, therefore, appears to have a decidedly favorable influence upon the growth of the fungus.

An alkaline or an acid condition of the soil becomes a serious matter in certain potato growing regions. This question has been very thoroughly studied by the Rhode Island experiment station\* and several of the conclusions obtained are here given.

“Wood ashes (which, like air slaked lime, consists largely of calcium carbonate), pure calcium carbonate, calcium acetate and calcium oxalate, promote the scab in a high degree.

“Calcium chloride injured the potato plants but entirely prevented scab, although an abundance of germs was probably introduced.

“Calcium sulphate (known as land plaster and gypsum) is the only form of lime employed which has not injured the growth of the crops, and which has at the same time failed to promote with certainty the development of the scab.

“Upon our acid soil, which has been partially neutralized by air-slaked lime, the use of ammonia sulphate has, under otherwise like circumstances, resulted in producing tubers less scabby than where the same amount of nitrogen in form of sodium nitrate was used.

“Common salt has reduced the percentage of scab.

“Sodium carbonate acts in the same way as calcium carbonate, though perhaps not in the same degree, and promotes decidedly the development of disease.

“Barnyard manure, owing to its alkalinity or the production of carbonate from it, has probably in and of itself increased the scab.

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\* Wheeler and Tucker. Bull. 33, pp. 58-79.



“Oxalic acid seems to have a tendency \* \* \* to reduce the percentage of scab.

“By the use of ammonium sulphate and probably muriate and sulphate of potash, Kainit and common salt in connection with *dissolved* phosphate rock, dissolved bone, or dissolved bone black, soils which now tend to produce scabby tubers, would probably become less favorable to the disease. It is possible that a rational system of rotation of crops *which would include no beets or other root crops*, and perhaps no cabbages, would also help to alleviate the condition in such soils.”

## Part II. Insects.

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1. POTATO BEETLE. (*Doryphora decemlineata*, Say.) This insect is too well known to require description. During the past twenty-five years it has been very generally destroyed by the use of Paris green, and in more recent years also by London purple. These poisons were first applied in dry form, being mixed with flour, plaster, air slaked lime, and similar powders. The proportions of the ingredients varied greatly, one part of the poison being added to from one to fifty parts of the diluent. The mixture was then dusted upon the plants by means of perforated boxes, or bags made of coarse material. In recent years very effective machines have been invented for the purpose of making uniform applications of powder with great rapidity, and these have largely supplanted the older devices. The powder is driven forcibly from the machines by means of an air blast; when applied in this manner it is well to mix one part of poison with one to three parts of air-slaked lime. The lime makes the powder visible as it leaves the machine, and it also prevents injury from the poison; for these reasons it is probably the best diluent to use. One and one-half pounds of these arsenites per acre is sufficient for each application.

The more popular methods of applying arsenites at present is to mix them with one hundred and fifty to two hundred gallons of water. An equal weight of quicklime should be added to the mixtures, first slaking the lime in water. This prevents the caustic action of the arsenites, and yet does not interfere with the machinery. When poisons are applied in water with proper machinery, rapid applications may be made at all hours of the day, and with but little regard to the weather.

Paris purple\* is another form of arsenic which has been sold during a number of years for the destruction of potato beetles. It resembles London purple, but is of a deeper color and mixes with

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\* Chemical analysis of Paris purple showed it to contain 34.1 per cent. arsenic trioxide, 40.7 per cent. of this being soluble in water. It is sold by Sykes & Street, 85 Water street, New York.

much greater difficulty with water. In our experiments it proved effective when used at the rate of one ounce to four gallons of water.

Within the past few years another form of arsenic, known as English purple poison,\* has been offered for sale in this country. The results of various trials of the poison upon potato foliage show that when used at the rate of one ounce to four gallons of water it is effectual in destroying the insects. But it also possesses the serious objection of mixing slowly with water.

2. FLEA-BEETLES — The most serious insect enemy of potatoes is undoubtedly the flea-beetle. The insects are scarcely a tenth of an inch in length; they are nearly black in color, and the quickness of their movements has caused them to receive their popular name. There appear to be several broods each season, so their work is more or less continuous during the growing season.

Many remedies have been suggested for the destruction of this pest. Among them may be included the following: Paris green; London purple; decoction of tobacco; kerosene emulsion; air-slaked lime; land plaster; wood ashes; tobacco powder; Bordeaux mixture.

With the exception of the last named remedy, all the above appear to be without practical value for potatoes. I have tried Paris green, London purple, kerosene emulsion, tobacco powder and air-slaked lime with no apparent benefit; and as others have failed in obtaining satisfactory results with these as well as with all the others except the Bordeaux mixture, their use cannot be recommended.

The Bordeaux mixture, however, appears to be a promising remedy. Jones has tested the material very thoroughly and the following is his opinion of the value of his treatments.† “The actual number of holes per leaflet, from the unsprayed row was found upon counting to be 262, which from the sprayed row the average was but 12. \* \* \* These results bear out completely the conclusions of last year, and justify the claims that the Bordeaux mixture is the best practical remedy known for the flea-beetle as it occurs upon potatoes.” The leaves examined by Professor Jones

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\* The poison was introduced by Henry S. Ziegler, 400 N. Third street, Philadelphia, Pa. It contains 36.75 per cent arsenic trioxide, 14.58 per cent of which is soluble in water.

† *Ann. Rep. Vt. Agric. Exp. Sta.* 1894, 96.

appear to have been sprayed with the mixture June 16 and July 17, and the results obtained by him are decidedly encouraging. His work indicates that these early treatments are essential for obtaining the most thorough protection, but as applications of Paris green are generally made at this time for destroying potato beetles, very little extra work is required for treating the vines with the Bordeaux mixture also.

The results of my work during 1895 do not show such marked differences as those quoted above. The foliage of all the plants mentioned in the preceding pages was several times examined with particular regard to the work of the flea-beetle. The number of holes in the leaves was not counted, but the independent estimates of different observers practically agreed with those of the writer, and they may be considered as representing fairly well the amount of protection afforded by the Bordeaux mixture. Upon the university farm it was estimated that the amount of injury upon the sprayed foliage was from sixty to seventy per cent as much as upon untreated vines. The section which was treated with the old mixture showed less injury where the greatest amount of sediment was applied, and more at the other end where the mixture was much diluted.

The potato foliage on the farm of Mr. McNair was also protected, but to a less degree. His plants were treated the first time July 19. The foliage already showed considerable injury from the insect, but no blighting of the foliage was apparent. Five weeks later we estimated the amount of flea-beetle injury upon the section which received the most concentrated mixture to be about eighty-five per cent of that upon untreated vines. In the other sections the difference was still less marked. It would seem that in order to derive the greatest benefit from the Bordeaux mixture in preventing the attacks of flea-beetles, the applications must be made during June and July, and a strong mixture should be used.

## Part III. Spraying Machinery.

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A trial of machinery suitable for the spraying of potatoes was made July 18 upon the farm of J. S. Coombs, Stafford, Genesee Co., N. Y. All manufacturers were invited to be present and to exhibit machines, for the field which Mr. Coombs kindly placed at their disposal was particularly well adapted for such a trial. The land was perfectly level, well cultivated, and the plants only about one-third grown. The farm is accessible from three railroads, and no more favorable conditions could have been desired. The circular letter addressed to the manufacturers stated that the normal Bordeaux mixture (see page 312) would be applied, as this would give them an opportunity to work their machines under actual field conditions.

Upon the appointed day, the following manufacturers were represented: Aspinwall Mfg. Co., Jackson, Mich.; Deming Co., Salem, O.; W. & B. Douglas, Middletown, Conn.; Excelsion Co., New Haven, Conn.; Leggett & Bro., 301 Pearl St., New York; F. E. Meyers & Bro., Ashland, O.; Potter & Ware, Batavia, N. Y. (exhibited a machine made for their own use); Seth K. Samms, Byberry, Philadelphia, Pa.; J. R. Steitz, Cudahy, Wis.; Studebaker Mfg. Co., South Bend, Ind. The machines shown by these ten exhibitors were of very varied nature; small bucket pumps, barrel pumps, power sprayers, gravity sprayers, and powder guns were to be found among them. Twenty machines were exhibited, and most of them were tried in the field, each manufacturer having at his disposal an acre of land.

Before the field work was commenced, a committee of local potato growers was appointed; this committee was to judge of the merits of the various machines, considering them from the standpoint of practical growers. The men selected by the local Grange were as follows: J. G. Fargo, E. D. Rumsey, J. H. Potter, C. E. Shepard, all of Batavia; and J. Lathrop, of Morganville. Following is the report of the committee:

“The first machines in the field were those in which no pumps were used for forcing the liquid. The only power used was the force of gravity, the fluids passing downward from the tank to the outlet orifices. The Steitz potato sprayer was soon found to be working under disadvantage. The agitator broke almost at the moment of starting. The machine is designed to spray two rows at once; the liquid runs over two broad pieces of galvanized iron, one being over each row, and then it is broken up into a fine spray by means of rapidly revolving brushes. The holes through which the liquid passed upon the iron were too small, so that the plants



100.—An excellent home-made potato sprayer, treating four rows.

were not properly covered. Another objection to the machine was found in the tank; this was too small, and it could be increased two or three times its present capacity to advantage.

“The Studebaker machine was built on the pattern of a street-sprinkler. The mechanism forming the discharge was designed to be so constructed that any desired amount of liquid could be thrown in a fairly fine spray. The machine could not be made to work satisfactorily, as too much or too little liquid was thrown, and the spray was altogether too coarse for efficient and economical work. Even clear water was not thrown satisfactorily.

“The Aspinwall sprayer was then tried, the result being somewhat similar to that produced by the preceding machine. It

clogged repeatedly, and proved to be unsuited to throwing Bordeaux mixture.

“A change was introduced with the appearance of Samms’ machine, this being known as ‘Roberts’ Improved Atomizer.’ It is designed to spray four rows. Three small streams of liquid left the machine over each row, but immediately upon leaving the discharge pipes, they were broken by blasts of air into an exceedingly fine spray which was well distributed over the plants. The machine worked admirably, and demonstrated its capability of spraying 4 rows of potatoes as fast as a walking team could draw it. The amount of liquid leaving the discharge pipes was found to be too small, but this defect could be easily remedied. Another objection was the cost of the machine, the price being \$65.00.

“Power sprayers were represented by Deming’s ‘Monarch.’ This is constructed so that five rows may be sprayed at once. A double-acting brass pump is worked by gearing, and it is sufficiently powerful to supply the nozzles, which are held over each row, with the required amount of liquid. The work of this machine was also very satisfactory. The spray was produced continuously, it was forcibly applied to the plants, and the amount of liquid thrown could be varied by the use of different nozzles. The ‘Monarch’ was one of the most useful machines exhibited; but its high price, \$75.00, is an item which may discourage some from using it.

“The greatest sensation of the day, however, was occasioned by the appearance of the home-made sprayer of Potter and Ware. Figure 100 represents the appearance of the outfit. An ordinary barrel spray pump was fastened to a barrel having a capacity of about fifty gallons. The liquid was pumped into a gas-pipe which was supported upon a light frame at the rear of the wheels. This pipe was fitted with four discharges to which nozzles could be attached. Four rows were sprayed at once, the work being fairly well accomplished as the horse walked across the field. Mr. Ware drove and pumped at the same time, and the machine worked without a break. The plants were uniformly although rather lightly covered, and the machine was pronounced a decided success by the four or five hundred people who saw it in operation. It should serve as a model to potato growers who desire this kind of an outfit.

“The Douglas and the Deming knapsack pumps were then brought into the field and both worked well. The pumps are sufficiently strong to force the Bordeaux mixture through Vermorel nozzles, and a very thorough application could be made. But the severe labor, and the slow rate of progress will prevent this type of machine from becoming popular for potato spraying. Myers’ ‘Fountain Knapsack Spray Pump’ is a gravity sprayer, the liquid being forced through a perforated disk by means of a rubber bulb situated immediately behind it. Bordeaux mixture could not be applied with this device, as the holes in the disk clogged continually. When clear water is used, good work may be done.

“The powder guns of Leggett and of the Excelsior Co., did excellent work. They are easily worked and efficient. The only objection to them is that they treat but one or two rows at a time and this becomes a serious fault when large areas have to be treated. This objection is the more weighty when one considers that the most efficient applications of powders can be made only on a still day and when the foliage is wet.

“The other pumps which were exhibited were not tested in the potato field. The Deming and the Douglas pumps were found to be very strong, serviceable, and apparently durable, and with the proper attachments they could be made of service in spraying potatoes.

“In conclusion, it is the opinion of the committee that as a rule the best machines are those in which a pump forces the liquid through nozzles, so that a uniformly fine spray may be produced. Gravity machines, with the exception of ‘Roberts’ Improved Atomizer,’ proved to be unsatisfactory, although the Steitz machine, if slightly modified, could be made serviceable.

“Signed

J. G. FARGO, Chairman.

E. D. RUMSEY.

J. H. POTTER.

C. E. SHEPARD.

JAY LATHROP.”



## SUMMARY.

1. Potato rot, or late blight, is caused by a fungus which may develop with extreme rapidity under favorable circumstances; it may cause the decay of all parts of the potato plant, including the tubers. (Page 297.)

2. The conditions favoring the growth of the parasite are a temperature of about 70° F. and a moist atmosphere. Few sections of New York are every year seriously troubled by the disease. (Page 298.)

3. A leaf affected by late blight normally shows distinct brown and mostly large areas of varying form, but usually not circular spots; these may enlarge very rapidly, the under surface of the leaf showing a frost-like growth in the parts first attacked. Unaffected portions of the leaves retain their healthy green color. (Pages 299, 300.)

4. Tubers affected with potato rot assume a dark color where the fungus is found. Where decay takes place slowly, the dead portions become dry and shrivelled; during rapid invasions considerable moisture may be present in the rot. (Page 301.)

5. The early blight of potatoes does not cause the tubers to rot. A more or less rapid drying and curling of the leaves and stems mark the presence of the disease. The edges of the leaves are first visibly affected; the color changes to yellowish brown, while the central parts of the leaflets gradually become lighter green or even yellow and more or less spotted. Eventually all portions above ground turn brown. (Pages 302, 305.)

6. Young, vigorous potato plants do not appear to suffer from early blight. (Page 306.)

7. The probable causes of early blight, as found in New York, are the following: A fungus, this having the power of attacking only such tissues as have become weakened to a certain extent; unfavorable conditions of soil or atmosphere; mechanical injuries to the foliage, commonly produced by flea-beetles or other insects. (Pages 307, 309.)

8. Potato scab, as commonly found upon the tubers, is due to the presence of a fungus. Similar blemishes have also been ascribed to the work of bacteria, and to insect injury. (Pages 309, 312.)

9. The late blight of potatoes may be successfully treated by spraying the vines two or three times with the Bordeaux mixture. The first application should be made during the latter part of July; it may be repeated at intervals of one to three weeks. (Page 312.)

10. The early blight of potatoes may be treated with partial success by means of the Bordeaux mixture. The vines should be sprayed when about two-thirds grown, and the application should be repeated as necessary, the foliage at all times being well covered with the mixture. (Pages 312, 313.)

11. Proper methods of fertilization and cultivation have also proved to be of much value in reducing injury from early blight, as was shown by greatly increased yields. (Page 313.)

12. The apparent increased yield per acre of potatoes sprayed with the Bordeaux mixture was 44.8 bushels. (Page 318.)

13. The increased yield per acre of potatoes well fertilized and cultivated, as compared with partially neglected plants, was 100 bushels per acre. (Page 318.)

14. Seed potatoes affected with scab may be cleaned and made fit for planting by soaking them in a solution of corrosive sublimate. (Pages 318, 319.)

15. An alkaline condition of the soil favors the growth of the scab fungus; an acid condition checks it.

16. Land in which the fungus causing potato scab is known to exist should not be used for growing potatoes or beets except at intervals of several years. Fertilizers which tend to produce an acid condition of the soil should be applied. Even treated seed will produce scabby potatoes, if the scab fungus is in the soil. (Pages 319, 321.)

17. Potato beetles may easily be destroyed by means of the arsenites. Paris green and London purple are the safest insecticides to use. (Pages 322, 323.)

18. Flea-beetles cannot be controlled satisfactorily. Bordeaux mixture thoroughly applied, appears to be the best practical remedy against these insects. This material probably does not kill the beetles, but simply keeps them away. (Pages 323, 324.)

19. In a comparative trial of many kinds of machines designed for spraying potatoes, it was found that those machines were unsatisfactory in which liquids are distributed wholly by the force of gravity.

20. Gravity sprayers are of value when the liquids are broken

into a spray after leaving the discharge pipes. This may be done by means of air blasts or by revolving brushes.

21. Pumps for driving the liquids through nozzles are on the whole most satisfactory. They can be arranged so that several rows may be sprayed at once.

22. Horse-power sprayers can be recommended for spraying potatoes. If the plants are sprayed for the potato beetle, one nozzle over each row is sufficient; for flea-beetles and for fungus diseases it is better to have two nozzles for each row, that a more thorough application may be made.

23. Powder guns are very satisfactory when insecticides are to be applied to potatoes, although wind and dry foliage may lessen the value of the treatment.

24 Fungicides should usually be applied in liquid form, using machinery which will treat the vines thoroughly as fast as a man or a horse can walk.

E. G. LODEMAN.

1871  
1872  
1873  
1874

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BULLETIN 114—February, 1896.

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HORTICULTURAL DIVISION

OF

CORNELL AGRICULTURAL EXPERIMENT STATION.

I. P. ROBERTS, Director, Ithaca, N. Y.

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SPRAY CALENDAR.

By E. G. LODEMAN.

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Office of the Director, 20 Morrill Hall.

The regular bulletins of the Station are sent free to all who request them.

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## BULLETINS OF 1896.

106. Revised Opinions of the Japanese Plums.
107. Wireworms and the Bud Moth.
108. The Pear Psylla and the New York Plum Scale.
109. Geological History of the Chautauqua Grape Belt.
110. Extension Work in Horticulture.
111. Sweet Peas.
112. The 1895 Chrysanthemums.
113. Diseases of the Potato.
114. Spray Calendar.

## Spray Calendar.

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In the preparation of this calendar the most important points regarding sprays have been selected and arranged in such a manner that the grower can see at a glance what to apply and when to make the application. The more important insect and fungous enemies are also mentioned, so that a fairly clear understanding of the work can be obtained by examining the table below. When making the application advised, other enemies than those mentioned are also kept under control, for only the serious ones could be named in so brief an outline. The directions have been carefully compiled from the latest results obtained by leading horticulturists and entomologists, and they may be followed with safety.

NOTICE.—In this calendar it will be seen that some applications are in parentheses and these are the ones which are *least important*. The number of applications given in each case has particular reference to localities in which fungous and insect enemies are most abundant. If the crops are not troubled when some applications are advised, it is unnecessary to make any. It should be remembered that in all cases success is dependent upon the exercise of proper judgment in making applications. Know the enemy to be destroyed; know the remedies that are most effective; and finally, apply them at the proper season. Be *prompt, thorough, and persistent*. Knowledge and good judgment are more necessary to success than any definite rules. See Bulletin 101.

### APPLE.

*Scab.* (1. Copper sulphate solution before buds break); 2. Bordeaux mixture when leaf buds are open, but before flower buds expand; 3. repeat 2 as soon as blossoms have fallen; 4. Bordeaux mixture 10 to 14 days after the third; (5, 6, repeat 4 at intervals of about two weeks). See Bulletin 84.—*Canker-worm.* 1. When first caterpillars appear apply Paris green—very thoroughly; 2. repeat 1 after 8 to 10 days; (3, 4. repeat every 10 days if necessary.) See Bulletin 101.—*Bud-moth.* 1. As soon as leaf tips appear in buds,

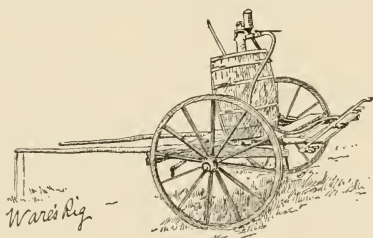
Paris green; repeat 1 before the blossom buds open; (3. repeat 2 when blossoms have fallen). See Bulletin 107.—*Codlin-moth*. 1. Paris green immediately after blossoms have fallen; 2. repeat 1, 7 to 10 days later; (3, 4, Paris green at intervals of 1 to 3 weeks after 2, especially if later broods are troublesome). Paris green may be added to the Bordeaux mixture and the two applied together with excellent effect.—*Case-bearer*. As for *bud-moth*. See Bulletin 93.

#### BEAN.

*Anthracnose, Pod-rust*. Bordeaux mixture, when first true leaf has expanded; 2, 3, etc., the same, at short intervals to keep the foliage covered by the mixture.

#### BEET.

*Leaf spot*. 1. When 4 or 5 leaves have expanded, Bordeaux mixture; 2, 3, etc., the same every 10 to 14 days.



#### CABBAGE AND CAULIFLOWER.

*Aphis*. 1. Upon young plants, kerosene emulsion or arsenites, when worms are first seen; 2. if plants are not heading repeat 1 when necessary; 3. when beginning to head, hot water (130°F.) or hellebore; 4. repeat 3 when necessary.—*Cabbage-worm*. 1. If plants are not heading, kerosene emulsion or arsenites; 2. repeat 1 at intervals of 7 to 10 days; 3. if plants are heading, hellebore, or water at 130° to 135°F.; 4, 5, etc., repeat 3 when necessary.—*Plusia*. 1. Make very thorough applications as recommended under *cabbage-worm*. For *Root-maggot*, see Bulletin 78.

#### CARNATION.

*Anthracnose, Rust, Spot*. 1. At first appearance of disease, Bordeaux mixture thoroughly applied in *fine* spray; 2, 3, etc., if plants



are not blooming, Bordeaux mixture; ammoniacal copper carbonate to avoid staining the flowers. Keep foliage covered with a fungicide.  
*Red spider.* Syringe freely with clear water; kerosene emulsion.

## CELERY.

*Leaf blight, Rust.* 1. Ammoniacal copper carbonate at first appearance of disease; repeat 1 to keep foliage protected.

## CHERRY.

*Black-knot.* See PLUM.—*Rot.* 1. When buds break, Bordeaux mixture; 2. when fruit has set, repeat 1; 3. when fruit is grown, ammoniacal copper carbonate.—*Aphis.* 1. Kerosene emulsion when insects appear; 2, 3, repeat at intervals of 3 to 4 days if necessary.—*Slug.* 1. When insects appear, arsenites, hellebore or air-slaked lime; 2, 3, repeat 1 in 10 to 14 days if necessary.

## CHRYSANTHEMUM.

*Leaf-spot.* 1. Bordeaux mixture, or ammoniacal copper carbonate at intervals of 10 to 14 days, to keep foliage protected.

## CRANBERRY.

*Fire-worm, Fruit-worm.* 1. When larvæ first appear, arsenites, kerosene emulsion, or tobacco water; 2, after 10 to 14 days repeat 1; 3, repeat if necessary.

## CURRANT.

*Leaf-blight.* 1. When injury first appears, before the fruit is harvested, ammoniacal copper carbonate, to avoid staining the fruit; 2. After fruit is harvested, Bordeaux mixture freely applied; 3, repeat 2 when necessary.—*Worm.* 1. When first leaves are nearly expanded, arsenites; 2. After 10 to 14 days, hellebore; 3, repeat 2 if necessary.

## EGGPLANT.

*Leaf-spot.* 1. As soon as plants are established in the field, Bordeaux mixture; 2, 3, repeat 1 at intervals of 2 to 3 weeks till first fruits are  $\frac{1}{2}$  grown; 4. ammoniacal copper carbonate, repeat when necessary.

## GOOSEBERRY.

*Mildew.* 1. Before buds break, Bordeaux mixture; 2, when first leaves have expanded, Bordeaux mixture or potassium sulphide;

3, 4, etc. repeat 2 at intervals of 7 to 10 days, if necessary throughout the summer. Avoid staining the fruit. — *Currant-worm*, see under Currant.

#### GRAPE.

*Anthracnose*. 1. Before buds break in spring, sulphate of iron and sulphuric acid solution; 2. Repeat 1 after 3 or 4 days to cover untreated portions — *Black-rot*. (1, as soon as first leaves are fully expanded, Bordeaux mixture). 2. after fruit has set, Bordeaux mixture; 3. repeat 2 at intervals of 2 to 3 weeks until fruit is  $\frac{3}{4}$  grown; 4. ammoniacal copper carbonate when fruit is nearly grown. 5, 6, etc. repeat 4 at intervals of 7 to 14 days as required. — *Downy mildew*, *Powdery mildew*, the first applications recommended under *Black-rot* are of especial importance. See Bulletin 76. — *Ripe-rot*, apply very thoroughly the later applications recommended under *Black-rot*. — *Steely-bug*. 1. As buds are swelling, arsenites; 2, after 10 to 14 days, repeat 1.



#### HOLLYHOCK.

*Rust*. 1. In spring, when foliage expands, Bordeaux mixture; 2, 3, etc., apply a good fungicide at short intervals to keep new growths covered.

#### NURSERY STOCK.

*Fungous diseases*. 1. When first leaves appear, Bordeaux mixture; 2, 3, etc., repeat 1 at intervals of 10 to 14 days to keep foliage well covered.

#### PEACH, NECTARINE, APRICOT.

*Brown-rot*. 1. Before buds swell, copper sulphate solution; (2. Before flowers open, Bordeaux mixture); 3. When fruit has

set, repeat 1; 4. Repeat after 10 to 14 days; 5. When fruit is nearly grown, ammoniacal copper carbonate; 6, 7, etc., repeat 5 at intervals of 5 to 7 days if necessary. For *Yellows*, see Bulletin 75.

## PEAR.

*Leaf-blight or Fruit-spot.* (1. As buds are swelling copper sulphate solution); 2. Just before blossoms open, Bordeaux mixture; 3. After fruit has set, repeat 2; 4, 5, etc., repeat 2 at intervals of 2 to 3 weeks as appears necessary.—*Leaf-blister.* 1. Before buds swell in spring, kerosene emulsion, diluted 5 to 7 times—*Psylla.* 1. When first leaves have unfolded in spring, kerosene emulsion diluted 15 times; 2, 3, etc., at intervals of 2 to 6 days repeat 1 until the insects are destroyed. See Bulletin 108.—*Slug.* See under CHERRY.

## PLUM.

*Brown rot.* See under PEACH.—*Leaf-blight.* (1. When first leaves have unfolded, Bordeaux mixture); 2. When fruit has set, Bordeaux mixture; 3, 4, etc., repeat 2 at intervals of 2 to 3 weeks, use a clear fungicide after fruit is  $\frac{3}{4}$  grown.—*Black-knot.* 1. During first warm days of early spring, Bordeaux mixture; 2. Repeat 1 when buds are swelling; 3. During latter part of May, repeat 1; 4. Repeat 1 during middle of June (5. Repeat 1 in July). See Bulletin 81.—*Curculio*, spraying is not always satisfactory; jar the trees after fruit has set, at intervals of 1 to 3 days during 2 to 5 weeks.—*Plum Scale.* 1. In autumn when leaves have fallen, kerosene emulsion, diluted 4 times; 2 and 3. In spring before buds open, repeat 1. See Bulletin 108.—*San José Scale.* Thorough applications of kerosene emulsion as recommended under Plum Scale may prove effective if followed later in the season by others, diluting the emulsion to avoid injuring foliage.

## POTATO.

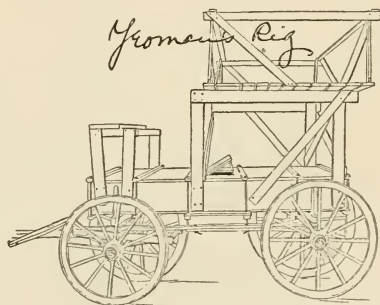
*Early blight.* 1. When vines are  $\frac{2}{3}$  grown, Bordeaux mixture; 2 and 3, repeat 1 at intervals of 2 to 3 weeks (only partially successful).—*Rot.* 1. During middle of July, Bordeaux mixture; 2 and 3, at intervals of 1 to 3 weeks, repeat 1.—*Scab.* Soak uncut seed potatoes  $1\frac{1}{2}$  hours in solution of 1 ounce corrosive sublimate in 8 gallons water.—*Potato beetle.* 1. When beetles first appear, arsenites. 2 and 3, repeat 1 when necessary. See Bulletin 113.

## QUINCE.

*Leaf-blight*, or *Fruit-spot*. (When blossom buds appear, Bordeaux mixture); 2, when fruit has set, repeat 1; 3, 4, etc., repeat 1 at intervals of 2 weeks until fruit is  $\frac{3}{4}$  grown; if later treatments are necessary, ammoniacal copper carbonate. See Bulletin 80.

## RASPBERRY, BLACKBERRY, DEWBERRY.

*Anthracnose*. 1. Before buds break, copper sulphate solution, also cut out badly infested canes; 2, when growth has commenced, Bordeaux mixture; 3, 4, etc., repeat 2 at intervals of 1 to 3 weeks, avoid staining fruit by use of clear fungicide. (Partially successful).—*Orange-rust*. Remove and destroy affected plants as soon as discovered. See Bulletin 100.—*Saw-fly*. 1. When first leaves have expanded, arsenites; 2, after 2 to 3 weeks repeat 1, or apply kerosene emulsion (unsatisfactory).



## ROSE.

*Black-spot*. Spray plants once a week with ammoniacal copper carbonate.—*Mildew*. Keep heating pipes painted with equal parts lime and sulphur mixed with water to form a thin paste. Spray with copper fungicides.—*Aphis*, *Leaf-hopper*. Kerosene emulsion or tobacco water applied to the insects' bodies at short intervals, is effective.—*Red spider*. Spray as for APHIS, or with forcible streams of clear water.

## LEAF-BLIGHT.

*Leaf-blight*. 1. When growth begins in spring, Bordeaux mixture; 2. when first fruits are setting, repeat 1; 3. during fruiting season, ammoniacal copper carbonate; 4. after fruiting, or on non-bearing plants, Bordeaux mixture at intervals of 1 to 3 weeks. See

Bulletin 79.—*Saw-fly*. Spray plants when not in bearing with arsenites, repeating application if necessary.

TOMATO.

*Leaf-blight*. 1. As soon as disease is discovered, Bordeaux mixture or a clear fungicide. 2, 3, etc. repeat 1 at intervals of 7 to 10 days.—*Rot*. Spray as directed under *leaf-blight* (unsatisfactory in many cases).

VIOLET.

*Blight ; Spot*. 1. When disease is first seen in summer or fall, Bordeaux mixture ; 2, 3, etc., repeat one at intervals of 1 to 2 weeks, using ammoniacal copper carbonate to avoid staining blossoms. (Not always satisfactory as good culture must also be given.) Remove affected leaves.

FORMULAS.

PARIS GREEN.

Paris green . . . . . 1 pound  
Water . . . . . 150-300 gallons

If this mixture is to be used upon fruit trees, 1 pound of quicklime should be added, and repeated applications will injure most foliage, unless the lime is used. *Paris green and Bordeaux mixture can be applied together with perfect safety.* Use at the rate of 4 ounces of the arsenites to 50 gallons of the mixture. The action of neither is weakened, and the Paris green loses all caustic properties. For insects which chew.

LONDON PURPLE.

This is used in the same proportion as Paris green, but as it is more caustic it should be applied with two or three times its weight of lime, or with the Bordeaux mixture. The composition of London purple is variable, and unless good reasons exist for supposing that it contains as much arsenic as Paris green, use the latter poison. Do not use London purple on peach or plum trees unless considerable lime is added. For insects which chew.

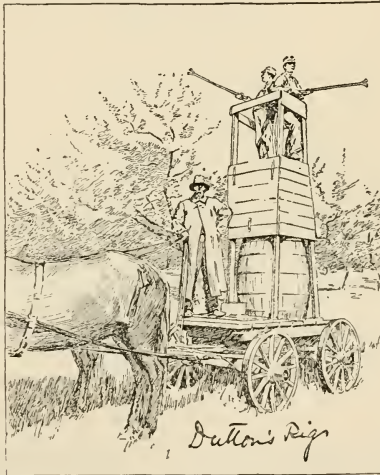
NORMAL OR 1.6 PER CENT. BORDEAUX MIXTURE.

Copper Sulphate . . . . . 6 pounds  
Quicklime . . . . . 4 pounds  
Water . . . . . 40-50 gallons

Dissolve the copper sulphate by putting it in a bag of coarse cloth and hanging this in a vessel holding at least 4 gallons, so that it is just covered by the water. Use an earthen or *wooden vessel*. Shake the lime in an equal amount of water. Then mix the two and add enough water to make 40 gallons. It is then ready for immediate use. If the mixture is to be used on peach foliage it is advisable to add two pounds of lime in the above formula. When applied to such plants as carnations or cabbages it will adhere better if about a pound of hard soap be dissolved in hot water and added to the mixture. For rots, moulds, mildews, and all fungous diseases.

IRON SULPHATE AND SULPHURIC ACID SOLUTION.

Water (hot).....	100 parts
Iron sulphate, as much as the water will dissolve.	
Sulphuric acid (commercial).....	1 part



The solution should be prepared just before using. Add the acid to the crystals, and then pour on the water. Valuable for grape anthracnose, the dormant vines being treated by means of sponges or brushes.

POTASSIUM SULPHIDE SOLUTION.

Potassium sulphide.....	$\frac{1}{2}$ -1 oz
Water.....	1 gallon

This preparation loses its strength upon standing, so should be made immediately before using. Particularly valuable for surface mildews.

AMMONIACAL COPPER CARBONATE.

Copper carbonate..... 1 oz.  
 Ammonia, enough to dissolve the copper.  
 Water..... 9 gallons

Before making the solution, the ammonia should be prepared as follows: Use 26° ammonia, and dilute with 7 to 8 volumes of water. Then gradually add the necessary amount to the copper carbonate until all is dissolved. It is best treated in large bottles, and in them it will keep indefinitely. Dilute as required. For same purposes as the Bordeaux mixture.

COPPER SULPHATE SOLUTION.

Copper sulphate..... 1 pound  
 Water..... 15 gallons

Dissolve the copper in the water, when it is ready for use. *This should never be applied to foliage, but must be used before the buds break.* For peaches and nectarines use 25 gallons of water. For fungous diseases.

HELLEBORE.

Fresh white hellebore..... 1 ounce  
 Water..... 3 gallons

Apply when thoroughly mixed. This poison is not so energetic as the arsenites, and may be used a short time before the sprayed portions mature. For insects which chew.

KEROSENE EMULSION.

Hard soap.....  $\frac{1}{2}$  pound  
 Boiling water..... 1 gallon  
 Kerosene..... 2 gallons

Dissolve the soap in the water, add the kerosene, and churn with a pump for 5-10 minutes. Dilute 4 to 25 times before applying. Use strong emulsion for all scale insects. For such insects as plant lice, mealy bugs, red spider, thrips, weaker preparations will prove effective. Cabbage worms, currant worms, and all insects which have soft bodies, can also be successfully treated. It is advisable to make the emulsion shortly before it is used.

TOBACCO WATER.

This solution may be prepared by placing tobacco stems in a water-tight vessel, and then covering them with hot water. Allow to stand several hours, dilute the liquor from 3 to 5 times and apply. For soft bodied insects.





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BULLETIN 115—February, 1896.

Cornell University—Agricultural Experiment Station,  
ITHACA, N. Y.

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# THE POLE LIMA BEANS.



By L. H. BAILEY.

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E. J. DURAND.....	<i>Botany.</i>

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## BULLETINS OF 1896.

106. Revised Opinions of the Japanese Plums.
107. Wireworms and the Bud Moth.
108. The Pear Psylla and the New York Plum Scale.
109. Geological History of the Chautauqua Grape Belt.
110. Extension Work in Horticulture.
111. Sweet Peas.
112. The 1895 Chrysanthemums.
113. Diseases of the Potato.
114. Spray Calendar.
115. The Pole Lima Beans.

CORNELL UNIVERSITY, Ithaca, N. Y., *February 29, 1896.*

*Honorable Commissioner of Agriculture, Albany.*

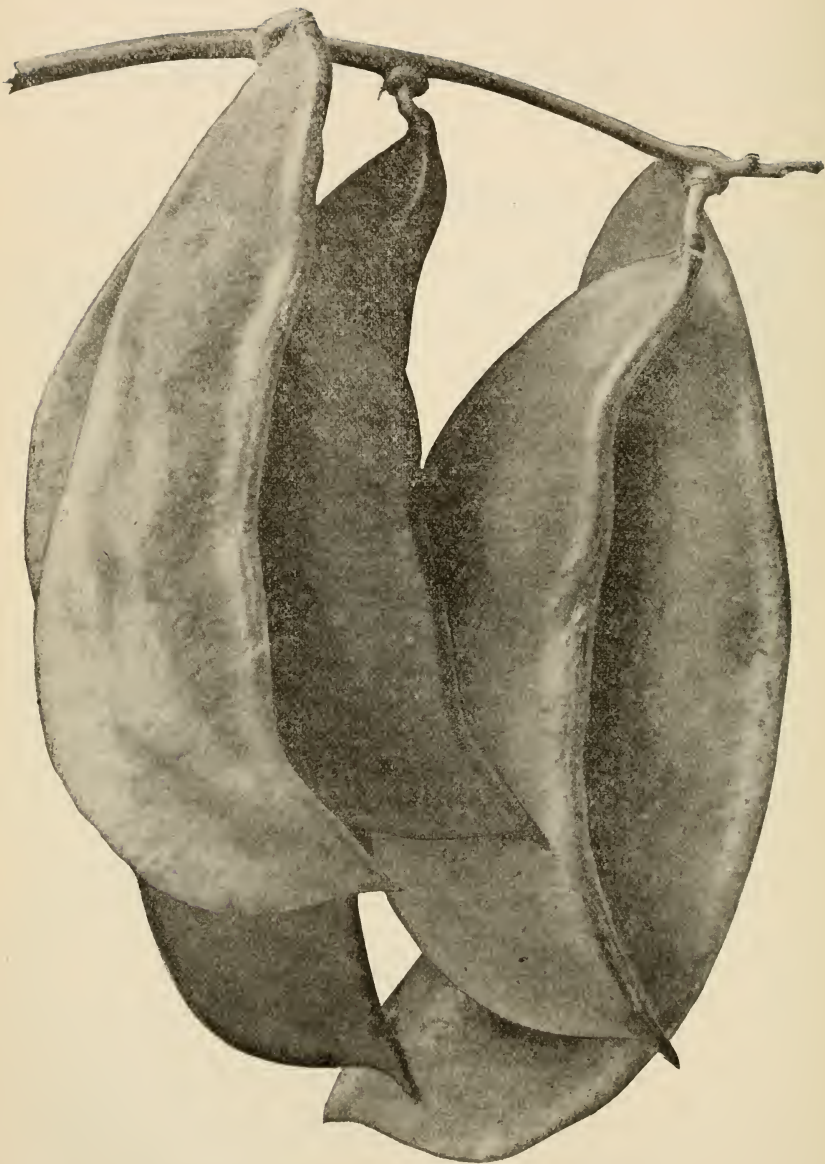
Sir.—The following paper — a complement to No. 87, upon the Dwarf Lima beans — is submitted for publication and distribution under Chapter 230 of the Laws of 1895.

L. H. BAILEY.

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SYNOPSIS.

I.	Types and Varieties, pages 349 to 350.	
A.	The Sievas.....	350
B.	The large, flat Limas.....	353
C.	The potato Limas.....	357
D.	Varieties not tested.....	361
E.	The Horticultural Lima.....	361
F.	The Chickasaw Lima or Jack bean.....	362
II.	Remarks on the Growing of Lima beans, pages 365 to 372.	
1.	Methods for New York.....	365
2.	The California practice.....	368
III.	Index.....	372



108.-- New Extra Early Lima Bean. Natural size. See page 355.

# The Pole Lima Beans.

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## I. TYPES AND VARIETIES.

About a year ago we tried to say something (Bulletin 87) about the dwarf Lima beans. We found that those beans are all modern developments from the pole Limas, and that they represent each of the three types or tribes of Lima beans,—the Sieva, Flat and Potato Lima types. A discussion of the botanical features and the history of these groups was then given, and it is therefore unnecessary to repeat the account here. We need only recapitulate the leading marks of the groups.

The Sieva or Carolina bean is a small and slender grower as compared with the large Limas, early and hardy, truly annual, with thin, short and broad (ovate-pointed) leaflets, numerous, small papery pods which are much curved on the back and provided with a long upward point or tip and which split open and twist when ripe, discharging the seeds; beans small and flat, white, brown, or variously marked with red. This, like the true Lima, is a native of South America, and was early cultivated by the aborigines of North America and countries to the southward. It is the plant which Linnæus meant to designate by the name *Phaseolus lunatus*. The distinguishing marks of the pods of the Sieva beans may be seen in Figs 102 and 103; and the beans of two of the varieties are shown in Fig. 101. The reader may consult Bulletin 87 for fuller information of the botany and history of the Lima beans.

The true Lima bean is distinguished from the Sieva by its tall growth, lateness, greater susceptibility to cold, perennial in tropical climates, large thick often ovate-lanceolate leaflets, and fewer thick fleshy straightish (or sometimes laterally curved) pods with a less prominent point and not readily splitting open at maturity; seeds much larger, white, red, black or speckled. The botanical name of this plant is *Phaseolus lunatus* var. *macrocarpus*. Of this true or large Lima there are two types in cultivation:

The Flat or Large-seeded Limas, which have large, very flat and more or less lunate and veiny seeds, very broad pods with a distinct point and broad ovate leaflets. See Figs. 107 and 109 for foliage; 106, 108 and 110 for pods; and 101 for the beans.

The Potato Limas, with smaller and tumid seeds, shorter and thicker pods with a less prominent point, and long ovate leaflets tapering from a more or less angular base into a long apex. See Figs. 112 for foliage; 111 and 113 for pods; and 101 for the beans.



Kaighn.

Willow-Leaf.

Speckled.

Black.

Dreer.

101.—Types of Lima beans. Natural size.

#### A. *The Sievas.*—

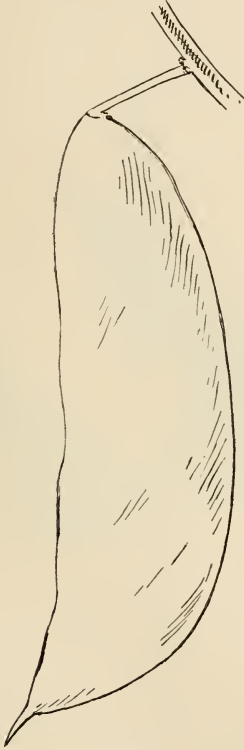
There are four dwarf varieties of the Sieva type, the Henderson, Jackson, Dwarf Carolina, and Northrop, Braslan and Goodwin Dwarf Lima. The Sievas are valuable chiefly because of their earliness. The beans are not so rich as those of the large Limas, and seem to us to be scarcely worth the growing where the latter can be successfully raised.

Last year we made an effort to grow all tall Lima beans. The seeds were all started in good garden soil on the 31st of May, and kept in very clean cultivation throughout the season. Amongst the pole or running Limas, the following in our test, are Sievas:

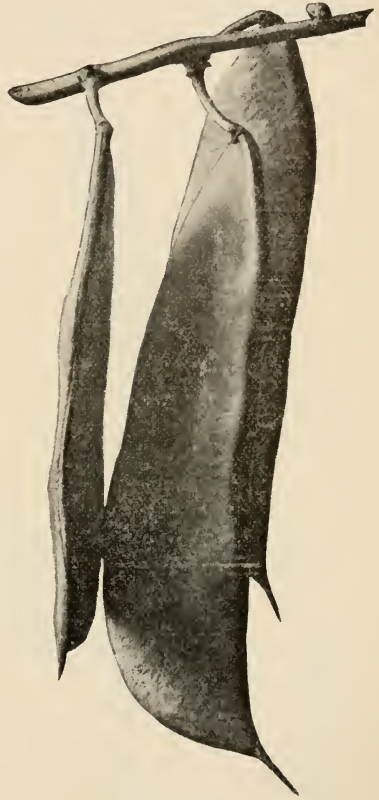
1. *Small Carolina* or *Sieva Lima*.—An early variety which began to bloom July 29, and ripened its crop before frost. Green beans were ready for the table late in August. The beans are

small, clear white, three or sometimes four in the small and profuse papery pods. It is a heavy grower, a tall climber and very productive. Henderson Dwarf is like this except in stature. Seeds from Burpee.

2. *Black or Early Black*.—(Figs. 101, 102)—Differs from the last chiefly in the color and shape of the beans, which are black (or



102. Black Lima. Natural size.



103. Willow-Leaf. Full size.

deep purple black) blotched and stained with white near the ventral edge, more or less angular or irregular in shape. Ripened its crop well. Very productive. The beans are in every way as good in quality as the white Sievas. Sent out for trial by Burpee in 1892 and introduced by him in 1893. Various purple spotted Sievas have long been known. Seeds from Thorburn and Burpee.

3. *Willow-Leaf* (Figs. 101, 103, 104, 105).—Later than No. 1, with which it is practically identical in the beans and pods. The

distinguishing feature of this interesting bean is the very curious foliage. The typical form of leaf is shown in Fig. 104, but the bean is not well fixed, and many plants bear leaves as shown in Fig. 105 or even as broad as those of the ordinary Sieva. The Willow-



104.—Willow-Leaf. Half size.

Leaf Lima is a very ornamental plant, and is worth growing for its attractive foliage and habit. It is a tall grower, and if given a moist soil would make an effectual screen until frost comes. We have grown it two or three years, but have never prized it greatly



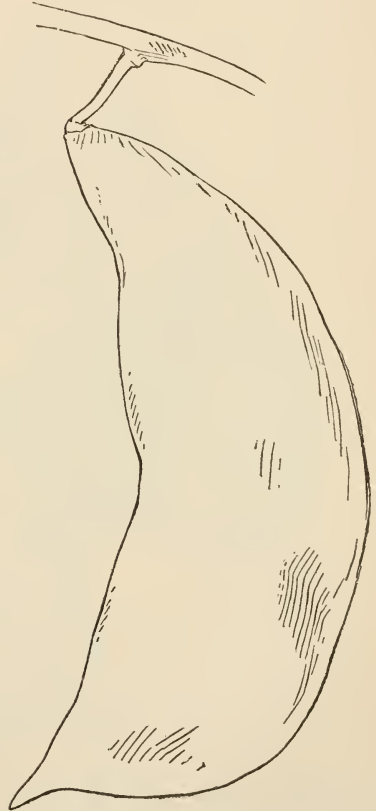
for the vegetable garden. It is a sport or offshoot of the common Sieva type. It was introduced in 1892 (but distributed for trial in 1891) by Burpee, who received it from the south. Seeds from Burpee.

*B. The large flat Limas.*

Of the large white or flat Limas there are several important varieties. This type of bean is the one which chiefly represents the spe-



105. Willow Leaf. Half size.



106. Bliss. Natural size.

cies in the gardens. It is much superior to the Sieva type in bearing larger and much richer beans. The earlier strains mature most of their crop in central New York, if properly grown. The filled green pods which remain when frost comes yield excellent green beans for the table. Burpee Dwarf is an offshoot of this type of Lima.

4. *Large White*.—The old stock of Lima bean, from which most other varieties have sprung. It was catalogued by Dreer as long ago as 1838. It has probably been somewhat improved in the meantime, however. As we grew it last year, it had little value. The growth was short or medium (not climbing strongly), and it was late and unproductive. Although it began to bloom as early as the Sievas, it had ripened very few beans by the first of October.



107. *New Extra Early*. Half size.

The pods were medium large, flat and curved, with a short tip. Beans flat, clear white, two to three in a pod. Of a variety which has been so long cultivated, there are certain to be strains of varying merit. Very likely the exact type cultivated twenty years ago is now unknown. Seeds from Burpee.

5. *Jersey*.—A good early strain of the Large White Lima, usually a week or ten days earlier. A strong, tall grower. Pods medium size, much curved when ripe, and strongly tip-pointed.

Beans medium size, flat, greenish white, averaging two or three in a pod. Seeds from Landreth.

6. *Bliss* (*Bliss's Extra Early, Extra Early, Extra Early Jersey*) Fig. 106. — A good early bean, fully as early as No. 5, and



109.—Mammoth Kidney-Shaped. Half size.

more productive. Tall, bearing broad pods of medium length with three to five large flat greenish white beans in each. One of the very best of the early strains of the large Limas. Introduced by B. K. Bliss & Sons, 1878. Seeds from Rawson, and May.

7. *New Extra Early* (Figs. 107, 108). — A low plant (2 to 4

feet high), mostly not disposed to climb, with large pods, each containing three or four rather large white beans. Began to bloom the 19th of July, but was not so early in maturing fruit as No. 6. It is probably the same as No. 6, however, the difference being due to seeds or other incidental circumstances. Seeds from Burpee.

8. *Platt*, or *Platt's King of the Garden* (also called *King of the Garden*).—A very large podded bean, late, producing very large and excellent white kidney-shaped beans. A short and slender grower, and not very productive with us last year. Sent out by Frank S. Platt, New Haven, Conn., as early as 1886, and said to be a cross of the Large White Lima and Dreer Improved. Seeds from Burpee, and Perry (Syracuse).

9. *Mammoth Kidney-Shaped* (Figs. 109, 110).—A good selection of the Large White Lima, the strain we grew being a medium tall grower, bearing broad and short-tipped pods of medium size, and white, flat, kidney-shaped medium sized beans. Productive, and ripens most of its crop before frost. A kidney-shaped form of the Large White Lima was catalogued as early as 1846 by Coates. Seeds from Livingston's Sons.

10. *Kaighn*, or *Kaighn's Improved* (Fig. 101).—The best large Lima on our grounds last year. Medium strong grower, bearing heavily of very large curved and pointed pods. Beans three or four to the pod, very large and flat, white, of most excellent quality. Ripened well before frost. The variety is a selection out of the Long White Lima by John M. Kraighn, Camden, N. J. Seeds from Landreth.

11. *May Champion*.—An extra good strain of Large White Lima, with very large and broad curved tip-pointed pods, and large white very broad kidney-shaped white seeds, of which there are two or three in each pod. A large part of the crop ripened up before frost. A tall, strong grower, and altogether a good bean. Seeds from May.

12. *Speckled Lima* (Fig. 101).—An early form of Lima, with handsome, medium sized flat beans which are speckled and blotched with very dark red-brown. Pods rather long and slender, tipped, containing three or four beans. A tall grower, ripening about all its crop before frost. A good bean, but the color is objectionable to most persons. The Speckled Lima originated in 1867, and is said to be a cross of the common Lima with Red-Seeded Giant Wax Pole Bean, but I fail to discover any evidences of hybridity. It is

possible that there are different breeds of this Speckled or "striped" bean, and that our strain is not a direct descendant of the form introduced in 1867. Seeds from Thorburn. Red Lima is evidently the same.



110.—Mammoth Kidney-Shaped. Full size.

111.—Dreer Improved. Full size.

*C. The Potato Limas.—*

The Potato Lima type was represented in our text by two kinds. The Kumerle, Thorburn or Dreer Dwarf Lima belongs to this type. The beans are perhaps the richest in quality of all the Limas.

13. *Dreer Improved* (Figs. 101, 111).— A most excellent bean, producing almost straight pods of medium size, lacking the tip, thick and without the thin edges of the common large Limas. Beans three to four in each pod, of medium size, irregular in shape, turgid and rounded on the edges, dull or greenish white, of best quality.



112.—Challenger. Half size.

A strong grower, productive, and ripening a large part of the crop before frost, although not so early as two or three of the varieties of the large Lima. This variety can be strongly recommended for its quality and for the large yield of shelled beans in proportion to the bulk of pods.

This bean was offered first time in Dreer's Garden Calendar of 1875. This is the description then given: "This bean is the product of the green wrinkled variety obtained from Mr. H. Kimber, of Kimberton, Chester County, Pa, about thirty years ago. Selections of the best specimens were annually made for seed until the bean has increased in early maturity and size, and established the present standard character.

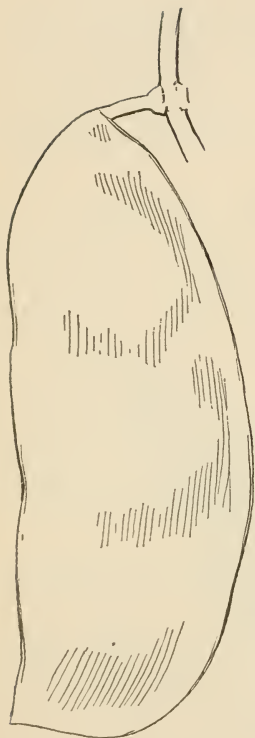
"The distinctive features of this sort are early maturity, prolificness and extra quality of bean; containing more saccharine matter and producing one-third more shelled beans to the pole than the Large Lima, while the shelling becomes an easy matter, from the fact of the pods being entirely full of beans, forming one against the other like peas in a pod.

"The *American Agriculturist* of November 1874, says: 'In these beans the pods are not only full, with no spaces between, but are as full as they can stick, the seeds so crowding one another that the ends of the central beans are square; the bean is also much thicker than the ordinary kind. A vine of this kind bearing the same number of pods as one of the ordinary variety would, we should judge, yield nearly if not twice as much in shelled beans. The pod being so completely filled, the shelling becomes an easy matter, and the beans when cooked are much superior to the ordinary ones, as the amount of skins is much smaller in proportion to the enclosed nutriment.

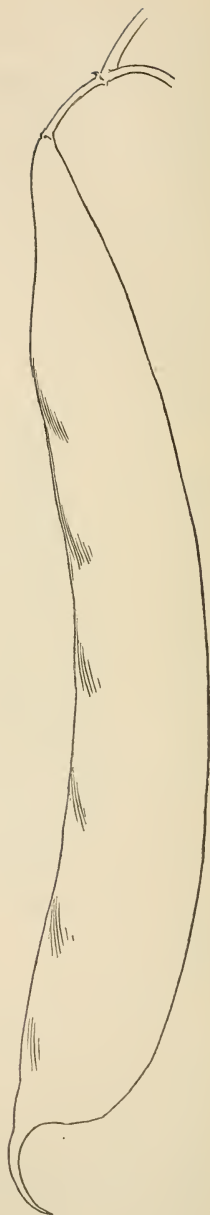
"We regard the improving of this bean as one of the most important of the recent contributions to horticulture.'"

14. *Challenge* or *Challenger* (Figs. 112, 113). — So like Dreer Improved that I cannot distinguish any constant differences, but the pods are perhaps shorter. Introduced some years ago by J. M. Thorburn & Co. Seeds from Livingston's Sons.

John W. Kumerle, Newark, New Jersey, a well known Lima bean grower and the originator of the Kumerle or Thorburn dwarf Lima, writes me as follows respecting this bean: "I have sold this variety for a number of years under the name of Hedden Lima bean. It is the same as J. M. Thorburn & Co. of New York City sell as Challenge. I receive my supply from V. J. Hedden, Esq., of East Orange, N. J. This bean has been in the Hedden family for at least eighty years and they have been very particular in selecting them every year for seed until they have succeeded in producing a bean that yields from five to six beans in the pod."



113. Challenger. Full size.



114. Horticultural Lima.  
Full size.



*D. Varieties not tested.*—

Other varieties of true Lima beans which were catalogued last year but which we did not grow, are the following:

*Ford's Mammoth podded*—“Selected by James Ford of Philadelphia from Large Lima, with reference to five and six beans in pod of large size; the pod is also very and unnecessarily large.”

*Salem Mammoth*—A greenish Lima, similar to the Ford, from Salem Co., New Jersey.

*Stokes' Evergreen or Mammoth Green Jersey*—“A very large green seeded Lima. Valuable because it retains its green color even after ripening.” Our seeds of this variety failed to grow.

*Washington Market*.—We know is only by name (catalogued by Perry Seed Store, Syracuse).

*E. The Horticultural Lima.*—

There are two other species of beans which are sometimes known as Limas, which should be mentioned in this connection. The Horticultural Lima (Fig. 114) is one of these. This is not a Lima bean at all, but simply a form of the common garden pole bean (*Phaseolus vulgaris*). It is not a vigorous climber, reaching only three or four feet high, ripening its slender pods very early. The beans are dun-colored with pretty brown markings. A good and early bean (maturing before any of the Limas), valuable either for a “shelled” bean or for use when fully ripe. A Horticultural Lima was raised some years ago by O. H. Alexander, Charlotte, Vermont, and I suppose that the current stock passing under this name is the same bean. Mr. Alexander describes the variety as follows: “This is a cross from the Boston Horticultural bush bean on Dreer's Extra Early Lima, and I find it, after testing it several years, to be the best of all pole beans. In color and foliage it resembles the Horticultural; in form it resembles the Lima. The quality I find is superior to either of its parents. It is very prolific, and throws out handsome green pods from five to six inches long.” It is also known as Child's Horticultural Lima. We grew the variety last year from seeds obtained from Burpee and from Childs. The two stocks were identical, and neither of them gave the least suggestion of a cross with the Lima. I have never yet seen any evidence of hybridity between *Phaseolus lunatus* and *P. vulgaris*.

*F. The Chickasaw Lima.*—

The Chickasaw Lima, Jack Bean, or Horse Bean (Figs. 115, 116) is a curious bean which I mention here only because it is sometimes called a Lima. It is *Canavalia ensiformis*, a tropical species which is widely cultivated. It has become generally distributed in the southern states during the past few years, where it is generally known as the Jack Bean. I have not been able to trace its



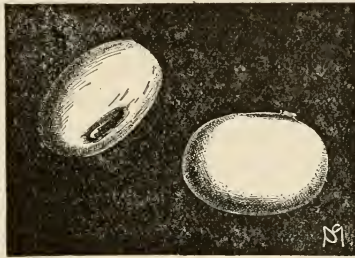
115. The Chickasaw Lima or Jack Bean (*Canavalia ensiformis*). One-third size.

introduction into this country, nor have I found any recent American literature describing it. It has probably come into the United States from the West Indies or Mexico. Griesbach and others speak of its cultivation in Jamaica, and we are growing it from there at the present moment.

The Jack Bean will probably not ripen in the north. We have grown it under glass, where it makes a twining vine four to eight

feet high. In warm countries, it is a bushy plant with little tendency to climb. The pods reach a length of ten to fourteen inches, the walls being very hard and dense when ripe. The halves of the pod, when split apart, roll up spirally, often into an almost perfect cylinder. The large white turgid beans, bearing a very prominent brown seed-scar, are packed crosswise the pod, imbedded in a very thin white paper lining. The flowers are small and light-purple, resembling those of the Cow-pea (though larger), and of various species of dolichos. The leaflets are three, large and broad (5 to 8 inches long and half or three-fifths as broad), strong veined and dull dark green, abruptly pointed and smooth.

This *Canavalia* seems to be a rather coarse bean when fully matured, but some of my correspondents commend its culinary qualities when green. Naudin and Müller in "Manuel de l'Ac



116. Chickasaw Lima. Full size.

climatureur," remark that "it is said that the seeds, whilst not poisonous, are digested with difficulty by those persons which are not accustomed to using them." Mr. John Dehoff, Tabor Lake, Florida, sends specimens for determination and writes: "The bean makes a large bush two and a half to three and a half feet high and broad. It stands all kinds of weather except frost, and blooms and bears unremittingly. The beans are quite acceptable as a 'snap bean,' when the pods are not more than four or six inches long." Alex. Raff, Orange Grove, Mississippi, who sent me the seeds for a name says: "The plant is a bush about thirty inches in height. The blossom is pink, and the seed pods average about twelve inches in length, containing from twelve to fourteen beans. They were grown this season on poor piney-wood sandy soil, fertilized with a little barnyard manure, and I think would

average in yield from twenty to twenty-five of these large pods to the plant. In quality for table use, we think it is fully equal to the Lima bean." A. Jones Taylor, Vernon, Texas, sends the bean to me under the name of Chickasaw Lima. It is said to be cultivated by the Chickasaw Indians. Professor Georgeson describes and figures it as one of the economic plants of Japan in "American Gardening," for February, 1893.

Professor S. M. Tracy, of the Agricultural College of Mississippi, wrote me as follows about this bean in August, 1895: "I know very little about Jack beans. I suppose them to be *Canavalia ensiformis*. A few Mexicans who have sent them say that they are common in that country, where they are used for food. One of my assistants saw them at a county fair in the southern part of this state five years ago, and brought a couple of pods home with him. I grew them on small plots three years, and last year had about half an acre, which yielded at the rate of twenty-three bushels per acre. A neighbor claims to have had thirty bushels, which I think is reasonable, as my crop of this year appears as though it would be even heavier. I have eaten the beans, and find them quite edible, though rather coarse. I have not fed them to cows, but chemical analysis shows them to be fully equal to other beans. We have ten acres this year, and propose to give them a thorough test in feeding next winter. I do not know any one who has used them, or who has grown them in any quantity."

The result of this last crop, Professor Tracy now reports, this month, as follows: "The Jack Beans yielded thirty to forty bushels per acre. We have used the beans this winter in feeding steers, cows and hogs, and I am greatly surprised to find them of almost no value. Cattle soon learn to eat the meal made from the beans, but it appears to be very difficult of digestion. We have used it constantly for ten weeks until yesterday, when I decided that there was no occasion for any further work. Next week I shall commence feeding the cooked meal, and if I get satisfactory results from that, shall try cooking some of the beans also."

I have grown this Jack Bean only as a curiosity and have not tested its culinary qualities. It fruits freely under glass. I report it here because there is considerable inquiry concerning it and because there is no accessible literature of it.

## II. REMARKS ON THE GROWING OF LIMA BEANS.

1. *Methods for New York.*

The Lima beans are amongst the most delicious of all our garden vegetables. There are no beans grown in this climate which approach them in richness. They are excellent either when used green as "shelled" beans, or when used ripe and dry during the winter season. The merits of the green or shelled Limas are nearly everywhere known and appreciated, but comparatively few people seem to understand that the ripe beans are just as excellent in the winter time as the green beans are in the summer. At the present time, the writer is using the ripe Lima beans in the same way that the common field beans are cooked for the table, and they are the most satisfactory of any beans which can be served. These beans may be shelled in the fall after the pods are fully ripe, or they may be put away in the attic or other dry room in the pod and shelled as occasion requires. If they are stored in the pod the only caution is that these pods should be thoroughly dried and cured.

The Lima beans are natives of warm countries. The large flat Limas are perennials, or at least plur-annuals, in their native countries. They therefore require a long season, and one who expects, to grow them in the north should endeavor in every way to shorten the period of growth. This may be done, in the first place, by planting the earlier varieties; and, in the second place, by exercising great care in the selection of soil and in giving particular attention to cultivation. Light and so-called "quick" soils are best. Soils which are naturally sandy and loose, but which have been enriched in previous years by the addition of manure, are excellent for Lima beans, especially if they have a warm exposure. The soil should also be dry. Coarse, raw manure should be avoided on Lima beans, because it tends to make too rank and too late growth. If any fertilizer is applied the year in which the beans are planted, it should be such as will become available very quickly and therefore tend to hasten the maturity of the crop. We prefer, therefore, to use some of the concentrated fertilizers, especially those which are rich in potash and phosphoric acid, and avoid those which contain very much nitrogen. If nitrogenous fertilizers are used at all, they should be applied in comparatively small amount and be of such kind that they will give up their fertility early in the season. If ordinary

stable manure is used, it should be applied in the fall in order that it may become thoroughly incorporated with the soil and be ready for use at the earliest moment in the spring.

We had an excellent chance last year to study the effects of moist soil upon Lima beans. Our experimental plantation ran through a low place on to a dry, sandy elevation. The soil was the same formation throughout the plantation, but in the sag it had become somewhat enriched by the washings of the higher lands. This sag was so dry and so well drained that it never held water, and the season was characterized by a prolonged drought; yet, in spite of these facts, the beans in this sag were at least three or four weeks later than those upon the dryer end of the plantation, and some varieties did not ripen a single pod in this spot. It should be said, however, that the soil throughout this plantation was very thoroughly tilled all during the season so that the moisture upon the high land was conserved to the greatest possible extent. Lima beans delight in hot, dry weather, if only they have an opportunity of getting their roots deeply into the soil before dry weather comes on, and if they are given frequent shallow tillage for a time.

Whilst it is essential that the Lima beans should be given the longest season possible, it is nevertheless futile to plant them before the weather is thoroughly settled; for, even though the seeds may germinate, the young plants will be seriously checked by inclement weather. We prefer to plant them a week or ten days after it is safe to plant the ordinary bush garden beans. We have our ground very thoroughly prepared, plant them about an inch deep in about twice the quantity which we desire to have them stand, and then expect to keep them growing rapidly until they have reached the tops of the stakes or trellis. If we use stakes, we plant the beans in hills about three feet apart and the rows about four feet apart, dropping seven or eight beans in each hill. When the beans are well up, and danger from bad weather and cut-worms is past, we pull out all but three or four. The poles should not be more than six feet high. If they are taller than this, they are not only expensive to procure and hard to keep in place, but the beans will run too high and grow too late. When the beans reach the tops of poles which are five or six feet high, the ends of the vines swing out horizontally and the growth is checked, and the setting of fruit is thereby, no doubt, hastened. It is the practice of many persons to clip back the ends of the

vines when they have reached a certain height. For myself, I doubt the efficiency, or at least the necessity, for this practice. It seems to me that it is better to prevent too rapid growth by withholding the strong fertilizers and then by the use of comparatively short poles. Some persons prefer to grow the beans upon a trellis, and this is the most economical of room. In this way the beans can be planted more or less continuously, so that the vines will eventually stand about a foot apart. The trellis can be made very cheaply by placing a very strong braced post at each end of the row and then running a strand of fence wire from one post to the other about eight or nine inches above the ground, and another strand about five feet above the ground. These wires can be kept from slacking by placing stakes at intervals of ten or fifteen feet. Ordinary wool twine is then run from the bottom to the top wire and thence to the bottom wire again, and so on, in a zigzag fashion, throughout the length of the row, placing it in such manner that the strands of string will be no more than a foot or fifteen inches apart. This makes a very cheap and serviceable trellis and is, no doubt, better than stakes.

Our Lima beans were planted in 1895 on the 31st day of May. They might have been planted a few days earlier, no doubt, with perfect safety. If one desires to get his beans ahead very early, he can plant them in a forcing-house or cold-frame in pots or on inverted sods, or in refuse berry boxes, about two weeks in advance of the time they are to be set out of doors. From these receptacles they can be transferred easily to the ground. One of our constituents says that he always greases his Lima beans thoroughly with lard when he plants them and is thereby able to plant his crop a week or ten days ahead of the usual time, because the grease preserves the beans from rotting. We have not tried this method and do not know what value it has. It is an easy matter to transplant Lima beans, even when they are not grown in pots or boxes, if the ground is moist when they are taken up so that a large lump of earth adheres to the roots and if the weather is somewhat humid following the transfer. But, in spite of all that can be done, nearly every variety of the large Lima beans will fail to mature its full crop in the north before frost. If half the pods which the vines have set should mature before frost comes, the grower may feel that he has been very successful. The green pods which remain at frost

time, if the beans are partially grown, can be picked, the beans shelled out and dried, and these can be used in the winter time to as good advantage as if they were thoroughly ripe. If these dried beans are soaked in water some time before they are cooked, they are scarcely inferior to green beans directly from the vine.

It is generally considered that the richest of all the Lima beans are those of the Potato Lima type, like Dreer's Improved and Challenge. This type of beans makes a smaller and less showy pod than many of the large white Lima type, but the pods are usually closer packed with turgid seeds. To the person who buys Lima beans in the pod, these are much the more economical, whilst the one who sells beans in the pod would secure a larger bulk by growing some of the very large-podded flat Lima type, like Kaighn, Jersey, May Champion and the like. For ripe beans, the large white flat Limas usually sell the best, but there are many persons who prefer a green Lima. A number of the varieties are greenish even when they are fully ripe, and therefore have the appearance of being more fresh and tender. The red and speckled Limas are in every way as good in quality, as the white or green ones, but most persons do not like this dark color. In our own test of last year, we thought that the best six beans, considering earliness, productiveness and quality, were the Jersey, Extra Early or Bliss, Kaighn, May Champion, Dreer Improved and the speckled Lima.

It is difficult to state what the yield of Lima beans may be. As a rule they are not grown much for market in the dry state in the east, for the California product can be grown with more certainty and more cheaply and is shipped east in very large quantities. Mr. C. J. Pennock, of Kennett Square, Pa., one of our former students, writes that upon a half acre he gets a yield of about 120  $\frac{5}{8}$ -bu. baskets of pods, and the price runs about fifty cents per basket. He uses poles seven feet long, stuck three and one-half by four and one-half feet apart, and he cultivates twice before setting the poles, hoes the beans about once, and trains the vines to the poles by hand.

## 2. *The California Practice.*

In the East, the Lima bean is much grown in New Jersey, but southern California is undoubtedly the largest producer of Lima beans in the world. The following estimates show the enormous output of Lima beans from this region :



	Ventura County.	Santa Barbara County.
1893.....	1,500 car loads.	250 car loads.
1895.....	1,100 " "	120 " "

A car load is about ten tons.

It is a question if Lima bean seed which is grown continuously in the long seasons of California is as reliable for our short seasons as home grown seed is. For myself, if I were expecting to grow Limas for market in central New York, I should prefer to select and grow my own seed or else be sure, if it were California grown, that the "stock" were annually grown in my own geographical region.

A most instructive account of the interesting Lima bean industry of southern California was printed in the "American Florist," for December 28, 1895, written by L. B. Hogue, Santa Paula, California. J. C. Vaughan, of Chicago, who has given considerable attention to this western bean interest, writes me commending the article. In order to complete the contemporaneous history of the Lima bean as well as to instruct our own people in some of the essentials of the cultivation of these plants, I append the larger part of the article:

"More than twenty years ago a farmer in the Carpenteria valley experimented with the Lima bean. None of them had been grown on this coast for market at that time. The experiment proved a perfect success. Every requisite for producing this variety in its perfection seemed to be supplied here. A remunerative price was readily obtained for the mature bean. From this time others began to grow them. The demand grew with the increase of the product. The profits became much greater than were those of any other farm crop, which proved a great stimulus to improved methods. Something like exact science was finally reached in the matter of the preparations and cultivation of the soil. The primitive way of harvesting by hand, where one man could cut one acre per day by hard work, was superseded by a simple horse power device, with which one man could cut fifteen acres per day. Also implements were invented for cultivating the land before planting, which facilitated the work in like manner. To the credit of these farmers let it be said that the machinery for the successful cultivation and harvesting of this crop was invented by them.

"As a matter of course the success of the industry in the Carpenteria soon attracted wide attention, and farmers in other parts

of the state began to make trials to grow the Lima bean. Their efforts, though, proved to be failures. Our section, however, that of the Santa Clara valley of the south, in Ventura county, and only about twenty miles from the Carpenteria, would seem to possess nearly all the requirements in soil and climate. But some way the business did not 'pan out' right as the 'forty-niner' would say. Carpenteria farmers had their eyes on the operations in Ventura county, however. They noticed that their own farms were usually from ten to twenty acres, while the Ventura farms averaged at that time about one thousand acres to each farmer. They noticed also that the farming was done in a slipshod out-of-season fashion that would not succeed even in their own section. Finally some of them rented small tracts of land in the Santa Clara valley and instituted their methods of farming. When lo! Dame Nature smiled upon them. Ye rancher on a thousand acres came around to see how it happened that the despised 'small farming' had resulted in as much clear gain from a few acres as he had received from his thousand. Other practical bean growers settled in the valley and the shipments of Limas from southern California doubled, trebled, and quadrupled — when finally improved facilities had rendered large farming practicable. However, the average yield per acre, about one ton, continues larger in the Carpenteria valley than in most other places. Although numerous attempts are made to grow the Lima bean in other sections of the state the fact remains that nearly all of this variety shipped from California came from the extreme southern part of Santa Barbara county, and from the valley of Ventura county lying near the coast. The little valley of the Carpenteria sends out about one hundred car loads, and those of Ventura about twelve hundred car loads annually. (Estimate of 10 tons each.)

"The methods adopted here in growing and harvesting the Lima bean could not be pursued in countries where rain falls during the summer season. The cultivation proper is all done during the winter and spring and before the beans are planted. The cultivation is very thorough and by the best of implements.

"After all danger of rain is passed in the spring, say from the 1st to 20th of May, the seed is put into the ground in rows about forty inches apart and from six to fourteen inches in the row with machines that plant from two to four rows at a time. After the crop is well up and growing, some weeds will have started too.

These are destroyed by using a horsepower weed knife, which passes just under the surface of the ground, killing the weeds in one or two rows at a time without disturbing the soil, which is by this time perfectly dry on top. As the season advances the plants send out their vines over the dry surface, until the ground is finally hidden from sight, and thus, all through the latter part of our rainless summers, thousands of acres may be seen covered with beautiful light green foliage.

“In the latter part of September the beans are all cut loose from the ground a little below the surface and are forked into piles convenient for pitching onto wagons. They are then allowed to dry in the sun for about two weeks before threshing. Formerly all threshing was done in the following manner: A round space on the ground sixty to eighty feet is made quite wet, then it is wagoned over, packed and smoothed down and allowed to dry hard. Two or three big wagon loads are placed in a ring on this floor during very dry clear weather. Formerly horses attached to light wagons were driven over the beans (usually two or three teams at a time), till they were all shelled from the pods. The vines are then thrown off and more beans from the field placed on. This process is continued until there are many tons of beans on the floor under those that are being threshed out. After this the whole mass of chaff and beans is run through winnowing and screening machines and the beans placed in sacks of seventy-five to eighty pounds each and are ready for market. Of late years the teams on the floor are attached to disc machines instead of wagons, which greatly facilitates the work.

“The process of threshing by large steam machines which clean up from fifty to seventy five acres of beans per day, has more recently been adopted by most of the large growers. It is a singular fact, however, that while the expense to the farmer who employs the steam thresher is usually five dollars per ton, the work is done by the first named method at about four dollars per ton. The machine threshed beans have also to be recleaned before they are marketed, and are broken so much that they are never fit for the seed trade. Yet there is one great advantage with the steam thresher. The rainy season, so called, is approaching and a shower is liable to fall in October while the threshing process is in full blast, so that any beans that are caught on the floor are ruined if they do not manage to cover them in some way, while by the machine process all beans are sacked as they are threshed.

“Nineteen years ago an eastern seed firm having learned of the successful culture of the Lima bean in this section, made arrangements to have a small lot grown, to be used in his business. The project proved to be a feasible one. Other wholesale seedsmen gradually came into this field and made contracts for seed. Some of them were at first unfortunate in dealing with careless farmers, the business proving unsatisfactory. The demand upon careful seed growers, however, increased until they virtually held a monopoly of that branch of the seed business in the United States, the writer having had contracts with eastern seed houses amounting to nearly one hundred and fifty tons in a single year. Within the past two or three years the extensive wholesale dealers in beans for all purposes have been securing the contracts of seed houses and farming them out to whoever would grow them for the lowest price, with the result that an inferior grade for less money is now being supplied, while the careful and successful seed growers have mostly gone out of the business into other horticultural pursuits which promise better returns for their skill.

“For the benefit of some readers it might be well to state even at this late date in the history of agriculture in California that these crops are grown without irrigation and without any rain from the time the seed is planted till the beans are harvested, unless it be that an unwelcome shower is liable to come in the harvesting season in the month of October.”

### III. INDEX.

For the choice of varieties in our last years test, see page 368. The Sievas are described on pages 350 to 353; the large flat Limas on pages 353 to 357; the potato Limas on pages 357 to 359; the horticultural Lima on page 361; the Chickasaw Lima or Jack bean (*Canavalia ensiformis*) on pages 362 to 364. The methods of culture recommended for New York are detailed on pages 365 (uses), 365 (soils and fertilizers), 366, 367 (planting and training), 368 (choice of varieties). The California operations are expounded on pages 368 to 372.

L. H. BAILEY.

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BULLETIN 116—May, 1896.

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Cornell University—Agricultural Experiment Station,

ITHACA, N. Y.

HORTICULTURAL DIVISION.

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# DWARF APPLES.



See page 391

By E. G. LODEMAN.

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Office of the Director, 20 Morrill Hall.

The regular bulletins of the Station are sent free to all who request them.

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## BULLETINS OF 1896.

106. Revised Opinions of the Japanese Plums.
107. Wireworms and the Bud Moth.
108. The Pear Psylla and the New York Plum Scale.
109. Geological History of the Chautauqua Grape Belt.
110. Extension Work in Horticulture.
111. Sweet Peas.
112. The 1895 Chrysanthemums.
113. Diseases of the Potato.
114. Spray Calendar.
115. The Pole Lima Beans.
116. Dwarf Apples.

CORNELL UNIVERSITY, ITHACA, N. Y., *May* 11, 1896.

*Honorable Commissioner of Agriculture, Albany.*

Sir.—The interest in dwarf pears continues to be unabated in this State, and one of the questions which comes to us very frequently is a request for information as to why dwarf apples may not also be a source of profit. Unfortunately, we are unable to answer these questions from any American experience, for dwarf apples have been grown in this country chiefly as single or specimen trees and not in plantations of commercial extent; and even as specimen trees, they are comparatively little known. Yet the inquiry concerning them is so great that we have thought it wise to collect and publish as much as possible of the scattered experiences of New York people. The Experiment Station Extension Law, under the auspices of which this bulletin is published, has for one of its leading objects, as we interpret it, the collecting and publication of the very valuable experiences of horticulturists in the Fifth Judicial Department of the state, which experiences are commonly lost to the public, but which are intrinsically as valuable as similar work which may be taken up by the station. In fact, they may be more valuable. The law is designed to promote the spread of information amongst the horticulturists of its territory. Its motive is distinctly educational. We have, therefore, no hesitation in presenting this average of experiences as a bulletin, even though it is not all founded upon experiments actually made at the station at Ithaca. To wait for the maturing of experiments would mean the delay of publication and a refusal to satisfy inquiry for several years to come. The reader must bear in mind, however, that we make no recommendation respecting the setting of dwarf apples for commercial purposes. We have simply given the gist of what evidence we have been able to collect in a two years' inquiry, and the reader must draw his own conclusions. The present writer has been more or less familiar with dwarf apples for twenty years, and has known some good commercial results to be obtained; but he is of the opinion that if dwarf apples are to be planted at all for market they should comprise only those varieties which are suitable for a very fancy or dessert trade.

The bulletin is submitted for publication under Chapter 230 of the Laws of 1895.

L. H. BAILEY.

## OPINIONS OF DWARF APPLES BY AMERICAN WRITERS.

*Patrick Barry* : "The apple, worked on the Paradise, makes a beautiful little dwarf bush. We know of nothing more interesting in the fruit garden than a row or a little square of these miniature apple trees, either in blossom or in fruit. Those who have not seen them may imagine an apple tree four feet high and the same in width of branches, covered with blossoms in the spring or loaded with magnificent golden and crimson fruit in the autumn. They began to bear the third year from the bud, and the same variety is always larger and finer on them than on standards."—*Fruit Garden, New Edition*, 1883.

*W. C. Strong* : Dwarf apples are "well adapted for garden culture, giving the advantage of early fruitfulness, an increase in the number of small trees, and consequently in the number of varieties, when this is desired . . . . Constant watchfulness will be required in the culture of dwarfs to give annual supplies of food, to preserve the form by pruning, and also to prevent rooting above the dwarf stock and thus destroying its character."—*Fruit Culture*, 1885.

*John A. Warder* : "Such are very appropriate for the small garden, or for the specimen grounds of a nursery establishment, and they sometimes make beautiful objects on the lawns or among the shrubbery, but they are wholly unsuited for orchard planting."—*Apples*, 1867.

*John J. Thomas* : "For summer and autumn sorts, dwarf apples are valuable in affording a supply to families. They begin to bear in two or three years from setting out, and at five or six years, if well cultivated will afford a bushel or so to each tree. A portion of a garden as large as the tenth of an acre, may be planted with forty or fifty trees, without crowding. All the different varieties of the apple may be made dwarfs by working on the Paradise or Doucin stock—the former are smaller and bear soonest; the latter are larger and ultimately afford the heaviest crops. Among the handsomest growers as dwarfs, are Red Astrachan, Jersey Sweet, Porter, Baldwin, Dyer, Summer Rose, Benoui, and Bough."—*The American Fruit Culturist, Revised Edition*, 1885.

*George Jaques* : "No one, we suppose, will attempt to cultivate these little trees in this country, excepting for ornamental purposes. They are very pretty garden pets in the midst of a flower-bed, or at the corners of alleys, or elsewhere where fancy may locate them. They seldom bear more than a dozen or twenty apples, and therefore the economical orchardist, looking to profit alone, ought not to consider them as worthy of his attention . . . . There is nothing very peculiar in the management of the dwarf apple. Its place is the garden, not the field; still less will it answer to put these little trees in grass-ground, or to subject them to rough usage."—*A Practical Treatise on the Management of Fruit Trees. Worcester, Mass.*, 1849.



# Dwarf Apples.

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## I. DWARFING IN GENERAL.

*Effect of checking the movement of sap.*—All fruit trees are provided with certain well-defined courses through which the sap passes to every part of the plant. After the roots have taken in the water with its freight of dissolved plant food, the crude sap, as it may then be termed, enters a definite course which eventually brings the nourishment to the parts in which the materials are used for constructing plant tissue. There is no circulation of sap in plants in the sense in which there is in animals, no definite tubes through which it flows. It passes through the plant tissues by a process of absorption. The regions in which this transfer takes place will become apparent upon consideration of a few common facts.

Let us suppose a very common case. Labels are frequently secured by means of a wire which surrounds either a branch or the trunk of the tree. It is no unusual occurrence that such labels are neglected, and as the stem increases in size, the wire becomes imbedded in the bark. This forms a constriction about the stem, and the connection between the parts above and below the wire is more or less effectually destroyed, especially in the outer portions. As the wire becomes more deeply buried, an unequal growth takes place in the adjoining tissue. The stem immediately above the wire becomes abnormally enlarged, while the rate of growth below is greatly lessened or almost entirely checked. If the wire is not removed, union of the tissues separated by the wire may take place, and the tree will be little the worse for the check. More frequently, however, young trees are so severely cut that the increased weight of the top forces the stem to break where it is surrounded by the wire, causing a total loss of this portion.

Another familiar example may be named. When the trunk of

a plant has been entirely girdled, as frequently occurs with orchard trees, and as is sometimes purposely done with grape-vines when particularly large fruit is desired, it is interesting to note that the plant makes little attempt to cover the wound from below, but the healing takes place from above. At the same time the foliage does not wilt as if suffering from water, unless the cut has been made very deep, but it frequently remains green and apparently healthy for a long time.

The above facts lead to but one conclusion: the sap upon entering the plant rises through the inner tissues to the extremities of the branches, or to the leaves; from here it descends, choosing for its path, however, the tissues which lie between the outer bark and the wood. The part through which the sap rises is well known under the name sap-wood. In many plants this wood is very conspicuous in sections of the stem on account of its light color. The sap descends through what for convenience may be loosely termed the inner bark, which consists of the soft tissues that lie directly underneath the hard, corky covering of the stem.

Endogenous plants, such as the palm, corn, and others, do not have these tissues separated from each other as above described. The tissues which correspond to the sap-wood and to the inner bark are arranged in the form of long, slender, thread-like bundles which are readily distinguished as coarse fibers, thinly scattered in the pith as seen in corn stalks, and more thickly at the edges of the stems. The sap rises and descends in each of these many bundles of fibre, so that the girdling of this class of plants is not followed by such abnormal growths as occur on our fruit trees; the primary result of such injury is that the amount of sap which reaches the foliage is reduced in proportion to the number of these fibres which are cut.

The reason why the sap passes directly to the foliage before it returns to the growing parts of the plant is obvious; in the tissues of the leaves the crude sap is acted upon by various agents, with the result that the nourishment which was carried to the leaves is made available for use by growing cells. The process of changing the unavailable food to that which is of use to the plant is known as assimilation; the green portions of the plant are the only parts in which this change can take place, and it can pro-

ceed only in the presence of light. The leaves may, therefore, be considered as one of the most important factors in the nourishment of plants. An injury to them is not merely a local matter, but it affects the entire plant economy.

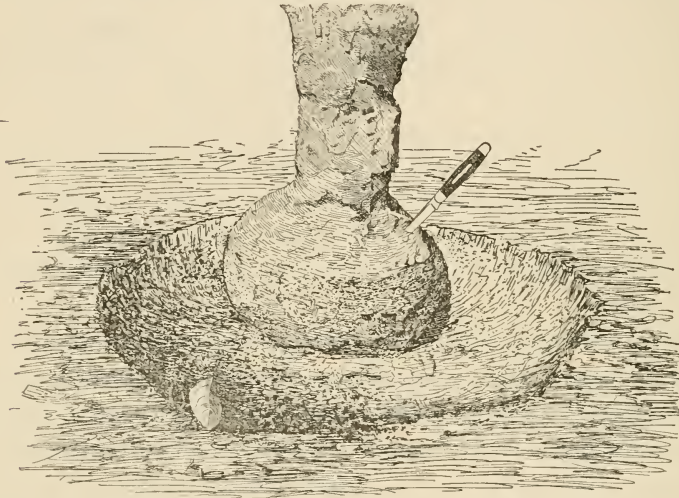
After the sap has been elaborated by the foliage, it is in proper condition for nourishing any of the growing cells of the plant. It passes to the growing tips and there assists in lengthening the shoots, in forming new leaves, and in producing buds — some of which may be fruit-buds — which remain dormant until the following year. It passes to the main branches and the trunks of the plant, and supplies the cells which are forming wood and those which are forming the tissues of the inner bark with the materials necessary to their support and growth. It passes down into the root system of the plant and furnishes the roots with the food required for their proper growth; but if an insufficient amount of food is present the roots are the first to suffer, for it seems that only the part which is not needed by the parts above ground is allowed to go as far as it may towards the nourishment of the roots.

We are now prepared to consider the effect upon a plant of any injury or other abnormal modification. When a plant is girdled, the nourishing sap is prevented from returning to the roots; these must suffer and eventually die. But when only a part of the top of a plant is girdled, the roots need not necessarily be deprived of their proper amount of food, since the remaining branches may perform their duty without the aid of the girdled portion. This part, however, may show very marked effects of the treatment. The sap is allowed to enter the branch freely; but when it is returning from the foliage it cannot pass the point of injury and we, therefore, find the abnormal growth of tissue which so commonly results from such mutilation. Yet all the food is not deposited at the girdle. Girdled branches are frequently the most fruitful ones; in fact, they may be the only ones upon a tree which produce fruit. The branch may be said to be congested with food, and relief from this condition is sought in the production of fruit.

Girdling may have other effects than to promote fruitfulness. Grapes are girdled not in order to make them more fruitful, but

that the fruit may be larger, and that it shall mature a little earlier. These are results which naturally follow from the abundance of the food supply.

The girdling of trees has been considered in connection with dwarfing because the two subjects appear to be closely connected. The results of checking the flow of sap are very pronounced in girdled trees. Figure 117 represents a union of a Fallwater apple upon the dwarf Paradise stock. The stock was budded about 22 years ago, and an enormous swelling has been



117.—Union of Fallwater apple upon Paradise stock. The swelling, in which the knife is placed, is of the cion. The earth is removed in order to show the malformation.

formed at the point of union. The slow growth of the stock, as compared with that of the cion, prevents the free passage of sap from the foliage to the roots. The stock in such cases may be said to form an obstruction to the descending sap, much as the wire does upon improperly labeled trees. If in spite of such an obstacle, the roots receive all the prepared sap which they require, the tree should prove to be very fruitful.

Dwarfing a tree is done primarily for the purpose of growing a certain variety of fruit upon a slow-growing stock so that the top may never attain its normal size. Other things being equal, this dwarfing need not necessarily cause it to be more precocious or more fruitful. Yet dwarf trees do, as a rule, bear earlier than

standards; this is especially true in the case of apples. Fruitfulness depends largely upon a proper food supply. The reason that a tree bears earlier when it is dwarfed may probably be ascribed to the fact that it comes to an earlier maturity, and that certain buds receive better nourishment than when growing as standards. A dwarf tree never makes a rank growth, so in this respect it may be said to be at all times more inclined to bear fruit than the standard. If, in addition, the stock serves as a check to the return passage of sap, we have the condition which we suppose will produce fruit in standard trees.

In the case of pears, there is less difference between the bearing periods of standards and dwarfs than there is in apples. The difference that does exist may be caused by the same conditions which were advanced above as causes for the earlier fruiting of apples. Dwarf pear trees are also supposed to produce larger and handsomer fruit than standard trees, but I know of no experiments which have shown this to be the case, although the truth of the statement is highly probable. All pear growers seem to agree that dwarf trees bear more regularly than standards, and it is the general impression that they bear more abundantly in proportion to their size.

The entire subject of plant dwarfing is an extremely intricate one. Directly connected with it are all the questions relating to the formation of leaf and fruit buds, the effects of more or less active vegetative growth upon fruitfulness, the kinds and proportionate amounts of food which are most influential in producing a desired effect, the influence of certain mechanical disturbances which were advanced above as causes for the earlier fruiting of important points still require investigation. Laws controlling such behavior of plants undoubtedly exist, but continued observation and wide experience must be had before these laws may be formulated with any degree of certainty.

*Fruits grown as dwarfs.*—The pear is the fruit most commonly dwarfed. It might be said that in the eastern states fully 50 per cent. of the trees are grown in this manner. The quince is used for stock. Such trees are very productive and under proper treatment they are long lived. One interesting point to consider in connection with dwarf pears is the fact that some varieties do

not grow well upon the quince, while others behave better when dwarfed than when grown upon free stocks. Apple varieties, however, are supposed to grow with equal readiness upon Paradise or upon Doucin stock.

Cherries may also be grown as dwarfs. The stock most generally used in such cases is *Prunus Mahaleb*, but the top must be kept severely pruned, otherwise large trees will be formed; but the dwarf trees are rarely grown in this country.\* In Europe, however, the small cherry bushes have the reputation of being exceedingly productive, the fruit at the same time being of very fine quality. These plants are grown mostly by amateurs.

Plums have long been dwarfed by pruning the roots severely every year or two, so that the top growth of the tree may be checked. Such trees bear regularly and abundantly; cherries may be treated in a similar manner with the same result.

## II. DWARFING THE APPLE.

Apples are at present regularly dwarfed by grafting or budding the desired variety upon some small form of the common apple species, *Pyrus Malus*. The species is extremely variable, having produced the bulk of the varieties now in cultivation (all save the crabs are of this species) as well as the dwarf forms, the Doucin and Paradise apples, which at present serve as stocks to check the growth of the more vigorous sorts. These dwarf apples were originally seedlings, the same as our present varieties are; and no doubt similar varieties appear at the present day, but we do not look for them and save them. Gardeners have known the dwarf varieties of apples for many centuries, and the introduction of these forms into cultivation can no longer be traced with certainty. The subject is made the more difficult because of the repeated transfer of the same name to different varieties of apples; this has been done so frequently that the term "Paradise apple" may more properly be considered to refer to a class of apples rather than to a single variety.

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\* As a matter of fact, the sour cherries, and very often the sweet ones, are grown upon Mahaleb stock in New York state. The Mahaleb stock is more easily worked and managed than the Mazzard or Sweet Cherry stock. The trees which are grown upon Mahaleb ordinarily reach their full stature. They are made dwarf only by judicious pruning.

*The Paradise apple.*—Early botanists considered as different species many forms of apples which are at present recognized as mere varieties of one species. The Paradise apple, as now known, is probably similar to the plant described by Bauhin as *Malus pumila*, “whose fruit is the apple of Adam.”\* It was said to bear both red and white fruits. Linnæus classed it as *Pyrus Malus*, var. *Paradisiaca*,† while Roemer called it *Malus Paradisiaca*.‡ The plant is distinguished, aside from dwarfness, according to Koch, by its smooth, shiny branches, both the old and the newly matured wood having a dark brown color. The leaves are finely serrated and taper at both ends. One of the most important characters of this apple as well as other dwarf forms, is the production of underground stems, and of stolons by means of which the plant may be rapidly propagated. These forms are also easily grown from cuttings, in which they differ from most strong growing varieties. In southern Europe, and especially in France, the roots are said to be extremely brittle, although in northern Germany this character is not always very marked. The fruit as a rule is small with a yellow skin and white flesh; it generally ripens during late summer or early fall.

Bauhin mentions two explanations for the origin of the common names of this variety.|| They are not entirely satisfactory, but the first probably contains a hint of the truth. He says: “Tragus, who describes the Argentinæ, describes certain kinds of apples from Germany. Some are sweet, white, oblong, etc., and are called Paradise apple. It is seen that Tragus, according to the common opinion, believed that this apple is from the tree

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\* 1. “*Malus pumila*, que potius frutex quàm arbor.

*Mala præcocia*, Trag. Tab.

*Malus humilis*, ejus fructus pomum Adami.

Gesn. Hort.” [Py. and g. *malus paradisiaca*].

“Fruit both red and white”

The name in the brackets has been written in the volume of Bauhin's *Pinax* owned by Harvard University. The writing is old and whose it is has not been determined. The copy at the congressional library at Washington contains no specific mention of the Paradise apple.

† “*Species Plantarum*,” 1753, 479.

‡ “*Synopses Monographica*,” iii, 1847, 195.

|| “*Historiæ Plantarum Universalis*,” i, 1650, 7.

whose fruit the great Jehovah forbade our first parent, Adam, to eat. \* \* \*

"Hieron Brunsch calls that apple the Paradise in which the bite of Adam and Eve can be seen." \* \* \*

"Gesnerus \* \* \* says there are two kinds of dwarf apples, one of which is called the Paradise apple. This variety, \* \* \* is similar to that which Matthiæ Curtius calls the Paradise. It is white, and ripens late in July. The plant is a bush not more than 4 cubits [6 feet] high, propagating itself from the roots."

Parkinson describes the Paradise apple in the following brief terms:\* "The Paradise apple is a faire, goodly yellow apple, but light and spongy, and of a bitterish sweet taste, not to be commended."

No single variety can, therefore, have been considered as the true apple of Paradise, or Adam's apple, by those early writers. Their descriptions include those apples which grow upon bushes or low trees, these having the power of propagating themselves rapidly by suckers or underground stems, and whose fruit is light colored, often tinged with red on the sunny side. Even in more modern times, the name Paradise has been very loosely used. Koch speaks as follows regarding its present significance in Germany.† "By the name Paradise apple we now designate, as was formerly done by the Italians especially, a considerable number of different varieties, all of which are especially handsome. In northern Germany the name applies to *Pyrus spectabilis*. The pomologist Henne considered it as belonging to the White Winter Kalvill, while the Red Fall Kalvill was called by Diel the Red Paradise. In the Netherlands, the Eiser also bears the name of the Double Sour Paradise. We also have a yellow Paradise; and the Red Stettine is frequently termed Paradise. Many other cases might be mentioned."‡

These examples will suffice to show with what freedom the name Paradise was applied to apples which possessed such beauty that their beholders were brought under the same spell as

\* "Paradisus Terrestris," 1629, 588.

† "Die Duetschen Obstgehölze," Stuttgart, 1876, 62.

‡ See volume I. of Dochnal's "Führer der Obstkunde."



that once exerted by the forbidden fruit of the Garden of Eden.

Three forms of apples which are suitable for stocks are mentioned by Philip Miller in his Gardener's Dictionary.\* They are all included under *Malus pumila*. They are as follows:

“The Crab [*Malus sylvestris, acido fructo albo*, Tourn.], which is the first sort here mentioned, has been generally esteemed as the best stock for grafting apples upon, being very hardy, and of long duration; but of late years there have been few persons who have been curious enough to raise these stocks, having commonly sown the kernels of all sorts of cider apples for stocks without distinction, as these are much easier to procure than the other; so the gardeners generally call all those crabs, which are produced from the kernel, and have not been grafted; but were the kernels of the crabs sown, I should prefer those for stocks; because they are never so luxuriant in their growth, as those from apple-kernels; and they will continue longer sound; besides, these will preserve some of the best sorts of apples in their true size, color and flavor; whereas the other free-stocks produce larger fruit, which are not so well tasted, nor will they keep so long.

“The Paradise-apple hath, of late years, greatly obtained for stocks to graft or bud upon; but these are not of long duration; nor will the trees grafted upon them ever grow to any size, unless they are planted so low as that the Cyon may strike root into the ground, when it will be equal to no stock; for the graft will draw its nourishment from the ground, so that it is only by way of curiosity, or for very small gardens, that these stocks are proper, since there can never be expected any considerable quantity of fruit from such trees.

“These trees have been much more esteemed in France, where they were frequently brought to the table in the pots growing with their fruit upon them; but this being only a curiosity, it never obtained much in England; so that the gardeners do not propagate many of them here at present.

“There is another apple which is called the Dutch Paradise-apple, much cultivated in the nurseries, for grafting apples upon in order to have them dwarfs; and these will not decay or canker

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\*Sixth edition, 1752.

as the other, nor do they stint the grafts near so much; so are generally preferred for planting espaliers or dwarfs, being easily kept within the compass usually allotted to these trees.

“Some persons have also made use of Codlin-stocks, to graft apples upon, in order to make them dwarf; but the fruits which are upon these stocks are not so firm, nor do they last so long; therefore the winter fruits should never be grafted upon these.”

The Dutch Paradise mentioned by Miller is at present unknown in England under that name. From the description given above it would appear that this variety, or class, is the same as the stock now known as Doucin (see page 387). His Paradise apple, on the other hand, is very similar to that which at present is more definitely termed the French Paradise. The following extract will indicate clearly what the nature of this variety is:

“At the same time will be forwarded to that gentleman 500 specimens of ‘*the dwarf apple of Armenia*.’ They are all much past the age of puberty, though only 18 inches high. I received them two years ago from Armenia, and they do not appear to have grown at all. They increase slowly in thickness. I have often seen them planted in pots and cases on the terrace in the city of Aleppo, of 40 and 50 years’ growth, never exceeding 2 feet in height, nor in the thickness of their stems, that of your forefinger, without their ever having been pruned. To test the fact that their diminutiveness was not caused by their being always kept in pots and boxes, I planted out three of full 15 years’ growth, and after keeping them 18 years in the open ground, found they had made no perceptible progress. I remarked that they bear best when their roots are cramped. They are very easily propagated, as they make abundant offsets, and take remarkably well from cuttings. Among the trees now sent, there are seventeen which were made from cuttings two years ago; and 10 budded, at the same time, with the Ribston pippin, and other sorts.”\* By the use of such stocks, plants could easily be grown in pots and set upon the table, as stated by Miller; but they can possess little practical value.

The French Paradise was known in France as early as the beginning of the 15th century.† It was considered as one of the

\* Jour. of the Hort. Soc., London, 1848, iii. 116.

† Koch. “Die Deutschen Obstgehölze,” 63.

most highly flavored varieties then grown, and according to Champier, who lived about a hundred years later, it was identical with two of the best varieties grown in his day. The first published account of the fruit, according to Koch, appeared in Jean de Ruelle's "De Natura stirpium, libri tres." This fruit was of a red color on the side exposed to the sun,\* and for this reason could not have been identical with other forms classed in the group.

*The Doucin apple.*—The introduction of the Doucin stock can be traced with more accuracy than that of the Paradise. According to Koch,† "It appears that the Doucin is of Italian origin and was first brought to notice by Agostino Gallo during the first century following the middle ages [probably the 16th century.] He mentioned two forms, Dolciano nano and Dolciano Mezzano, meaning the dwarf and the semi-dwarf sweet-apple. We do not know when the Doucin was brought to France, but it was probably introduced soon after it became known in Italy." The time of its first use in England is also a matter of doubt, and judging from the writings of Philip Miller, it does not appear to have retained its original name. (See page 386.) Yet Parkinson briefly mentions it:‡ "The Deusan or apple John is a delicate fine fruit, well relished when it beginneth to be fit to be eaten, and endureth good longer than any other apple."

The Doucin is a stronger growing stock than the French Paradise, forming a bush or small tree intermediate between the latter and a standard tree. It also is said to have the power of throwing out underground stems or suckers, although it does not have stolons, and it may be propagated from cuttings of ripened wood. The wood is more or less covered with fine hairs, or tomentum. The fruit resembles the Paradise in size, but the color is more red, especially on the sunny side. The sweet flavor has caused it to receive its common name, Doucin.

Koch states|| that the plant apparently grows wild in southeastern Russia, where it forms thickets, especially in the region of the lower Don and Danube rivers. It was called *Pyrus prae-*

\* Bauhin, "Historia Plantarum" i. 18.

† "Die Deutschen Obstgehölze," 66.

‡ "Paradisus Terrestris." 1629, 587.

|| Die Deutschen Obstgehölze. 65.

*cox* by Palas, and may be identical with *P. Sieversii* of Ledebour, who found a similar plant growing in southern Siberia. As the botany of the apple is as present understood, however, the Doucin and Paradise, as I have already said, are held to be simply forms of the common apple.

*The Rennette apple (Pommier nain de Rennette).*—A third stock, one mentioned by Duhamel,\* is rarely named in horticultural writings. Duhamel compared it with the two more common forms: “The Doucin apple forms but a large shrub, the Paradise rises to a less height, while the Rennette apple scarcely exceeds a gilly flower in size; and thus it is that the size and the habit of apples vary with the different forms.”

The Rennette of Duhamel seems to resemble the Paradise, and also the “Apple of Armenia” mentioned on page 386. The characters which distinguish the Paradise from the Doucin, the Doucin from the Codlin, the Codlin from the Crab, and the Crab from our named cultivated varieties, are by no means satisfactory or reliable. One form gradually approaches another as regards stature, and seedlings which are more or less dwarf have undoubtedly been referred to the class which they most closely resembled. All who have observed the height reached by seedling apples will have seen that they vary exceedingly. Some plants grow slowly and remain small; others start off from the beginning and make a clean rapid growth. As all such seedlings are generally the offspring of vigorous sorts, it is rather surprising that some should remain as small as they do. If the seed of smaller varieties were to be planted, undoubtedly still more dwarf forms would appear, and eventually the small French Paradise stock might be reproduced.

The power of producing offsets and stolons, which has been emphasized by some of the writers mentioned above, need not necessarily be considered as an essential character of the dwarf forms at present grown. Local conditions probably exert considerable influence upon this habit, for we have a plant of the so-called Paradise apple which has been growing upon the station

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\* *Traité des Arbres Fruitiers*, 1768, I. 273.

grounds for six years, and it has as yet failed to produce a single creeping or under ground stem which could be used in forming an independent plant. Neither is the power of growing from hard wood cuttings, limited to dwarf trees. Some of our orchard varieties may be propagated readily in this manner, even with little care, so that this character also may be considered as possessing only relative importance.

*Propagation of dwarf apple stocks.*—When the stock plants sucker freely, the suckers may be detached with a certain amount of root system, and then be transplanted and grown as independent plants. A very common nursery practice, however, is to subject the plants to mound-layering. This is performed by growing the plant or “stool” until it has become well established. It is then cut off within a few inches of the ground and all the shoots which are thrown out are allowed to grow. These shoots are made to root by heaping the earth about their bases, thus burying their lower half. This may be done the first year and rooted plants will be formed by fall, especially if the shoots have been partially cut or injured near the stock; such plants, however, are weak, and it is better to allow the shoots to grow unmolested during the first year, the mound being formed in the spring of the second.

The rooted shoots are removed in the fall of the second year, and if sufficiently vigorous they may be grafted with the desired variety during the following winter, or budded the next summer. Small stocks should be grown on in the nursery until they have reached the desired size for working.

*Pruning.*—Dwarf apple trees should be very thoroughly pruned from the time they are set. The object of this pruning is three-fold: the wood which is capable of bearing fruit will be more freely produced, the fruit spurs will be distributed evenly over all the lower parts of the trees as well as the top, and the tree will be kept in a dwarf habit. These results may not be obtained if too little wood is removed. Each year's growth, if vigorous, should be cut back at least one-half or two-thirds, and generally more may be removed with perfect safety. Occasion-

ally, dwarf trees will be found in which the natural vigor of the cion seems to have stimulated an undue growth of roots, so that the tree, instead of remaining small, increases rapidly in size,



118.—Dwarf Ben Davis six years from planting ; before pruning.

and soon it bears little resemblance to the plants frequently illustrated in books to show how a dwarf apple tree ought to appear. The annual growths may be from one to two feet in

length, and at this rate good sized trees are formed in a short time.

Figure 118 represents a Ben Davis apple upon Paradise stock; the tree has been growing in the Cornell plantation six years and although it is considerably smaller than a standard tree of the same age, still it can scarcely be considered as more than a half dwarf. A true dwarf tree, as described in most writings, would have a top hardly one-third as large. In past years this tree has been pruned with but moderate severity, so that it reached a height of fully eight feet. In this case, no material disadvantage resulted from such treatment, for an abundance of fruit spurs may be found distributed in all parts of the tree. A Maiden Blush dwarf which received similar prunings was affected differently; the buds which were near the point at which the annual growth was cut back were the only ones that started, and their growth was so rapid that practically no fruit spurs were formed during the first two or three years, and those which have appeared since that time are so high up in the tree that the lower parts of the main branches are bare and therefore unproductive. This defect frequently becomes exaggerated as the tree grows older. An excellent example of the ruinous effect of continually removing the lower branches from a dwarf apple is shown in Fig. 120. This tree, an Early Joe, was planted in its present position fully thirty years ago (not upon the Cornell plantation). It has been pruned gradually higher until at present the lowest fruiting branches are at least five feet from the ground, and a total height of practically twelve feet has been reached. This is not an ideal dwarf! The tree shown on the title-page represents a much better type. The original from which the drawing was made was five feet in height, the lowest leaves being but eighteen inches from the ground. The top has been allowed to assume its natural spreading form, but a firm control has continually been exercised over any too ambitious efforts of the branches. The tree has practically the same form and size which it will retain during its entire existence. The main branches will increase in circumference, the outer limbs will

gradually lengthen, and the fruit spurs will become more crooked, yet the tree will always be low and spreading. The one criticism which might be made is that the lowest fruiting branches are still too high. The foliage of the ideal dwarf apple tree almost touches the ground; it has all its main branches



119.—Same as Fig. 118, after pruning.

well studded with smaller ones, or with fruit spurs, so that, when in full leaf, it shall appear "feathered" from bottom to top.

The tree represented in Fig. 118 is worthy of careful study. The lower branches spring from the trunk at a height of less than ten inches from the ground. Several large branches rise



in an upward and outward direction, and these form an almost perfect framework for supporting the smaller limbs, which bear the fruit. The wood is well distributed, and its amount is more than ample for clothing the entire top with an abundance of leaves; it is well that this should be so, for it allows a greater choice of branches when the tree is being pruned.

The same tree is shown in Fig. 119, after having been pruned. The pruning has been severe, as the tree has already reached such size that further increase should be made slowly. Much wood is allowed to remain near the ground and in the center of the tree, for it is always easier to remove superfluous branches than it is to insert them where they are wanted. The form of the pruned tree is that of a rather broad vase, this being the shape which the tree naturally assumes. During the coming season, it should be well provided with foliage so that none of the main branches shall be exposed to the full glare of the summer sun. The fruit produced will also receive proper shade and the specimen as a whole may be considered as a good type of dwarf apple tree which has not been forced to assume a form which is unnatural to it.

The summer pruning of dwarf apple trees is, as a rule, unnecessary when the plants are grown as above described. If branches are desired in certain parts of the tree, a more or less severe pruning during early summer will have a strong tendency to force growth to appear from dormant or adventitious buds. It will cause the appearance of "water-sprouts," which, if checked in turn, may be converted to useful purposes. Another advantage of summer pruning is that it probably induces the formation of fruit-buds, but as dwarf trees rarely possess the fault of bearing too little fruit for their size, this end need seldom be sought.

The study of the fruit-buds of an apple tree is an interesting one, the more so on account of the mystery which will be found connected with their formation. One who studies fruit-buds, will not conduct his investigations very far before he is puzzled first by one question, then by another, and eventually he may feel lost in a sea of doubt. Dwarf apple and pear trees are ex-

cellent subjects for the inquisitive to begin with; later speculations may include all the other fruits. The method in which fruit-buds are formed is illustrated in Fig. 121, the spurs having been taken from a dwarf Ben Davis tree.

The twig *a* in the figure shows a stem which is nearly all two



120.—Neglected dwarf apple about 30 years from planting.

years old. The growth of the past year may be seen only near the top, starting just above the upper spur. The terminal bud of the shoot, therefore, grew straight on and may have reached a length of 12 or 15 inches. But it was not so with the lower side buds. These made a growth of scarcely half an inch, yet they are perfectly strong and healthy. What they would have done had

no fruit been borne the following season may be discovered by examining *b*. The two spurs upon the twig are each two years of age, the twig being three years, for it made one year's growth before the spurs broke from the buds. These spurs average scarcely over half an inch in length, and their diameters are probably but little larger than they were the year before. In *d*, in the center of the plate, we also find two-year-old spurs, but one became ambitious during the second year of its existence, and grew outward, probably in search of more light. The portion *c* represents a spur which has seen four summers. The small irregular line at its base shows where the first year's growth stopped; those an inch higher mark the increase of the second year; the third year added about an eighth of an inch and the fourth applied the top story to the structure. The spurs of *e* on the lower side of the plate, have the same age, but the annual growths are of more uniform lengths.

By examining the buds upon these spurs, it will be found that some are smaller than others and that they vary also in form. Such buds as are borne at the ends of the long spur upon *d*, *c* and the two upon *b* are pointed and they have a diameter which is less than that of the twig upon which they are borne. Larger and more spherical buds may be found upon *a*, *e*, and *d*. These are what are generally termed fruit-buds, as they contain minute blossom buds which, with the coming of spring, will develop flowers as well as leaves. No blossom buds will be found in the smaller buds, but only leaves, and during the coming season a leafy shoot will be produced, and the terminal bud may prepare for flowering the next year.

Young fruit-bearing wood, therefore, appears as shown in the illustration, and such wood should be well distributed throughout the entire tree. Its removal means the removal of fruit, although the fruit may not appear for a year or two or three; still it will appear sometime upon spurs, and such small branches should always be removed cautiously. The same remarks apply also to standard trees, and these should never have their branches pruned so that they resemble long-handled brooms, the

brush of which projects from certain parts of what should be a symmetrical tree.

III. COMMERCIAL VALUE OF DWARF APPLES.

*Yield of dwarf orchards.*—The first thought which naturally arises when the commercial value of dwarf apples is considered,

a                      b      d (center)                      c    e (bottom.)



121.—Spurs of Ben Davis apple showing leaf buds upon b, c, d and e ; blossom buds are upon a, and also upon c and d.

is the amount of fruit produced by such trees. The statement is generally accepted that such fruit is larger, handsomer, and perhaps a little earlier and of better quality than that produced by standards. The extent to which this is true has not yet been clearly defined, and careful investigation may modify the force of

the assertion; but even granting its entire truth, there still remains the consideration of the ultimate yield of fruit, in bushels, per acre. The question is, unfortunately, answered with difficulty. There are at present extremely few dwarf apple trees growing in New York, and those which do exist are mostly of different varieties so that comparative yields can not be made with entire satisfaction. Methods of pruning, or of not pruning, as well as differences of soils, location, etc., also enter as modifying circumstances. Nevertheless, some data are available for estimating approximate yields.

The following remarks refer entirely to trees grown on Paradise stock; they do not include such trees as have taken root above the point of union of cion and stock. Dwarf trees which have been set so that the union is several inches below ground, are apt to form roots at the lower end of the cion, and then more active growth takes place. Such trees are no longer dwarfs, but they must be considered as standards or at least as half-dwarfs.

The first estimates here given are based largely upon actual observation of dwarf apple trees, and also partly upon theoretical grounds. The printed descriptions for growing dwarfs almost invariably state that the trees should be set at intervals of about six feet each way for ordinary culture. In Thomas' *American Fruit Culturist* the distance named is eight feet for round-headed trees upon Paradise stock; and "for pyramids or dwarf standards on Doucin stock, ten feet." Doucin stock is at present neither grown nor used in this country except to a very limited extent, and I have as yet been unable to find a bearing tree growing upon it. Practically all trees now sold by New York nurserymen are upon Paradise stock, and the trees scattered about the State are also said to be growing upon this variety. The Doucin stock must therefore be omitted from this discussion; only the plants growing upon the so-called Paradise stock can be considered in detail, the value and characters of plants growing upon the Doucin resting upon the statements of correspondents (see page 402).

I am lead to believe that even eight feet is too close for dwarf

apples when grown in a closed vase form, or when allowed to assume their most natural shape, as shown in the frontispiece, these two methods being the only ones followed to any extent in New York. Upright growing varieties are trained according to the first system, while those of spreading habit are allowed to grow in their natural form. Ten feet appears to be none too much for either form of tree, and probably twelve feet would frequently be preferable. On rich soils and with vigorous varieties, a distance between the trees of fifteen feet will prove advantageous, and it thus appears that the number of trees which may profitably be planted upon an acre depends largely upon the habit of the variety, and upon the character of the soil; similar variations occur also in the case of standard trees. Assuming, however, an average distance of twelve feet between the trees, there may be set 300 trees per acre. During the first five years of their growth, these trees may yield some fruit, or they may not; the dwarf apples growing upon the Cornell grounds have been set six years, and none of the trees have borne over a dozen apples during any one season. The fruit which was produced was in no particular extraordinary; size, color, and quality were apparently identical with fruit from standard trees. Thus far, therefore, our dwarfs have not distinguished themselves as possessing superiority of any kind, except possibly early fruiting, yet we have several standard trees of other varieties which have borne more fruit than these.\*

When dwarf apples have reached the age of ten or fifteen years, they become more useful. Such trees seem to average in this State from three to four pecks of apples annually. Assuming the average annual yield of these trees to be three pecks per tree, about seventy-five barrels of fruit would be obtained from each acre of orchard, every year, by no means a poor yield. But after a tree has passed its twentieth year still larger returns may be expected. I have seen dwarf trees over thirty years of age which were bearing from three to four bushels of fruit, but

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\* These trees, however, were removed after they had been set two years, so that their behavior may be somewhat abnormal.

such trees are rare exceptions. From four to six pecks may be stated as representing approximately the annual yield of mature trees of naturally productive varieties which are grown as dwarfs, and which have been well fertilized and pruned. It will be found that the apples must be borne with considerable regularity that such an average shall be maintained; one year's partial failure, and such do occasionally occur, means a heavy crop for the succeeding year or two, and that in turn leaves an exhausted tree. A yield of about one hundred and twenty-five barrels per acre would be obtained from a uniform plantation, at the rate here assumed, and I believe this amount represents the present production of dwarf trees which have been well grown.

*Yield of standard orchards.*—In estimating the yield of standard apple trees, the same difficulties are encountered as in the case of dwarfs, but the uncertainty of the crop is here even more pronounced. The natural fruitfulness or barrenness of a variety expresses itself unequivocally, for the modifying circumstance of dwarfing does not obscure these characters. Soil and location are also free to exert a direct influence, and methods of cultivation, differing widely from each other, also play an important part. In considering standard orchards, the two extremes in their powers of bearing must be avoided, as has also been done in the discussion of dwarf trees.

An apple orchard which is composed of vigorous-growing varieties should be set so that the trees shall be at least forty feet apart each way. This allows twenty-seven trees upon an acre. If the varieties are but moderately productive, and the trees have been fairly well cultivated, a yield of about three barrels may be expected as the average annual crop per tree while the orchard is from 15 to 25 years of age. From this period until the trees begin to fail from old age, an average yield of five barrels per tree is more than is generally obtained. At this rate, the total returns from an acre would be about 135 barrels, a crop which exceeds the estimate of the dwarf trees by only 10 barrels. When orchards are composed of the less vigorous varie-

ties of apples, the trees may be set closer together; the yield per tree will be less than that of the larger growing sorts, but the greater number of trees may bring the average for standards to practically the same figure.

It would appear, therefore, that the yields from well grown standard and dwarf trees do not differ essentially, but such difference as does exist is in favor of standards. Definite data of undoubted accuracy are extremely difficult to obtain. The above figures, however, are founded mainly upon my own observation. Fortunately the estimates of others are also at hand, and a comparison of these conclusions should be made.

*Other estimates of yields and profits.*—Rivers writes\* as follows regarding the returns from a plantation of 100 trees of Cox's Orange Pippin grown as bushes upon Paradise stock: "These trees will this season (1864), the third of their growth in their present quarters, and the fourth of their age, give an average of a peck from each tree, so that we might have from 4,840 [set 3 x 3 feet], growing on an acre of ground, 302 bushels of fine apples, worth 5s. per bushel, or £75. In 1866, the trees then averaging half a peck each, would double this sum, and make an acre of apple trees a very agreeable and eligible investment." It was the plan of this writer constantly to renew certain rows of trees so that the orchard should continue in regular bearing condition.

Another interesting account is that of Cheal. The yields cited by him were actually attained by one of his friends. The name of the stock is not mentioned. The tree was a Warner's King, of pyramidal form, and was planted at Ramsden, in Essex, in November, 1871:

1872 Crop, 3 large apples.	Pecks.
1873 Crop.....	1½
1874 Crop.....	2
1875 Crop.....	4
1876 Crop.....	6
1877 Crop.....	7

\* "Miniature Fruit Garden." From 13th English Ed. 1866, p. 69 *et seq.*

† "Fruit Culture," London, 1892, p. 65.



	Pecks.
1878 Crop, 2 or 3 apples.	
1879 Crop.....	6
1880 Crop.....	5
1881 Crop.....	4
1882 Crop.....	3

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“Thus the average crop for 10 years was 4 pecks per year. These he sold in Chelmsford market at an average of 1s. 6d. per peck.

“The tree occupies a space of not more than 3 square yards; and calculating an acre of such trees 8 feet apart, or 681 per acre, the gross return would be £204 per acre yearly.”\*

A valuable series of tables has been furnished me by P. Pederson, Huntingdon Valley, Pa. The figures refer to Danish orchards, not to experience in America; nevertheless, they serve to indicate what may be expected in this country where the conditions in many localities do not differ very materially from those existing in Denmark:

“Distances of planting:

Standard apples, 30x30 ft., (quincunx, 27x30 ft.).

Apples on Doucin, 10x12 ft., or 12x12 ft.

Apples on Paradise, 6x8 ft., or 8x10 ft.

“Expected longevity of trees:

Standard apples, 50 to 60 years.

Apples on Doucin, 30 to 35 years.

Apples on Paradise, 20 to 25 years.

“Yield per tree and per acre:

Standards, 30x30 ft., extra good, per tree, 6 bus.; per acre, 270 to 290 bus.

Standards, 30x30 ft., good, per tree, 4 bus.; per acre, 180 to 190 bus.

Standards, 30x30 ft., medium, per tree, 2 bus.; per acre, 90 to 100 bus.

On Doucin, 12x12 ft., extra good, per tree, 1 bus.; per acre, 290 to 310 bus.

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\* A pound (£) is equal to about \$4.86.

On Doucin, 12x12 ft., good, per tree, 3 pks.; per acre, 210 to 230 bus.

On Doucin, 12x12 ft., medium, per tree, 2 pks.; per acre, 100 to 120 bus.

On Paradise, 8x10 ft., extra good, per tree, 2 pks.; per acre, 250 to 270 bus.

On Paradise, 8x10 ft., good, per tree, 1 pk.; per acre, 120 to 140 bus.

On Paradise, 8x10 ft., medium, per tree,  $\frac{1}{2}$  pk.; per acre, 60 to 80 bus."

Probably the most interesting feature of the above figures is the general uniformity in the yield of trees of an equal grade, regardless of the method of growth. The Doucin stock invariably shows greater fruitfulness than either of the others, but still the differences are not great. When the above yields are considered in connection with the condition existing in this country, one is involuntarily led to the statement that methods of culture, pruning, etc., have more to do with the yield of an acre of apple trees than does the method of propagation; and it is by no means impossible that experience will prove the truth of the thought.

An extended correspondence with many American growers of dwarf apples has resulted in the receipt of letters which frequently express somewhat contradictory opinions. Upon one point, however, all the writers agree fairly well, viz.: that apple trees grown upon Paradise stock are unprofitable. A variety of causes for this opinion are advanced, chief among these may be mentioned unproductiveness, short life, amount of care required, want of uniformity in the stock, and that only few varieties (of which one is Gravenstein) do well upon it.

Even greater variety of opinion exists regarding the Doucin stock. The majority agree in saying that the Doucin is in no marked degree an improvement over our ordinary free stocks. The trees do not bear earlier, they grow equally large, and for these reasons they have no particular value. On the other hand, some who have had experience with these trees say that they pos-

sess value, perhaps not so great as that of standards, but that if properly grown they will produce good crops.

The general opinion is that all dwarf trees are more regular in bearing than standards, although the total yield is not so great. They also have advantage of being more easily pruned and sprayed, and the picking of the fruit is also more easily performed; and the fruit upon such trees should therefore be more uniform and of better quality than that ordinarily obtained from standards. Evidently the true value of dwarf apples has not yet been thoroughly investigated and proved in this country, and before the trees are wholly condemned for commercial plantings they should be carefully grown in some quantity.

*Varieties suitable for dwarfing.*—There appears to be much less difficulty in growing all varieties of apples upon dwarf stocks than is the case with pears. No variety appears to have shown itself useless for this purpose, although some are recommended above others. It may probably be said that varieties which are naturally shy bearers will do better when dwarfed; naturally prolific sorts may be better as standards.

Cheal has published\* a list which includes the varieties most suitable in England for dwarfing:

1. "Dessert Apples. Red Astrachan, Duchess of Gloucester, Worcester Pearmain, Lady Sudeley, King of Pippins, Margil, Cox's Orange, Mother, Scarlet Nonpareil, Bradick's Nonpareil, Court Pendu Plat, Ross Nonpareil, Mannington's Pearmain, Duke of Devonshire, Sturmer Pippin.

2. "Kitchen Apples. Keswick Codlin, Professor, Lord Suffolk, Duchess of Oldenburg, Ecklinville, Lord Grosvenor, Mank's Codlin, Pott's Seedling, Cellini, Stirling Castle, Frogmore Prolific, Hawthornden, New, Schoolmaster, Cox's Pomona, Lord Derby, Prince Albert, Striped Beaufin, Wellington, Northern Greening."

American varieties have not been sufficiently tested to allow very definite statements to be made. The firm of Ellwanger & Barry, Rochester, N. Y., has been most energetic in growing

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\* "Fruit Culture," London, 1892, p. 122.

dwarf apples, and the following list given by Barry\* is probably the best now available:

“Red Astrachan, Large Sweet Bough, Primate, Beauty of Kent, Alexander, Duchess of Oldenburg, Fall Pippin, Williams Favorite, Gravenstein, Hawthornden, Maiden Blush, Porter, Menagère, Red Beitigheimer, Bailey Sweet, Canada Reinette, Northern Spy, Mother, King of Tompkins County, Twenty-ounce, Wagener.” To this list might also be added Jonathan and Ben Davis, both doing well when dwarfed.

#### SUMMARY OF THE EVIDENCE.

The evidence shows that dwarf apple trees have been so little and so carelessly grown in this state that no definite evidence of their value can be obtained. Nearly all writers and correspondents agree in saying that they are unprofitable for commercial planting, although they are equally ready to admit that the trees may be satisfactory as single specimens or as ornaments in the garden. It is a general and apparently well founded opinion that apples grown on dwarf trees are handsomer and of better quality than those grown upon standards. This suggests that dwarf trees may be profitably employed for growing varieties which are suitable for very fancy or dessert uses. Dwarf trees can be easily sprayed and tended, and the fruit can be carefully thinned. They may be planted as close as eight feet apart each way, although a greater distance is probably preferable. A mature dwarf tree, which has been well grown, may average two or three pecks of apples each year. The Paradise is evidently the best stock to use, but this stock is not perfectly uniform in habit of growth or in the size which it may attain. In short, the name Paradise belongs rather to a class of very dwarf-growing apple trees than to any single and definite variety. These Paradise stocks are grown from layers, chiefly in France whence our nurserymen obtain them. From all the evidence which I have been able to collect, therefore, I cannot advise the planting of dwarf apple trees for commercial rewards, but it seems to me, nevertheless, that they are worth experimenting with for this purpose.

E. G. LODEMAN.

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\* “Fruit Garden,” New York, 1890, p. 362.

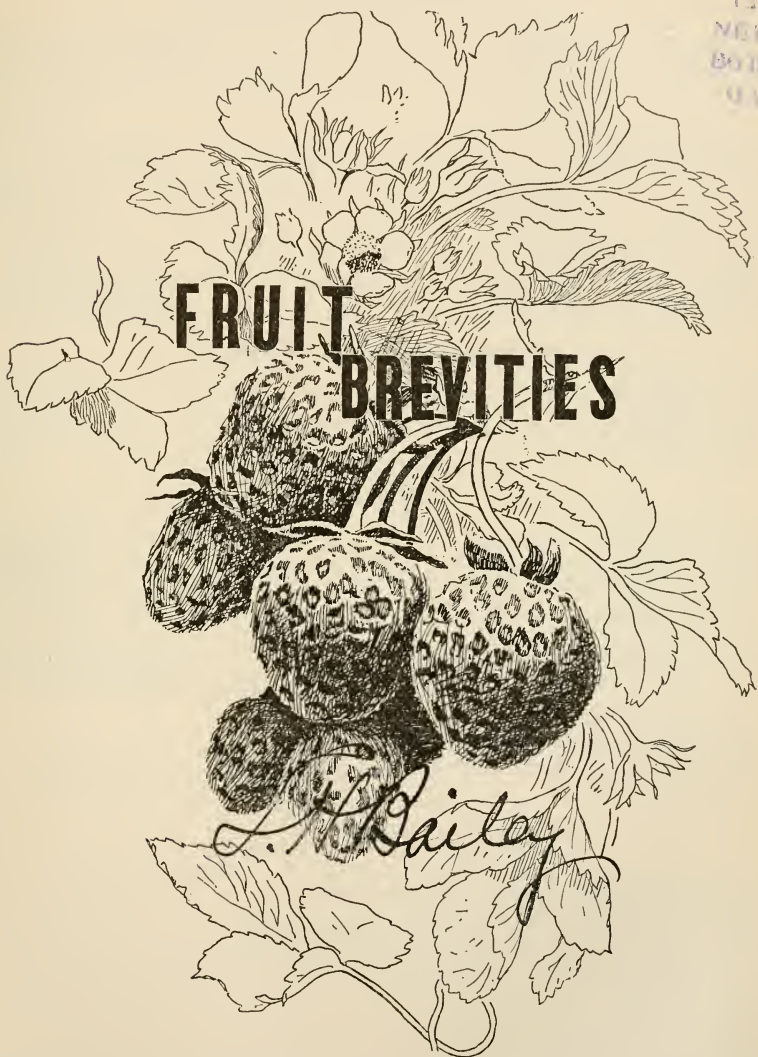
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BULLETIN 117—May, 1896.

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Cornell University—Agricultural Experiment Station,  
ITHACA, N. Y.

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Office of the Director, 20 Morrill Hall.

The regular bulletins of the Station are sent free to all who request them.

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## BULLETINS OF 1896.

106. Revised Opinions of the Japanese Plums.
107. Wireworms and The Bud Moth.
108. The Pear Psylla and The New York Plum Scale.
109. Geological History of the Chautauqua Grape Belt.
110. Extension Work in Horticulture.
111. Sweet Peas.
112. The 1895 Chrysanthemums.
113. Diseases of the Potato.
114. Spray Calendar.
115. The Pole Lima Beans.
116. Dwarf Apples.
117. Fruit Brevities.

CORNELL UNIVERSITY, ITHACA, N. Y., *May* 20, 1896.

*Honorable Commissioner of Agriculture, Albany :*

Sir: This bulletin is submitted for publication under the Experiment Station Extension Law (Chapter 437, Laws of 1896), which appropriates funds, "for the purpose of horticultural experiments, investigations, instruction and information, in the fifth judicial department" of the state, and for "disseminating horticultural knowledge by means of lectures or otherwise." The papers herein contained are incidents to our main lines of research, but they seem to be worth permanent record. The information contained in the first article is much called for by the fruit-growers of our district and the apparently increasing prevalence of root-galls on fruit trees is a subject of much apprehension. It is hoped that the remarks upon the treatment of winter-injured trees may be timely.

L. H. BAILEY.

## CONTENTS.

I. *Packing-houses for fruit.* (Page 409).—There are two types of packing-houses for fruit in use in western New York. One is a combined packing and storing house, and an excellent example is figured in cuts 112 and 123. The other is a packing-house only, without cellar, and is cheaply built. A good style of this type of building is shown in Figs. 124 and 125. These houses were built for grape packing, but they could be easily adapted to other fruits. The sorting and packing of grapes by Kenka and Chautauqua methods are illustrated in Figs. 126 and 127 respectively. The methods of handling apples on a large scale in sheds, are represented by Fig. 129. The value of these figures and descriptions lies less in the direct information which they give than in the emphasis which they place upon the importance of careful handling and packing of fruit.

II. *History of the Ohio Raspberry.* (Page 420).—The Ohio raspberry of western New York, which is the leading variety used in the extensive evaporating industry, is not the Ohio Everbearing of the books. The latter was the first variety to introduce black raspberry culture. It is probably lost to cultivation. The present Ohio came into cultivation about thirty years ago, presumably coming from Ohio.

III. *The Mistletoe Disease of the Blackberry.* (Page 424).—The account describes an injury to blackberry canes caused by the blackberry psylla or flea-louse. Spraying with kerosene emulsion and burning the deformed clusters, if they appear, are the proper remedies.

IV. *Root-galls.* (Page 425).—There is much complaint of the presence of root-galls in orchards and nurseries. So far as we know, these galls are not due to the work of any organism. They appear to be the result of some injury, or of some untoward condition of the soil or the treatment. When numerous, they may seriously interfere with the vitality of the tree. Galls should be removed from all trees before setting (Page 426).

V. *Are Dewberries worth growing?* (Page 435).—The Lucretia dewberry is earlier than the standard blackberries, and the fruit sells for a blackberry. If properly grown and trained on stakes or a wire trellis, it is capable of being made a profitable fruit.

VI. *The Goumi.* (Page 442).—This bush, a native of Japan, is a most desirable shrub for ornament, and its fruit is edible and gives promise of much usefulness if improved by cultivation and selection.

VII. *The Winter Injuries.* (Page 441).—The past winter was excessively severe upon vegetation. The injuries were no doubt augmented by the unusual drought and the dryness of the soil. Suggestions are given for the pruning and treatment of winter-injured trees.

VIII. *Crimson Clover for Orchards.* (Page 451).—The recent experience shows that crimson clover is often useful in orchards, but that we have not yet fully learned how to grow it. If sown in late July or early August on a well prepared seed-bed, it is about as reliable as red clover.



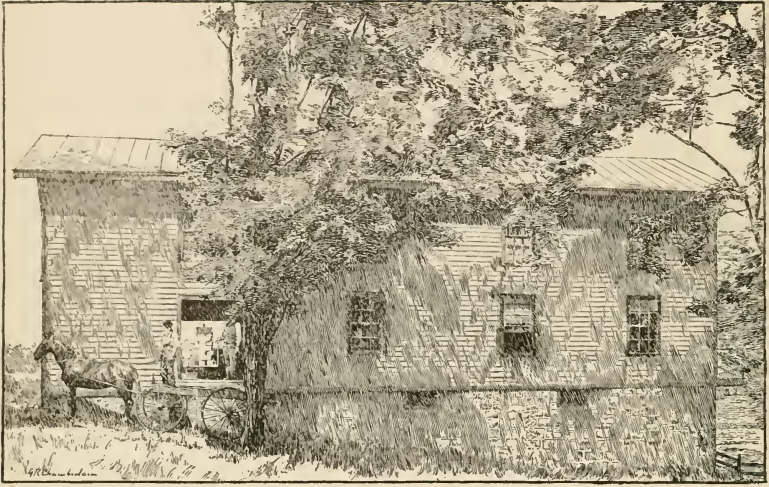
# Fruit Brevities.

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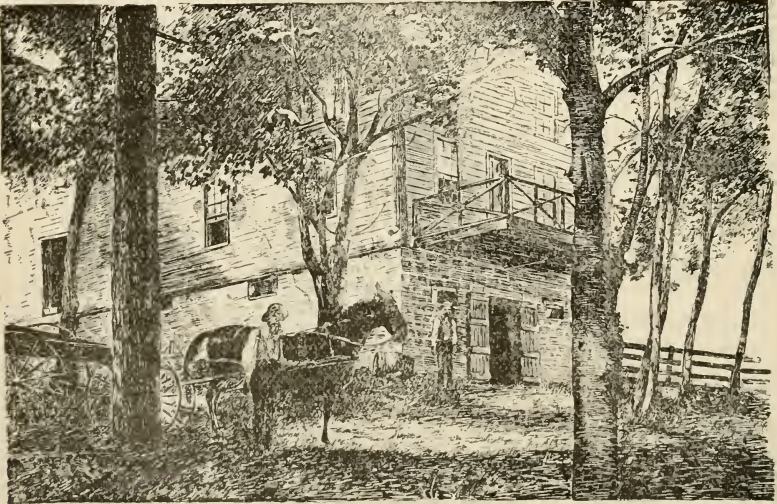
## I. PACKING-HOUSES FOR FRUIT.

There is much demand for instruction upon the style of houses which are best suited for the packing and handling of fruits. The subject is one which cannot be treated specifically for each grower, from the fact that every person has a different ideal, and he may grow fruits for a market which demands particular treatment of the products. The packing-houses most frequently seen in western New York are those used by the grape men; and if one studies the question, he will find that there are two distinct types of packing-houses in use in the grape regions. One type is a combined packing and storage house, and is used very largely in the central lake region, where Catawbas are grown and where the grapes are often stored for some time before they are marketed. The other type of house is that which is used in Chautauqua County and which is simply a half-way station between the field and the railway station,—a shelter place for the packing of grapes,— and is not used for the storage of the fruit.

In the lake region, as about Keuka and Seneca lakes, the grape interest developed at a very early period, before the market could take large quantities of fruit, before the Concord was known, and the Catawba is still the dominant variety. This variety is a good keeper; so it has come that the packing-houses of this district are very largely such as have cellars or cool rooms connected with them, and in these cellars the grapes may be kept until winter or even until spring. One of the best of this type of packing-houses which I know is that of George C. Snow, at Branchport, on Keuka Lake. This house is illustrated in Figures 122 and 123. It is built on a side hill, and the basement or cellar is used for the storage of grapes, the first floor is used for packing, and the second floor or attic for the storage of baskets, crates, and the like. This building measures 25x60 feet over all.



122.—Packing-house of George C. Snow, showing the packing-room entrance.

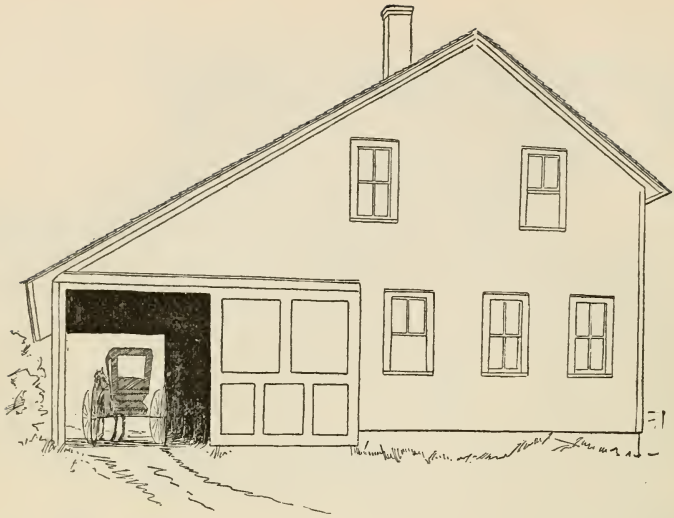


123.—Packing-house of George C. Snow, showing the basement entrance.

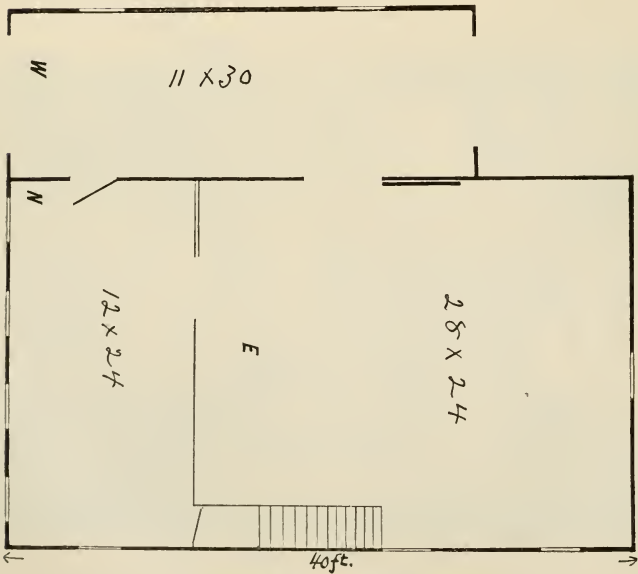
The foundation walls are 24 inches thick, and the cellar is provided with ample means of ventilation by outside windows, and also by means of a chimney which runs from near the middle of the cellar up through the roof. The floor is of dirt. By means of careful attention to ventilation, this cellar can be kept to 50 degrees or below during September and October, and is frost-proof during the winter. The windows are provided with close-fitting screens to keep out rats and squirrels. This cellar will easily hold fifty tons of grapes in the picking trays. The first floor is divided into two rooms, the front one being a packing-room 25 feet square, and the back room being a storage and shipping department 25x35 feet. This packing-room is provided with heat and is lighted by seven large windows. The floor above the cellar is double and made of 1½ inch matched pine, with an abundant air space between the two layers. This, therefore, protects the cellar from sudden fluctuations of temperature. The building is also shaded, especially from the afternoon sun, by large trees. This building can be erected for about \$1,200. It has 18 foot posts, a tin roof, the two rooms in the first floor ceiled with pine, but the top floor not ceiled.

The requisites for keeping grapes during the winter are given as follows by Mr. Snow in the *Rural New Yorker* for Feb. 1, 1896: "Any good building in which the temperature can be held even at about 35 degrees, with ventilation as may be required, this to be determined by noting how the fruit is keeping, will be found available for grapes. No positive rules can be laid down. A cooling room, in which the fruit can be first cooled, is a necessity; be determined by noting how the fruit is keeping, will be found to be raised rapidly by placing a quantity of warm fruit in the room. As even a temperature as possible is much the best. Grapes should not be packed in baskets for shipping before being stored. They should be ripe, as grapes do not mature after picking. Niagara or any other variety can be held only for a limited time, some varieties longer than others.

The Chautauqua type of packing-house is admirably illustrated by Figures 124 and 125, which are pictures of the house



124.—Packing-house of W. W. Pettit, Brocton, N. Y.



125.—Plan of Mr. Pettit's packing-house.

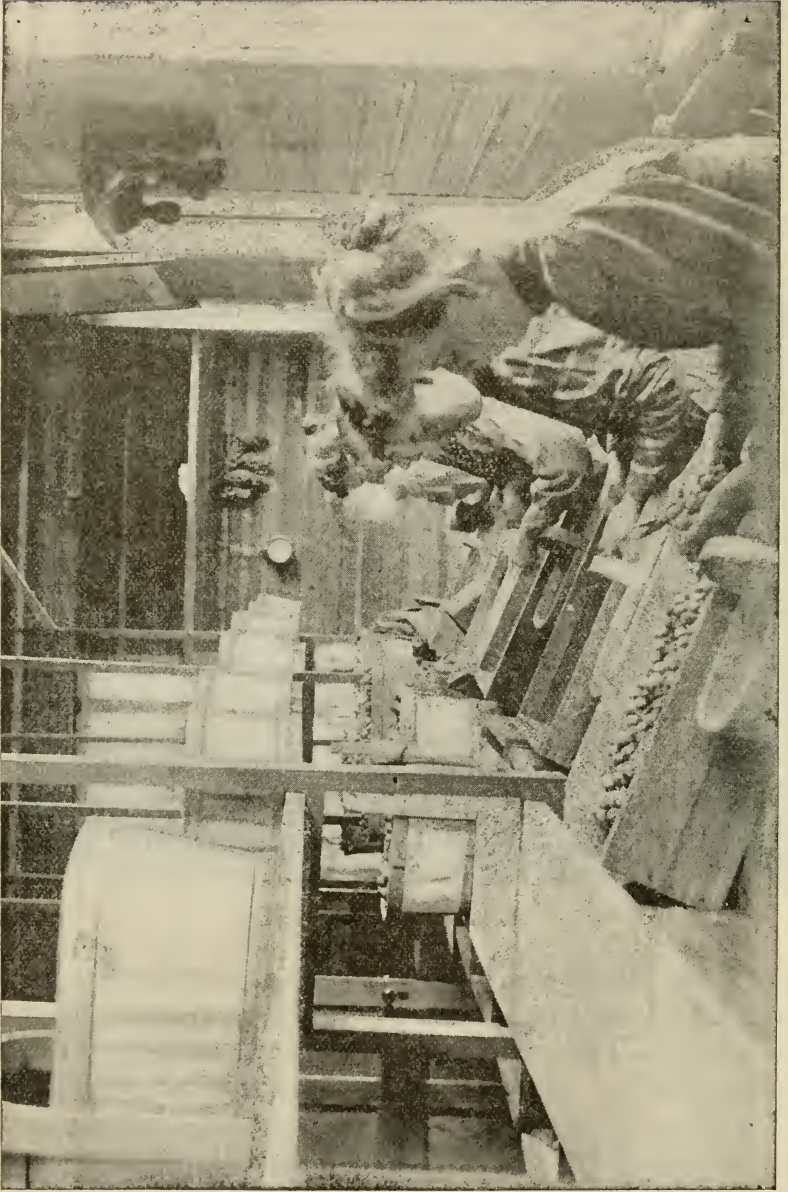
of W. W. Pettit at Brocton. In this case there is no cellar, for the grapes are not to remain in the house more than a day or two at the farthest; and they ordinarily pass directly through it on their way to the railway station. This is a house which can be built for about \$500. The main floor of the building is 24x40 feet in size, and aside from this there is a driveway under the same roof and which measures 11x30 feet. This driveway connects with the main floor by two doors. The front room, which is lighted by four windows in the front and one upon the side



126.—Mr. Snow's packing - table.

and is 12x24 feet in size, is the packing-room. In the rear of this is a store-room for the grapes. The half-story above is used for baskets and crates, and these are delivered into the packing-room by a chute. This building will accommodate ten packers and will easily handle the grapes from fifty acres of land. The main floor is ceiled, but the half story above is unfinished.

In the packing of grapes the greatest care is required to keep the fruit clean and fresh, to prevent the bunches from being broken, and to preserve the bloom upon the fruit. It is very es-



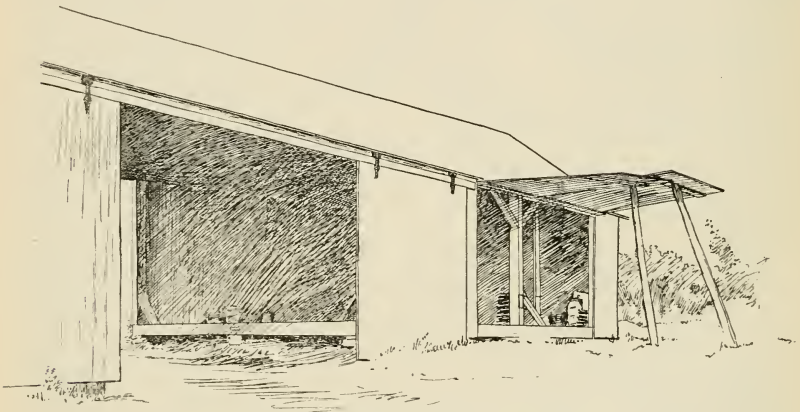
137.—Packing-room in Mr. Pettit's house.

essential that the house should be kept thoroughly clean and sweet at all times. It is especially important that the storage-room for the baskets and crates should be dry and airy, in order that the baskets may not become moldy or musty; and this room should also be kept darkened to prevent the baskets from coloring. Figure 126 shows a packing table in Mr. Snow's packing-room. This is a circular revolving table about which the packers sit. The packer holds the basket in her lap and takes the grapes off the table, which is turned as fresh fruit is put upon it. Figure 127 shows the packing-room in Mr. Pettit's house. In this case, the picking trays are set before the packers upon an inclined table, and the packer handles the grapes from this tray into a basket which she places at her left. When the basket is filled, it is placed upon a flat ledge in front of her, and is taken off by an attendant who places the baskets on a truck and rolls them into the back room, from which they are delivered to the wagon. When the tray is empty, it is slid through an opening just in front of the packer and underneath the flat ledge upon which she places her finished baskets. A quantity of empty baskets are kept upon a shelf just above this ledge and these are replenished by an attendant, as necessary.

Another type of packing-house is shown in Figure 128, which is a picture of a peach-house upon the farm of James Austin, at Morton, N. Y. The illustration shows one-half of the house. In the middle of the house is a driveway extending completely through it, which is closed by rolling doors. The fruit from the orchard is driven into this driveway, and is unloaded upon either side. The two ends of the house are opened by doors which are hinged at the top and the packed fruit is delivered through these doors or to the wagons in the driveway. This is a very convenient cheap type of house which may be used for peaches or apples during the fruit season, and for the storage of tools and barrels during the winter.

There is the greatest difference of opinion concerning the best ways of handling apples. These differences arise very largely from local conditions. If the apple grower sells his crop to the

traveling buyer in the fall, he will handle his fruit in the manner which this buyer prescribes. Ordinarily, the fruit is handled from the trees into piles, from which the barrels are packed as opportunity offers. In other cases, the apples are placed directly upon a sorting-table and the barrels are filled immediately. In still others, the apples are placed directly from the picker's basket into the barrel without being sorted. Every grower must decide for himself how he shall handle his crop. If he desires to market his crop himself and to hold it for some time, awaiting the movements of the market, he will find it essential to have some temporary storage place for his fruit. For myself, I am



138.—Packing-house of James Austin.

convinced that apples can generally be packed better and will keep longer if they are stored for a time after they are picked, in a cool building. This will allow the natural sweating process and the shrinkage to take place, all the inferior fruit will show its blemishes, and the apples can be packed at leisure. If it should happen that the market will not pay for the handling of the fruit in barrels, it is in convenient shape for selling in bulk or for use in evaporators. Figure 129 shows a storage house for apples upon the fruit farm of T. G. Yeomans & Sons, of Walworth, Wayne County, N. Y. In this case the apples are picked in bushel baskets, and from these baskets they are turned into bins in a shed which has an open front. In these apple

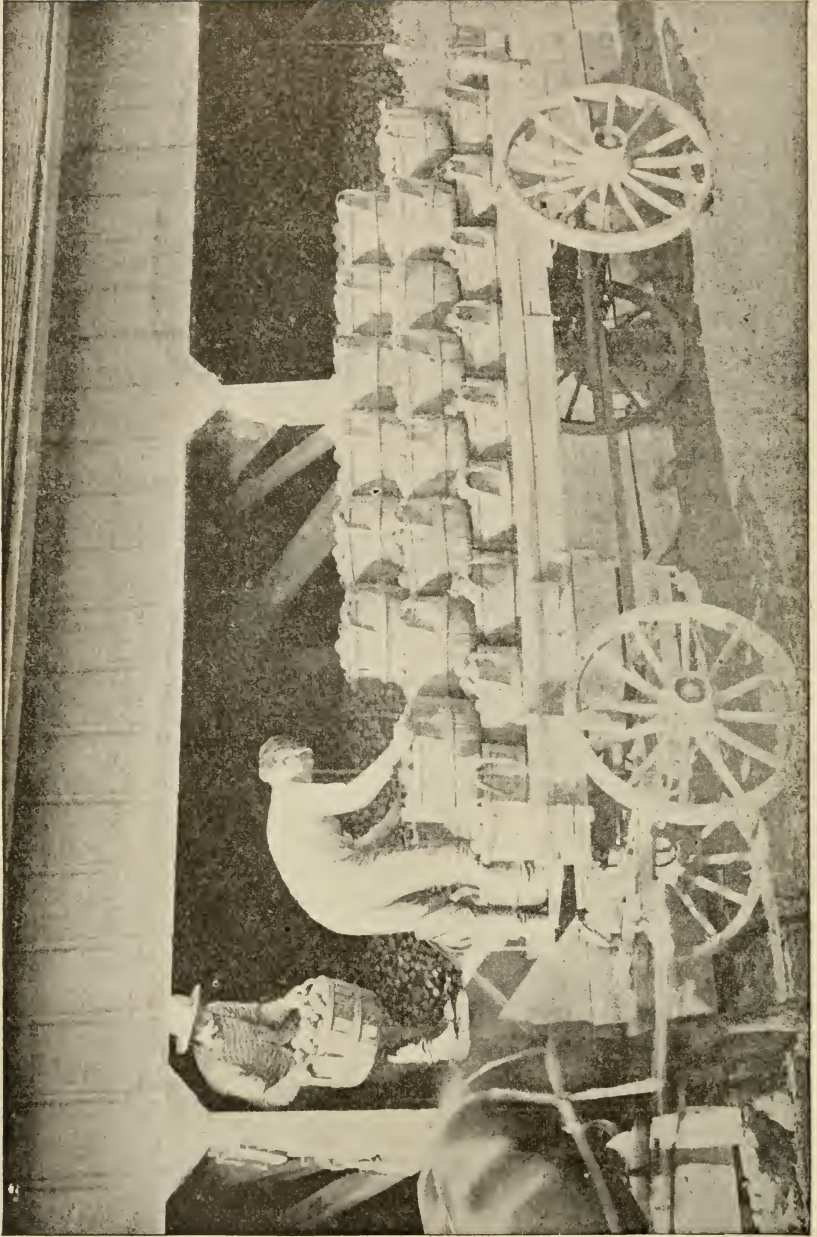


sheds it is important that the roof be well shaded in order to keep the building cool; or if that cannot be done, then there should be a story or half-story above the apples to keep the heat of the sun from the storage room.

I have been so much pleased with the thorough and systematic way in which the Yeomanses handle their fruits, that I have asked Mr. L. T. Yeomans to give me an account of their practice and which now follows: "We long ago found that it economized labor in the hurry of the gathering season, if we could put our apples under cover, where we could keep them much later than in the open orchard, and could work on rainy or very cold days, thus prolonging the season, for both the workman and ourselves, at the time when it is most difficult to secure plenty of help. We think it a great advantage, when it is desired to keep apples late, that they be packed in the barrels as late as possible. Allow them to sweat in the pile rather than in the barrel, and any which are disposed to decay early will have begun to show signs of decay and can be thrown out. The weather is also colder than when they are picked from the tree, especially where one has large orchards and must begin picking as early as possible.

"In gathering quinces and pears, we send all the packing force to the orchard during the latter part of the day, and by spreading the fruit thinly, on a little clean straw on the ground under the open shed, they become cooled during the night, and are in good condition for putting up the next morning; when, if left on the trees, they would be so wet from the dew that we could rarely pick them until they had become warmed by the sun and in an undesirable condition for packing.

"For a packing-house, we prefer an open shed, opening to the east, adjacent to a building in which the barrels can be stored. These barrels should have one head nailed and marked with the grower's brand, and the other taken out and placed in the open barrel before passing it out into the shed for filling. We use a ground floor covered with a little clean straw. Our shed is 20 feet in depth, in bents of 14 feet. Planks 2x10 or 12 inches are placed across the front from post to post as desired when filling,



129.—Packing-shed of T. G. Yeomans & Sons.

and are readily taken out as the packing progresses. When filling with apples, we use a plank for the man to walk on as he carries the fruit to the back of the shed. The empty barrels are set on one or more planks, which are not quite as wide as the heads of the barrels, where one person faces the bottom (which is to be the head), by placing the first course of fruit; the same person empties the half-bushel round baskets (in which we sort all of the No. 1) into the barrels in order as they stand on the plank, giving the barrel a vigorous shake for every basket, while the packers work constantly sorting from the piles, the apples rolling down to them. These half-bushel baskets should be of such shape and size that they can be readily turned over in the barrel in emptying, to avoid bruising the fruit as is done when poured into the barrel. All rejected fruit is put into bushel baskets and taken away. Each sorter uses a separate basket, so that it is easy to detect poor work when the baskets are emptied into the barrel. One man heads, nails and rolls out the barrels; another faces, and empties baskets. As far as possible, each person has his particular kind of work, and, if not satisfactorily done, the responsibility is readily located. We expect to pack our apples early in November. The first heads of the barrels are nailed on rainy days during the summer or early fall. When the barrels are packed, they are piled up outdoors, and if weather is dry, we sprinkle them thoroughly to prevent the barrel from absorbing the moisture of the fruit, thereby causing it to shrink and to rattle in the barrel.

“It is important that the quality shall be the same all through the barrel, and, as far as possible, that one barrel shall be a fair sample of a car load or more. Great care should be taken in all the stages of gathering and packing never to needlessly bruise the fruit. For picking, which for winter apples begins about October 1st, each man uses a half-bushel handle basket, which he empties when filled into one holding one and one-fourth bushels, by capping the latter over the former and inverting to avoid bruising in emptying the first basket. We use these bushel baskets in which to draw all of our fruit to the packing-house,

drawing forty-six at a load, as illustrated. The wagon is a broad tire half-truck, with springs which raise the rack only about four inches above the bolster, and carries 4,500 pounds. When shipping, we draw 20 barrels on end on such a rack."

## II. HISTORY OF THE OHIO RASPBERRY.

Confusion has arisen concerning the history of the Ohio raspberry which is so extensively grown in New York for the evaporating industry (see Bulletin 100), because of the fact that the Ohio raspberry of the books is a distinct variety. The history of this Ohio raspberry of New York is given in the report of the Iowa Horticultural Society for 1886 (page 88), but some of the details seem to be inaccurate. I now put on record the true history of this invaluable berry, as written for me by Dr. H. P. VanDusen, of Rochester, N. Y.:

"Some where in the sixties, my grandfather, Hiram VanDusen, of Palmyra, N. Y., bought a lot of Doolittle plants of Mr. Purdy, of same place, enough to plant something less than an acre. When these plants were getting old and nearly worthless, he discovered a plant which was apparently as good as new. He also knew from previous observation that it ripened later, was firmer and always loaded. He took pains to get tips down, and secured a few plants, and from these still more, until he had two rows a few rods long. At this time, my father bought this stock of him, and my father and myself increased the stock rapidly. We had also Mammoth Cluster, Seneca Black Cap, Doolittle and others. Its value was more and more impressed upon us until about 1876, when I sent out a circular offering plants for sale. The circular increased in size from year to year, and in 1882 or 1883 I received orders for more than a million plants, nearly three times the stock I had on hand. The Doolittle plants amongst which this variety was found, came from Ohio, and to distinguish it from the Doolittle, grandfather called it the Ohio. Some years later another berry under the name of Ohio came to our notice, but it was worthless and never came into general cultivation."

Mr. A. M. Purdy, of whom the stock of Doolittle plants was obtained, writes me that this Ohio raspberry which the eldest VanDusen propagated was "precisely identical with what I grew at that time as the Miami, obtained from Ohio, and it was so decided by John J. Thomas and Patrick Barry, who saw them on my grounds."

All the true Ohio raspberry which is now grown in western New York seems to have come from this VanDusen stock, and the variety is now widely distributed in other states. Mr. L. T. Yeomans gives me the following note:

"There are two distinct kinds of the Ohios; one is a dead black berry, more prolific and sweeter, and the plant a stronger grower; the other a firm berry, and slightly reddish. The latter is much more common here. The former is by some supposed to be the same as Johnston's Sweet."

The Ohio Everbearing raspberry of the books, with which this New York Ohio has been confounded, is probably no longer in cultivation. It will be worth our while to inquire into its history, however, for we shall thereby recall how recently it was that the wild raspberry began to be impressed into cultivation. This Ohio Everbearing, or Monthly Black-Cap, was, so far as I know, the very first cultivated native black raspberry. It was brought to notice by Nicholas Longworth of Cincinnati, to whose enlightened and prophetic efforts American fruit-growing owes so much, particularly in the cultivation of the grape and strawberry. The earliest record of the variety seems to have been made in the *Genesee Farmer*, but I know this reference only by the following entry in Hovey's *Magazine of Horticulture*, 1837, page 154:

"*Everbearing Raspberry*.—The *Genesee Farmer* states that a new kind of raspberry has been found in New York state, near Lake Erie, by the Shakers residing there, and that it produces its fruit throughout the summer and autumn. It is also stated to be really a valuable variety, and worthy of extensive cultivation. The fruit in appearance is longer than the wild black raspberry, and approaches near, in size and excellence, to the White Antwerp, but is not so high flavored. The habit of growth is

somewhat similar to the common purple raspberry, the shoots of which are very vigorous, bending over and touching the ground, and take root, by which mode it is rapidly increased. Its mode of producing its fruit is as follows: In the spring the old shoots throw out their new branches, as in other sorts upon which the first crop appears, but soon the new shoots begin to grow, and when they have attained a good size, which is generally just before the first crop is gone, they produce the second crop; to this latter circumstance it owes its name, and its peculiarity. The fruit of the second crop is considered the best. It is grown by Mr. Longworth, of Cincinnati, and by the Shakers near Lebanon, but has not yet found its way into any of our Atlantic cities."

The next account I find of this berry is in the *Magazine of Horticulture* for 1842:

"*The Everbearing Raspberry.*—In our Vol. III, p. 154, under our Miscellaneous Notices, we gave an account [quoted above] of this fruit which had then just been brought into notice: since then, we have heard very little of it till the past year. It is now attracting more attention, and as it is deemed a valuable acquisition, we have copied a further description of it below, which we find in the *American Agriculturist*:

"The Ohio Everbearing raspberry was first discovered some fifteen years ago, in the northern part of the state, near Lake Erie, but in what particular part is unknown. Mr. Longworth, of Cincinnati, introduced it into his garden in 1832, at which period he was driven into the back country by the cholera, where he found it growing. It has been little known, however, in Cincinnati, until within the last two years, but there is now great effort made by the gardeners to cultivate it for the market of that city. The fruit resembles the wild native raspberry, but is much larger, more fleshy, and of a much finer flavor, and is always a very profuse bearer. In Cincinnati, the wood of the previous year bears one crop in June, after which it soon dies; the young shoots then come into bearing, and continue doing so into October, till the frost cuts them off, when may be seen buds

and blossoms, and the fruit in every stage from green up to full ripe, on the bush, stayed by the hand of nature in the midst of their productiveness. The fruit is preferred by many to the Red Antwerp, and with its large erect clusters of flowers, presents a beautiful appearance.

“ Mr. Longworth, in a communication describing this fruit, in the *Gardener's Magazine*, states that the plants, in light dry soils, are not very productive in the autumn crop; but if grown on a stiff loam, on a clayey subsoil, bear profusely till destroyed by frost. From all that has been said in relation to it, it appears a desirable fruit, and we hope soon to test its qualities ourselves.”

One is not quite sure, after reading the above extracts, whether this variety came from New York or Ohio. It is first said that the plant was “ found in New York state, near Lake Erie,” but it was growing only in the garden of Mr. Longworth and with the Shakers at Lebanon, which is thirty miles from Cincinnati. In the second extract it is said that the plant was found “ in the northern part of the state,” but the name of the state is not mentioned. All doubts are set at rest, however, if one consults Longworth's own account of the berry in the *Gardener's Magazine* of London, to which reference is made in the second article quoted above. Dating his communication at Cincinnati, Ohio, Sept. 30, 1841, Mr. Longworth says: “ When driven into the interior of the state by the cholera, in September and October of 1832, I found a raspberry in full bearing, a native of our state, and the only ever-bearing raspberry I have ever met with.” Longworth moved to Cincinnati about 1804 and lived there until his death, in 1863. In this letter to the London periodical, Longworth expresses the belief that this raspberry would succeed in England, and he sent plants of it there by James Howarth, who went to the old country “ to purchase plants.” The editor of the magazine adds a note that “ plants of this raspberry are in a London nursery, but none of them will be sold till the worth of the variety is tested.”

Indigenous raspberry growing began with this Ohio Everbearing variety; but the contemporaneous Ohio has no connection with this historical berry save an accidental similarity of name.

### III. THE "MISTLETOE DISEASE" OF THE BLACKBERRY.

During the last fall, we were asked about a curious disease or malformation of blackberry canes by a fruit-grower in Delaware, which is known locally as the "mistletoe disease," because of the mistletoe-like bunches of foliage. We asked for specimens, which, upon examination showed the work of a psylla-like insect



130.— "Mistletoe" of the blackberry.

known as the "Bramble Flea-louse." This disease has long been known in New Jersey, and is also reported from New York. It therefore seems to be desirable to mention and illustrate the disease so that our own berry growers may recognize it, if it should invade their plantations. Our Delaware correspondent writes that the disease is "found on Early Harvest, Erie, Taylor, Minnewaski, and several other blackberries, but not much on the Wilson. I notice it most on neglected patches and on poor land."



Professor F. W. Card, of the University of Nebraska, to whom I mentioned the disease, gives me the following references to it: Bulletin 45, Ohio Experiment Station, p. 209; American Entomologist, i. 225, iii. 62; Illinois Entomological Report, viii. 17; Strong, Fruit Culture, 3d ed. 179; Saunders, Insects Injurious to Fruit, 320.

The specimens were referred to Mr. Slingerland who reports as follows: "The curling of the shoot is caused by a psylla known as the blackberry flea-louse (*Trioza tripunctata*). The insect was discovered by Dr. Fitch in 1851, and was common in New Jersey in 1869 and for several years after. The insect is said to be common on pine trees from Florida to Canada. There are said to be at least two generations annually. I do not know how it winters. It is recommended to cut out and burn all infested tips as soon as discovered. Doubtless much of the curling of the leaves is also due to the psylla, but a plant-louse (species unknown) had also contributed to this injury."

This insect is sometimes called *Psylla rubi* and *Psylla tripunctata*. Thorough spraying with kerosene emulsion before the injury has been wrought will probably keep the psylla in check; but in ordinary attacks the collecting and burning of the deformed clusters as soon as the disease is apparent will be sufficient to check the trouble.

#### IV. ROOT-GALLS.

We have many inquiries respecting galls upon the roots of various kinds of fruit trees. These galls are irregular swellings or excrescences upon the roots or upon the main stem just below the ground, ranging in size from that of a pea to one's fist, or even to several inches in diameter upon large trees. They are best known upon nursery stock, because the roots of the tree are exposed for observation. Specimens of affected apple roots are shown in Fig. 131. The galls are probably common upon old trees, however. In our Bulletin 74 ("Impressions of the Peach Industry in Western New York"), I made a discussion and illustration of galls taken from large peach trees. Since that time,

one pear grower has complained to us that his young standard orchard is gradually failing and that the difficulty seems to be the abundance of galls which he finds upon the roots.

Unfortunately, the cause of these galls is unknown, and it is also uncertain as to just how much damage they do. They seem to be widely spread in many countries, and they are known to be abundant in some of the nurseries of New York state. No one has ever been able to discover any insect or fungus which seems



131.—Root-galls upon apple trees from a nursery.

to be the cause of the mischief.\* We are now making experiments with the affection; but in the meantime we desire to give our fruit-growers the latest information which we possess on the subject, because the extent of the injury in this state seems to demand that the attention of every tree-planter should be drawn to it. We always advise that trees with galls shall not be planted; or if they are planted, that all galls should be removed. We do

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\*The root-knot of the southern states and of greenhouses is a wholly different trouble and is the work of a nematode worm. There is also a root swelling or gall on raspberries due to the work of an insect.

not know if the trouble is communicable from tree to tree, but the fact that great numbers of trees sometimes become infested in the nursery rows, seems to show that it may spread from tree to tree. However, one of the most distinguished German authorities upon plant diseases, Sorauer, thinks that these galls are simply abnormal deposits of woody tissue consequent upon the abrupt bending or injury of the roots when the trees are planted. A portion of his account is here translated (Sorauer, "Handbuch der Pflanzenkrankheiten," 1886, p. 737):

"These swellings have been seen by me mostly upon apples and pears. They appear generally at the crown of the roots of young trees, the enlargements having the size of hazel nuts or walnuts. In older specimens they may attain the size of one's fist. Their appearance upon the younger nursery stock is generally limited to the crown, but not unfrequently they are found lying deeper in the earth, or even upon slender one-year-old roots. In older trees they are much less frequent. The swellings have been found only upon those roots which lie near the surface of the soil. In those cases in which the galls have attained considerable size, a decreased growth of the branches of the trees may be noticed. Apparently, the gall absorbs so large a part of the nourishing material that the branches suffer. An unfavorable effect of these galls upon the roots appears to be a decreased development of small fibrous roots. This is especially noticeable in older trees.

"The color of the gall is similar in its younger stages to that of the sound root. Later, a darker color appears, in consequence of a deposit of dead material which forms the bark of the gall. If one examines the galls which are produced upon the smaller roots, it will be seen that they are generally located upon one side of the root body; that they have a softer tissue than the root, but that their color within is perfectly normal; and that they also possess an equal amount of starch. The large galls are composed of hemispherical growths which are superseded upon each other in such a manner that the surface has a very irregular granular and warty appearance. In the springtime the more

prominent of these elevations possess a light brown appearance and a perfectly herbaceous consistence. . . . A cross-section of the gall shows an irregular fibrous mass. In the smallest swellings on the most slender roots, there may be recognized a small dead portion in the center, and it is also the case in large roots that a properly made cut will show that the swelling originated from an injury to the woody cylinder of the root during the first year of its existence. The injury may consist of a small crack which extends from the outside to the center of the root at the time when the latter was small, or the root during its first year may have been torn and thereupon a callus appeared over the wounded surface and this callus eventually developed into a root-gall. The manner in which the first cracks appear has not been clearly shown, but certain indications lead to the belief that they may be caused by extremes of expansion and contraction. There may be frequently found wedge-shaped bodies of parenchymatous tissue in the rings formed during the first and second years' growth of the root. These bodies (which may have the power of forming adventitious buds) must show fairly deep crevices by the alternate expansion and contraction of the tissues. The circumstance that such parenchymatous wedges may also appear upon uninjured roots leads to the conclusion that the root-gall may also arise without injury to the roots, but this is always a more rare case. . . .

"I therefore consider the root-gall as a swelling which appears either upon the body of the root, or at the crown, but which is not caused by the action of any parasite. In the decayed surface tissues of the galls, many organisms may be found; but in the sound tissues I have been unable to discover any parasite. I have also looked in vain for a form of plasmodium. They appear to be caused merely by an abnormal flow of sap. Instead of the uninterrupted return, to the ends of the roots, of the sap which has been modified by the stems above ground, it finds a constriction. This may be due to an injury of the root, or to its having been bent at an acute angle. In such places the accumulation of nourishing sap leads to the excessive growth which

appears to consist of a rich callus over the places of injury, and in the case of bent roots, the growth appears to be an abnormal development of tissues of wood and bark. The younger the root is, which has been bent, the more easily the crevices may appear which lead to the formation of the above mentioned parenchymatous wedges; an expansion, of the medullary sheath may occur, and the formation of adventitious buds be induced. . . . I have frequently found woody bodies entirely isolated from the woody cylinder of the branches of various trees, especially in apples and in conifers. These bodies were buried in the tissues of the bark. Adventitious buds may be formed easily upon the roots of apples and pears since root cuttings of these plants will frequently produce shoots. Such shoots may also be found upon the more horizontal-growing roots of these trees, even when they are not separated from the parent plant.

“The formation of root-galls, therefore, does not appear to me more strange than similar swellings which are so commonly seen above ground. At first thought, it would seem strange that these root swellings should appear so much more frequently in certain nurseries. The prevalence of the attacks and the season of their appearance seem to indicate a parasitic origin, but I have been unable to find any plants or animals to which the trouble may be ascribed. The examination of many seedlings from nurseries upon which root-galls had been commonly observed lead me to what I believe to be the true explanation of this disease, which has appeared during recent years in so many different localities. Specimens of diseased and healthy roots which were taken from the upper part of the root system show that they have been well nourished and also that they bear many sharp angles, which, in some cases, have led to the growing together of roots that have been closely pressed together. In other cases, it will be seen that the early root system was cut back closely and a great many side roots have been produced near the cut surfaces. Since the young plants, in a vast majority of cases, show by their root systems that they have been well nourished, it may well follow that this good nourishment is also favorable to the formation of root-galls.

The disturbing influence may be ascribed either to the short cutting of the roots, or to the bending of the roots when the plants were set into the ground. If one watches the practices of the workman in transplanting seedlings in nurseries, an explanation for these crooked roots may be very easily found, frequently the holes are too shallow to receive the deeper roots of the plants. The plant is therefore pressed into the soil so that the trunk may be set at the desired depth, and many of the roots are more or less seriously bent. If, at the same time, the roots are pressed in a horizontal direction, or if they are bent upon a large curve, this shallow method of planting is not followed by any serious consequences. The steady return flow of the nourishing sap should thereby be diverted toward a more free production of side roots, especially from the main roots which have been but moderately bent; but in case the plant has been pressed into the soil so that the root makes a short and sharp turn, then the flow is so great that an abnormal deposit of material may easily induce the formation of root-galls.

“It is, therefore, just these improved methods of culture, the fertilizing and cultivation of the soil used for nursery purposes, and the methods which nurserymen have of growing seedlings rapidly (because in this manner stronger trees are produced), which bring about the conditions under which the root-gall is found.

“The experiment should be made of growing stock after it has been pruned in various ways, and with different methods of transplanting.”

It seems to have been generally assumed that this root-gall is a specific disease and due to some fungous parasite, and upon this assumption various fungicidal dressings of the roots have been advised (see, for example, Bulletin 74). The only actual experiments which I know to have been reported, in this country, are by W. E. Smith, Napa, California, and W. A. Yates, Brenham, Texas. Mr. Smith presented his results before a recent meeting of the Fruit Growers' Convention. I reprint the paper as it was published in the *California Fruit Grower* (Dec. 15, 1894, p. 481):

“The principal damage from root-knot appears to occur only when the knots approach the crown of the root; when they encircle the crown of the root the tree is hardly worth saving. Hence, where root-knots exist they should be destroyed early, at least before they encompass the root crown.

“Methods of Work.—As to the method of the work I will say, that as fast as the knots were uncovered by the man with shovel and trowel, I followed with brace and bit and a large bottle of concentrated solution of bluestone [sulphate of copper]. In the cork of the bottle a quill is fixed to guide the fluid easily into the bored holes. After two days' work the method of treatment was modified.

“A Phenomenon.—A curious and interesting thing occurred. I noticed that the leaves on certain branches of trees treated the first day had turned very dark, with a sort of coppery tint which was very noticeable. The leaves dried up shortly and fell off, leaving the branches naked, while other branches on the same tree retained their green leaves. Not one tree only, but a score of them were showing this strange effect of the cupric solution. With those dead, copper-hued leaves before my eyes, there was little room for doubting that the cupric fluid had thus quickly entered into the circulation of the tree. It must have done so to produce the effect observed. And it must have gone up at a season when we speak of the sap as going down. I was a little scared at this phenomenon and modified my treatment by striking off the knots and puncturing the diseased wood, especially the core of the knot, with a sharp, pointed iron, then applying the cupric solution with a swab, in this way avoiding a too excessive quantity of the fluid penetrating the fiber of the tree. However, in the light of future events, there seemed to be no need of this precaution. The trees thus curiously, and, it would seem seriously affected, were all right in bud, leaf, blossom and fruit in the spring and summer following. They have shown no signs of injury since, but on the contrary seem to have taken on a healthier tone than the other trees, so that I now believe the treatment by boring is perfectly safe, if done in September or October. I could not vouch for it at other seasons of the year.

“Final Results.—After two years, not one of the 200 trees has died. Every tree treated was marked by tying a strip of cotton cloth on a south side branch next to the trunk of the tree. These marks still remain. Only last week I dug away the earth from about twenty of these marked trees, and found dead knots only—a specimen of which I brought with me, that members of this convention interested might see for themselves. The trees treated for root-knot now look as clean and healthy as those not treated—no difference can be seen—they all made a splendid growth last year and no finer trees can be seen in our section of the same age. In the light of these facts, I consider the treatment with bluestone, in the manner herein described, a success. Even if the knots should reappear after three or four years, it would still be profitable to apply this remedy to keep the knot growth in check. The cost of application need not be more than three to five cents a tree, and the bluestone used is so trifling in quantity that it need not be considered in the bill of expense. My treatment of root-knot has always been in the fall months of the year. Whether other seasons would do as well or better I am not prepared to say.

“Suggestions.—In using this remedy, my advice is to make the bluestone solution as strong as the water will dissolve.

“In applying the solution be sure that it penetrates the core of the root-knot.

“If the knot is on the main stem of the root, so as to be easily accessible, I would advise to knock it off and puncture the soft core repeatedly with any pointed implement. Then apply the solution with a swab. Be sure to have the solution penetrate the diseased wood.”

This experiment, as here reported, is by no means a proof that the sulphate of copper is a cure for the root-gall. Mr. Smith simply reports that the treated roots did not again develop galls; but if Sorauer's hypothesis of the formation of these galls is correct, we should expect that they would not return if once removed. Mr. Smith should have left some trees untreated from which the knots had been removed; and he should also have determined if



trees from which the knots were not removed, tend to develop still more knots. Mr. Smith's paper brought out a discussion from Mr. Yates, the larger part of which I am glad to quote (*California Fruit Grower*, Feb. 9, 1895, 111), particularly as his conclusions are essentially like those of Sorauer:

“ In common with many other horticulturists, Mr. Smith assumes the root tumor to be a disease, which in the strictest sense of the word it is not, as the tumors when first formed are composed of healthy cellular tissue; disease being afterwards superinduced by the abnormal condition of the enlargements interfering with the proper functions of the sap in regard to circulation.

“ My first investigations of tumor were made with the idea that possibly such curious growths resulted from an inherited cause, or were perhaps the work of minute fungi and therefore contagious; so I budded, grafted and inoculated unaffected from affected trees, but all to no purpose; the tumors refused to be reproduced.

“ But while investigating along this line, I noticed that wherever the free circulation of sap under certain conditions had been checked or impeded, it was no uncommon thing to see some of these tumors commence to form, and several years' observation has but served to convince me that they are primarily caused, either by impeded circulation of sap and consequent disorganization of the sap vessels and surrounding tissues, or by a lack of equality in the absorption of moisture by the roots and its transpiration by the leaves and branches.

“ In the first instance, the sap being forced out of its regular channels and unable under these changed conditions to perform its proper functions, commences to throw out callus formations, which enlarge very rapidly owing to the amount of sap forced into them through what is generally known as the core of the knot. This mass of callused matter thus irregularly formed becomes after a time diseased, and it is at this stage that the fungus growths have been found which have led many investigators into the error of supposing these tumors to be the result of fungi. The causes of this impeded circulation are many;

among which may be mentioned, grafting and budding, when there exists, as is often the case, a disparity in size or lack of affinity between scion and stock; and abrasions or wounds of any kind made on the tree beneath the ground surface.

“In the second instance the lack of harmony between root and branch may be caused by an unseasonable loss of foliage, either through severe summer pruning, or the killing of the young growths by a late freeze. The means of transferring the moisture absorbed by the roots being thus suddenly cut off, the sap cells in the lower portion of the tree become congested, resulting in the ruptures that cause the formation of the callus knots, or tumors.

“As to the remedy for these tumors, I have always found cutting them off quite effective if taken in time, and when the work has been well done I have seldom seen a return of the knots; it is well to cover the wounds thus made with grafting wax or any substance that will answer the purpose of excluding the air without injuring the tree.

“From my present knowledge of root tumors I fail to see where Mr. Smith’s solution of bluestone remedy can be of much benefit. Regarding the dead knots he found on trees previously treated with this remedy, I may say I have frequently noticed the same thing, as in many cases the tumors when partly rotten became detached from the tree, often, however, leaving a canker spot that later may endanger the life of the tree affected, if not attended to.

“I have more commonly met with these tumors on peach, plum and apple, but also occasionally on over thirty other species of fruits, shade trees and evergreens.”

The conclusion of the whole matter, then, as we now understand it, is that these root-galls are not the work of a parasite, but are a malformation following some injury of the root or some uncongenial condition in soil or treatment. The galls may seriously interfere with the nutrition of the plant, in many cases causing it to become weak and sickly. It is probable that the trouble is not communicable, and that cutting off the gall averts further trouble from that source. As a precautionary measure, however, we much prefer to plant only trees with perfectly clean and normal roots.

## V. ARE DEWBERRIES WORTH GROWING?

Nearly five years ago, we published a bulletin (No. 34) upon the dewberry and concluded, from the results of our experiments and inquiry, that there is a future for the berry for commercial purposes. There was a brisk demand for the bulletin, largely due, it seems, to the novelty of the subject; but it ap-



132.— Lucretia dewberries trained to stakes.

pears to have had comparatively little immediate effect in encouraging the cultivation of the fruit. The dewberry is so unlike all other small fruits in its habit of growth, that growers seem to be slow to learn how to handle it; and many of them are no doubt prejudiced against it because the species is so common, and often so troublesome, in old fields and vineyards. The rasp-

berry and blackberry have had a similar history, and the prejudices against them are only recently outgrown. Here and there, a person has studied the dewberry and has found it to be a valuable addition to the market fruits of early summer. I. A. Wilcox, of Portland, Chautauqua County, is one of these, and he read a paper commending the berry to the Western New York Horticultural Society last winter. I know Mr. Wilcox's plantation, and am convinced that the dewberry is an acquisition to him. As our bulletin is now out of print, I shall make a few extracts from it and give some further directions for the growing of the plant.

Of the dozen or twenty varieties of dewberries which have been named and introduced, only two, the Lucretia and Bartel, have gained wide prominence. In fact, there may be said to be only one leading variety, and that is the Lucretia, and it is the only one which has been well tested in New York. The full history of this and others is given in the Bulletin 34. The dewberry bears the fruit upon the canes of last year's growth, the same as raspberries and blackberries do. These canes are long and weak and naturally lie perfectly prostrate on the ground. "There are several methods of training the Lucretia dewberry," we wrote in 1891. "It is commonly allowed to lie upon the ground. The canes are cut back to three or four feet in length in the same manner as blackberry and raspberry canes are treated, and if the best results are expected the canes should be thinned to four or five in a hill. The canes are usually allowed to branch freely, although it is evident that some checking of the growth may often be essential to good results. A mulch is often placed under them to keep the berries clean and to retard the weeds. When this is applied, the vines are raised with a fork. A. M. Purdy\* recommends two stakes, one to hold the bearing cane, and one the growing cane. This implies that only one cane is to be allowed to fruit each year. This method does not appear to be in practice and it is doubtful if it has anything to recommend it. Trellises and racks of various kinds have been devised. In our plantation of Lucretia we have tried three methods of training. In one portion of the plantation the plants are allowed to lie upon the ground without mulch, and the canes are cut off when three or

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\*Small Fruit Instructor, 94 (1887); Pop. Gard. ii. 100, 160.

four feet long. Another portion is trained upon a common grape trellis of three wires, the canes being tied to the wires the spring of the bearing year by means of wool twine. In the third portion the vines lie upon a flat rack standing 18 inches above the ground, and made of light slats laid crosswise the row and resting upon bents at the sides. There has been no gain in productiveness or earliness upon the trellised or racked plants; the only advantages have come from the greater ease of picking and cultivating and the less amount of room occupied. And these advantages are considerable, and seem to me to warrant the adoption of some simple trellis, preferably a wire trellis, in garden culture. Whether it would pay in field or market culture is a question which must be determined by the grower himself. The labor of tying the canes to the wires is somewhat onerous, but it is needed only once in the season. This training does not interfere with covering for winter protection, for the young or growing canes are allowed to lie upon the ground and are tied up the following spring. If the canes interfere with cultivation while growing they can be placed lengthwise the row with a rake or they can be thrown over the lowest wire. After the



133.—Dewberries on a wire screen.

canes have borne, they are cut out, in the same manner as the canes of raspberries and blackberries." Mr. Wilcox trains to three strands of No. 13 wire, the top strand being three feet from the ground.

Upon several accounts, however, I prefer tying the canes to stakes as shown in Fig. 132. Three or four canes may be allowed to grow from each plant, and these are tied to the stakes, with wool twine or willow thongs, two or three times during the season, as they grow. The canes may be left on the stakes all winter, although it is better, particularly in exposed localities, to lay them down late in fall. Whilst the year-old canes are bearing fruit, the new ones are growing on the ground. As soon as the fruit is removed, the old canes are cut out and the new ones are tied up for the remainder of the season. To prevent the breaking of these young canes by the early cultivating, it is necessary to turn them lengthwise the row with a fork. If they become very strong and if the land gets weedy, it may be advisable to tie up these young canes along with the old ones before the fruit is picked. On the other hand, if the land is clean, so that much cultivating or hoeing is unnecessary, the

new canes may be allowed to lie on the ground throughout the entire season. This is scarcely advisable, however, for they are likely to make a weak and soft growth in weeds and grass and shade, and the ground cannot receive the attention which it should have. Some persons tie dewberries to a woven wire screen, as seen in Fig. 133. This is a neat practice for a few vines in the garden, but is too expensive for the field, and the spaces in the screen are not large enough to allow of the easy movement of the hand through it when tying and picking.



134. *Lucretia* dewberry, natural size.

The one great merit of the dewberry is the earliness of the fruit. The fruit is indistinguishable from the blackberry by the general public, and it is ten days and often two weeks earlier than the standard varieties of blackberries. "Dewberries, raspberries, and blackberries grow side by side in our plantations, and we have had, therefore, a good opportunity to observe the earliness of the *Lucretia*. This year (1891) the first ripe raspberries — Marlboro

and Rancocas — were obtained July 4. At this time a few dewberries were about fully grown and had turned red. July 8 a few dewberries were secured. July 11 dewberries on some of the vines were ripening rapidly, and at this time Ada raspberry was just ripening and Doolittle and Souhegan were in their prime. July 16 Early Harvest blackberry, our earliest sort, gave its first ripe fruits, while the first picking of Agawam was not obtained until July 22. July 16 there were no flowers to be found upon the dewberries, but the blackberries were still blooming freely. A week later, pickings from the dewberries had practically ceased. It will be seen, therefore, that the dewberries ripen with the earliest black raspberries. But it must be said that there is a great variation in the time of ripening between different plants," a fact which is due to natural variation in the character of the variety. In propagating the dewberry, it is important that only those plants which bear large and uniform fruits shall be chosen for parents.

In quality, the Lucretia dewberry is probably inferior to the best blackberries. The canes are also rather more tender, but they are so easily laid down and covered that this is not a serious objection. The berries, on well grown plants, are large and handsome, glossy-black, and firm enough for shipping. The dewberry is not so heavy a cropper as the blackberry. Fifty to sixty bushels per acre may be considered to be a fair crop. To secure this yield, the rows should stand about three and a half feet apart, and the plants from two to three feet in the row.

The Lucretia is the only variety which I can confidently recommend for this state, although I should like to see the Bartel given some attention. All the dewberries propagate by rooting at the tips and joints of the canes, and they are therefore easily increased by any grower.

In order to bring the gist of the entire dewberry question to the reader's attention, I will reprint the conclusions of Bulletin 34, adding the results of later experience:

1. The cultivated dewberries represent three distinct species of rubus or bramble, and two well marked botanical varieties. It is therefore reasonable to expect that different managements may be required in the different classes, or at least that various results will be obtained from their cultivation.

2. The botanical types to which the cultivated dewberries belong are these:

I. The northern dewberry, or *Rubus Canadensis*. To this type belong the Windom, Lucretia's Sister, and Geer.

(a) The Lucretia sub-type, or variety *roribaccus*, comprising the Lucretia.

(b) The Bartel sub-type, or var. *invisus*. To this belong Bartel or Mammoth, General Grant, and Never Fail.

II. Southern dewberry, or *Rubus trivialis*. Here belong Manatee, Bauer, Wilson's White, and Austin, and probably Fairfax.

III. The western dewberry or *Rubus vitifolius* (known also as *R. ursinus*). Here belong the varieties known as Aughinbaugh (one of the reputed parents of the Loganberry), Skagit Chief, Belle of Washington, and Washington Climbing. None of these berries have been well tested beyond the Pacific coast region.

3. The dewberries are distinguished from the blackberries by a true trailing habit, cymose and few-flowered inflorescence, and the habit of propagating by means of "tips." Like the blackberries and raspberries, they bear their fruit upon canes of last year's growth, and these canes die or become weak after they have fruited. They are propagated by means of "tips" and root cuttings.

4. The peculiar merits of the dewberries as cultivated fruits are earliness, large size and attractive appearance, and the ease with which they may be protected in winter.

5. The peculiar demerits of the dewberries are the failure of the flowers to set, the formation of nubbins, and the difficulty of picking the fruit. There is no positive method known by which the first two difficulties can be overcome, and the causes of them are unknown, but there is reason to believe that tying up the canes, and pruning and thinning will tend to make the plant productive. The labor and unpleasantness of picking may be



avoided by training the plants on a rack or trellis, or upon stakes, and by keeping them well pruned.

6. Various methods of training and cultivation are advised. In the earlier methods, the plants were generally set about the same distance as blackberries (3x7 or 4x7) and the canes are allowed to lie upon the ground, being headed in when they reach about three feet in length. A mulch of straw beneath the canes was sometimes used to keep the berries clean and render picking pleasanter. At present, the canes are either trained on a two-wire or three-wire trellis, or tied to stakes, and the plants are set in rows which are three or four feet apart. Only three to six fruiting canes should be allowed to the plant. Some varieties, particularly Windom and Bartel, appear to do best if the fruit is shaded.

7. About twenty varieties of dewberry have been named and more or less disseminated during the last twenty years. Of these four have gained more or less prominence east of the Rocky Mountains, and are found to possess decided merits in certain places. This is a fair proportion of good varieties to inferior ones, as indicated by the annals of other fruits. These four are Lucretia, Bartel, Windom and Manatee.

8. Many persons have found dewberry culture to be profitable. This is evidence that the fruit is an acquisition. But it has not yet found general favor, and it is probable that it will never become as popular as the blackberry. Only the Lucretia is well known in New York.

9. The Windom possesses promise for the northwest. It is a native of Minnesota. It has not yet been tested to any extent elsewhere. It appears to demand partial shade for the best success.

10. The Lucretia has been found to be a desirable and profitable fruit in many places over a large extent of territory, and it is therefore safe to conclude that its range of adaptation is large. Many, however, have failed with it. It appears to be variable and many of the plants are worthless. It is sometimes seriously

attacked by anthracnose and by a bramble rust. The Lucretia is a native of West Virginia.

11. Bartel has found great favor with some growers in the west, from Wisconsin to Nebraska. It has not succeeded well in the east so far. The variety known as Mammoth appears to be identical with Bartel. It is native to southern Illinois.

12. Manatee is said to be valuable for the south. It is a form of *Rubus trivialis*, and was found in Florida. Other types of this southern species are no doubt destined to be very useful.

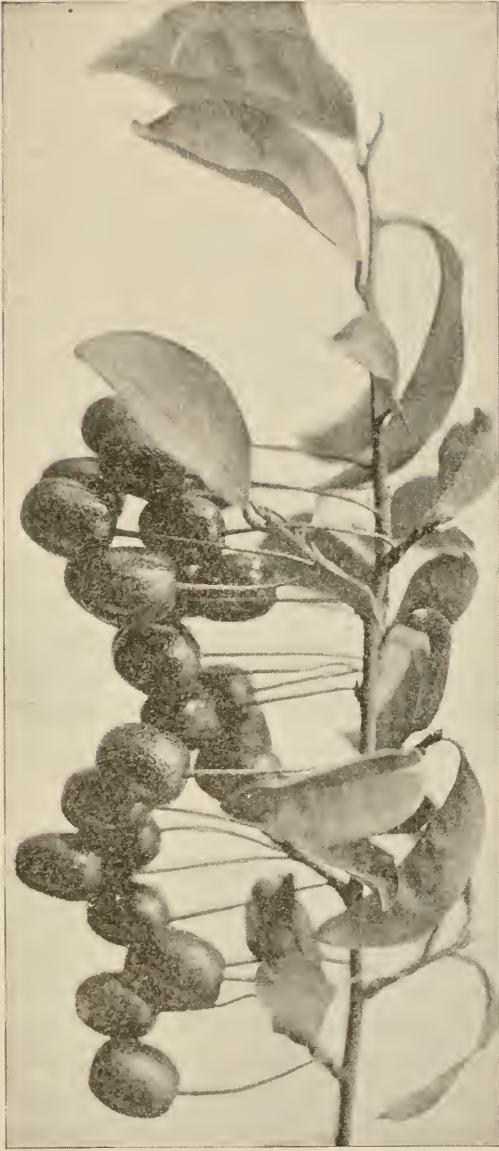
#### VI. THE GOUMI. *ELÆAGNUS LONGIPES*.\*

Much has been said,† during the past five years, about the gumi, all of which is deserved. It is a graceful and handsome bush of five or six feet high, bearing a profusion of silvery-white leaves and most abundant crops of cinnabar-red and gold-flecked berries. Whether considered for ornament or for fruit, it is one of the best of the many excellent shrubs which have come to us from Japan. Its silken-gray foliage is of a kind which is always desirable in shrubberies, and of which we have little in our native flora. The bush is as hardy as an apple tree. It stood the past winter in western New York without a blemish. It is enormously productive of fruit, and the berries are a delight to look upon, even if one does not desire to eat them. At first, these berries are very astringent, but when they are fully ripe and soft, they have a juicy piquancy which I enjoy. I have not tried them for culinary purposes, but it is said that they may be used for sauces and pies and in the many ways in which cranberries are so delicious. The fruits begin to ripen the first days of July in western New York, and they continue upon the bush for three weeks, much to the delight of birds.

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\* Pronounced lon-gi-pees. The name means "long-footed," that is, long-stemmed, and refers to the fruit stems.

† For illustrated accounts of it, see *Garden and Forest*, i. 499 (1889); *American Garden*, xi. 565 (1890); Van Deman, Rept. Dept. Agric., 1890, 423, colored plate (under the name of *Elwagnus pungens*); *Orchard and Garden*, xiv. 157 (1892); *Gardening*, i. 275, 277 (1893).



135. The Goumi. (*Elæagnus longipes*, var. *hortensis*  
Natural size).

I do not know when this delightful bush first came to this country. William Falconer wrote in 1893 (*Gardening*, i. 275) that "although it has long been cultivated in gardens, it is only within the last few years that its merits have been generally appreciated, and it has become in much demand." It could not have been a very old resident of American gardens. It seems to have been first brought prominently to notice in England in 1873, by an illustration and description in *Gardener's Chronicle*, by Maxwell T. Masters. The species was described by Asa Gray in 1859. Maximowicz (Bull. Acad. Imper. Sci. St. Petersburg, vii. 560, 1870) divides the species into four varieties, two of which bear edible fruit. The form which is grown in this country is the variety *hortensis*, characterized by spineless branches, elliptical leaves, very long fruit-stems, and large edible fruit. In nurseries, the plant is sometimes called *Elæagnus edulis*.

The goumi grows readily from seeds. These should be sown or stratified in summer, before they become dry, and allowed to freeze the following winter. The next spring, they should germinate freely. Cuttings of the half-ripened wood strike readily in June or July, if handled in frames. As soon as attention is given to cultivation and selection, we may expect the goumi to become prized for the edible qualities of its fruit.

## VII. THE WINTER INJURIES.

The past winter was unprecedentedly severe upon vegetation throughout the state. In most parts, all stone fruits were much injured. Only sour cherries seem to have escaped the havoc, and even they are not a heavy crop. Pears were also seriously hurt.

The University premises are not ideal lands for the tenderer fruits. The location is too high and bleak, and it is too far removed from the influence of Cayuga lake. The condition of the stone fruits, particularly of peaches, in the Cornell plantations is not an accurate guide to the conditions in the more favored fruit sections; yet a brief discussion of the winter injuries to fruits at this place may have some points of usefulness.

## RAINFALL AT CORNELL UNIVERSITY, IN PERIODS OF JULY TO DECEMBER INCLUSIVE, FROM 1889 TO 1895.

	July.	August.	September.	October.	November.	December.	Total for the period.	Total for the year.	Temperatures below zero in the various winters.
1889	6.73 in.	3.32 in.	2.57 in.	3.63 in.	3.35 in.	2.46 in.	22.05 in.	41.04 in.	3° March 8, 1890.
1890	1.24 in.	4.92 in.	6.02 in.	4.66 in.	1.93 in.	3.47 in.	22.84 in.	46.39 in.	2° March 2, 1891.
1891	4.25 in.	3.24 in.	2.13 in.	5.25 in.	2.25 in.	3.85 in.	20.97 in.	38.05 in.	0.5° January 20, 1892.
1892	4.93 in.	6.91 in.	1.88 in.	1.52 in.	3.50 in.	0.85 in.	19.59 in.	40.49 in.	4° December 27, 1892.
1893	5.13 in.	3.86 in.	4.38 in.	2.15 in.	1.25 in.	2.03 in.	18.80 in.	37.58 in.	12° January 17, 1893.
1894	3.17 in.	0.59 in.	5.17 in.	4.94 in.	1.94 in.	2.39 in.	18.20 in.	40.15 in.	1° January 20, 1894.
1895	1.96 in.	4.12 in.	2.03 in.	0.99 in.	2.69 in.	4.07 in.	15.86 in.	28.66 in.	14° February 25, 1894.
									1° December 28, 1894.
									5° January, 1895.
									9° February 7 and 8, 1895.
									2° December, 1895.
									15° January 6, 1896.
									18° February 17, 1896.
									3° March 24, 1896.

At the outset, it should be said that the phenomenal injury wrought by last winter was probably not wholly the result of low temperature. The drought of the last summer and fall no doubt augmented the injury. It is well known that trees suffer more from cold weather when the ground is very dry. I have compiled some figures from the reports of our meteorological bureau to show the conditions existing last winter. It will be seen that the total rainfall for last year was about twenty-eight and a half inches, whilst the normal precipitation is thirty-five to forty inches. During the period from July to December, inclusive, of 1895, the rainfall was less than sixteen inches, which is two and a third inches below the rainfall of the like period of 1894, even though that period was also a very dry one.

There are probably two ways in which the effects of a drought augment winter injuries. In the first place, the tree is probably weakened in vitality by an excessively dry season, and is thereby unable to endure so great exposure to cold. In the second place, there is evaporation of moisture from trees during the winter season, and if the ground is very dry this loss cannot be readily met; and the tree thereby "freezes dry," a condition which every nurseryman knows is generally fatal to trees. The extent to which loss of moisture may take place through the bark of dormant twigs may be determined by cutting off the twigs and quickly sealing over the ends with wax, weighing them, and then detecting the loss in weight from time to time. The following figures of such measurements will serve to emphasize the fact that moisture is lost from winter twigs, although they are not designed to show the actual rate of this loss when the twigs occupy their natural position on the tree.

April 7th, a cion of apple weighing 4.425 grams was placed on a balance, and the loss by evaporation measured at intervals during three days. The cut end of the cion was sealed with wax to confine evaporation to that which may take place through the bark. The balance or scales was placed in a living room, where the readings could be taken at frequent intervals. It will be

noticed that the rate of evaporation was nearly constant, averaging about  $\frac{1}{2}$  centigram per hour.—

	Lost in 2 hrs.	Additional loss in 12 hrs.	In 18 hours.	In 24 hours.	In 26 hours	In 36 hours.	In 44 hours	In 48 hours.	In 51 hours.	In 60 hours.	In 64 hours.	In 68 hours.	In 77 hours.	Total loss.	Per cent loss.
Twig weighing 4.425 grams.	1 cg.	5 cg.	2 cg.	5 cg.	2 cg.	5 cg.	4 cg.	2 cg.	2 cg.	4 cg.	2 cg.	2 cg.	3 cg.	39 cg.	.088

It has been said that the rate of the loss of moisture from trees in winter determines the relative hardness of different varieties of apples, and of some other fruits. The following table shows studies of twigs of varieties of different degrees of hardness, but it will be seen that the per cent. of loss of moisture bears no relation to the supposed hardness of the varieties:

VARIETIES.	Original weight.	Weight at the expiration of two days.	Loss.	Per cent of loss.
	Grammes.	Grammes.		
Seek-no-further, Twig No. 1.....	1.07	.985	.085	.0794
Seek-no-further, No. 2.....	1.3275	1.255	.0725	.0546
*Fameuse, No. 1.....	1.095	1.025	.07	.0639
*Fameuse No. 1.....	.82	.725	.085	.103
Fall Jennetting, No. 1.....	1.0475	1.	.0475	.0453
Fall Jennetting, No. 2.....	1.45	1.3875	.0625	.0431
*Northern Spy, No. 1.....	1.38	1.3125	.0675	.0489
*Northern Spy, No. 2.....	1.155	1.0925	.0625	.054
*Oldenburg, No. 1.....	1.595	1.55	.045	.028
*Oldenburg, No. 2.....	1.8475	1.7475	.1	.053
*Oldenburg, No. 3.....	1.3725	1.265	.1075	.078
Baldwin, No. 1.....	2.11	2.0025	.1075	.0509
Baldwin, No. 2.....	1.34	1.26	.08	.059
Baldwin, No. 3.....	.93	.87	.06	.064
Rhode Island Greening, No. 1.....	1.1825	1.11	.0725	.061
Rhode Island Greening, No. 2.....	1.055	.99	.065	.061
*Titovka.....	1.8075	1.7075	.1	.055
*Red Astrachan, No. 1.....	1.45	1.3425	.1075	.074
*Red Astrachan, No. 2.....	1.4825	1.4075	.075	.051

\*Supposed to be the hardest varieties.

Early in April, twigs, from the previous year's growth were taken from several varieties of apples, which vary much in their ability to endure our climate. The twigs were carefully weighed, and the cut ends were then sealed with wax to prevent evaporation save through the bark. At the expiration of two days the wax was removed and the twigs again weighed. The twigs were kept in an open shed.

The following table shows that there is great variation in the rate of water loss between twigs of the same variety of apple:

VARIETIES.	Original weight.	Weight at the expiration of three days.	Loss.	Per cent of loss.	Average per cent of loss.
	Grains.		Grains.		
Baldwin, Twig No. 1.....	19.	16.9	2.1	.110	
Baldwin, No. 2.....	19.425	17.2	2.225	.114	
Baldwin, No. 3.....	18.9	16.75	2.15	.113	
Baldwin, No. 4.....	29.25	26.4	2.85	.0974	
Baldwin, No. 5.....	24.2	21.4	2.8	.115	.1098
Oldenburg, No. 1.....	31.3	29.4	1.9	.0607	
Oldenburg, No. 2.....	34.65	31.35	3.3	.0952	
Oldenburg, No. 3.....	15.8	14.3	1.	.0949	
Oldenburg, No. 4.....	28.95	26.6	2.35	.0812	
Oldenburg, No. 5.....	9.5	8.25	1.25	.131	.0926

PEACHES, AND THE TREATMENT OF INJURED FRUIT TREES.— Not only the fruit buds of peaches were killed, but the trees themselves were very seriously injured upon the University place. Most of the last year's growth was wholly killed, and in many instances vigorous branches an inch in diameter were destroyed. All peach wood was markedly browned and discolored.

The proper treatment for any trees so seriously injured as this is to cut them back very heavily. This severe heading-in — sometimes to the extent of three or four feet — removes the driest and weakest portions and concentrates the energy of the tree into a comparatively small area of top. Heavy pruning always tends towards the production of wood, and this wood production is probably never more needed than in winter-injured trees, for it tends to renew the vitality of the tree. The philosophy of this becomes apparent upon a moment's reflection. The browned and injured wood can never regain its former usefulness. New tissue must be developed as quickly as possible in order to carry forward and to maintain the vegetative energies. This new tissue is laid on over the old, and the old, thereby, quickly becomes sealed in, so to speak, and removed from the agencies of decay. Every observant fruit-grower knows that if a tree which is severely winter-injured in limb and trunk were to bear even a partial crop of fruit in the coming season, it would very likely die outright. If, however, all its energies were directed to the development of



new tissue, the injury would soon be overgrown. The injured wood, like the heartwood of the tree, is soon removed from active participation in the vital processes. It therefore follows that the danger resulting from the browning or blackening of the wood by winter injury, depends very much upon the subsequent treatment of the trees.

PEARS.—In the Cornell plantation, pears will be a very light crop this year, largely as a result of the winter. There was no injury to the growth or to fruit-spurs, but many of the fruit-buds were killed.

There is much complaint of the blackening of the pear wood by the winter injury. Several varieties upon our own plantation show wood which looks to be lifeless, yet the trees are making good growth. Much of this wood really is irreparably injured, but the new layer which is now making may be expected to maintain the health of the trees in perfection, as explained above. I have observed this injury to pears from time to time for twenty years, and the trees have invariably recuperated if given good care. I recall making the experiment of setting cions of pear wood which was so completely blackened as to appear as if hopelessly injured. The grafts grew, and bore for many years, and were in no way inferior to ordinary pear grafts.

In some parts of the state, pear trees were ruined by the winter. In most instances, these trees will leaf out this spring and they may make some growth, but later on they will be found to droop and die much as if attacked by blight. The wood, upon being cut, will be found to be much discolored. This serious injury to pear trees will probably not be found in the well known fruit regions of the state, however.

PLUMS.—There are practically no plums upon the University place this year, except of native species. The trees had set profusely of buds, but the buds, and, in most instances, the entire fruit-spur, were killed outright. There is now and then a fruit on Lombard and a few other varieties. None of true domestica plum trees were injured in body or limb by the winter.

Of the Japanese plums we shall have no fruits, except now and then one on cions set two years ago in Lombard tops. The fruit-

spurs of the Japanese varieties were killed in about the same degree as those of the domesticas. Georgeson and Abundance, however, were somewhat injured on the top growths, but the trees do not appear to have been damaged. Burbank, Red June, and Yosebe (of our Bulletin 106, Fig. 13), were wholly uninjured, save the loss of the fruit-spurs. Yosebe even bore a few flowers, but they did not set fruit. Judging from the behavior of the Japanese plums upon our grounds last winter, they are about as hardy in tree and bud as the common run of the domesticas.

In contrast to the domestica and the Japanese varieties, the Americana types stood the winter without a blemish and are now carrying a full setting of fruit. Even one or two of the Chicasaws blossomed, but they will probably mature no fruit. Wild Goose was not injured.

APRICOTS.—The winter totally destroyed the entire fruit-spurs of all the apricots upon the Cornell plantation, including the Russian varieties (Budd, Gibb, Catherine, Nicholas), and the Russian almond of Lovett (which is an apricot). The only variety which was seriously killed back in limb is the Royal, but the wood of nearly all apricots is discolored. Early Golden and Moorpark did not kill back; and young trees of the *Prunus Mume* type (see Bulletin 71) were only slightly injured. The Russian varieties were least injured in wood of any of our apricots. When pruning the trees this spring, it was very noticeable that the wood of the Russians was hard and firm and comparatively little discolored. Yet, I should not advise the growing of Russian apricots in this region, because other kinds bear so much better fruit, and it is only at long intervals that we have such winters as the last one proved to be.

DWARF CHERRIES.—We have three types of dwarf cherries (see Bulletin 70) growing together in a border alongside a lawn. One of these is the common sand cherry (*Prunus pumila*) of the east. This was uninjured. Another is the western dwarf cherry (*Prunus Besseyi*). The form of this known as the Improved Rocky Mountain dwarf cherry was very severely injured, and one bush of it was killed back to within six or eight inches of the

ground. Bushes which we have grown from Nebraska and Manitoba seeds were wholly uninjured and are now laden with fruit. The third type is the Utah Hybrid cherry, which wholly escaped injury and which is now bearing a very heavy crop of fruit. This cherry is a hybrid of *Prunus Besseyi* and *Prunus Watsoni*. The latter is the sand plum of Nebraska. A small bush of it, growing with the above cherries, was practically uninjured.

NUTS.— Spanish and Japanese chestnuts were set in the spring of 1889, in a protected location. They were from a northern nursery. The Spanish have been killed back by every winter, sprouting out from the trunk or the crown each year. Last winter they were killed to the ground.

The Japanese chestnuts have stood fairly well, although they are not fully hardy. The trees are now only eight feet high, however, because of the killing back of the leading shoots nearly every winter. They are well branched and broad-headed, but look as if they would always be weak and poor trees.

The European or English walnut rarely escapes winter injury at Cornell. Last winter the branches froze back a foot or two.

The filbert (variety known as Prolific Cob) lost all its fruit buds and male catkins, and the young growth froze back severely.

The Japanese walnut (*Juglans Sieboldiana*) passed the winter without injury and is now in full bloom.

#### VIII. CRIMSON CLOVER IN ORCHARDS.

The experience with crimson clover in western New York is now sufficient to show that it is capable of enduring the winter under favorable conditions, but that the failures are quite as numerous as the successes. It is probable that we have not yet learned just how to grow it. Yet even now, there appears to be as uniform success with crimson clover sown in July and August as there is with the common red and mammoth clovers sown at the same time.

There are certain misapprehensions respecting crimson clover which I desire to correct. In the first place, we recommend it only for orchards, not as a forage or hay crop. The common

clovers, sown in the spring, are much more useful in the general farm rotations. This crimson clover is an annual and is capable of living over winter. It may, therefore, be sown after the summer cultivation is done, and afford some benefit to the land at a time when the trees are comparatively quiescent. The various uses of crimson clover in the orchard are discussed at some length in our Bulletin 102. Persons err in looking for a too heavy stand of crimson clover. It must not be expected to give the amount of herbage which the ordinary clover seeding does. Even a thin covering, if it passes the winter, is very useful in improving the conditions of the land; and a good fall stand which wholly kills out during the winter is also worth the growing upon the greater part of our fruit lands. We are convinced that crimson clover has come to stay, but we are equally convinced that it is unwise to rely upon it year by year for a cover crop. It will find its place in a judicious alternation of cover crops, the particular alternation to be determined by every farmer for himself.

Crimson clover is often sown too late. We think that the last week in July or the first week in August is as late as it can be sown with safety in the average year. If sown later, it obtains too little root-hold; if sown in June, it becomes too ripe before winter. The latest sowing which we know to have successfully passed last winter, was made for us in a nursery at Dansville (by F. M. Hartman) on the 17th of August. Upon the drier portions of the area, the stand was very poor, but in the moister places it made an excellent show this spring. Mr. George A. Sweet, of Dansville, sowed a large area upon the 8th of August. In parts of the field there was an excellent stand this spring, but in large portions of it there was none. There are many experiences like this, and most of them are traceable to a poor catch of seed in the fall. What agencies underlie these poor catches it is difficult to determine, but they are probably such as are associated with the mechanical preparation of the seed-bed, and are undoubtedly of the same kind as those which are responsible for so many poor stands of common clover.

We made an experiment last year upon crimson clover upon

hard clay land, sowing it at four intervals, July 25, August 14, August 29 and September 9. Only the first sowing passed the winter. The details of the experiment are as follows:

A strip of land in the Cornell pear orchard was sown to crimson clover July 25, 1895, the seed being harrowed in. A second sowing was made August 14; a third, August 29; and the fourth, September 9. At the time of the third sowing the soil, which is a heavy clay, was in excellent condition; it was moist and well pulverized, while the first two lots of seed did not have equally favorable conditions. The stand from the first sowing was fairly good during the latter part of August, the plants being from one to five inches high. The growth in the moister parts of the plat was the most vigorous. Seedlings from the second sowing were also slowly appearing, but not uniformly.

When the last sowing was made September 9, the plants of the first lot stood from one to eight inches high; the strongest growth was made by a few plants upon the more moist soil. The plants of the second lot were from one to three inches high, only a few, however, measuring the greatest height. Most of the plants were small, and the growth was weak. The seed leaves were appearing upon the third plot, and a few plants, again in the more moist places, had each produced a true leaf.

Notes taken October 18 show that the plots differed greatly. The plants from the first sowing averaged about six inches in height in the more favorable spots, and they covered the ground thickly, the remainder of the plot having fewer and smaller plants, some spots being entirely bare.

The stand of the second plot proved to be fairly good, but the plants were all small, those in the drier places being not more than an inch or two in height, while in the most favorable places the average height was scarcely over four inches.

The growth upon the third plot was unexpectedly poor considering the favorable circumstances under which the seed had been sown. Only a few seedlings had survived, and these were small and very spreading, in this respect resembling those which were making a poor growth in plot 2.

The fourth sowing, made September 9, showed a better stand of plants, and the growth had been so rapid that they fully equaled in size those of plot 3.

Such was the condition of the plots when winter set in. A slight growth was made late in the fall, but no material change took place in the appearance of the plants. But in the spring of 1896 the effect of the winter was very plainly to be seen. April 17, all the plants which were growing in the dry places of plot 1 had been killed, as well as those whose roots had been exposed more or less by the wash of water during rain; these probably suffered from drought when the land began to dry, and were consequently unable to withstand the cold of the winter or of early spring. In uniformly moist places fully 90 per cent. of the original stand passed the winter in good condition, and growth was vigorously continued as the weather became warmer.

In plot 2 apparently not more than 1 per cent. lived through the winter. One place, much favored by uniform conditions of moisture, contained many small but healthy plants; the remainder of the plot was almost totally bare.

Plots 3 and 4 showed no trace of the presence of crimson clover. Every plant appeared to have been destroyed, and only the bare soil and an occasional weed were visible.

Experiments made, partially under our supervision, by T. G. Yeomans and Sons, well known fruit growers at Walworth, Wayne County, are reported below. These plots were upon good dark orchard loam, which is in a good state of cultivation, and the test was in every way as fair as we could wish to have tried. The season, of course, was exceptional.

*Plot No. 1.*—Early in May we sowed a plot of crimson clover which was in bloom July 29th, after having been cut back to cut off the weeds growing with it. The clover on this plot was all dead this spring.

*Plot No. 2.*—June 23, 1895, sowed three strips in orchard, one each of crimson, medium red, and alsike. The seed was harrowed in by a Breed's weeder, and rolled. We had a fine shower the

day previous. It came up quickly, and on September 4th, the crimson had a few blossom heads. At this time the red and the crimson were about the same size, and covered the ground. The alsike was only about half as large as the other two. All of these plots had a good deal of barnyard grass at this date, while that sown one month later had none, and was quite free from all weeds. The crimson clover of this plot is all dead in the spring of 1896, while the red and alsike are about the same size, and both cover the ground nicely.

*Plot No. 3.*—July 16, 1895. Sowed three and one-half acres of crimson clover in orchard. It came up quickly and covered the ground completely, and was admired by all. Much of it was killed during the winter, although it was in a sheltered place where the snow did not blow off. The ground was rather low. It was plowed under about May 15, 1896, leaving the ground in finer and better condition than we have ever seen it on that plot.

*Plot No. 4.*—July 16, 1895. Sowed three more strips of the three clover orchards, as in plot No. 2. This all came up well, and did not have weeds growing in it, as did plot No. 2. In the spring of 1896 the strip of crimson is nearly all killed, while the red is as large as the red of plot No. 2, and the alsike about half as large.

*Plot No. 5.*—On July 18th, plowed under five acres of stubble in open field, after cutting off a crop of hay. Sowed it all to crimson clover, which came up quickly and covered the ground well before winter. This spring it was in fine condition and covered the ground completely, except a small strip through one side, where the snow had evidently been blown off from a ridge. This plot is located on the east side of a large piece of woods, which shelters it from the west winds, which are our prevailing winds. This plot was plowed May 11th this year and planted to corn.

*Plot No. 6.*—August 17th. Sowed three more strips in orchard similar to plot No. 2, but a shower, just as we were finishing the harrowing, prevented our rolling it. Neither of these strips grew in the fall of 1895, and it is apparently a failure.

“As the result of our experiments last season with these clovers, we will not sow any more crimson on any large scale until we have experimented further with it, but will try medium red, sown in our orchards about June 15th to July 20th. Our objects will be to secure a covering for the ground during the latter part of the summer, fall and winter to improve the mechanical condition of the soil, and to add fertility. Our intention would be to plow under the clover in May and June following. We refer to orchard purposes entirely. We think the red is worthy of further experiments, and would advise others to try it for themselves. We have long felt the need of something which will give us the results we have attained the past season with the red clover, and if results are generally as satisfactory as they have been this time, we will be satisfied;” but we are not yet ready to give any final opinion upon the question.

L. H. BAILEY.





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BULLETIN 118—July, 1896.

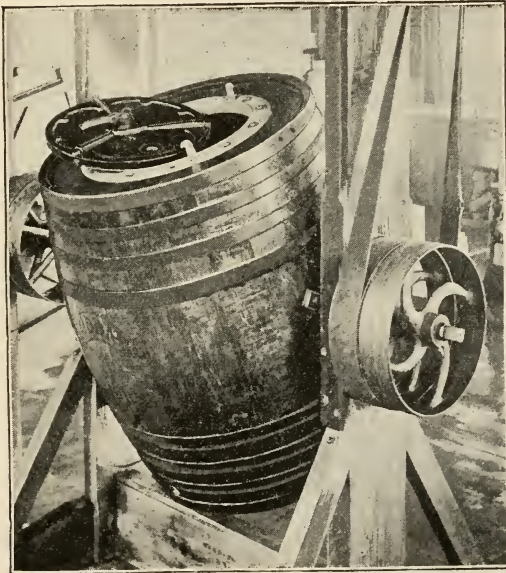
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Cornell University—Agricultural Experiment Station,  
ITHACA, N. Y.

CHEMICAL DIVISION.

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FOOD PRESERVATIVES  
— AND —  
BUTTER INCREASERS.



By GEO. W. CAVANAUGH.

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118. Food Preservatives and Butter Increaseers.

## Food Preservatives and Butter Increaseers.

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The subject of the preservation of articles of food against decay is one of no little importance. Decay or fermentation is known to be due to the action of living germs or ferments. If in any way these germs can be destroyed or their development prevented, without any change in the food product itself, it seems possible that food might be preserved almost indefinitely.

Two conditions that are absolutely necessary for the growth and multiplication of these germs are a moderate temperature and moisture. The methods most generally used for the preservation of food aim to destroy these germs by depriving them either temporarily or permanently of one or the other of these conditions. These methods may be grouped as follows:

1st. Those depending upon the use of heat for the destruction of the germs and subsequent sealing to exclude other germs. This principle is illustrated in the process of canning fruits and vegetables.

2d. Those depending upon the use of cold to prevent the multiplication of the germs for lack of sufficient heat. An example of this is found in our extensive systems of cold storage.

3d. Those in which the food product is dried in order that the germs present may not multiply for lack of sufficient moisture. The production of evaporated fruits illustrates this principle.

Where it is impossible to employ any of the above methods, or where their use might injure or destroy some desirable quality of the food resource is often had to the direct addition to the food of some substance that is detrimental to germ life. The familiar process of preserving meats, especially pork, by salting illustrates this class. There seems to be little or no objection to the

use of foods preserved by any of the first three general methods, nor to this last provided that the substance added has itself no bad physiological effect. Besides common salt the following substances are often used: borax, boric acid, salicylic acid, benzoic acid, sulphate of soda, saltpeter and formalin. There is no doubt that they possess the power of arresting the action of germs, but there is some question about the advisability of the continued use of foods containing them. Inasmuch as there is some prejudice on the part of dealers and consumers against their use, frequent attempts are made to introduce preparations of these substances under new forms and names. Two of these preparations have been recently examined at this Station.

The first bore the name

“Preservitas, a Special Cream Preservative.”

It is a fine white powder that dissolves readily in water. The following directions are given for its use: “Add  $\frac{1}{2}$  oz. to one oz. of the preservitas to each gallon (Imperial) of cream, according to the length of time it is desired to keep it fresh. The smaller proportion will keep cream sweet and with full flavor for a fortnight, and the larger proportion for a month if the cream is quite fresh at the time of the addition. It is advisable to make a paste of the preservitas with a little of the cream, rubbing it into the cream, and then to add the paste to the bulk of the cream.

Note: This preservative is suitable for cream only.

(Signed)

The Preservitas Co.,

Managers Burton, Baker & Co.,

110-112 Southwork St.,

London, S. E.”

An analysis showed that it contained 30 per cent. borax, a small proportion of salicylic acid; the remainder was sugar. Its preserving power is due, of course, to the borax and salicylic acid. The sugar helps to bring the borax into solution, as borax has the peculiar property of dissolving more readily in water containing sugar than in water alone.

The second preparation is called

“Callierine, the Ideal Food Preservative.”

It is a colorless liquid having a disagreeable pungent odor. It is a little heavier than water. The following are some of the recommendations and directions which accompanied the sample: “Callierine is efficient, *cheap* and reliable. One ounce of callierine is equal to one pound of salicylic or boracic acids. Not only is callierine harmless to human life, but when any article of food which has been treated with callierine is cooked, the callierine is completely eliminated by the heat.

#### General Directions.

For Milk:—Add 1 ounce (2 tablespoonfuls) Callierine to 14 gals. milk. This will keep it three days at a temperature of 75° F. For longer keeping or warmer weather, use more Callierine.

A solution of 2 ounces of Callierine to 1 quart of water will be found an efficient wash for preserving meat, poultry, game, fish, vegetables, etc. Articles should be carefully washed with the above solution, or, better still, allowed to remain in solution for a few minutes.

Price: Gallons, \$6.00.

We are putting up a Special Working Sample (16oz.) which we will forward on receipt of \$1.25.

(Signed)

Callierine M'fg. Co.,  
44 North St.,  
Philadelphia, Pa.”

An analysis showed it to be a 7 per cent. solution of formalin, or formic aldehyde. Formalin is the name under which this substance is ordinarily sold, while formic aldehyde is its strictly chemical name. The use of two names for the same substance may be sometimes misleading, but in this case the two names are used similarly to the terms blue vitriol and copper sulphate. Blue vitriol is the common commercial name while copper sulphate is the chemical name for the same substance. Formalin is at present much used as a germicide and general antiseptic

and preserving agent. It is sold as a 40 per cent. solution and quoted at \$.60 per pound.

There is no doubt that formalin is a most effective preserving agent. Prof. R. T. Thomson (*Analyst*, xxi, p. 65) shows that it is more effective than boracic acid, borax, salicylic or benzoic acids. According to his experiments  $17\frac{1}{2}$  grains per gallon kept milk sweet 11 days.

The 40 per cent. solution of formalin has a specific gravity of 1.080. Since a gallon of water weighs about 8 1-3 lbs. a gallon of the formalin weighs 8 1-3 times 1.080, or 9 lbs. At \$.60 per lb. a gallon of this 40 per cent. solution costs \$5.40. From one gallon of the 40 per cent. solution 5 5-7 gallons of a 7 per cent. solution can be made. Therefore the difference in cost between formalin bought as such and callerine at \$6 per gallon is:

1 gal. formalin.....	\$5.40
5 5-7 gal, callerine at \$6 per gal.....	34.28

If bought in the Special Working Sample (16 oz.) at \$1.25 the difference in cost is:

1 lb. formalin .....	\$.60
• 5 5-7 lbs. callerine at \$1.25.....	7.14

Or in other words \$34.28 and \$7.14 are asked, respectively, for \$5.40 and \$.60 worth of formalin. By purchasing the original material at \$.60 per lb. and adding water at the rate of 4 4-7 lbs. to each pound of formalin a solution of the same strength as callerine is obtained.

As to the effects of formalin on digestion Prof. R. T. Thomson in the article above referred to quotes from Dr. Leffmann "Processes of digestion are allied to processes of decomposition, in so far that the latter are frequently preceded by transformation under the influence of ferments. We may infer then that whatever prevents putrefaction at least delays digestion." While there is no evidence that evil effects have followed from the use of such small quantities of formalin as are necessary to preserve milk, it seems advisable from Dr. Leffmann's statement to be cautious about its use in any considerable quantity.

It would seem unwise to endanger the healthful condition of the stomach and diminish the digestibility of cream and milk, naturally rated among the most digestible food products. That milk and cream treated with formalin are injured, is not founded upon theory but upon facts. Digestion experiments have been made upon milk with and without the presence of formalin. In the cases so far reported the milk containing the formalin required a longer time for digestion than that which contained no formalin. Furthermore, the behavior in the Babcock test of milk which had been preserved by formalin shows that its composition is in some way affected. Ordinarily, the curd of milk is dissolved by the sulphuric acid that is used in this test. Where formalin is used the curd often fails to dissolve and becomes a compact mass. If this preservative can so alter milk that sulphuric acid may fail to dissolve its curd, is it not at least probable that the action of the gastric juices of the stomach may be rendered less effective?

#### CHASE'S BUTTER INCREASER.

Agents have been busy throughout different parts of the State attempting to introduce the above named substance. It was guaranteed to bring about an increased yield of butter in churning. A sample of this substance was examined at this Station. It was a liquid having the general appearance of vinegar and a slight odor of oil of wintergreen. The label bore no name of the firm manufacturing it nor any address showing where it might be obtained. It guaranteed to double the yield of butter from cream if added in small proportions to the cream before churning.

It was a 25 per cent. solution of acetic acid, which is the acid of vinegar, and a small amount of salicylic acid. (Salicylic acid is a constituent of the oil of wintergreen.)

The action of acids on milk is to curdle the casein. This is shown in the souring of milk itself when lactic acid is formed from the milk sugar; or by adding vinegar or other acids to milk. Hence it is plain what the effects of Chase's Butter Increaser would be. The acetic acid would curdle the casein which would

become mixed with the fat, and yield a product that would be neither good butter nor poor cheese.

A second article of an even more fraudulent nature has also been sold by agents. It goes under the name of "Gilt Edge Butter Compound." It guarantees to make two pounds of butter from one pound of butter and a quart of sweet milk. In general the directions were to warm the butter until soft, mix in the milk and add as much of the compound as could be placed on a one cent piece and mix all together. The resulting butter (?) will weigh two pounds. This "Gilt Edge Butter Compound" is a mixture of about equal parts of alum and soda with a little pink coloring matter. It was sold in ounce packages for \$1.

These substances would act in a similar way to the acid in the "Increaser," *i. e.*, by incorporating the casein and also a considerable amount of water with the cream. This incorporated casein furnishes a medium for the growth and multiplication of millions of organisms. It is to remove this casein and so get rid of these germs that butter is so carefully washed.

While the food preservatives may have some valuable uses, as keeping milk samples for composite tests, there is absolutely no excuse for "Butter Increasers" in an honest community. They are fraudulent in that they pretend to teach the producer how he can get more butter from cream than there is in it. They promote dishonesty by throwing in the way of an unscrupulous producer a means of defrauding his customers; and worse than all, the use of these "Increasers" is an attempt to put on the market a product which not only cheats the producer but may possibly endanger the health of the consumer.

GEORGE W. CAVANAUGH.



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BULLETIN 119—August, 1896.

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Cornell University—Agricultural Experiment Station,

ITHACA, N. Y.

HORTICULTURAL DIVISION.

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# THE TEXTURE OF THE SOIL.

“Men of the greatest Learning have spent their Time in contriving Instruments to measure the immense Distance of the Stars, and in finding out the Dimensions, and even Weight of the Planets: They think it more eligible to study the Art of plowing the Sea with Ships, than of Tilling the Land with Ploughs; they bestow the utmost of their Skill, learnedly, to prevent the natural Use of all the Elements for Destruction of their own Species, by the bloody Art of War. Some waste their whole Lives in studying how to arm Death with new Engines of Horror, and inventing an infinite Variety of Slaughter; but think it beneath Men of Learning (who only are capable of doing it) to employ their learned Labours in the Invention of new (or even improving the old) Instruments for increasing of Bread.”—*Jethro Tull.*

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By L. H. BAILEY.

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119. The Texture of the Soil.

CORNELL UNIVERSITY, ITHACA, N. Y., *August 1, 1896.*

*The Honorable Commissioner of Agriculture, Albany:*

Sir.—This bulletin and its successor (No. 120) are designed to inaugurate a new type of experiment station publication. They are written for the purpose of giving their readers a few simple and primary lessons in some of the most fundamental subjects connected with the cropping of the land. It is hoped that they do not contain a single new fact. It is their sole ambition to teach, not to discover or to record. The writers hope that they may be used as texts in horticultural societies, granges and farmers' clubs. It is wished that they may inspire some persons to read further into the subjects, and especially that they may suggest the reading of King's book upon "The Soil," from which the bulletins themselves have heavily drawn. These bulletins are published by the State appropriation which was given, (chapter 437, Laws of 1896), in part, for "disseminating horticultural knowledge" in the Fourth Judicial Department of the State. We expect to use them in the schools of horticulture which are to be held under the auspices of this State grant. If the simple principles which they attempt to enunciate were to be clearly apprehended by our farmers, all the money and effort expended in experimentation in this State would be many times repaid.

L. H. BAILEY.



136.—The unproductive clay from which Sample I. was taken.



137.—The good bean soil from which Sample II. was taken.

## The Texture of the Soil.

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The other day I secured one sample of soil from a very hard clay knoll upon which beans had been planted but in which they were almost unable to germinate, another sample from a contiguous soil in which beans were growing luxuriantly, and as a third sample, I chipped a piece of rock off my house, which is built of stone of the neighborhood. All of these samples were taken to the chemist, Mr. Cavanaugh, for analysis. The area from which I took the hard and unproductive clay (Sample I.), is shown in Fig. 136. The reader will not be able, I think, to discover any bean plants upon it, although the seed was drilled into it at the same time as in the soil which furnished Sample II. Fig. 137 shows the area from which Sample II. was taken. This area is only twenty feet removed from the other, and is of the same original formation, but it differs in being in a slight depression or "draw" and the soil is in a fairly fine degree of division. It is really a good bean soil. The samples of soil which were actually taken to the chemist are shown in Fig. 138. The rock (Sample III.) was hard limestone, known to geologists as the Tully formation.

The chemist reports as follows:

	Moisture.	Nitrogen.	Phosphoric acid.	Potash.	Lime.	Organic matter.
I. Unproductive clay .....	13.25	.08	.20	1.1	41	3.19
II. Good bean land .....	15.95	.11	.17	.75	.61	5.45
III. Lime rock .....	.....	.....	.08	2.12	2.55	.....

In other words, the chemist says that the poorer soil—the one upon which I cannot grow beans—is the richer in mineral plant food, and that the rock contains a most abundant supply of potash and about half as much phosphoric acid as the good bean soil.

All this, after all, is not surprising, when we come to think of

it. Every good farmer knows that a hard and lumpy soil will not grow good crops, no matter how much plant food it may contain. A clay soil which has been producing good crops for any number of years may be so seriously injured by one injudicious plowing in a wet time as to ruin it for the growing of crops for two or three years. The injury lies in the modification of its physical texture, not in the lessening of its fertility. A sandy soil may also be seriously impaired for the growing of any crop if the humus, or decaying organic matter, is allowed to burn out of it. It then becomes leachy, it quickly loses its moisture, and it becomes excessively hot in bright sunny weather. Similar remarks may be applied to all soils. That is, *the texture or physical condition of the soil is nearly always more important than its mere richness in plant food.*

A finely divided, mellow, friable soil is more productive than a hard and lumpy one of the same chemical composition because:

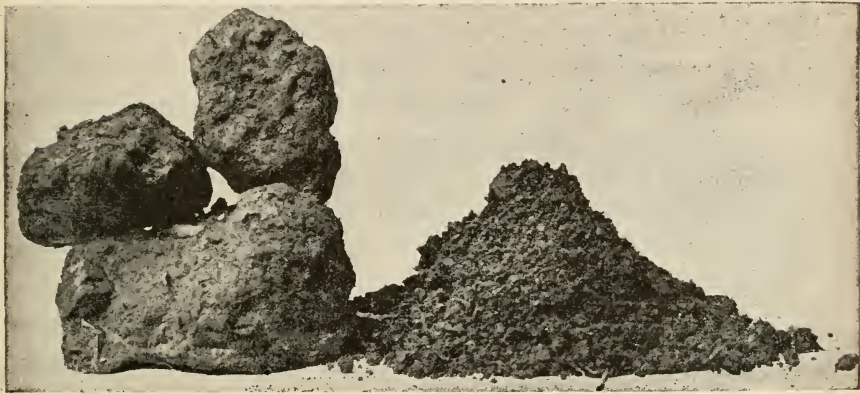
It holds and retains more moisture; holds more air; presents greater surface to the roots; promotes nitrification; hastens the decomposition of the mineral elements; has less variable extremes of temperature; allows a better root-hold to the plant.

In all these ways, and others, the mellowness of the soil renders the plant food more available and affords a congenial and comfortable place in which the plant may grow.

The reader will now see the folly of applying commercial or concentrated fertilizers to lands of poor texture. He will see that if potash, for example, were applied to the hard lumps of Sample I. (Fig. 138), it could not be expected to aid in the growth of plants, because plants cannot grow on such soil. If the same quantity were applied to Sample II., however, the greater part of it would be presented to the roots of plants at once, and its effects would no doubt be apparent in the season's crop. The reader will readily understand that *it is useless to apply commercial fertilizers to lands which are not in proper physical condition for the very best growth of crops.*

The poor or lumpy soil contained a greater percentage of potash and phosphoric acid, no doubt, because, of the lack of humus

in the sample. As it contains less organic matter, it therefore has less nitrogen than the good soil (Sample II.). Probably because of this less percentage of organic matter, this lumpy soil also contains less moisture than the other. As a matter of fact, however, these differences which the chemist found in the organic matter, nitrogen and moisture, are not sufficient to account for the very great differences in the productivity of the two soils. The chemical examination would have thrown more light upon the value of these soils if a determination had been made of the amount of potash and phosphoric acid which is soluble; but even then, the chemist could not have told, from analysis alone, how



138.—Sample I.

Sample II.

valuable this land might be for any particular crop. Analysis does not show how agreeable or comfortable the land may be to the plants. There is sufficient potash in the rock (Sample III.), and even enough phosphoric acid, to grow a crop of beans; and yet, even if I add the nitrogen and water and make the mineral plant food soluble, I cannot hope to grow a crop on the walls of my house. In brief, *a chemical analysis of soil is only one of several means of determining the value of land, and in the general run of cases it is of very secondary value.*

How can the texture of lands be improved? In general, by three means—by judicious plowing and tillage, by the incorporation of humus, and by the use of underdrains. The value of

simple tillage or fining of the land as a means of increasing its productivity was first clearly set forth in 1733 by Jethro Tull, in his "New Horse Hoeing Husbandry." The premises upon which Tull founded his system are erroneous. He supposed that plant roots actually take in or absorb the fine particles of the earth, and, therefore, the finer and more numerous these particles are, the more luxuriantly the plant will grow. His system of tillage, however, was correct, and his experiments and writings have had a most profound influence. If only one book of all the thousands which have been written on agricultural and rural affairs were to be preserved to future generations, I should want that honor conferred upon Tull's "Horse Hoeing Husbandry." It marked the beginning of the modern application of scientific methods to agriculture, and promulgated a system of treatment of the land which, in its essential principles, is now accepted by every good farmer, and the appreciation of which must increase to the end of time. These discursive remarks will, I hope, emphasize the importance which simple tillage holds in agricultural practice.

Farmers do not appreciate the importance of humus as an ameliator of land. In farm lands it is usually supplied in the form of green crops, stubble or sward, and barn manures. When humus is absent, sandy soils become too loose and leachy and hot, and clay soils bake and become lumpy. The different physical characteristics of our Samples I. and II. are largely due to the greater amount of humus in the good soil, and yet we have seen that the chemist pronounced the other soil richer in native plant food.

The writer has much of this hard, unproductive land, like Sample I. What is to be done with it? To cover it with commercial fertilizer would be of little benefit. It must first be put in fit condition for the growing of crops. A crop of clover plowed under would quickly improve it, but the land is newly planted to orchard and he does not care to seed it down. The next recourse is stable manure. Of this enough can be had to cover the hardest spots. For the rest, catch or cover crops must be used. Follow-



ing beans or potatoes, he can sow rye and plow it under very early in the spring (see Bulletin 102). Now and then he can use a fall crop of sowed corn or oats, or something of the kind. After a time, he may be able to get the land in such a condition of tilth as to secure an occasional stand of crimson clover. This practice, continued judiciously for a few years, ought to radically change the character of the land; but all this will be of little avail unless the plowing and cultivation—which are now so inadequate—can be done in a timely and intelligent way. All this will take time and patience. He wishes that there were some short-cut and lazy way of improving this land by making some application of fertilizer to it, but there is not. The most he can do is to slowly bring it into such condition that it will pay to put concentrated fertilizers on it. In short, *the first step in the enrichment of unproductive land is to improve its physical condition by means of careful and thorough tillage, by the addition of humus, and perhaps by underdrainage. It must first be put in such condition that plants can grow in it. After that, the addition of chemical fertilizers may pay by giving additional or redundant growth.*

L. H. BAILEY.



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BULLETIN 120—August, 1896.

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Cornell University—Agricultural Experiment Station,  
ITHACA, N. Y.

AGRICULTURAL DEPARTMENT.

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# THE MOISTURE OF THE SOIL AND ITS CONSERVATION.



Page 488.

By L. A. CLINTON.

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118. Food Preservatives and Butter Increasers.
119. The Texture of the Soil.
120. The Moisture of the Soil.

## THE LESSON OF THE DAISIES.

No one who has chanced to make a somewhat extended tour through the farm-lands of any part of the middle states during the last of June or the first of July can have failed to notice how large a fraction of the area was white for the harvest—a harvest not of grain, but of Ox-eye Daisies. Fields of buckwheat at the height of their bloom were never whiter than many lowlands which once were rich meadows, and many hillsides which once were rich pastures. The daisies are so prevalent and luxurious this year that a stranger might suspect that all the farmers had gone into the business of floriculture, but a few questions will soon dispel this illusion, for the growers of the daisies very rarely appreciate their beauty. It is a genuine and destructive invasion, and yet the daisies have not conquered the meadows; they have merely stepped in to occupy and possess the soil which the grass had abandoned. The worst of it is that the great majority of the tillers of the soil do not apprehend the true condition of things, and while they bewail the fate which forces them to harvest daisies instead of grain or hay, they do not realize the fact that they have invited the attack and encouraged the invaders.

Occasionally a farmer is heard to ask how these weeds can be killed, but he does not realize that if by some rapid process they could all be dispatched new legions would fill their places at once if the conditions which they enjoy remain. What farmers need to comprehend is that without some radical mistake in the management of their land the daisies never would have gained such a foothold. All plants, including weeds, settle and thrive where the competition for life is such that they can enter into it and prosper. A good stand of grass leaves no room nor any hope for weeds. It is not in well-tilled fields that Canada thistles flourish, but in neglected pastures and by the roadsides. In the contest with the best agricultural practice they cannot prevail. It is in the untilled plains of the west or in the tilled regions where there is mile after mile of plowed land producing only eight or nine bushels of wheat to the acre year after year, without any rotation, where the Russian thistle is a natural and inevitable intruder.

The remedy for weeds is to keep the land busy with a good crop on it, and this means that the farmer must give persistent and connected thought to his business. If the daisies crowd out the grass, it is because the meadow has been neglected and the grass has begun to fail, and wherever there is a vacancy by the failure of the grass every enterprising weed finds a rightful opportunity to establish itself. If the farmer asks, therefore, what will kill the daisies, there is one answer; better farming. Weeds find nourishment and a home wherever there is waste ground, which means ground not properly occupied. Widespread areas of daisies, buttercups, wild carrots, mustards and the like are, therefore, the types and measures of the prevailing ignorance of farmers respecting the very fundamental principles of their calling. The one good thing that weeds can accomplish is to prove by their presence that there is a weak point in the established

system of agriculture; the only way to turn their visits to advantage is to heed this instruction by revolutionizing farm practice and organizing some profitable rotation which will exclude them.

If farmers cannot interpret the teachings of the weed it certainly would be advisable for the agricultural experiment stations to help them in this particular. The existence of these invaders means that what the farmers of these states primarily need is more instruction in fundamental matters concerning the handling of their land. We are glad, therefore, to see that many of the stations are turning to this subject, and that they are doing more than merely furnishing botanical descriptions of the various noxious plants. The Cornell Station, for example, in a bulletin entitled *Reflections Upon Weeds*, gives some sound primary instruction in agricultural science. It is to be hoped that both this station and others will continue work of this sort even if they forego to some extent experimentation in higher fields. So long as the farmer needs elementary teaching it ought to be furnished to him, even if it takes the time of officials who ought to be searching for scientific truth. A late bulletin of the Geneva Experiment Station upon the principles which underlie the application of commercial fertilizers deals with the simplest matters, matters with which every intelligent farmer ought to be familiar, and yet there is no doubt that every word of it is needed. The time may come in America, as it has come in some older countries, when the common schools instruct children in the principles of agriculture—so that in fundamental points of practice the ordinary farmer will know what to do, and will be able to tell why he does it. Until that day arrives every effort to increase his knowledge of principles deserves encouragement.—*Editorial in Garden and Forest, July 22, 1896.*

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*The Honorable Commissioner of Agriculture, Albany:*

Sir.—This expository bulletin is submitted, as explained in the prefatory note of Bulletin 119, for publication under Chapter 437 of the Laws of 1896.

L. H. BAILEY.

## The Moisture of the Soil, and Its Conservation.

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The conservation of soil moisture is one of the most important problems presented to the farmer and gardener. Hardly a season passes in which some important crop is not reduced in yield from twenty-five to seventy-five per cent. because of lack of sufficient moisture to bring it to maturity. The soil may have been put in proper condition, plant food may have been supplied in the form of fertilizers, and all other conditions may have been favorable for the development of a full crop, yet with the supply of moisture deficient all this labor and expense count for little or nothing. The questions, therefore, arise, "To what extent can the amount of soil moisture be controlled?" "Is it possible to do anything to save crops from the oft-recurring droughts?"

The insufficient water supply is not due to lack of rainfall, but to its unequal distribution. The average annual rainfall in New York for the last seventeen years is 34.31 inches. The lowest rainfall ever recorded in the state was in 1879 when only 19.74 inches fell. In 1895 there was also a deficiency, only 28.66 inches being recorded. In the arid portions of Kansas, a rainfall of 20 inches which is well distributed, is reasonably sure of making a good crop. The loss there by surface drainage is, however, very slight, it being estimated at not more than ten per cent. or about 2 inches, leaving 18 inches for crop growth. In New York, with a rainfall of from 34 to 40 inches, nearly one-half passes off by surface drainage and is lost so far as immediate plant growth is concerned. Not only is the water lost to the crops, but it carries with it much of the soluble plant food of the surface soil. This, then, would suggest one important step in the attempt to store up moisture. This surface flow of water must be prevented and caused to sink into the soil to supply a reservoir from which plants can secure moisture during the period of growth.

*How the soil holds its water.*

That a proper understanding of the question may be reached, it is necessary to have a knowledge of the conditions under which water exists in the soil, and of the part it plays in the mysterious operations of plant growth. Water may be in one of three forms,—as free, capillary, or hygroscopic water. The free water of the soil is that which flows under the influence of gravity. It is the source of supply for wells and springs. It is not directly used by plants and its presence in the soil within eighteen inches of the surface is detrimental to the growth of most cultivated crops. It is valuable, however, because it is the supply from which capillary water is drawn.

The capillary water does not flow by gravity. It is the direct source of moisture for plants. It may be either drawn upwards or it may pass downwards depending upon whether the soil is drier at the surface or below. In time of droughts, the capillary action of the soil may be sufficient to raise the water through a distance of five or six feet, its power in this respect depending



139.—The soil mulch.

directly upon its physical condition. If the soil is coarse and cloddy and the particles are not compact, then the water can not rise to take the place of that which is carried off by evaporation or used up by plants in their growth. If, however, the soil is fine, in good condition, and homogeneous, the water passes freely and continuously to the surface. Notice the track of the horse on the plowed

ground, or the foot-print of the driver, and see how the moisture comes directly to the surface, because the soil has been compacted and there is intimate capillary relation between its particles. This moist surface shows that the water is passing off from it into the air. This observation should teach a lesson. The soil may be pulverized and made compact, but the capillary pores near the surface must be enlarged by tillage so as to break the capillary connections and stop the water in its upward course, and thus force it to pass off through the tissues of the plant. This loose surface stratum, two or three inches deep, is the "soil mulch" (Fig. 139) of which so much has been said



in recent writings. It is one of the most important means of preventing the loss of water from the soil. It breaks off the capillary pores in the soil structure and interposes between the lower moist soil and the air a layer so loose that the water can not rise through it. This mulch may itself dry to dust, but it nevertheless protects the soil below. When soils become baked, the minute capillary pores connect directly with the atmosphere and the evaporation of water is very rapid. Hence it is exceedingly important that the crust be broken after every rain.

The hygroscopic water of the soil flows neither under the influence of gravity nor capillarity. It is held firmly in place upon the particles of soil and can only be driven off by a high degree of heat. Just how important this water is in the growth of plants has not been determined, but it is probable that during severe droughts it may assist in carrying the plant over, enabling it to maintain itself until capillary action is restored.

*The necessity of water for growing plants.*

The importance of water to the growing plant can only be understood when we apprehend and appreciate how large a part of its structure is composed of water, and that even this large percentage of its composition is but a fraction of the total amount used in its development. The quantity of water entering into the structure of plants varies from sixty to as high as ninety-eight per cent. of their total weight. During the entire period of growth, there is a constant giving off of moisture by the foliage, and it must be made good by that which is taken up by the roots. By experiments conducted at the Wisconsin Experiment Station, it has been found that in raising oats, for every ton of dry matter produced there were required 522.4 tons of water; for every ton of dry matter of flint corn there were required 233.9 tons of water; for dent corn, 309.8 tons of water for every ton of dry matter. On plots at this Station, 1.8 tons of dry matter of oats per acre represented an expenditure of 940.32 tons of water. Potatoes used 422.7 tons of water per ton of dry matter. The yield of potatoes on the experiment plots of 450 bushels per acre during the dry season of 1895 represented an amount of water equal to 1310.37 tons.

Just why so much water is required by the growing plant and how it obtains this supply is not usually understood. It has

been the subject of considerable research and even now presents interesting problems for further study. The roots of the plant are its feeders and all of the water ordinarily used by it passes in through these channels. The particles of soil hold a film of water in firm contact. The roots and rootlets of the plant, in burrowing through the soil, come into intimate relation with these soil particles (Fig. 140). The finer the soil, the closer the relation established between it and the roots. The roots are thus surrounded by a thin film of water, a portion of which they are able to absorb. The water passes up through the tissues of the plant, carrying with it soluble plant food which is conveyed to the manufacturing or elaborating organs, the leaves. There, in the pres-



140.—A corn plant showing the intimate relation between the roots and the soil particles. From life.

ence of sunlight, the fixation of carbon from the air takes place and by means of the movement of the sap the now organized material is carried to all growing parts of the structure. That part of the water no longer required passes off through the breathing pores of the leaf, called stomata. As evaporation is a cooling process, there is no doubt that this loss of water has an important influence in lowering the temperature of foliage and in promoting the fixation of carbon.

As already stated, the plant roots can absorb food only in the soluble form, and the passage of a large quantity of water through their tissues is necessary to furnish the supply of mineral elements required by growth. Not only is a large quantity of moisture demanded for the direct use of the plant, but its presence in the soil is necessary in order that the plant food may

be rendered available. Few soils are so lacking in fertility that they would not grow crops could the mineral plant food which they contain be unlocked and brought into fit condition for use. This important operation, as well as nitrification,—or the conversion of nitrogen compounds into the form of nitrates,—can proceed only in the presence of moisture. Crops plowed under for green manuring, and barn manures, can be made available only when there is sufficient moisture in the soil to cause breaking down and decomposition. With moisture in the soil, there is a constant movement towards the plant roots to restore the equilibrium, or to make good that used by the plant. This movement of the moisture brings to the roots the soluble plant food.

The living root itself has the power of disintegrating and decomposing the particles of soil and of dissolving and extracting some of the plant food. This powerful action, by which the solid rock is broken down and its plant food liberated and by which even polished marble can be corroded, goes on only in the presence of moisture. Supply the plant with moisture, and its roots are able to set free from the particles of the soil a part of the mineral elements required for its growth. Supply even our sandy desert plains with abundant moisture and immediately they change from a desert to a garden.

An acre of soil to the depth of one foot weighs approximately 1,800 tons. If 25 per cent. of this is moisture, we should have 450 tons of water per acre. An acre of soil to the depth of eight inches weighs about 1,200 tons. If 25 per cent. of moisture were found here it would contain per acre 300 tons of water. Plants can maintain themselves with as low as 5 per cent. of water, but their growth seems to go on most rapidly in soils whose water content is from 13 to 25 per cent.

#### *The conservation or saving of moisture.*

The annual rainfall in New York is sufficient for the requirements of plants, could it be distributed or conserved during the growing season. The experiments conducted by the U. S. Dept. of Agriculture with a view to controlling the distribution of rainfall, proved that it was beyond control by any means known at present. Dependence must then be placed upon irrigation or

conservation of moisture to overcome the disastrous effects of drought. In the arid and semi-arid regions of the West, where irrigation is successfully practiced, the problem is apparently solved, or is at least reduced to a mere matter of co-operation and cost. But in the Eastern states, entirely different conditions are met. To supply the enormous amount of water required for growing crops means an outlay of money entirely beyond the individual means of most farmers and gardeners. In the West where irrigation is practiced most uniformly, farmers are not required to take into consideration the possibilities of rain. They know that there will be no heavy downpour immediately after flooding their crops. But here there is no such guarantee, and to flood the fields by irrigation and have that followed immediately by a heavy rain might mean the entire destruction or serious injury of the crop. Although irrigating systems may be introduced in special cases, yet the great dependence, in this State, must be the rainfall and the conservation of the moisture of the soil.

The means by which moisture may be conserved are as follows:

By plowing and tillage,  
 mulches,  
 underdrainage,  
 lessening the influence of winds,  
 applications of lime, salt, etc.,  
 rotation of crops to increase humus,  
 adapting the crop to the soil.

*Plowing to save moisture.*—As already indicated, the first step in the conservation of moisture must be the preparation of the soil so that the rain will sink down and not be carried off by surface drainage. In many sections of the country, especially in the Southern States, the great bane to agriculture is the surface washing of the soil. Owing to shallow plowing and shallow cultivation, the water is unable to settle into the hard soil with sufficient rapidity and is carried along the surface, producing those gullies which are there so destructive to farm lands.

The improvements in the plow have done much towards remedying these defects, but there is still a large amount of ignorance

as to the proper use of this implement. As an implement to be used in the preparation of the soil for the reception of moisture, it stands pre-eminent. Good plowing does not consist — as ordinarily supposed — in merely inverting a portion of the earth, but in pulverizing and fining it and burying the sod or refuse which may be on the surface. The amount of water which a soil is capable of holding depends directly upon the fineness of its particles. Then that plow which will break and pulverize the soil most thoroughly is the one best adapted to fit the soil for holding moisture. This point is well illustrated by King in his book on “The Soil.” He says, “Since each independent soil grain of a moist soil is more or less completely surrounded by a film of water, it is evident that, other conditions being present, the largest aggregate surface area may retain the most water per cubic foot. Now, a cubic foot of marbles one inch in diameter possesses an aggregate surface of 27.7 square feet while if the marbles were reduced in diameter to one-thousandth of an inch, then the total area per cubic foot is increased to 37,700 square feet.” From this it is evident that the total amount of water capable of being absorbed by a soil which is cloddy and lumpy is very slight in comparison with what it would be were it in a finely divided state; and not only is its absorbing power less, but its power of holding moisture is also greatly reduced. King found the rate of percolation from soils of different degrees of fineness to be as follows, the column of soil being eight feet in height:

TIME OF PERCOLATION.

SIZE OF GRAINS.	Per cent. lost in 1 hour	Per cent. lost in 2 hours.	Per cent. lost in 24 hours.	Per cent. lost in 48 hours.
.186 inch.....	9.19	10.45	13.05	13.52
.073 inch.....	7.95	9.47	12.31	12.72
.061 inch.....	6.22	9.21	11.71	11.73
.045 inch.....	1.76	2.83	7.64	8.44
.032 inch.....	1.28	1.91	5.83	6.79

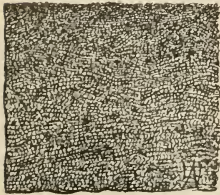
This striking difference in the rate of percolation from soils of different degrees of fineness shows most forcibly the importance of thorough pulverization of soils to increase their water absorbing and moisture holding capacity.

A large amount of water is lost during the winter and spring

months owing to the surface drainage of melting snows and heavy rainfalls. To prevent this loss, fall plowing should be extensively practiced, and where the subsoil is very hard and compact the use of the subsoil plow may prove most beneficial. Should the ground break up in clods, then it may be allowed to remain during the winter without harrowing to more thoroughly subject it to the beneficial action of the elements. But should the soil be in good mechanical condition, then some plants should be growing on it during the winter. The importance of keeping growing plants on the soil during the winter can hardly be over-estimated. They serve to bind the soil, to take up the plant food which may be soluble and liable to loss by drainage. If these plants are plowed under in the spring, organic matter is added to the soil. In corn fields, wheat or rye may be drilled in without plowing and it will obtain sufficient growth to act most beneficially upon the soil during the winter and it may be plowed under in the spring, having served its purpose as a soil protector. The use of cover crops for orchard lands is fully discussed in Cornell Bulletin 102.

It should be said, however, that hard land which is bare or devoid of humus is very apt to become puddled or cemented during the winter if plowed in the fall. In such cases, all that is gained by fall ploughing is more than lost by this running together of the soil.

On land that has been fall plowed, work can begin in the spring several days earlier than on unplowed land. It should be the practice to stir the surface soil just as early in the spring as conditions will permit, that a soil mulch may be formed which will serve to prevent the escape of the water from below. On clay land it is of special importance that work be commenced early, and yet on account of its peculiar nature it is the slowest in drying out and the last to be plowed. This delay may mean the difference between a success and a failure of the crop. Clay soils, owing to their fine state of division and their tenaciousness, are but slowly permeated by water (Fig. 141).



141.—Clay soil, showing its impermeable character.

But once saturated, unlike sandy soil, it does not permit the water to pass off by percolation and must wait until the sun's rays and the winds have dried off the surface sufficiently to permit of its being worked. Then, to conserve the moisture, frequent shallow tillage should be given and crops should be sown before the water has become exhausted. The slow passage of the water towards the surface, by means of capillary action, furnishes plants with moisture and insures a successful start, which is half the battle towards securing a successful crop. King found that the loss of moisture during seven days from April 29th to May 6th was 9.13 lbs. of water per square foot greater on the unplowed than plowed land, equal to a rainfall of 1.75 inches, or 198 tons of water per acre. Can it be afforded to thus delay the spring plowing and the preparation of the soil mulch? Then, the very evaporation is a cooling process and the soil, instead of becoming warm and of a proper temperature for the germination of seeds, remains cold and uncongenial as long as this wasteful process goes on. With sandy and gravelly soils the difficulty experienced in the spring is not so great. They are both permeable to water and furnish another means for its escape besides evaporation. The water passes off by percolation and the soil soon becomes warm and ready for the reception of the seeds. But moisture can be conserved better on clay lands than on sandy lands, because the loss occurs chiefly through evaporation. It is upon clay or heavy lands, therefore, that the value of the soil mulch is markedly apparent.

*Harrowing to save moisture.*—The harrow, besides pulverizing and fining the soil for the seed-bed, is most efficient in furnishing a soil mulch. The spring-tooth harrow is in reality a cultivator, and its action is similar to that of the cultivator. When used as an instrument to conserve moisture, the teeth should penetrate to the depth of about three inches, and to produce the best effect the ridges left by it should be leveled off by a smoother which can now be purchased as an attachment to the harrow. The tillage of orchards by the harrow is now practiced extensively, and nothing short of irrigation will so nearly meet the demands of trees for moisture, particularly upon the heavier soils.

The Acme harrow is a most excellent implement on soils which are comparatively free from stones and rubbish. The plow-like action of its blades serves to pulverize the surface soil, to spread the loose mulch evenly, and it leaves a most excellent seed-bed.

The cutaway or disc harrows may be either beneficial or of absolute injury. If the discs are so set that they cover but a portion of the surface with the mulch, they leave a ridge exposed to the action of the wind and sun, and the rate of evaporation is greatly increased. The discs should be set at such an angle that the whole surface shall be stirred or covered. Their chief value lies in their cutting and pulverizing action on clay soils, but as conservers of moisture they are inferior to the Acme or the spring-tooth. Soils which need the disc harrow should generally be gone over again with some shallower tool.

The mellowed soil the lighter should be the work done by the harrow. On most heavy orchard soils it will be found necessary to use the heavy tools, like the spring-tooth and disc harrows, in the spring, but if the land is properly handled it should be in such condition as to allow the use of a spike-tooth or smoothing harrow during summer. This light summer harrowing, as shown in the cut on the title page, should be sufficient to keep down the weeds, and it preserves the soil mulch in most excellent condition. With such a tool, and on land in good tilth, a man can harrow ten or more acres a day.

*Cultivators and conservation of moisture.*—The action of cultivators is not materially different from that of the spring-tooth harrow. The size of the teeth should be regulated by the work to be performed, a many small-toothed implement being preferable to a few large teeth, where the object is to conserve moisture. It must be borne in mind that in a dry time the less surface exposed the less will be the evaporation. If a large toothed-implement is used to destroy grass and weeds, then it should be followed by a smoother to reduce the ridges and prevent loss of moisture. Ridge culture is only allowable when the object is to relieve the soil of moisture on bottom lands where the water comes very near the surface, or for some special crops, where a high degree of warmth is required early in the season. In these

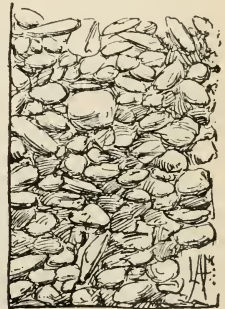


cases it may be necessary to throw up ridges to produce the proper degree of warmth for germination, but even then the ridges should be slight. Nothing could be better calculated to dry out a potato field or a corn field than throwing the ground up in high ridges, leaving a large surface exposed to the action of sun and wind.

In fruit plantations which are in a proper state of cultivation, a small-toothed or even spike-toothed cultivator will be found sufficient to maintain the surface mulch.

The following figures show how much the use of the cultivator may do to save moisture: In our determinations of soil moisture we found, on July 1st, in a plot where 14,080 lbs. of green forage per acre had been cut from one-half of it but 6.73 per cent. of moisture, while on the open cultivated space between plots, within five feet from where the other sample was taken, 10.54 per cent. of moisture was found. July 6th samples were again taken. The percentage of moisture in the standing oats was 4.07, and in the open cultivated space 13 per cent. This clearly illustrates the difference in the amount of soil moisture retained by frequent surface tillage compared with that which is found where a crop of grain covers the soil.

*The roller in its relation to soil moisture* is an implement whose value depends largely upon local conditions. There is no tool which requires more judgment as to its proper use. On light, loose sandy or gravelly soils, where every effort must be made to solidify and pack the particles closely together, the roller must be used repeatedly. The difficulty of such soils is that the spaces between the grains are so large that the water is permitted to pass through freely and is lost by percolation. The capillary openings are so large that there is very feeble rise of the water to take the place of that used by plants and lost by evaporation (Fig. 142). The roller lessens the size of these pores in solidifying the soil and the capillary force is then strong enough to draw the water to the surface (Fig. 143). If,



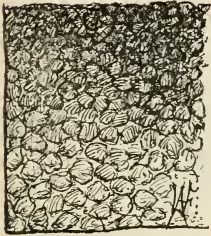
142.—Coarse gravelly soil, showing its loose structure.

now, the soil is left in this condition, it has been put in the best possible form for parting with its moisture, and it will take advantage of the opportunity unless prevented by establishing a surface mulch. In seeding land in a dry time the soil should be rolled in order to bring sufficient moisture to the seeds to insure germination. Where circumstances will permit, the roller should be followed by a smoothing harrow that the surface mulch may be restored and the moisture stopped before reaching the atmosphere (Fig. 144). On clay lands the roller must be used with much caution. If used immediately after grain is sown, and a heavy rain following, there would be danger of the soil becoming so compact on the surface that the tender shoots would be unable to get through, and the most direct connection would be established between the soil moisture and the air. A good method of treatment for clay is to roll before the seed is sown, then harrow and make a good seed-bed, and then drill in the grain. After the plants are well up the roller may be used again, which will bring the water to the surface, where the growing plants can make use of it before it passes off by evaporation.

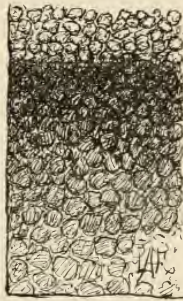
*Herbage mulches.*—The covering of the soil by a mulch of leaves or decaying vegetable matter is nature's way of conserving moisture and of restoring fertility to the soil. Go to any forest where the leaves have not been burned annually and notice the mulch which covers the soil (Fig. 145). The soil will be found to be moist and loose. Humus has been stored up and the covering of leaves prevents the escape of the moisture by surface evaporation. Many persons conclude that because nature tills by mulching, man should do the same, but the conclusion is fallacious. Farm areas are too open and too much exposed to searching winds to allow of the good results which nature obtains in the seclusion and coolness of the forest. Even our largest orchards do not give us forest conditions. This herbage mulch also induces shallow rooting of trees, as sod land does (see Bulletin 102). In most farm lands, also, it is necessary to plow or move the land at least once a year in order to sow the seed and harvest the crop, and this would destroy an herbage mulch. Aside from all this, it is impossible, except in very

special cases, to secure sufficient herbage to afford an adequate mulch.

*The humus of the soil* is the great store-house for nitrogen and moisture. It is the accumulation of decaying vegetable or animal matter, and its presence in the soil, while not absolutely necessary to the growth of plants, is the factor which makes the land congenial for the very best development of the crop. The constant use of commercial fertilizers, without being supplemented by barn manures or green manuring, will so reduce the percentage of humus in the soil that its water-holding capacity will be considerably diminished. This humus should be liberally supplied by means of cover crops, rotations, and stable manures.



143.—Showing the effect of the roller in compacting the surface layer.



144.—Showing how the soil mulch should be restored by tillage after the roller has been used.

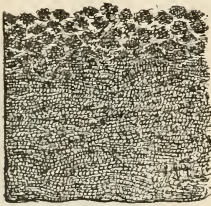


145.—The loose mulch on forest soils.

*Underdrainage* and how it acts as a conserver of moisture is popularly misunderstood. It is usually supposed that underdrains, instead of acting as conservers of moisture, produce exactly the opposite effect. It has already been noticed that water may exist in the soil as free or capillary and that the presence of the free water within eighteen inches of the surface is positively detrimental to the growth of most cultivated plants. Not only is it necessary that moisture be supplied, but also that the soil shall be in such condition that the air may have access to it, for a supply of oxygen is necessary to the breaking down and decomposition of organic matter and the making of plant food available. The underdrain removes only the free water which may come too near the surface and it leaves the soil above in a porous condition, so that the water of rainfall may sink down instead of being carried off by surface drainage. This rainfall water is not caught

and removed by the drains in its downward course, but the drainage flow begins only when, by the accumulation of the rainfall the level of the free water has been brought up to the level of the drain. Thus the reservoir for the supply of capillary water is kept nearer the surface during a drought and is removed a proper distance from the surface during a wet time to insure a healthy and proper development of the roots of plants.

*Mineral substances as conservers of moisture.*—Among the materials of commerce which are applied to soils as indirect fertilizers, are lime, gypsum and salt, all of which are thought to act as conservers of soil moisture. The application of quick lime to certain soils has been found to have a most beneficial action. When used upon a heavy clay it causes a certain adhesion or



146.—The flocculation of the surface of clay soils by the addition of quick lime.



147.—The action of lime, at a few inches in depth, in sandy soil.

flocculation, a binding together of the minute particles, and prevents their running, at time of rains, into a compact, hard crust (Fig. 146). It causes a more granular condition, making the soil looser and more porous, allowing the water of rainfall to permeate it more readily. As a result of flocculation, the pores of the soil near the surface are enlarged, and it thus better serves the purpose of a mulch to hold in reserve the moisture underneath.

On sandy soils the difficulty in conserving moisture arises from the fact that they are so open and porous that the water passes through and is lost to the plant. It would seem that an application of lime here would tend to aggravate the difficulty. On clay, the action of the lime takes place at or near the surface, the soil being so compact that it is not washed down through the soil. In sand, the pores are so large that the lime sinks readily into the soil, and instead of finding the effects of its appli-

cation at the surface we must look for it below. The binding property of lime is well known from its use in the trades. In its passage down through the particles of sand, it does not proceed far before it probably begins to bind the grains together, and there is formed a layer somewhat impervious to water (Fig. 147).

Frequent and small applications of lime have been found most beneficial. From twenty to forty bushels per acre will usually be found to give the best results. On marshy and boggy lands which have recently been drained, but still remain sour and full of undecomposed organic matter, the benefit derived from applying lime is very great. It breaks down the vegetable matter, neutralizes the acid and makes plant food available. In this case, its action upon the plant food in the soil is more important than its agency in the conservation of moisture.

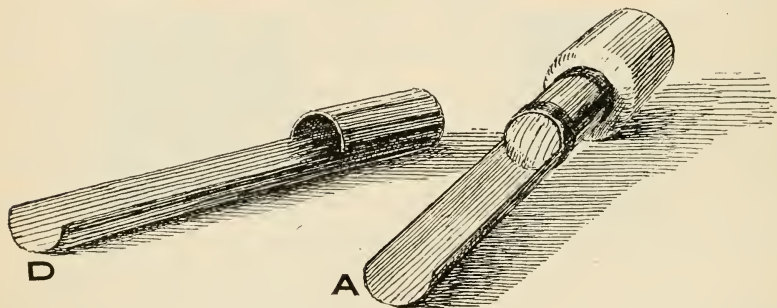
*Windbreaks to save moisture.*—The drying effects of the wind are well known, when it has unbroken sweep over a farm. The loss of moisture from this cause is very great. Windbreaks are not only a protection in winter, but they serve equally well in summer to protect the fields. The hedge-row around a field is not, then, entirely useless, since it serves its purpose as a conserver of moisture. (See our Bulletin IX.)

*Selection and management of crops in relation to soil moisture.*—Crops should, as far as possible, be adapted to the conditions best calculated to furnish them with a sufficient supply of moisture. The grasses and grains thrive best on loamy or clay soils where the moisture is held and not allowed to pass away by percolation. On sandy and gravelly soil crops should be grown to which frequent culture can be given, for in this way we may aid in bringing water to the reach of plants. On sandy soils so treated, some catch crop should be grown which can be plowed under for green manure, thus serving to keep up the humus of the soil. The practice of growing crops, especially grains and grasses, in an orchard, cannot be too strongly condemned. (See Bulletin 102.) The soil should be left bare in early summer, not only that we may harrow and cultivate and thus conserve moisture and set free plant food, but because the loss of moisture from the growing grain crop is so great as to deprive the fruit trees of the amount necessary for their use. Crop an or-

chard only for the purpose of green-manuring. If nitrogen is needed, then crimson clover or common clover may be sown and allowed to remain as a covering for the soil during the winter and may be plowed under in the spring. The surface tillage should begin and continue faithfully through the growing season.

*Suggestions for determining the amount of moisture in soils.*

It is a very easy matter to determine the amount of moisture in a soil. The only apparatus required is a pair of scales which will weigh to grains and a tube which can be driven into the soil for taking the sample. Such a pair of scales can be purchased for a small sum,\* and the tube may consist simply of a piece of boiler pipe about one and one-half inches in diameter which has had the outer edge at one end bevelled down to enable it better



148.—The soil sampler.

to be driven into the soil. Have a mark on the outside of the tube indicating eight inches or one foot from the sharpened end, according to the depth to which it is desired to take the sample. The sampler used by the United States Department of Agriculture (Figs. 148 and 149) is described as follows: "The soil sampling tubes are made out of brazed brass tubing about seven-eighth inch internal diameter and fifteen inches long. The tubing is No. 21 Stubb's gauge. On one end a brass collar about one-fourth of an inch wide is sweated in. The end of the tube is then turned off in a lathe giving a rather long taper but letting the point be the full thickness of the collar. A mark is cut into the tube twelve inches from this cutting edge." We have used this implement with much satisfaction.

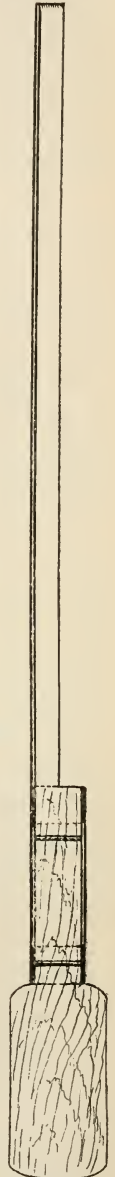
\*Eimer & Amend, New York, make a balance which, with weights, can be purchased for about \$3.00.

In determining the moisture in a given soil, several samples should be taken and these samples thoroughly mixed and then accurately weighed. Then subject the sample to a heat of 212 degrees Fahrenheit for a few hours, then weigh and heat again for one hour, then weigh again, and continue this operation until there is no further loss of weight by heating. The difference in weight between the original and the heated sample will indicate the amount of moisture which was present. Divide the difference in the weights by the first weight of the sample, to determine the per cent. of moisture in the original sample and multiply by 100. The following case will illustrate:

Original weight of sample .....	2	lbs.
Weight after drying .....	1.5	lbs.
Loss in drying.....	.5	lbs.
Per cent. of moisture in original sample = $.5 \div 2$ .		
= $.25 \times 100 = 25$ per cent.		

An interesting line of work for granges and farmers' clubs would be the investigation of soil moisture.

The importance of thorough culture to conserve moisture is so great that if its value was fully realized we should experience less trouble from droughts. Far better is a season with a deficiency of rainfall if continuous surface culture be given than a season of abundant rains with little culture. Much wiser is he who cultivates a small farm and cultivates it intensively than he who attempts to spread over a large area and allows his crops to suffer from droughts, because the moisture which they so much need has not been saved by frequent tillage. Neglect the soil, allow the orchard to care for itself, and when the time of harvest comes the reward shall be according to the labor; but treat the soil as a living thing, care for it faithfully and intelligently, study the plants and learn their ways and the conditions under which they thrive and give them congenial surroundings, and they will respond with a readiness that will abundantly repay the best efforts in their behalf.



149.—The soil sampler.

## SUMMARY.

1. The average annual rainfall in New York is sufficient for the growth of profitable crops. Owing to its unequal distribution and to the loss of nearly one-half of it by surface drainage, crops usually suffer from droughts.

2. The first step towards conserving moisture is to put the soil in such a physical condition that it will be pervious to water, or afford a reservoir for it.

3. Water exists in the soil as free, capillary or hygroscopic. The free water within eighteen inches of the surface is injurious to the growth of cultivated plants. The capillary water is the direct source of their supply and should be conserved by all possible means.

4. Capillary action of the soil depends upon the fineness of its particles and the closeness of their relation to each other. In coarse, loose, sandy or gravelly soils the action is weak; in fine, well-compacted soils it is strong.

5. When the capillary interstices or pores in the soil are continuous from the moist under soil to the surface, the moisture rises uniformly and passes off into the atmosphere by evaporation. If, however, these interstices or pores are made very much larger near the surface, the moisture is arrested in its upward movement, a result which is accomplished by light surface cultivation which produces a "soil mulch." This mulch of loose soil answers much the same purpose as a board or carpet would in cutting off the direct connection of the capillary soil with the atmosphere. As soon as the soil becomes baked or encrusted, the capillary connection with the atmosphere is renewed, and another tillage is required to re-establish the soil mulch.

6. A large amount of water is necessary for the plant, as its food is in a very dilute solution, and water is also used in building plant tissue.

7. Moisture in the soil is necessary that nitrification and decomposition of organic matter may take place. Without it the action by which the roots are able to corrode the solid rock and set free plant food cannot take place.

8. The distribution of rainfall cannot be controlled by any



known means. Dependence must be placed upon irrigation and the conservation of soil moisture.

9. Irrigation is expensive, and while entirely practicable in arid regions, yet in our section if flooding by irrigation should be followed by heavy rainfall, the effect might be disastrous. Where irrigation is not a common necessity, it must be secured by individual enterprise, and is, therefore, expensive. In New York we must depend largely upon conserving or preventing the loss of the moisture.

10. The means by which moisture may be conserved are: judicious plowing and tillage, mulches, underdrainage, wind-breaks, applications of lime, salt, etc., and adaptation of crop to the soil.

11. The absorbing or capillary power of a soil depends upon the fineness of division of its particles.

12. The plow is a most valuable implement for pulverizing and fining the soil. Fall plowing is recommended for heavy clays, the surface to be left rough and unharrowed. Fall-plowed lands catch and hold the water.

13. Surface tillage should begin early in the spring, as every day's delay after the soil is in fit condition means a loss of many tons of water.

14. The harrow is valuable as an implement with which to establish and maintain a surface mulch. Frequent harrowing of an orchard will greatly lessen the evaporation from the surface.

15. Where cultivators are used as conservers of moisture, many fine teeth are preferable to a few coarse teeth.

16. Ridge culture is calculated to promote evaporation. To conserve moisture, practice level culture and so reduce the area exposed.

17. The roller brings moisture to the surface by compressing the soil. On loose, sandy soils it is useful by compacting the particles. On clay its use may prove injurious if followed by heavy rains. Where possible it is well to follow it with a smoothing harrow to restore the mulch.

18. A surface mulch of leaves and decaying vegetable matter is nature's way of conserving moisture. It also adds humus to

the soil, which is the great store-house for nitrogen and moisture. An herbage mulch can rarely be used in farm areas, however.

19. Underdrains act beneficially in making soils porous above them and thus increasing their permeability, and in removing the free water and thus allowing the access of air, which is as necessary as moisture.

20. Lime, gypsum and salt are all used as conservers of moisture. An application of lime seems to have a beneficial effect on heavy clay and on light sand. It also acts favorably on marshy, sour lands.

21. Grasses and grains should be grown on clay and loamy soils, leaving sandy and gravelly lands for cultivated crops. The humus of tilled lands may be kept up by barn manures and by green manuring.

22. The space between the trees in orchards should be left free for tillage. A growing crop makes such a demand upon the supply of moisture that the trees may be seriously injured.

23. Determinations of soil moisture may be easily made by anyone. The importance of this line of work is called to the attention of granges, farmers' clubs and horticultural societies.

24. The importance of thorough tillage to conserve moisture cannot be made too emphatic. Deficiency in rainfall with intensified agriculture is preferable to abundant rains and neglect by the cultivator. The soil will respond in a large measure according to the treatment it receives. Neglect it and it will fail to bring forth liberal increase, but cultivate intelligently and thoroughly and it responds quickly.

L. A. CLINTON.

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BULLETIN 121—September, 1896.

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Cornell University—Agricultural Experiment Station,  
ITHACA, N. Y.

HORTICULTURAL DIVISION.

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SUGGESTIONS FOR  
The Planting of Shrubbery.



By L. H. BAILEY.

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107. Wireworms and the Bud Moth.
108. The Pear Psylla and the New York Plum Scale.
109. Geological History of the Chautauqua Grape Belt.
110. Extension Work in Horticulture.
111. Sweet Peas.
112. The 1895 Chrysanthemums.
113. Diseases of the Potato.
114. Spray Calendar.
115. The Pole Lima Beans.
116. Dwarf Apples.
117. Fruit Brevities.
118. Food Preservatives and Butter Increaseers.
119. The Texture of the Soil.
120. The Moisture of the Soil.
121. Suggestions for the Planting of Shrubbery.

CORNELL UNIVERSITY, ITHACA, N. Y., *September 1, 1896.*

*Honorable Commissioner of Agriculture, Albany :*

Sir.—The writer hopes that this paper may contain some suggestion for the betterment of home grounds in rural communities ; it is therefore submitted for publication under Chapter 437 of the Laws of 1896.

L. H. BAILEY.



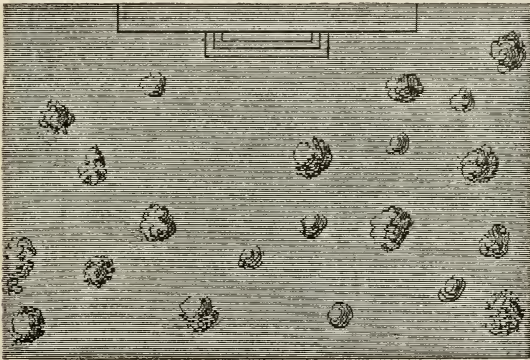
156.—An effective piece of planting. See page 513.

# Suggestions for the Planting of Shrubbery.

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## I. *Some general considerations.*

The trouble with home grounds is not so much that there is too little planting of trees and shrubs, but that this planting is meaningless. Every yard should be a picture. That is, the area should be set off from every other area, and it should have such a character that the observer catches its entire effect and purpose without stopping to analyze its parts. The yard should be one thing, one area, with every feature contributing its part to one strong homogeneous effect.

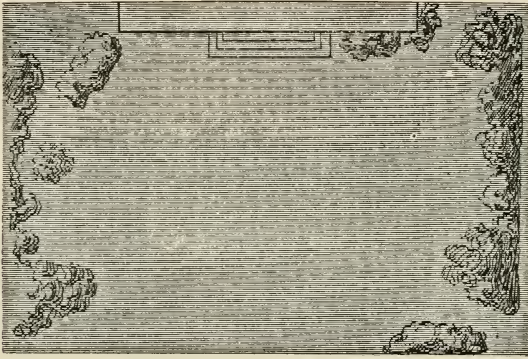


150.—The common or nursery type of planting.

These remarks will become concrete if the reader turns his eye to Figs. 150 and 151. The former represents the common type of planting of front yards. The bushes and trees are scattered promiscuously over the area. Such a yard has no purpose, no central idea. It shows plainly that the planter had no constructive conception, no grasp of any design, and no appreciation of the fundamental elements of the beauty of landscape. Its only merit is the fact that trees and shrubs have been planted; and this, to most minds, comprises the essence and sum of the orna-

mentation of grounds. Every tree and bush is an individual, alone, unattended, disconnected from its environments, and therefore meaningless. Such a yard is only a nursery.

The other plan (Fig. 151) is a picture. The eye catches its meaning at once. The central idea is the residence, with a warm and open greensward in front of it. The same trees and bushes which were scattered haphazard over Fig. 150 are massed into a framework to give effectiveness to the picture of home and comfort. This style of planting makes a landscape, even though the area be no larger than a parlor. The other style is simply a collection of curious plants. The one has an instant and abiding pictorial effect, which is restful and satisfying: the observer

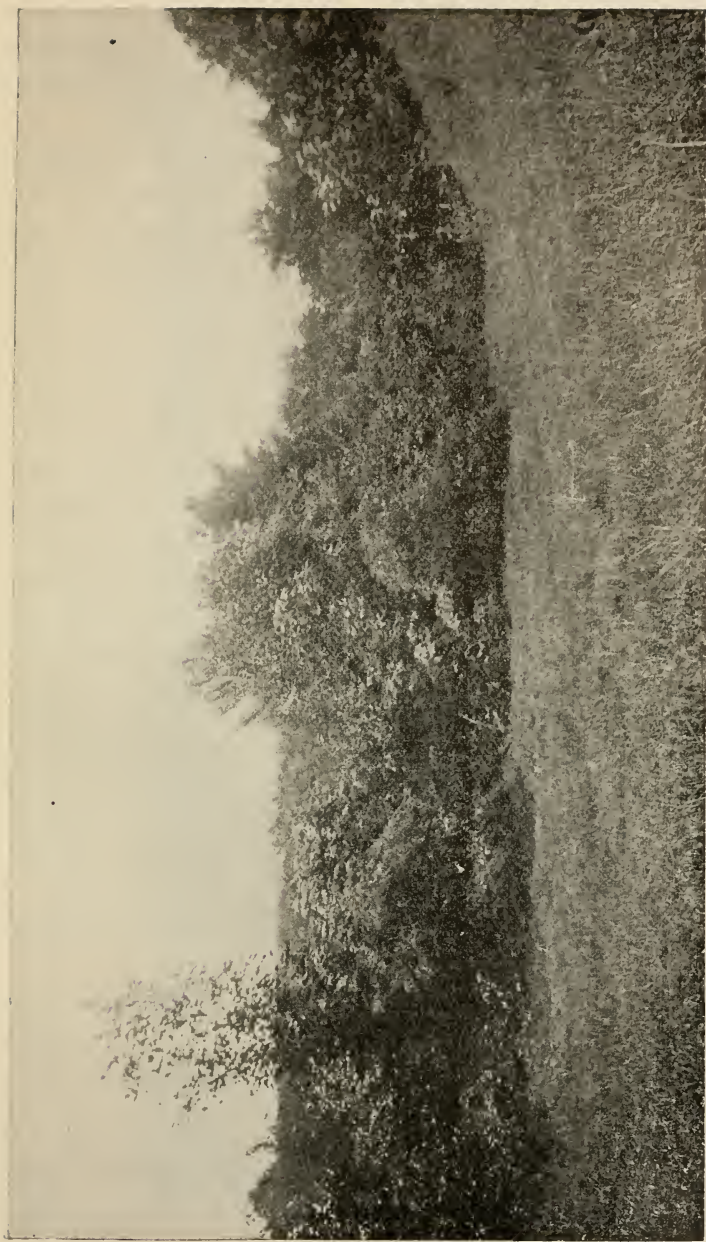


151.—The proper or pictorial type of planting.

exclaims, "What a beautiful home this is!" The other piques one's curiosity, obscures the residence, divides and distracts the attention: the observer exclaims, "What excellent lilac bushes these are!"

If the reader catches the full meaning of these contrasts, he has acquired the first and most important conception in landscape gardening. The conception will grow upon him day by day; and if he is of an observing turn of mind, he will find that this simple lesson will revolutionize his habit of thought respecting the planting of grounds and the beauty of landscapes. He will see that a bush or flower-bed which is no part of any general purpose or design—that is, which does not contribute to the making of a picture—might better never have been planted. For





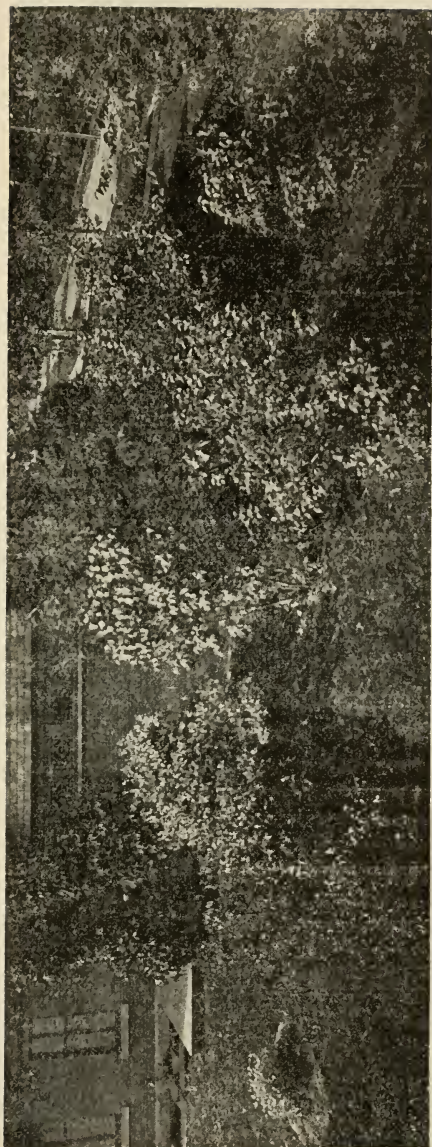
152.—A native mass of shrubbery, of elders, hawthorns, brambles, and the like.

myself, I had rather have a bare and open pasture than such a yard as that shown in Fig. 150, even though it contained the choicest plants of every land. The pasture would at least be plain and restful and unpretentious. It would be nature-like and sweet. But the yard would be full of effort and fidget.

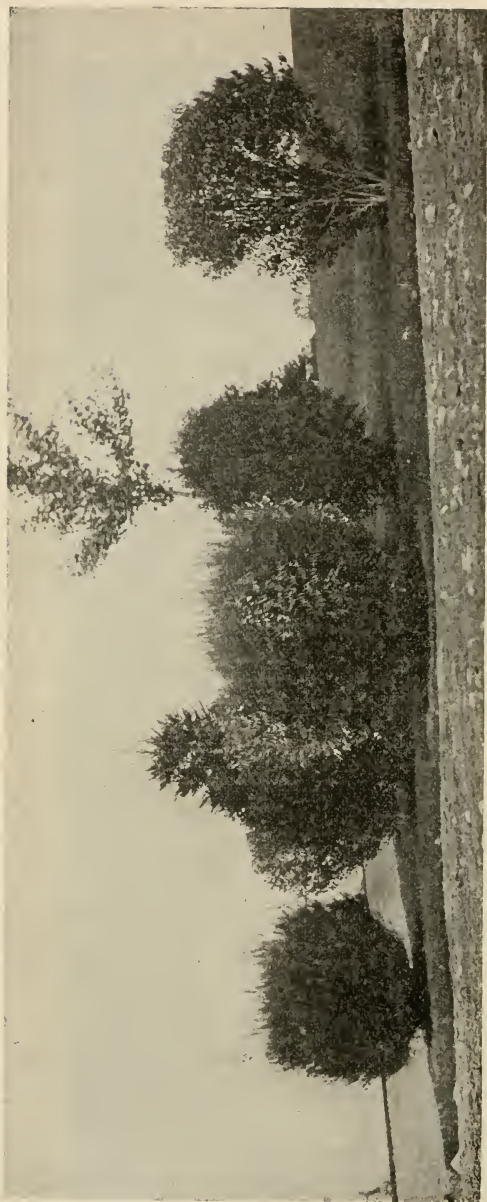
Reduced to a single expression, all this means that the greatest artistic value in shrubbery lies in the effect of the mass, and not in the individual shrub. A mass has the greater value because it presents a much greater range and variety of forms, colors, shades and textures, because it has sufficient extent or dimensions to add structural character to a place, and because its features are so continuous and so well blended that the mind is not distracted by incidental and irrelevant ideas. A couple of pictures will admirably illustrate all this. Fig. 152 is a picture of a natural copse. It stretches across a vale, and makes a lawn of the bit of meadow which lies in front of it. The landscape has become so small and so well defined by this bank of verdure that it has a familiar and personal feeling. The great, bare, open meadows are too ill-defined and too extended to give any domestic air; but here is a portion of the meadow set off into an area which one can compass with his affections.

This mass in Fig. 152 has its own intrinsic merits, as well as its office in defining a bit of nature. One is attracted by the carelessness of its arrangement, the irregularity of its sky line, the bold bays and promontories, and the infinite play of light and shade. The observer is interested in it because it has character, or features which no other mass in all the world possesses. He knows that the birds build their nests in it, and the rabbits find it a happy covert.

Now let the reader turn to Fig. 153, which is a picture of an "improved" city yard. Here there is no structural strength to the planting, no defining of the area, no continuous flow of the form and color. Every bush is what every other one is or may be, and there are hundreds like them in the same town. The birds shun them. Only the bugs find any happiness in them. The place has no fundamental design or idea, no lawn upon which a picture can be constructed.



153.—A typical city lot cramped and crowded by impertinent bushes.



154. — Well conceived but badly treated.

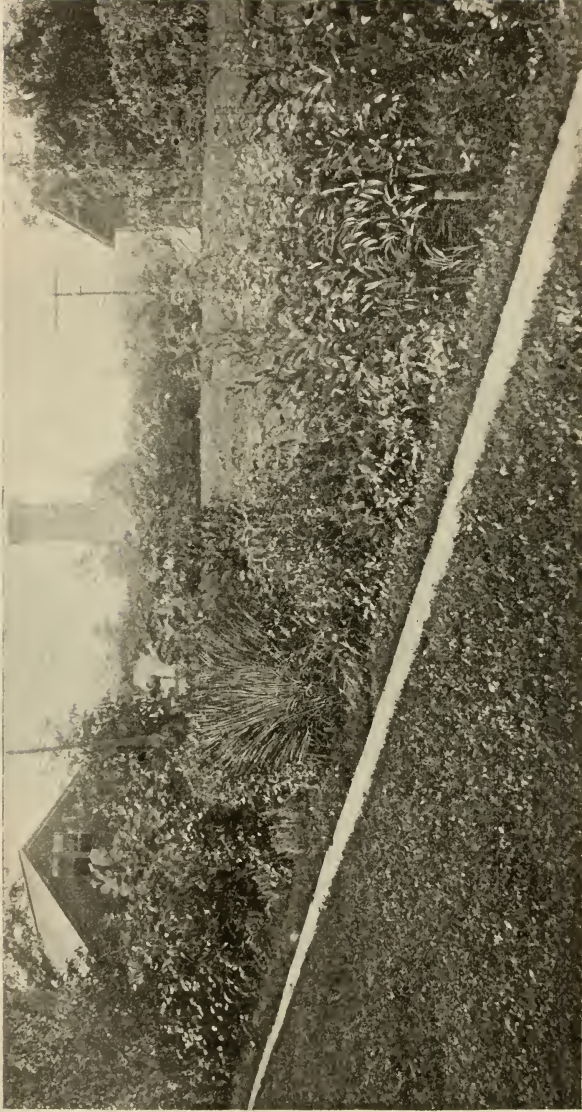
This leads me to say that if a landscape is a picture, it must have a canvas. This canvas is the greensward. Upon this, the artist paints with tree and bush and flower the same as the painter does upon his canvas with brush and pigments. The opportunity for artistic composition and structure is nowhere so great as in the landscape garden, because no other art has such a limitless field for the expression of its emotions. It is not strange, if this be true, that there have been few great landscape gardeners, and that, falling short of art, the landscape gardener too often works in the sphere of the artisan. There can be no



155.—The three guardsmen.

rules for landscape gardening, any more than there can be for painting or sculpture. The operator may be taught how to hold the brush or strike the chisel or plant the tree, but he remains an operator; the art is intellectual and emotional and will not confine itself in precepts.

The making of a good and spacious lawn, then, is the very first practical consideration in a landscape garden. This provided, the gardener conceives what is the dominant and central feature in the place, and then throws the entire premises into subordination with this feature. In home grounds this central feature



157.—A little weedland alongside a rear walk.

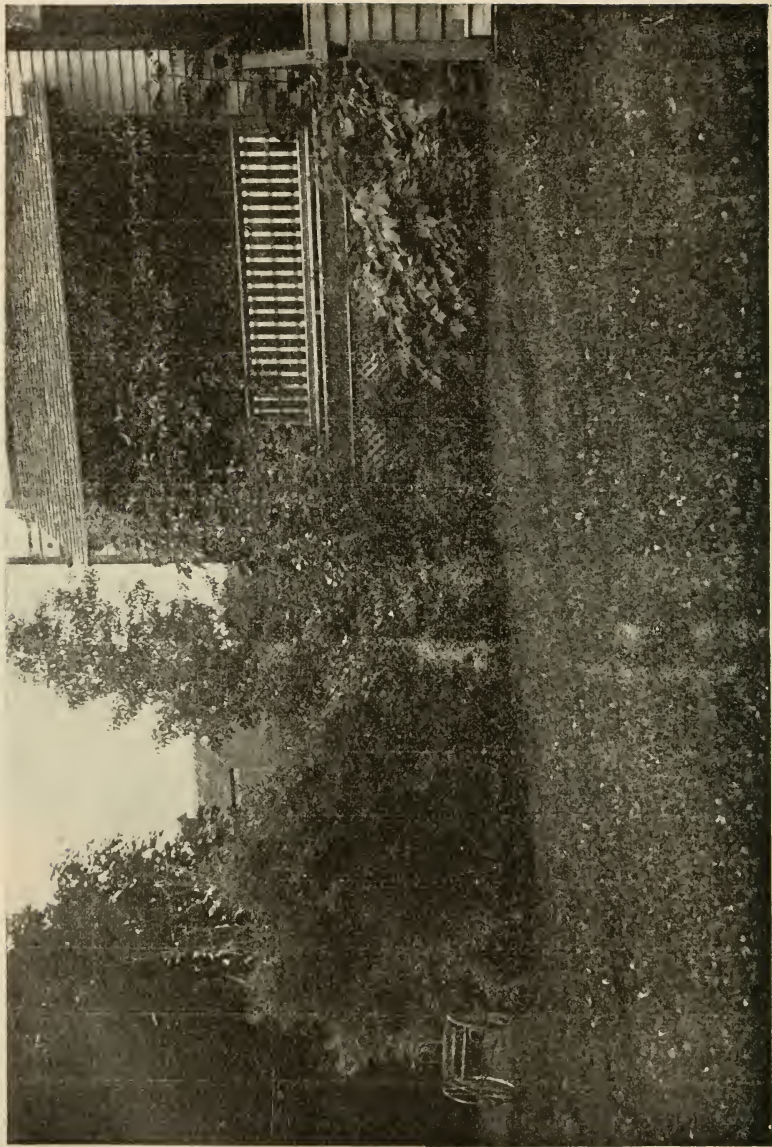
is the house. To scatter trees and bushes over the area defeats the fundamental purpose of the place,—the purpose to make every part of the grounds lead up to the home and to accentuate its homelikeness. Keep the center of the place open. Plant the borders. Avoid all disconnected, cheap, patchy, and curious effects.

It is not enough that the bushes be planted in masses. They must be kept in masses by letting them grow freely in a natural manner. The pruning-knife is the most inveterate enemy of shrubbery. Pictures 154 and 155 illustrate what I mean. The



158.—A front yard before planting.

former represents a good group of bushes so far as arrangement is concerned, but it has been ruined by the shears. The attention of the observer is instantly arrested by the individual bushes. Instead of one free and expressive object, there are several stiff and expressionless ones. If the observer stops to consider his own thoughts when he comes upon such a collection, he will likely find himself counting the bushes; or, at least, he will be making mental comparisons of the various bushes and wondering why they are not all sheared to be exactly alike. Fig. 155 shows how the same "artist" has treated two deutzias and a juniper.



180  
The same front yard, Dec. 1891, after planting.



Much the same effects could have been secured, and with much less trouble, by laying two flour barrels end to end and standing a third one between them.

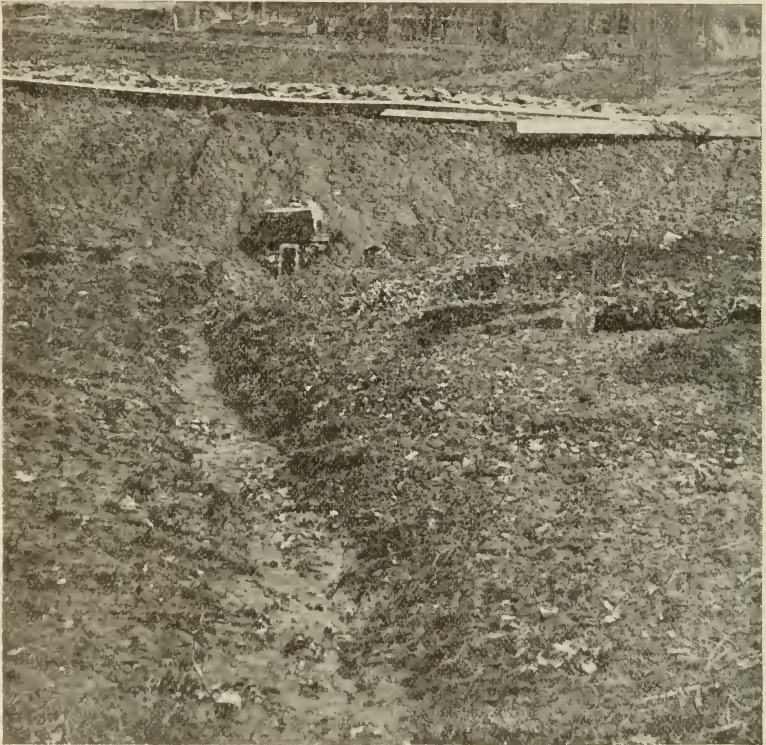
I must hasten to say that I have not the slightest objection to the shearing of trees. The only trouble is in calling the practice art, and in putting the trees where people must see them. If the operator simply calls the business shearing, and puts the things where he and others who like them may see them, objection could not be raised. Some persons like painted stones, others like iron bulldogs in the front yard and the word "welcome" worked into the door-mat, and others like barbered trees. So long as these likes are purely personal, it would seem to be better taste to put such curiosities in the back yard, where the owner may admire them without molestation.



160.—A good combination.

I do not mean to discourage the use of flowers and bright foliage and striking forms of vegetation; but these things are never primary considerations in a good place. The structural elements of the place are designed first. The flanking and bordering masses are then planted. Finally, the flowers and accessories are put in, in just the same way that a house is painted after it is built. Flowers appear to best advantage when seen against a background of foliage, and they are then, also, an integral part of the picture. The flower garden, as such, should be at the rear or side of a place, the same as all other strictly personal appurtenances are; but flowers and bright leaves may be freely scattered along the borders and near the foliage masses. Fig. 156 (at the beginning of the bulletin) is a model in this respect.

What kinds of shrubs and flowers shall I plant? This is a wholly secondary and largely personal consideration. Be sure that the main plantings are made up of hardy and vigorous species, and have lots of them. Then get the things which you like. I like bull-thistles, lilacs, hollyhocks, burdocks, rhubarb, dogwoods, spireas, elders and such careless things. But others have

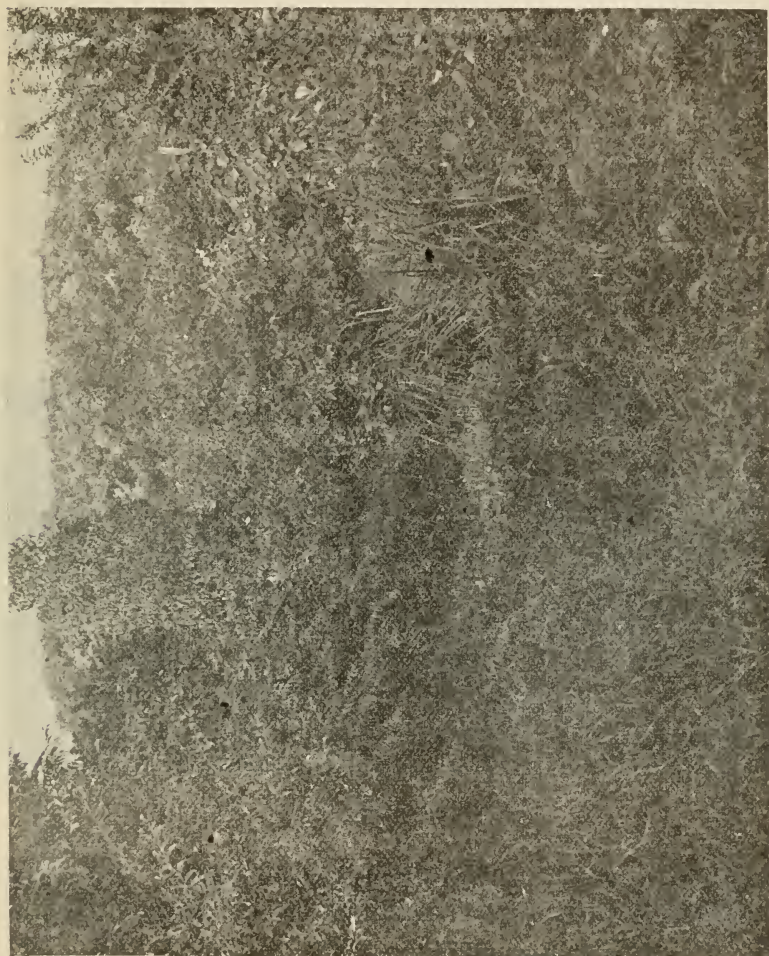


161.—A "fill" in a back yard.

better tastes. There is endless merit in the choice of species, but the point I want to emphasize is that the arrangement or disposition of the plants is far more important than the kinds.

It should be said that the appreciation of foliage effects in the landscape is a higher type of feeling than the desire for mere color. Flowers are transitory, but foliage and plant forms are abiding. The common roses have very little value for landscape planting, because the foliage and habit of the rose bush are not

attractive, the leaves are inveterately attacked by bugs, and the blossoms are fleeting. Some of the wild roses and the Japanese *Rosa rugosa*, however, have distinct merit for mass effects. Wild bushes are nearly always attractive when planted in borders and



163.—The same "fill" four years later.

groups. They improve the appearance under cultivation, because they are given a better chance to grow. In wild nature, there is such a fierce struggle for existence that plants usually grow to few or single stems and they are sparse and scraggly in form; but once given all the room they want and a good soil, and they

become luxurious, full and comely. In most home grounds in this state, the body of the planting may be very effectively made by the use of bushes taken from adjacent woods and fields. The masses may then be enlivened by the addition here and there of cultivated bushes, and the planting of flowers and herbs about the borders. It is not essential that one know the names of these wild bushes, although a knowledge of their botanical features



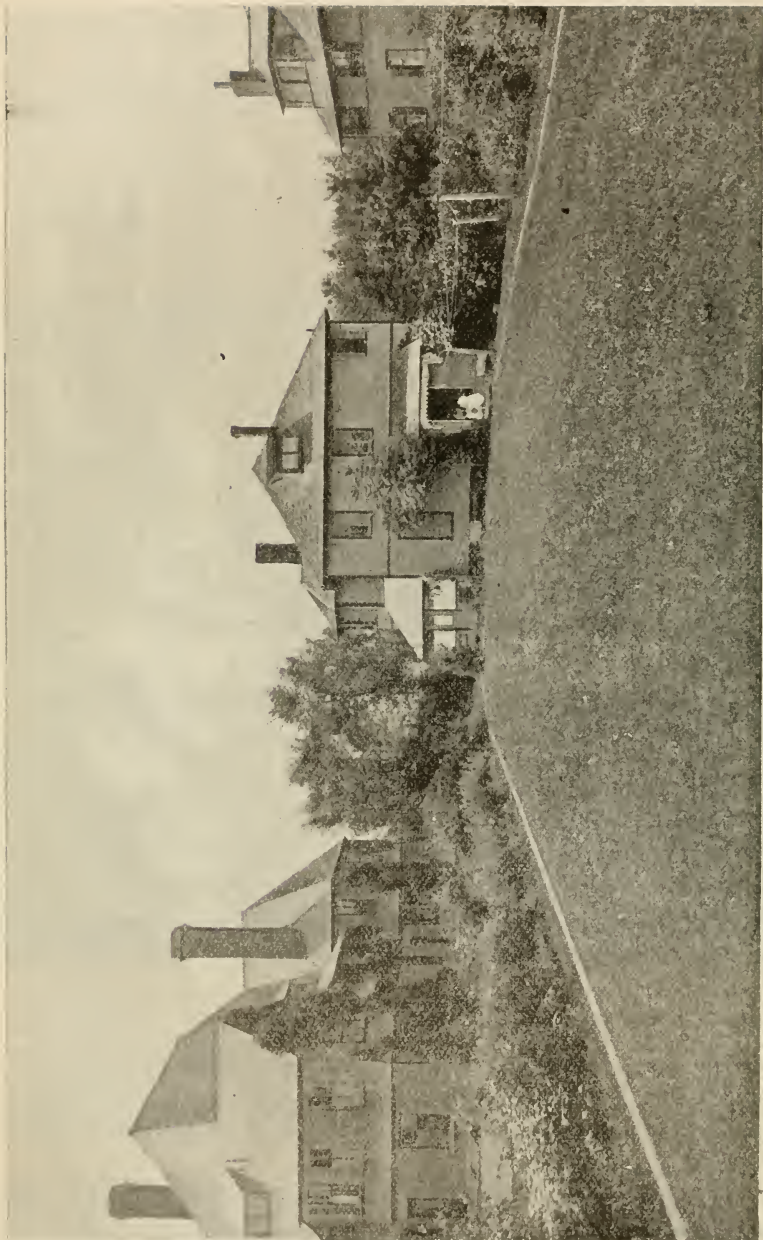
163.—The beginning of a back yard.

will add greatly to the pleasure of growing them. Neither will they look common when transferred to the lawn. There are very few people who know even the commonest wild bushes intimately, and the bushes change so much in looks when removed to rich grounds that few people recognize them. I have a mass of shrubbery which is much admired, and visitors are always asking me what the bushes are; yet I dug the roots in the neighborhood.

Wholly aside from any artistic value, a simple collection of common wild plants is always full of interest and merit. Fig. 157 shows a plantation which answers the double purpose of a wild garden and a border mass-planting. The area is about three feet wide and ninety feet long, and lies along one side of a small back yard (seen in Fig. 164). The soil was originally a most tough and obstinate clay, so hard that even yet annual plants can scarcely be made to grow in it. Plants have been brought from the wild at odd times and set promiscuously in the border, and it now contains over one hundred distinct species. Every day from April to October there are flowers in it, and every spring it renews itself with scarcely a care on the part of the owner. To be sure, there are some weeds in it, but then, the weeds are a part of the collection! A well grown bull-thistle in such a place is worth more than a bushel of potatoes. These plants have been lifted from the fields in the most careless fashion. A noble plant of the pink-hearted *Spiræa lobata* was pulled from a swamp in July when it was in full bloom; the bluebells have been stolen from cliffs without regard to time or season; some of the roots were carried in the pocket for hours before the opportunity came for planting, and this, too, in the height of summer. Of course, some plants have resented this treatment, but the border is a happy family and it is all the better and more personal because it is the result of moments of relaxation.

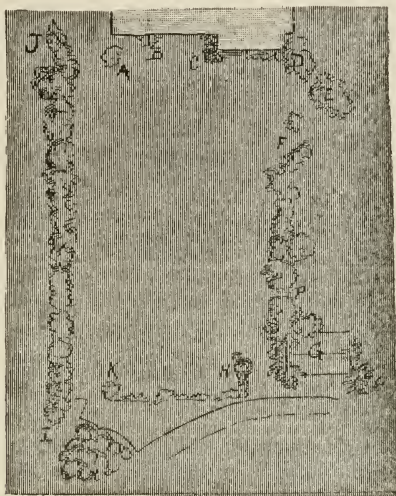
I have spoken of this choice little weedland to show how simple and easy a thing it is to make an attractive mass-plantation. Just set aside a bit of ground in the right place, spade it up and make it rich, and then set plants in it. That is all there is of it. You will not get it to suit you the first year, and perhaps not the second one. You can always pull out plants and put more in. I should be sorry if it did perfectly suit you, for I should then feel that you had lost interest in it. I should never want a lawn-garden if I could not change it a little or plant something new each year.

A word should be said about just how to make a group. Dig up the entire area. Never set the bushes in holes dug in the sod. Spade up the ground, set the bushes thick, hoe them, and then let them go. If you do not like the bare earth between



164.—The same back yard (Fig. 163) four years later.

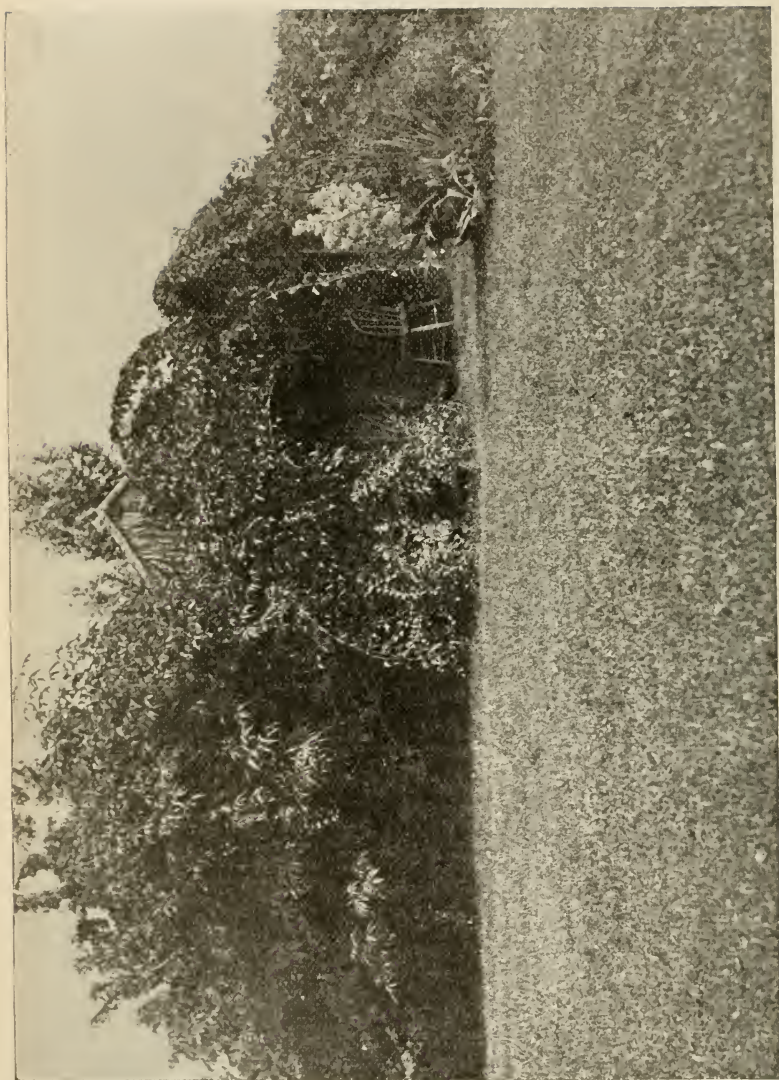
them, sow in the seeds of hardy annual flowers, like phlox, petunia, alyssum and pinks. The person who plants his shrubs in holes in the sward does not seriously mean to make any foliage mass, and it is likely that he does not know what relation the border-mass has to artistic planting. I have said to plant the bushes thick. This is for quick effect. It is an easy matter to thin the plantation if it becomes too thick. I should generally plant all common bushes as close as two feet apart each way, especially if I get most of them from the fields so that I do not have to buy them.



165.—Diagram of Fig. 164. 50 x 90 feet.

## II. *Some specific examples.*

All these remarks will mean more if the reader is shown some concrete examples. I have selected a few cases, not because they are the best or even because they are good enough for models, but because they lay in my way and illustrate what I desire to teach. We will first look at a very ordinary front yard. Fig. 158 shows the yard as it looked before the shrubbery was planted. The large tree seen in the foreground at the left, and the spruce, were removed. A little sprig of exochorda had been planted the year before and is now carefully guarded by stakes. Four years later sees the yard as shown in Fig. 159. The little



166.—The vine-covered cabin in which drawings for Cornell bulletins are made.



exochorda has now grown to be the large bush in the very foreground with the child's tricycle behind it, and the porch foundation is screened and a border is thereby given to the lawn. The length of this planting from end to end is about fourteen feet, with a projection towards the front, on the left, of ten feet. In the bay at the base of this projection the planting is only two feet wide, and from here it gradually swings out to the steps,



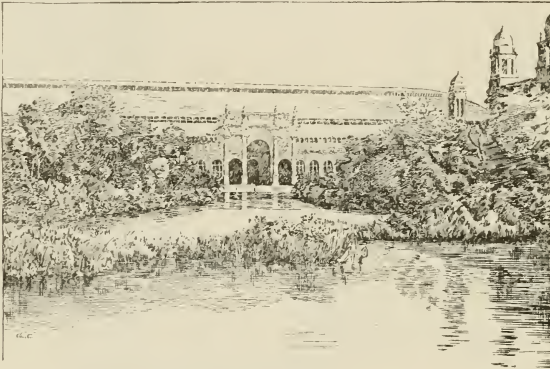
167.—A rustic corner.

eight feet wide. The prominent large-leaved plant near the steps is a bramble very common in the neighborhood, *Rubus odoratus*, and it is a choice plant for decorative planting. The plants in this tangle in front of the porch are all from the wild, and comprise a prickly ash, several plants of two wild osiers or dogwoods, a spice bush, rose, wild sunflowers and asters and golden-rods. The promontory at the left is a more ambitious but less effective mass. It contains the exochorda, a reed, variegated elder, saca-

line, variegated dogwood, tansy, and a young tree of wild crab. At the rear of the plantation, next the house, one sees a tall pear tree.

The best single part of the planting is the reed (*Arundo Donax*) overtopping the exochorda. The photograph (Fig. 159) was taken early in summer before the reed had become conspicuous, but Fig. 160 shows it as the artist saw it in September.

It became necessary to fill a little "run" in a back yard. Fig. 161 shows how it looked. The soil was the hardest clay. *Rubus crataegifolius* was planted on the bank, which it soon covered with an impenetrable tangle. Wild osiers, some asparagus

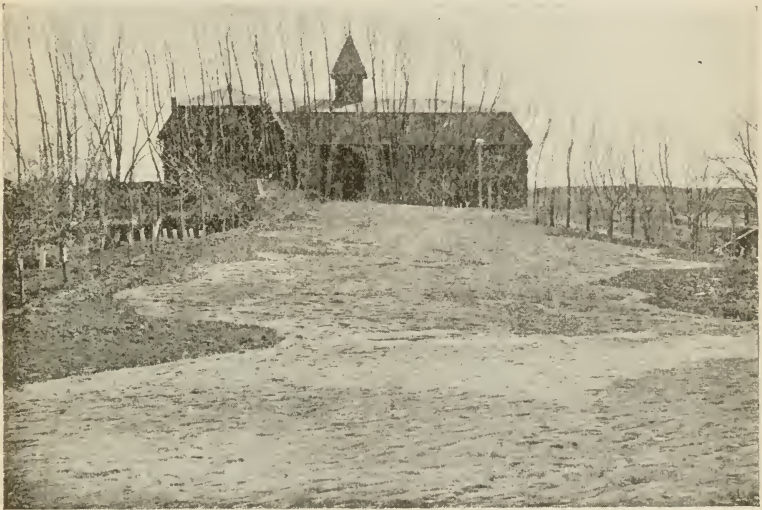


168.—The central open space and the mass-flanked sides.

plants, sedges, a sumac bush, and other common things were put in, and the aspect changed to that of Fig. 162.

A person had a back yard shown in Fig. 163. It was an unpromising subject. The clay was of the vilest kind. The owner wanted a tennis court, and the yard is so small as not to allow of wide planting at the borders. However, something could be done as shown in the sequel (Fig. 164). Upon the left is the weedland border, shown from the other end in Fig. 157. A diagram (Fig. 165) will show what has happened. In the first place, a good lawn was made. In the second place, no walks or drives were laid in the area. The drive for grocer's wagon and coal is seen in the rear, ninety feet from the house. From I to J is the weedland, separating the area from the neighbor's premises. Near I is a clump of roses. At K is a large bunch of golden-rods.

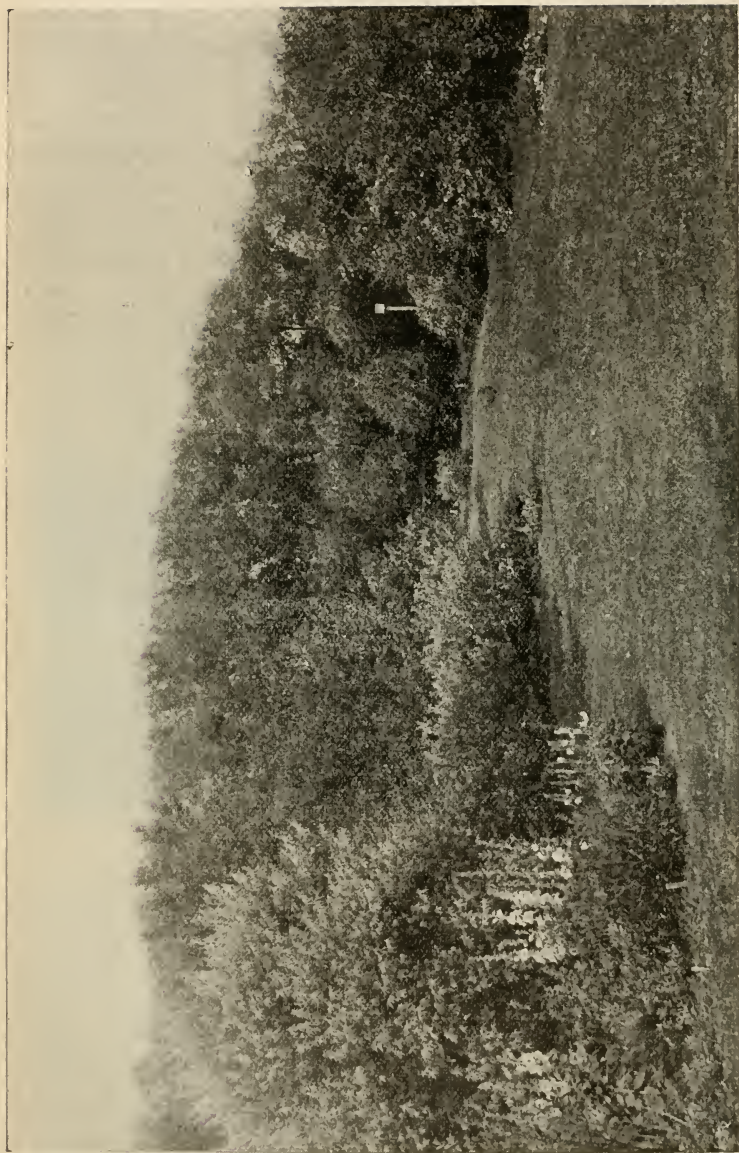
H marks a clump of yucca. G is a cabin, of which I will speak later. From G to F is an irregular border, about six feet wide, containing barberries, forsythias, wild elder, and other bushes. D E is a screen of Russian mulberry, setting off the clothes yard from the front lawn. Near the back porch, at the end of the screen, is an arbor covered with wild grapes, making a playhouse for the children. A clump of lilacs stands at A. At B is a vine-covered screen, serving as a hammock support. The lawn made and the planting done, it was next necessary to lay the walks. These are wholly informal affairs, made by sinking a plank ten



169.—A newly made landscape garden, ready for the border planting.

inches wide into the ground to a level with the sod. The border plantings of this yard are too straight and regular for the most artistic results, but this was necessary in order not to encroach upon the central space. Yet the reader will no doubt agree that this yard is much better than it could be made by any system of scattered and spotted planting. Let him imagine how a glowing carpet-bed would look set down in the center of this lawn.

The cabin which stands at G in Fig. 165 is shown in perspective in Figs. 166 and 167. This is a rustic bark-covered structure which was built to add picturesqueness to the area. The front view, Fig. 166, shows the use of the two best arbor vines yet in-



170.—Five years' growth upon the area shown in Fig. 169. On the Cornell horticultural grounds.

troduced into this country,—the Japanese actinidia and akebia. These vines are most vigorous, perfectly hardy, free of insect and fungous injuries and of extraordinary attractiveness in foliage and habit. The picture also shows the yucca group which is located at H in Fig. 165. The cabin is shown at rear view in Fig. 167; and the reader will be interested to know that the planting in the rear of this cabin is a part of the shrubbery shown in Fig. 162.

These various pictures will fix in the reader's mind the importance of a simple structural design for the home grounds. The essential elements of this design are the open center and the well-planted sides. It is particularly important that the view to and from the front of the dwelling house be kept open, for otherwise there can be little conception of pictorial effect in the composition. It is a grave mistake to cover up or to obscure the one central and important feature of the place. This principle is well shown in Fig. 168. This architectural composition would have little place or merit in the landscape if the foreground were promiscuously planted.

Let us now see how this principle may be applied to a very ordinary area. Fig. 169 shows a small clay field (75 ft. wide and 300 ft. deep), with a barn at the rear. In front of the barn is a screen of willows. The observer is looking from the dwelling house. The area has been plowed and seeded for a lawn. The operator has then marked out a devious line upon either border with a hoe handle, and all the space between these borders has been gone over with a garden roller to mark the area of the desired greensward. The borders are now planted with a variety of small trees, bushes and herbs. Five years later the photograph shown in Fig. 170 was taken.

The reader may now begin to appreciate the value of foliage masses in the landscape, and the comparatively trivial and weak effects of mere flower-beds in any rural picture. Let me illustrate again the uses of mass-effects by photographs taken in one of our most famous metropolitan parks. Fig. 171 is one of that common type of water pieces in our city parks, in which the artificial and ugly borders are wholly bare. It is difficult to con-



171.—A water piece devoid of effective planting.



172.—A water piece well planted.

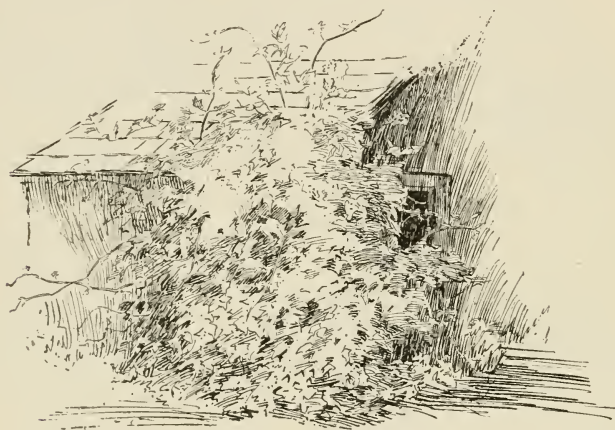
ceive of any use or beauty which is served by the butter ladle promontory at the right. The other view, Fig. 172, shows a similar structural design with the borders planted with elders and dogwoods and other common things. The one picture is a harsh and ambitious attempt at design; the other is as sweet and restful as a glimpse from paradise.



173.—Kerria, canna and wild sunflower, and the grass not too scrupulously sheared, in the corner by the steps.

But if one has no area which he can make into a lawn and upon which he can plant such verdurous masses, what then may he do? Even then there may be opportunity for a little neat and artistic planting. Even if one lives in a rented house, he may bring in a bush or an herb from the woods and paint a picture with it. Plant it in the corner by the steps, in front of the

porch, at the corner of the house, almost anywhere except in the center of the lawn. Make the ground rich, secure a strong root and plant it with care; then wait. The little clump will not only have a beauty and interest of its own, but it will add immensely to the furniture of the yard. About its base one may plant stray bulbs of glowing tulips or dainty snowdrops and lilies-of-the-valley; and these may be followed with pansies and phlox and other simple folk. Very soon one finds himself deeply interested in these random and detached pictures, and almost before he is aware he finds that he has rounded off the corners of the house,



174.—A careless corner. The growth came from a sod dug in a swale in early spring. Clematis and purple cupcatorium, and lesser weeds, comprise the colony.

made snug little arbors of wild grapes and clematis, covered the rear fence and the outhouse with actinidia and bitter-sweet, and has thrown in dashes of color with hollyhocks, cannas and lilies, and has tied the foundations of the buildings to the greensward by low strands of vines or deft bits of planting. He soon comes to feel that flowers are most expressive of the best emotions when they are daintily dropped in here and there against a background of foliage. Presently he rebels at the bold, harsh and impudent designs of some of the gardeners, and grows into a pure and subdued love of the plant forms and verdure. He may still like the weeping and cut-leaved and party-colored trees of the horticulturist, but he sees that their best effects are to be had when they



are planted sparingly, as flowers are, as borders or promontories of the structural masses.

It all amounts to this, that the best planting, like the best painting and the best music, is possible only with the best and



175. —A corner and doorway draped with honeysuckle.

tenderest feeling and the closest living with nature. One's place grows to be a reflection of himself, changing as he changes, and expressing his life and sympathies to the last.

L. H. BAILEY.





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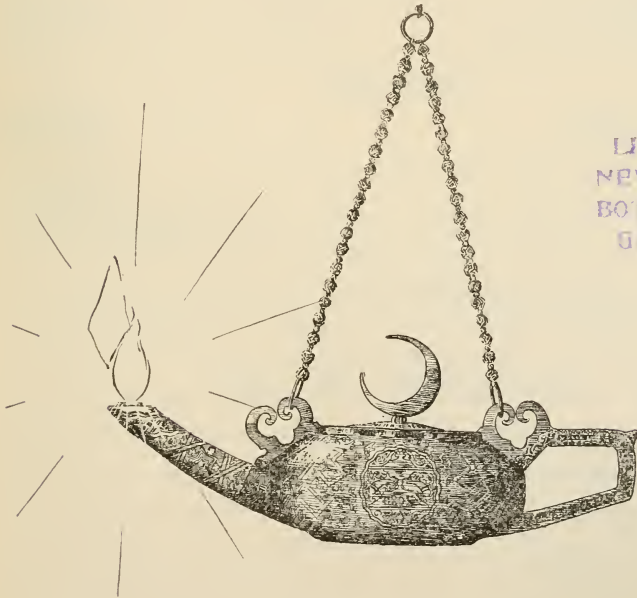
BULLETIN 122—December, 1896.

Cornell University—Agricultural Experiment Station,  
ITHACA, N. Y.

HORTICULTURAL DIVISION.

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SECOND REPORT UPON  
Extension Work in Horticulture.



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Office of the Director, 20 Morrill Hall.

The regular bulletins of the Station are sent free to all who request them.

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## BULLETINS OF 1896.

106. Revised Opinions of the Japanese Plums.
107. Wireworms and the Bud Moth.
108. The Pear Psylla and the New York Plum Scale.
109. Geological History of the Chautauqua Grape Belt.
110. Extension Work in Horticulture.
111. Sweet Peas.
112. The 1895 Chrysanthemums.
113. Diseases of the Potato.
114. Spray Calendar.
115. The Pole Lima Beans.
116. Dwarf Apples.
117. Fruit Brevities.
118. Food Preservatives and Butter Increaseers.
119. The Texture of the Soil.
120. The Moisture of the Soil.
121. Suggestions for the Planting of Shrubbery.
122. Second Report upon Extension Work in Horticulture.

# Extension Work in Horticulture.

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*The Honorable Commissioner of Agriculture, Albany:*

Sir.—About a year ago (in Bulletin 110), I made an official report of the progress of the work which had been undertaken by this institution in furtherance of the purpose of the Experiment Station Extension, or Nixon bill. That report was made at the expiration of the second year's work under that law. A third year has now been added to our experience, and we have also made some departures in the character of the work; and since the undertaking has now grown to such proportions that it can no longer be handled by any of the regularly organized departments of the College of Agriculture of Cornell University, it has seemed to us to be worth the while to address you another report of progress.

## 1. GENERAL SCOPE OF WORK.

In the former report, it was explained that the work of extending the influence and usefulness of the Experiment Station has been thrown into three more or less separate lines,—research or experiment, direct teachings, and the publication of the results of investigation. The animus of the entire enterprise has been an attempt to inquire into the agricultural status, to discover the causes of the rural depression, and to suggest means for improving the farmer's position. This attempt has been specifically directed to a single great branch of rural industry, horticulture, in pursuance of the provisions of the law; but what is true of the horticultural communities is essentially true of other agricultural regions, and, moreover, these two types of agricultural industry cannot be separated by any arbitrary lines. The work, therefore, has practically resulted in a broad study of rural economics. We conceive that it is impossible to really extend

the Experiment Station and University impulse to the people in such manner that it shall come to them as a living and quickening force, without first studying the fundamental difficulties of the farmers' social and political environment.

It is not necessary to the present report that I make any discussion of the agricultural status. I may only say that, as the result of the most painstaking study which I have been able to make, I am convinced that there is no agricultural disease. That is, there is no political condition which is peculiar to agriculture and which can be remedied by legislation. By reason of their inherent conservatism, the agricultural people have not yet adjusted themselves to the recent social and economic movements, and they have not fully assimilated the knowledge and impulses of the time; and I am also convinced that grave errors have been committed in forcing the development of western lands. If these general conclusions are sound, then it follows that the solution of our agrarian difficulties is to be sought in better education. By education, I mean literally what I say,—by means of a general waking up, a shaking out of all the old habits of thought, an injection of new conceptions of life, an intellectual stirring up of every rural community. I do not mean the simple giving of information, the cramming in of carefully assorted facts. We need to shake out the snarls and kinks of prejudice and indifference before giving great attention to the dissemination of more direct information. There is already enough popular knowledge of better agricultural methods to greatly improve our rural conditions, if only the farmers would assimilate it and apply it. This knowledge is of little account when it is a mere extraneous possession. It must be worked into the fibre of the man until he is not aware that he possesses it.

In this extension work, therefore, we have sought not so much for new facts as for some way of driving home the old facts. We have tried to set forces at work which would silently extend themselves when we had left them. Fortunately, we have been greatly aided by the hard times and the multitudes of

bugs and special difficulties. These things have driven people to thinking and to asking for information. The agricultural communities are thoroughly aroused, and now is the time to teach. When one is thoroughly prosperous in his business, there is little chance—as, in fact, there is generally little need—of teaching him other methods.

I must hasten to say that the agricultural status in Western New York is not such a deplorable one as my reader may suppose, or as he may infer from my preceding remarks. Those farmers who grow various and difficult crops are wide awake, intelligent, aggressive and for the most part contented. The man who grows only a few and staple crops is very apt to fall into stereotyped ways of thinking, which may mean that he drops behind the times. Just as fast as more varied farming is forced upon the agricultural communities by the inexorable struggle for existence, will the farmer's horizon and sympathies enlarge; and with the progress of this broadening and educative impulse—which now, fortunately, is rapidly rising—the farmers will find themselves in position to correct whatever minor faults of legislation that may have occurred, and to direct and control the social forces with which they are concerned.

We might classify our efforts to reach the people, in the progress of our work, under five general heads. These efforts have all been experiments in methods of extension teaching as applied to horticulture. We have tried to ascertain the value of:

1. The itinerant or local experiment as a means of teaching.
2. The readable expository bulletin.
3. The itinerant horticultural school.
4. Elementary instruction in the rural schools.
5. Instruction by means of correspondence and reading courses.

Unless all signs are deceptive, the greatest good which has yet been accomplished has come through the bulletins. We have wished that we might be able to make bulletins which would interest the reader aside from the information which they contain. We should have liked to put juice into them, for pemmican, whilst exceedingly nutritious, is difficult of digestion.

Aside from the reporting of definite experiment work, these bulletins have taken the form of surveys of the status of certain industries; and an effort has also been made to give a new flavor to country life by writing upon subjects of floriculture and ornamental gardening. Whilst it seems to us that the publications have been useful in furthering the work which we have had in mind, we are nevertheless convinced that an unlimited issue or even a very large number of such expository bulletins would not be proportionately useful at the present time. There are still a number of horticultural subjects which we desire to treat in this spirit; but it is evident that the real fundamental work of extension teaching must be prosecuted along other lines in connection with publication of a distinctly didactic kind. It may be said, before leaving this subject, that the entire number of bulletins thus far published under the auspices of the Nixon bill, including the present report, is forty. The experimental and investigational work which is still going forward—of which there is considerable—will be reported in forthcoming bulletins. For the present report, it is only necessary to explain the work of direct teaching which we have undertaken during the present year, and to draw certain conclusions from the general work of the Nixon bill.

## 2. EXPERIMENTS IN EXTENSION TEACHING.

During the past season, we have made an especial effort to determine the best methods of reaching the rural communities by means of personal teaching, and our work has fallen into three general lines. In the first place we have carried forward one month's work of consecutive teaching by means of the horticultural schools which we have heretofore held and which are somewhat fully reported in Bulletin 110; we have made another experiment of a month's duration in teaching nature-study and object lessons in the rural schools of the Fourth Judicial Department; and at the present time, we are endeavoring to carry forward the instruction which has been thus begun by means of correspondence and an attempt to establish reading courses in the various school districts and rural organizations.



The horticultural schools held during the month of September were as follows, the names of the teachers being in italic:

1. Aug. 28, 29, *F., S.* Jamestown, Chautauqua Co., Y. M. C. A. Hall, *Bailey, Slingerland & Lodeman, Roberts Powell & Cavanaugh, Clinton.*
2. Aug. 29, *S.* Ellington, Chautauqua Co. Case & Frisbee's Hall. *Lodeman, Slingerland, Powell.*
3. Aug. 31, Sept. 1, *M., T.* East Randolph, Cattaraugus Co. Hall's Opera House. *Clinton, Cavanaugh, Powell. Lodeman & Slingerland, Bailey.*
4. Sept. 2, 3, *W., Th.* Cuba, Allegany Co. Fireman's Hall. *Bailey, Cavanaugh, Powell. Slingerland, Powell and Clinton.*
5. Sept. 2, 3, 4, *W., Th., F.* Brocton, Chautauqua Co. Evenings only. *Bailey. Lodeman. Powell.*
6. Sept. 4, 5, *F., S.* Lyndonville, Orleans Co. Methodist Church. *Lodeman, Cavanaugh, Bailey. Clinton, Powell.*
7. Sept. 7, *M.* Romulus, Seneca Co. Romulus Hall. *Lodeman, Clinton, Roberts.*
8. Sept. 7, 8, *M., T.* North Rose, Wayne Co. I. O. G. T. Hall. *Powell, Duggar, Cavanaugh. Slingerland, Bailey.*
9. Sept. 8, 9, *T., W.* Williamson, Wayne Co. Grange Hall. *Powell, Duggar. Bailey, Slingerland, Cavanaugh, Clinton.*
10. Sept. 10, *Th.* Webster, Monroe Co. *Lodeman, Cavanaugh, Clinton.*
11. Sept. 9, 10, *W., Th.* Hilton (N. Parma), Monroe Co. F. W. Baptist Church. *Lodeman, Cavanaugh, Powell. Slingerland & Duggar, Bailey.*
12. Sept. 11, 12, *F., S.* Dansville, Livingston Co. Grange Hall, near Stone's Falls, Friday; farm of H. R. McNair, below Woodsville, Saturday. Basket picnics. *Bailey, Lodeman, Roberts. Cavanaugh & Duggar, Clinton.*
13. Sept. 12, *S.* Wyoming, Wyoming Co. *Powell & Slingerland, Roberts, Powell.*
14. Sept. 14, 15, *M., T.* Le Roy, Genesee Co. G. A. R. Hall. *Powell & Duggar, Clinton, Bailey. Cavanaugh, Mrs. Comstock.*
15. Sept. 15, *T.* Dundee, Yates Co. G. A. R. Hall. *Lodeman, Clinton, Slingerland.*
16. Sept. 16, *W.* Hall's Corners, Ontario Co. *Lodeman & Slingerland, Clinton, Lodeman.*
17. Sept. 16, 17, *W., Th.* Skaneateles, Onondaga Co. Library Hall. *Powell, Cavanaugh, Mrs. Comstock, Clinton, Roberts.*
18. Sept. 17, *Th.* Fayetteville, Onondaga Co. *Powell & Duggar, Cavanaugh, Bailey.*

19. Sept. 17, 18, *Th., F.* Oswego, Oswego Co. Court House.  
*Lodeman, Slingerland, Powell, Roberts, Cavanaugh.*
20. Sept. 18, 19, *F., S.* Mexico, Oswego Co. Town Hall.  
*Lodeman, Slingerland, Clinton, Cavanaugh, Powell.*
21. Sept. 21, 22, *M., T.* Lowville, Lewis Co. Court House.  
*Powell, Duggar & Slingerland, Bailey, Clinton, Cavanaugh.*
22. Sept. 22, 23, *T., W.* Poland, Herkimer Co. F. B. Church.  
*Bailey, Duggar & Slingerland, Powell, Clinton, Cavanaugh.*
23. Sept. 23, 24, *W., Th.* Trenton, Oneida Co. Grange Hall.  
*Bailey, Slingerland & Duggar, Powell, Cavanaugh, Clinton.*
24. Sept. 24, 25, *Th., F.* Clinton, Oneida Co. Scollard Opera House.  
*Bailey & Slingerland, Mrs. Comstock & Morrill, Bailey, Cavanaugh & Duggar, Powell.*

These schools were designed to impart specific horticultural instruction, and, more particularly, to awaken closeness of observation, and careful reasoning therefrom, upon the part of the attendants. These schools were arranged for in the various places through a local committee which was appointed by the person who applied for the school in that community. Posters were distributed some time in advance of the meetings, the subject matter of one of which is presented herewith:

### A SCHOOL OF HORTICULTURE

WILL BE HELD IN THE

Y. M. C. A. HALL, JAMESTOWN, CHAUTAUQUA  
COUNTY, N. Y.,

Friday and Saturday, August 28 and 29, 1896, beginning  
at 10 o'clock, sharp.

This school is held under the auspices of the Experiment Station Extension, or Nixon Law, which, for three years, has given funds for the promulgation of horticultural knowledge in Western New York. Its territory is the Fourth Judicial Department, comprising twenty-two counties, of which the easternmost are Jefferson, Lewis, Herkimer, Oneida, Onondaga, Cayuga, Seneca, Yates and Steuben. The demands of this law are met by conducting experiments, by publishing the results of these researches in bulletin form, in sending agents or experts to examine orchards and plantations when advice is needed, and in the holding of schools in which the various matters of science

and practice pertaining to fruit-growing, gardens and green-houses are discussed. The force of instructors who take part in these schools are Mr. George T. Powell and teachers in Cornell University:

Teachers upon General Subjects: Professor I. P. Roberts, George T. Powell, Professor L. H. Bailey.

Representing Spraying, Vineyards and Small Fruits: E. G. Lodeman, Instructor in Horticulture.

Representing Entomology: M. V. Slingerland, Assistant Entomologist in the Experiment Station.

Representing Tillage, Conservation of Moisture, Farm Tools, and the like: L. A. Clinton, Assistant Agriculturist in the Experiment Station.

Representing Chemistry, Plant Foods, Fertilizers: G. W. Cavanaugh, Assistant Chemist in the Experiment Station.

Representing Plant Diseases and Botanical Matters: B. M. Duggar, Assistant Botanist in the Experiment Station.

Instruction for Children: Mrs. J. H. Comstock.

Some or all of these persons will be present at every school.

These schools are free to everyone. It is especially desired that the women and young men should attend them. Each session will be devoted to one general subject, and all questions upon that subject should be reserved for that occasion. It is the purpose of these schools to awaken an interest in rural affairs and to inspire correct methods of observation and thinking, quite as much as to give explicit direction for horticultural work.

It will conduce to the interest of the occasion if the citizens make displays of flowers, fruits and vegetables. Participants are requested to bring in all specimens of insects, diseased plants, and the like, concerning which they desire information.

Come prepared to learn, not to criticize. Bring note-book and pencil. If forty or fifty earnest persons are in attendance at all the sessions, the school will be a success; but it is desired to reach as many people as possible.

A course of reading will be laid out, at the school, for all who desire to take it up. The local rural societies should further this work. The value of the school will depend greatly upon the extent to which it stimulates further reading and study.

Whenever practicable, it is desired that one session, or a part of a session, be given to the children of the public schools.

Please circulate this information widely.

For further information consult the local committee: Newell Cheney, Poland Center; A. A. Van Vleck, Jamestown; W. C. Gifford, Jamestown; M. Wample, Jamestown;

Or address L. H. Bailey, Cornell University, Ithaca, N. Y.

Programs will be ready before the school opens.

One of the most useful exercises in connection with these schools, and which we have uniformly employed from the beginning of our work, consists in observation lessons. Some small object, like leaves or roots, flowers or seeds, is put in the hands of all the attendants, and, after they have examined it for a few minutes, the instructor begins to ask questions concerning it. This exercise drills every participant in observation, in the drawing of proper inferences from what he sees, and the exercise has always been productive of the greatest interest and good. A sample program of one of these horticultural schools is herewith submitted:

Everyone interested in Rural Affairs is invited to attend a

### SCHOOL OF HORTICULTURE

TO BE HELD IN

SCOLLARD OPERA HOUSE, CLINTON, ONEIDA CO.,

Thursday and Friday, September 24 and 25, 1896.

The school is held under the auspices of the Nixon, or Experiment Station Extension Bill, which appropriates funds for the dissemination of horticultural knowledge in the Fourth Judicial Department of the State. The work is in charge of Cornell University (Ithaca), and the instruction is given chiefly by teachers in that institution, under the immediate supervision of L. H. Bailey.

*Local Committee:* E. P. Powell, Clinton; T. T. Thompson, Clinton; H. B. Sykes, Clinton; Ira F. Ellenwood, Clinton; J. H. Marvin, New Hartford.

THURSDAY, 10 A. M. (SEPT. 24).

Lesson upon *Flowers* — (Conducted by L. H. Bailey).

M. V. Slingerland — Insects: What they are and How they Live. Illustrated by specimens and models.

After this exercise questions may be asked about spraying.

THURSDAY, 2 P. M.

Lesson upon *Leaves* — (Conducted by L. H. Bailey).

E. P. Powell — Orchard Culture: How to secure healthy trees and healthy crops.

Mrs. J. H. Comstock — What bright-eyed children may see in their walks. Illustrated by original colored drawings.

It is hoped that the school children may be present at this latter exercise.

## THURSDAY, 7:30 P.M.

Lesson upon *Branches* — (Conducted by L. H. Bailey).

L. H. Bailey — The Philosophy and Practice of Pruning. Illustrated by specimens.

This exercise will consider certain phases of evolution, as well as of the pruning of trees.

## FRIDAY, 10 A. M. (SEPT. 25).

Lesson upon *Buds* — (Conducted by Professor Morrill).

A. D. Morrill — The Leaf-bud and Budding and Grafting.

B. M. Duggar — Fungi: What they are and How they Live.

At this point persons may ask questions about diseases of plants.

## FRIDAY, 2 P. M.

Lesson upon *Matches* — (Conducted by George W. Cavanaugh).

George W. Cavanaugh — The Chemistry of Some Plant Foods. Illustrated by chemical tests.

George T. Powell — How to Pick, Pack and Export Apples.

Will some one bring in a barrel of apples properly packed?

Be on hand promptly at the opening hour. Time is precious.

Bring note-book and pencil.

Bring all the family. The introductory lessons will be especially interesting to children, and there should be a good turnout.

Come prepared to ask and to learn, but do not come to criticize. The school is intended for those of an inquiring mind, not for those who wish simply to be entertained.

Each regular attendant will be enrolled as a scholar.

Printed synopses of each regular talk or lecture will be distributed.

Bring in specimens of fruits, insects, plants, and whatever else interests you.

*It is more needful to learn first to think correctly than to perform correctly; for all accurate labor is the child of accurate thought.*

☞ Bring this program with you.

We have taken up this experiment in teaching with the same spirit in which we would take up an investigation in natural science; that is, we have not attempted to prove any preconceived notions but have wished to seek for the truth. We have desired chiefly to know what is the best means of reaching the farming communities with the new educational impulses. In respect to these September schools, I may say that they were uniformly well received by the communities in which they were held. As

an experiment, all of them are considered to have been successful, although it should be said that one of them was not held because of a conflict with a county fair. These schools have drawn a limited number of participants, ranging all the way from twenty to two hundred. I presume that an average attendance would run from forty to sixty. The participants have almost uniformly been the most influential horticulturists and farmers of the neighborhood — persons who extend a wide influence and who will give great popularity to any work in which they are interested. In distinctively fruit-growing regions, and especially in those localities where farmers' institutes, grange meetings and other like assemblages have been held, these schools have been immediately worth many times more than they have cost. In certain other communities, however, especially those in which farmers' meetings have not been held energetically, and in grazing regions, these schools have, in my opinion, been of too technical or special character to produce the greatest amount of good. As a result of the holding of many of these schools, I am now of the opinion that they cannot be used as primary factors in university extension; they are capable of accomplishing a great amount of good when the community has been awakened by simpler and more elementary means. I should therefore consider that they could serve their best uses when they are given as a reward to those communities in which the greatest amount of interest in reading courses, in horticultural clubs, institutes and such other public factors has been developed. There are centers enough in New York State where such schools can be held with distinct advantage at the present moment; but they should be rather the culmination of a series of extension teaching efforts rather than a primary or preliminary means of awakening the rural communities.

During October a series of meetings was held in the school-houses of various parts of the Fourth Judicial Department. These were under the immediate supervision of Mr. George T. Powell, who was assisted throughout the month by Mr. John W. Spencer, of Westfield. These meetings were of the type which

had been so successfully inaugurated in Westchester county a year ago under the auspices of the Committee for the Promotion of Agriculture, a work which had been carried to its practical demonstration by Mr. Powell. The itinerary of the October meetings, together with some statistics thereof, are herewith submitted:

- Oct. 1. A. M. Charlotte Centre, Chautauqua Co., Geo. R. Mathewson, teacher; 36 pupils.  
 P. M. Sinclairville High School, Chautauqua Co., Professor F. L. Hannum, principal; 165 pupils.
2. A. M. Thornton, Chautauqua Co., Bates District, Blanche Stone, teacher; 37 pupils.  
 P. M. Ellington, Chautauqua Co., High School, Professor E. W. Storms, principal; 130 pupils.
3. P. M. Kennedy, Chautauqua Co., Mrs. Millie Lathrop Williams, teacher.
5. A. M. Ashville, Chautauqua Co., D. H. Findley, principal; three departments; 60 pupils.  
 P. M. Blockville, Chautauqua Co., J. C. Smith, teacher; 34 pupils.
6. A. M. North Collins, Erie Co., High School, L. L. Shore, principal; 130 pupils.  
 P. M. North Collins, Eugene Willitt's District, Elizabeth E. Kingsland, teacher; 23 pupils.
7. — East Aurora, Erie Co., Jewett District, Miss Luella Malon, teacher; 18 pupils.  
 A. M. Youngstown, Niagara Co., Henry Lutts' District, Cora A. Bradley, teacher; 27 pupils.  
 P. M. Youngstown, district near Model City, Elizabeth M. Berkley, teacher; 29 pupils.
8. A. M. Knowlesville, Orleans Co., Graded School, J. F. McNall, principal; 85 pupils.  
 P. M. Millville District, Orleans Co., Ernest A. Roll, teacher; 34 pupils
9. A. M. Spencerport, Monroe Co., Graded School, F. W. Hill, principal; 170 pupils.  
 P. M. Medina, Orleans Co., High School (Evening), Adams Basin, Monroe Co., W. H. Clark, principal; 50 pupils.
12. A. M. South Livonia District, Livingston Co., W. Arthur Turner, teacher; 47 pupils.  
 P. M. Livonia, Livingston Co., High School, W. H. Cone, principal; 200 pupils.
13. A. M. East Palmyra School, Wayne Co.; 14 pupils.

- Oct. 13. P. M. Palmyra, Wayne Co., High School, Professor S. D. Arms, principal; 600 pupils.  
Evening lecture.  
Conesus District, Livingston Co., S. L. McNinch, principal; 90 pupils.  
Foot's Corners School, Livingston Co., Josephine Stalee, teacher; 21 pupils.
14. A. M. Boughton Hill District, Ontario Co., Miss Mary T. O'Neil, teacher; 30 pupils.  
P. M. East Victor School, O. Smith, teacher; 23 pupils.  
Victor, Ontario Co., High School; 300 pupils. (Evening.)
- A. M. and P. M. Naples, Ontario Co., Naples High School, Professor W. C. Noll, principal; 225 pupils.
- Oct. 15. A. M. Phelps District No. 2, Ontario Co., Miss Emma Saulsbury, teacher; 27 pupils.  
P. M. Phelps Union School, Ontario Co., Professor D. D. Edgerton, principal; 330 pupils.  
A. M. Canandaigua, Ontario Co., District No. 17, Lucretia Adams, teacher; 22 pupils.  
A. M. Canandaigua, District No. 15, Mabel Merse-  
reau, teacher; 11 pupils.  
Canandaigua, District No. 14, Cora Parker,  
teacher; 20 pupils.  
P. M. Reed's Corners School, Ontario Co., Julia C. Caplise, teacher; 31 pupils.
16. P. M. Geneva School, Ontario Co., Miss Ellen Beach  
in charge; 40 to 50 in room.
19. Fayetteville, Onondaga Co., Union School,  
Professor T. J. House, principal; 338 pupils.  
P. M. Manlius Union School came to Fayetteville,  
Professor E. Neeley, Manlius, principal.  
Dwight Stone's District, Oswego Co., Mrs.  
Francis Gilbert, teacher; 25 pupils.  
Lansing, Oswego Co., F. D. Bradley, teacher;  
60 pupils.
20. A. M. Oswego Falls, Oswego Co., Maud Marden,  
teacher; 87 pupils.  
P. M. Fulton, Oswego Co., High School, Professor P.  
G. Clapp, principal; 1,000 to 1,100 pupils.
21. A. M. Volney District No. 7, Oswego Co., Mrs. Flora  
S. Davis, teacher; 27 pupils.  
Volney District No. 4, Lillian Hollunbeck,  
teacher; 19 pupils.



- Oct. 21. A. M. Volney District No. 3, Mrs. Anna Fradenburg, teacher; 30 pupils.
22. Mexico, Oswego Co., High School, Professor A. W. Skinner, principal; 300 pupils.
23. A. M. Allendale District, Adams P. O., Jefferson Co., Clarence Pitts, teacher; 35 pupils.
- P. M. Adams, Jefferson Co., Miss M. J. Salisbury, principal; 250 pupils.
24. Watertown, Jefferson Co., Horticultural school.
26. A. M. New Hartford, Oneida Co., District No. 10, Leon E. Jinks, teacher; 33 pupils.
- P. M. New Hartford, District No. 7, Miss Augusta Light, teacher; 14 pupils.
27. A. M. New Hartford Union School, Professor G. Spaulding, principal; 300 pupils.
- P. M. New Hartford Union School.  
Hornellsville, Steuben Co., District No 12, Miss Cassie Cunningham, teacher; 20 pupils.
28. A. M. Arkport, Steuben Co., High School, H. W. Harris, principal; 150 pupils.
- P. M. Canisteo, Steuben Co., High School, Professor W. D. Hood, principal; 500 pupils.
- Evening. Hornellsville High School, Professor W. R. Prentice, superintendent.
29. A. M. Rheims, Steuben Co., Pleasant Valley District, Miss Minnie E. Pierce, principal; 60 pupils.
- P. M. Hammondsport, Steuben Co., High School, Professor E. L. Monroe, principal; 300 pupils.

The plan of effort in this teaching was to visit two schools during the day, one in the forenoon and one in the afternoon. The arrangements were made in advance with the school commissioner or the trustees, and the fact that the speakers were to be at the school-house was ordinarily announced some days in advance so that parents and friends could visit the school at that time if they chose. The teacher was in every case willing to omit the regular exercises for an hour or two in order that our instructors might take up the work of object teaching with the children. The motive in this work was to find out just how the pupils could be reached by means of object lesson teaching, and just how much interest they would be likely to manifest in agricultural matters in case it were ever found to be desirable

to introduce such teaching as a part of the district school work. The instructor would first explain the reason for his coming and give the school to understand that no new text-books were for sale and that no new classes were to be required at the hands of the teacher. He then ordinarily took up some simple object lesson. It might be in one place a stalk of corn which he had in his hand and the process of growth of which he would explain from seed to harvest; it might be in another case the germination of a bean or a pumpkin seed; it might be in another case the habits or structure of a potato bug or some other insect; it might be, again, the reasons why there were knots and knot holes in the woodwork in the school-house; it might be a very elementary talk upon the different plant foods which are in the soil; it might be in other cases a very brief sketch, with charts, of some fungus; and so on. These exercises were uniformly well received by both the pupils and the teachers and this work has, I think, awakened more inspiration in the minds of our instructors than any other attempt which we have yet made to reach the people. The teachers in the schools have without exception expressed themselves as willing and desirous of taking up some such simple exercises as a rest for the pupils two or three times a week, if only they themselves could be instructed in the proper methods of carrying on the work. In order to afford this instruction to the teachers, we are now proposing to issue a series of experimental leaflets on object lessons and place these in the hands of the teachers.

There is no doubt of the necessity for work of this kind with the children. The love or antipathy of the farm is engendered at a very early age in the minds of the young. This has been demonstrated in these October meetings when we have asked those children who live on farms and who still desire to do so to raise their hands, and we almost uniformly find that the number who desire to live on farms is far less than those who actually do live on them. With these children, ranging from six to fifteen years of age, the question of pecuniary profits upon the farm has appealed very little, but they are influenced directly

by the environments under which they are living. These environments must be improved; and if they are, there is every reason to expect that children will love the country better than the city. We have thought, therefore, that it is eminently worth the while to instill the love of nature and the knowledge of a multitude of living things in the minds of the children; and by so doing we are fully convinced that we shall also be spreading the very same knowledge and impulse to the parents of these children. In fact, all the instructors whom we have had in the field during the present year are fully convinced, I think, that the fundamental method in improving the agricultural status is to begin with genuine and attractive nature-education in rural schools. As soon as a genuine interest in these matters is awakened in the children and teachers, school gardens, cabinets of plants, insects and minerals, and other enterprises will cluster about the school-center, and the influence thereof will spread throughout the country side.

A report of this October work by Mr. Powell is herewith submitted:

“That the agriculture of New York state has been seriously depressed for several years, there is no question; that this has affected the condition of the rural population unfavorably is also recognized. It is, however, difficult to see wherein legislation can be obtained that will materially change the present conditions, except upon some educational lines that would enable those engaged in agriculture, through greater knowledge, to more successfully meet some of the difficulties attending production, the interests of consumers being here closely connected with that of producers of food supplies.

“There has been a belief that our educational system, excellent as it is, could be made of greater value to the individual by helping him to obtain a closer knowledge of some of the forces of nature which contribute so largely to the necessities and comforts of life. While our country schools have instructed children in the common and higher English branches, and, in instances, have taught some of the principles of natural science, but little attempt has been made to give science instruction with its application made to living things or to those pertaining to the active affairs of life.

“Under the auspices of the committee, known as the Com-

mittee for the Promotion of Agriculture, organized in New York in 1895, for the promotion of agriculture and of agricultural education, the experiment was tried of giving a course of lectures on natural sciences applied to agriculture in the district and high schools of Westchester county. The work proved of practical value, and a demand came upon this committee to extend it to many other sections in the state. It was thought by the New York committee that Cornell University, having such a complete equipment for scientific instruction and able teachers in agriculture, could render valuable service to the entire state by extending this line of instruction, and combining with its experiment and investigation work that of instruction in some of the principles of agriculture on the University Extension plan.

“ During the month of October, 1896, this work was given to a number of schools in the different counties comprising the Fourth Judicial Department, under the provisions of the Nixon bill, for the extension of horticultural knowledge and instruction. Two classes of schools were reached: those in the rural districts and the union free schools. A district school would be visited in the morning, and in the afternoon a union or high school. Two lectures were given in each, namely, on plant and insect life. Observation lessons were given pupils, while methods of teaching these subjects were given the teachers. The most familiar objects were chosen from the plant life of the school district. Seeds representing familiar plants were germinated and placed in the hands of pupils for observation and study. The full corn in the ear was shown to illustrate what had taken place since the germination of the seed. Lectures on insects were given, choosing the familiar and injurious kinds of the district (those that do direct and serious damage to crops and to vegetation), giving their history, the different transformations through which they pass, and instruction on how to save the losses they cause. To the higher pupils, lectures were given on the beneficial insects, their relation to the flowers, and how they are an important factor in the fruitfulness of orchards and vineyards, in the distribution of pollen of different flowers, in cross-fertilization and formation of the seeds of plants; also on the relation of the soil to all forms of life, vegetable and animal, its important elements in plant food and how it can be studied in an elementary manner. Teachers were given instruction by objects and illustrations on how these subjects could be taught, without multiplying studies or exercises or without text-books, by dropping some regular exercise once or twice a week and putting in a twenty-minute natural science period as incidental work. Thus, during a term, much valuable instruction can be given on important topics without adding to the crowded demands upon teachers and pupils,

and in so doing the entire work of the school will be advanced in interest and in efficiency.

“ This work has been, without exception, received favorably and with interest by teachers, pupils, officers and patrons of the schools who have come to listen to this course of lectures. In some instances, in the rural districts, farmers have been present who were school trustees, and at the close of the exercises one said publicly in speaking of the work done that ‘ if he and his neighbors could have had that kind of instruction when they were boys, they would have been in a far more prosperous condition as farmers to-day.’ In some places, notably in districts near where a horticultural school had been held the previous month, the school-house was beautifully decorated with autumn leaves, with boughs of apples hanging on the walls of the schoolroom, flowers and plants brought in for the occasion, while the fruits of the orchard and of the garden were piled upon the teacher’s desk and on the floor to be correctly named and to ascertain the causes of some diseases and blights that were afflicting them; and in such cases there was a marked attendance of the patrons of the school. In several schools a vote was taken to ascertain the number of pupils who lived upon farms, both in district and high schools, and a further test vote taken to ascertain how many were satisfied to live on the farm and desired to do so when they had finished their school work. In some places the astonishing fact was met that not one hand went up or one vote was given in favor of living on the farm. This is a significant and vitally important fact brought out in this experimental educational work. These school children from the farm expressed the simple, honest convictions of their hearts that they were not satisfied with farm living and intended to get away from it in the future when opportunity might offer. Yet these children from the farms showed no lack of interest in the subjects as they were presented to them and showed an active interest in answering questions that pertain to some of the interesting things about the farm.

“ This is but a corroboration of the facts obtained in the recent investigation touching the condition of the rural population made by the New York Committee for the Promotion of Agriculture—that seventy per cent. of the replies received in this inquiry indicated a tendency on the part of the rural population to go to the city. An important question here arises. What is to be the future of our rural schools and of the agriculture of the state if the present generation, as seems so clearly indicated, is not satisfied with rural life and feels no interest in maintaining or contributing to the agricultural and educational interests of the state? While many more rural school-houses must become

deserted, there are thousands of children already in our cities who are deprived of school advantages because adequate room does not exist for them to get into the schools of the city. The further problem also arises of the difficult economic questions to be met in our cities as the result of congestion of population. The standard of teaching has been much improved in New York state. It has been gratifying to meet so universally teachers who are not only well qualified, but who are doing excellent work in their schools and who have the true teaching spirit. Our educational forces are thoroughly efficient and well equipped, but there is a need of different application of our school work in rural districts. The life of the district needs to be changed and it can in no way be so effectively done as through our schools. The best work cannot be done in schools with an attendance of only half a dozen children. School districts will be forced to even greater consolidation in the future, and it would be desirable if families could also be consolidated, for it is the lack of social opportunity that is felt. It is the isolation of the farm home that the boy and girl dislikes in these days of close communication and contact with the world which is brought about by steam and electricity. School grounds could be enlarged. They should furnish the opportunity for planting trees and shrubs; for the planting of seeds and growing of flowers; for having a nicely-kept lawn, and in time, these things, with their influences would extend to the homes of children who do not have them and bring with them those attractions and interest that make a home what it ought to be—pleasant and inviting in its surroundings. With some principles taught that apply to the life of the farm in its various forms, much that is to-day discouraging, unprosperous and almost hopeless will be gradually changed to better conditions, and general and permanent prosperity will follow.

“The great need in this work is teachers fitted for it. Many excellent teachers have felt their want of preparation for this kind of teaching, but our normal schools are already giving some instruction in nature-teaching, and by carrying the system somewhat further can render the state an invaluable aid in this direction.

“The instructors furnished by Cornell University in this work have shown excellent adaptability in it, and while scientific instruction has been given, it has been made to meet the understanding and interest of all, even the youngest in the primary grades. This work in the schools in the counties lying within the Fourth Judicial District has met with even a larger measure of interest than in Westchester county. In that county most

farmers look upon their farms as holding a special value outside of farming purposes, hence most farms are for sale at any time; while out in the state the interest in land is more permanent and this has awakened a general and active interest in this line of instruction in every school and school district where it has been given. The plan has been accepted, not only as practical by those who have witnessed its workings, but as helpful to all whatever may be the work they will take up in life. As a system of instruction, it will bring experiences of delight to children in their school days, such as they have not before known, in the many interesting subjects in nature that will be brought out to them to know and to study about.

“The future value to the state of this kind of instruction can hardly be measured. With some exceptions, the farms of New York are in a condition of sadly depleted fertility of the soil. Nearly everywhere is to be observed the absence of that most valuable renovator of the soil—the clover plant—and in its place a low type of herbage of little value. The cost of production is thereby much increased and the profits in farming consequently largely reduced. Many of the children living on the farms of New York are practically disinherited from the soil upon which they have been born because of the mistakes of their fathers. But while the soil is depleted, it is by no means exhausted of fertility; and by the study of its necessities, and by the employment of skill and intelligence in the art of agriculture, it is capable of vast improvement, of maintaining a great population and adding to the greater prosperity of those who shall cultivate it while contributing to the general prosperity and wealth of the state. The future of the agriculture of the Empire State can be determined through educational forces, and our public schools can be made a most certain and powerful factor in its elevation to a much higher position of prosperity.”

The following are samples of many unsolicited letters showing how this type of efforts appeals to teachers:

“Your visit to our school has been very pleasantly discussed by many of our students and teachers. I think that I may say by the more intelligent ones. I believe it sowed seed for thought and in good ground.

“We have perhaps seventy-five students from farms and presumably among the best of them, and I am of the opinion that a day or a half day spent by them under the instruction of your department, by coming to us, will be sowing seeds that will yield some sixty and some a hundred fold.

"I want to express myself in favor of such work being done in schools like ours in the state.

Most respectfully yours,

B. G. CLAPP,  
Principal Fulton High School."

Fulton, Oct. 28, 1896.

"I send you under separate cover a number of letters written by some of the children whom you addressed. They are sent you just as written by the pupils without assistance and are self-explanatory.

"We will be pleased to use whatever help you can give us for our general work which comes about once in two weeks.

"The impression you made upon the boys and girls here was excellent.

Yours with respect,

WM. C. NOLL,  
Principal Naples Union School."

Naples, November 16, 1896.

"Our children and teachers were so interested in the work presented by Mr. Powell and his assistants, that we write to thank the Horticultural Department, through you, for the incentive to work along the lines they so ably indicated, and the many hints as to ways and means. We wish we might have still further instruction.

"Thanking the Department again, for the added interest we shall take in the teaching of noxious insects, the necessity for fresh air, and plant life of the region,

I am, sincerely,

MARY J. SALISBURY,  
Principal."

Adams, November 3, 1896.

"It is with pleasure that I express to you my hearty approval of the work presented to our school by your instructors.

"The pupils were much interested and I believe that the introduction of the study into our schools must certainly meet with very practical results.

Very truly yours,

H. W. HARRIS,  
Principal Union School."

Arkport, November 2, 1896.

Intimately associated with these two attempts to teach the rural communities by personal means, has run the effort to awaken a living interest in the reading of bulletins and books.



We have therefore recommended, in every one of our schools and meetings, that the farmers procure certain reading matter for study and reflection during the winter time. We have printed circulars of suggestions for these courses of reading, a copy of which is here reprinted:

SUGGESTIONS FOR

A COURSE OF READING

UPON SUBJECTS RELATING TO HORTICULTURE (MORE ESPECIALLY TO  
FRUIT GROWING).

(SECOND EDITION.)

Most of the reading of farmers is of such a scattered and haphazard character, that the reader is unable to obtain any consecutive or fundamental ideas upon the various subjects. It is suggested that each local farmers' club, grange or horticultural society—or a neighborhood gathering, when other organizations do not exist—take up a prescribed line of reading and thinking for the coming winter.

The company which desires to take up such a course should be thoroughly organized, and each reader should secure and own the various bulletins and books which are to be read. At each meeting a prescribed number of pages is laid out to be read before the next gathering. Upon coming together, the leader asks a member to read the first paragraph of the exercise or lesson, and to give his opinion of the same. Discussion is then called for. Each paragraph is treated in similar manner.

It is obvious that one of the best subjects to select for the first readings is the soil and its management. Three or four meetings could be very profitably spent upon this general topic. From this, it would be well to pass to the fertilizing of the land. After this, various special topics could be taken up, depending upon the interests in the locality.

The course of reading suggested in this circular is designed for introduction following the Schools of Horticulture which are held in western New York (the Fourth Judicial Department), under the auspices of the Nixon or Experiment Station Extension Bill, which provides funds for disseminating horticultural knowledge in this territory. The circular, therefore, has no suggestions for reading in subjects pertaining to general farming and stock farming, although the silo has been mentioned because it may become such a valuable adjunct to the maintaining of the fertility of many horticultural farms. The readings are designed to be merely elementary and introductory. The time can-

not be far distant when a well-organized series of agricultural reading circles, and correspondence instruction, will be demanded. The present suggestions cannot be more than temporary expedients; and as soon as any company or club desires more extended study, other bulletins and books will be recommended.

Only such bulletins have been recommended in this list as are published in this state (by the State Experimental Station at Geneva, and the Cornell Experiment Station at Ithaca), and only those, too, which are of a general nature, or those which can be called reading bulletins rather than reference or technical bulletins. There are other reading bulletins published by these stations which have not been recommended because they are out of print. It is hoped that the reading of these bulletins may lead to the reading of books, where the subjects are set forth in more fullness.

L. H. BAILEY,  
Ithaca, N. Y.

#### SOILS AND TILLAGE:

- Bulletin 119, Cornell. The Texture of the Soil (L. H. Bailey).
- Bulletin 120, Cornell. The Moisture of the Soil and its Conservation (L. A. Clinton).
- Bulletin 72, Cornell. The Cultivation of Orchards (L. H. Bailey).
- "The Soil," by F. H. King. The Macmillan Co., New York. 75c.

#### MANURES AND FERTILIZERS:

- Bulletin 94, State Station. The Composition and Use of Fertilizers (L. L. Van Slyke).
- Bulletin 103, Cornell. Soil Depletion in Respect to the Care of Fruit Trees (I. P. Roberts).
- Bulletin 102, State Station. Silage and Silos (W. P. Wheeler).
- "The Fertility of the Land," by I. P. Roberts. (In press).

#### FRUITS AND THEIR CULTIVATION:

- Bulletin 69, Cornell. Hints on the Planting of Orchards (L. H. Bailey).
- Bulletin 102, Cornell. General Observations Respecting the Care of Fruit Trees (L. H. Bailey).
- "Fruit Culture," by W. C. Strong, Rural New Yorker, N. Y. \$1.
- Bulletin 84, Cornell. The Recent Apple Failures of Western New York (L. H. Bailey).

Bulletin 74, Cornell. Impressions of the Peach Industry in Western New York (L. H. Bailey).

Bulletin 100, Cornell. Evaporated Raspberries in Western New York (L. H. Bailey). Gives a general account of evaporators, and of raspberry growing.

*Other writings upon special fruits will be recommended if desired.*

#### SPRAYING, INSECTS, DISEASES:

Bulletin 86, Cornell. The Spraying of Orchards (E. G. Lodeman).

Bulletin 101, Cornell. Notions about the Spraying of Trees; with Remarks on the Canker-worm. (L. H. Bailey).

"The Spraying of Plants," by E. G. Lodeman. The Macmillan Co., New York. \$1.

#### THE MAKING OF HOME GROUNDS:

Bulletin 121, Cornell. Suggestions for the Planting of Shrubbery (L. H. Bailey).

Bulletin 90, Cornell. China Asters; with Remarks upon Flower-Beds (L. H. Bailey).

#### HELPS FOR TEACHERS:

"Elements of Botany," by J. Y. Bergen. Ginn & Co., Boston. "Familiar Trees and Their Leaves," by Schuyler Mathews. D. Appleton & Co., N. Y. "Plant Life on the Farm," by Maxwell T. Masters. Orange Judd Co., New York. "Chemistry of the Farm," by R. Warrington. Orange Judd Co., New York.

*Every grange or farmer's club should be slowly accumulating a library of good rural books for purposes of reference. Advice will be given when desired.*

This circular is simply an advisory one, although we are convinced that it has already awakened a genuine interest in many quarters in its subject. We find that there are very few rural books which are adapted to the needs of children or which can be put in the hands of teachers in the country schools. We have therefore conceived of a series of leaflets upon object lessons, dealing with common things, which may be put in the hands of teachers, and, when desired, of pupils as well. We have preferred that these little texts be not read to the pupils as stories, but that they shall answer as suggestions to the teachers who shall have the children perform the simple experiments and to make the direct observations which are there indicated. One of these leaflets is herewith reprinted:

## TEACHER'S LEAFLETS

FOR USE IN THE RURAL SCHOOLS

PREPARED BY

THE AGRICULTURAL EXPERIMENT STATION  
OF CORNELL UNIVERSITY,

ITHACA, N. Y.

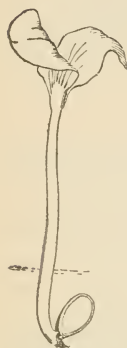
No. 1.

DEC. 1, 1896.

Issued under the auspices  
of the Experiment Station  
Extension, or Nixon Law.  
By L. H. BAILEY.

## HOW A SQUASH PLANT GETS OUT OF THE SEED.

BY L. H. BAILEY.



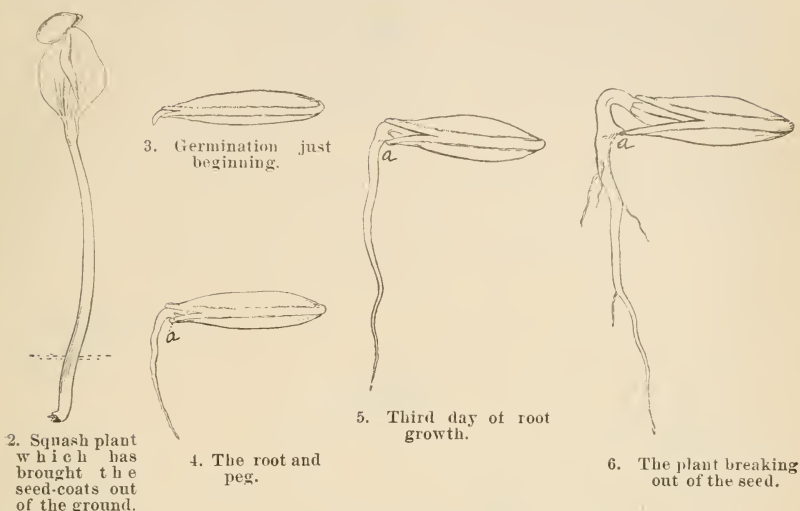
1. Squash plant  
a week old.

If one were to plant seeds of a Hubbard or Boston Marrow Squash in loose warm earth in a pan or box, and were then to leave the parcel for a week or ten days, he would find, upon his return, a colony of plants like that shown in Fig. 1. If he had not planted the seeds himself or had not seen such plants before, he would not believe that these curious plants would ever grow into squash vines, so different are they from the vines which we know in the garden. This, itself, is a most curious fact — this wonderful difference between the first and the later stages of all plants, and it is only because we know it so well that we do not wonder

It may happen, however,—as it did in a pan of seeds which I sowed a few days ago—that one or two of the plants may look like that shown in Fig. 2. Here the seed seems to have come up on top of the plant, and one is reminded of the curious way in which beans come up on the stalk of the young plant. If we were to study the matter, however,—as we may do at a future time,—we should find a great difference in the ways in which the squashes and the beans raise their seeds out of the ground. It is not our purpose to compare the squash and the bean at this time, but we are curious to know why one of these squash plants brings its seed up out of the ground whilst all the others do not.

Note.—These leaflets are intended for the teacher, not for the scholars. It is their purpose to suggest the method which a teacher may pursue in instructing children at odd times in nature-study. The teacher should show the children the objects themselves—should plant the seeds, raise the plants, collect the insects, etc.; or, better, he should interest the children to collect the objects. Advanced pupils, however, may be given the leaflets and asked to perform the experiments or make the observations which are suggested. The scholars themselves should be taught to do the work and to arrive at independent conclusions. Teachers who desire to inform themselves more fully upon the motives of this nature-study teaching, should write for a copy of Bulletin 122, of the Cornell Experiment Station, Ithaca, N. Y.

In order to find out why it is, we must ask the plant, and this asking is what we call an experiment.



We may first pull up the two plants. The first one (Fig. 1) will be seen to have the seed still attached to the very lowest part of the stalk below the soil, but the other plant has no seed at that point. We will now plant more seeds, a dozen or more of them, so that we shall have enough to examine two or three times a day for several days. A day or two after the seeds are planted, we shall find a little point or root-like portion breaking out of the sharp end of the seed, as shown in Fig. 3. A day later this root portion has grown to be as long as the seed itself (Fig. 4), and it has turned directly downwards into the soil. But there is another most curious thing about this germinating seed. Just where the root is breaking out of the seed (shown at *a* in Fig. 4), there is a little peg or projection. In Fig. 5, about a day later, the root has grown still longer, and this peg seems to be forcing the seed apart. In Fig. 6, however, it will be seen that the seed is really being forced apart by the stem or stalk above the peg for this stem is now growing longer. The lower lobe of the seed has caught upon the peg (seen at *a*, Fig. 6), and the seed-leaves are trying to back out of the seed. Fig. 7, shows the seed still a day later. The root has now produced many branches and has thoroughly established itself in the soil. The top is also growing rapidly and is still backing out of the seed, and the seed coats are still firmly held by the obstinate peg.

Whilst we have been seeing all these curious things in the seeds which we have dug up, the plantlets which we have not disturbed have been coming through the soil. If we were to



7. The operation further progressed.



8. The plant just coming up.



9. The plant liberated from the seed-coats.

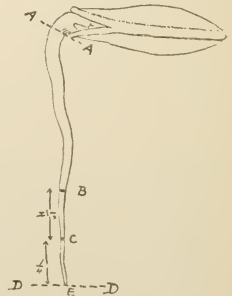


10. The plant straightening up.

see the plant in Fig. 7, as it was "coming up," it would look like Fig. 8. It is tugging away trying to get its head out of the bonnet which is pegged down underneath the soil, and it has "got its back up" in the operation. In Fig. 9, it has escaped from its trap and it is laughing and growing in delight. It must now straighten itself up, as it is doing in Fig. 10, and it is soon standing proud and straight, as in Fig. 1. We now see that the reason why the seed came up on the plant in Fig. 2, is because in some way the peg did not hold the seed-coats down (see Fig. 13), and the expanding leaves are pinched together, and they must get themselves loose as best they can.



11. The true leaves developing.

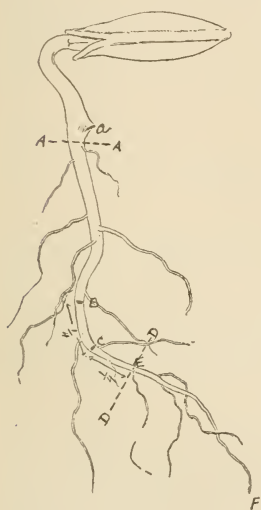


12. Marking the root.

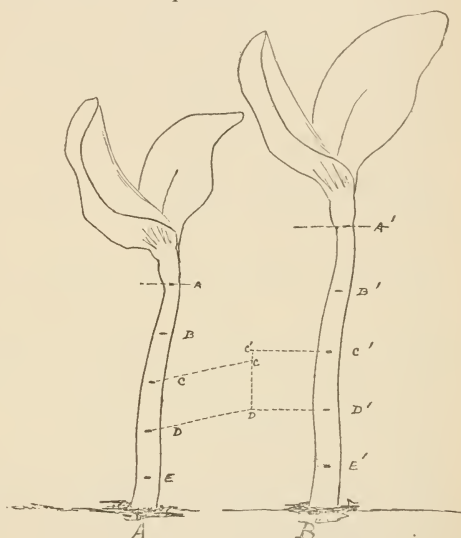
There is another thing about this curious squash plant which we must not fail to notice, and this is the fact that these first two leaves of the plantlet came out of the seed and did not grow out

of the plant itself. We must notice, too, that these leaves are much smaller when they are first drawn out of the seed than they are when the plantlet has straightened itself up. That is, these leaves increase very much in size after they reach the light and air. The roots of the plantlet are now established in the soil and are taking in food which enables the plant to grow. The next leaves which appear will be very different from these first or seed leaves.

These later ones are called the true leaves. They grow right out of the little plant itself. Fig. 11 shows these true leaves as they appear on a young Crookneck squash plant, and the plant now begins to look much like a squash vine.



13. The root grown in the end portions.



14. The marking of the stem, and the spreading apart of the marks.

We are now curious to know how the stem grows when it backs out of the seeds and pulls the little seed-leaves with it, and how the root grows downwards into the soil. Now let us pull up another seed when it has sent a single root about two inches deep into the earth. We will wash it very carefully and lay it upon a piece of paper. Then we will lay a ruler alongside of it, and make an ink mark one-quarter of an inch from the tip, and two or three other marks at equal distances above (Fig. 12).\* We will now carefully replant the seed. Two days

\*Note.—Common ink will not answer for this purpose because it “runs” when the root is wet, but indelible ink, used for marking linen or for drawing, should be used. It should also be said that the root of the common pumpkin, and of the summer bush squashes, is too fibrous and branchy for this test. It should be stated, also, that the root does not grow at its very tip, but chiefly in a narrow zone just back of the tip; but the determination of this point is rather too difficult for the beginner.

later we will dig it up, when we shall most likely find a condition something like that in Fig. 13. It will be seen that the marks E, C, B, are practically the same distance apart as before and they are also the same distance from the peg, AA. The point of the root is no longer at DD, however, but has grown on to F. The root, therefore, has grown almost wholly in the end portion.

Now let us make a similar experiment with the stem or stalk. We will mark a young stem, as at A in Fig. 14; but the next day we shall find that these marks are farther apart than when we made them (B, Fig. 14). The marks have all raised themselves above the ground as the plant has grown. The stem, therefore, has grown between the joints rather than from the tip. The stem usually grows most rapidly, at any given time, at the upper or younger portion of the joint (or internode); and the joint soon reaches the limit of its growth and becomes stationary, and a new one grows out above it.

*Natural science consists in two things—seeing what you look at, and drawing proper conclusions from what you see.*

Respecting the general necessity and requirements for such reading course, I submit the following report from Mr. John W. Spencer, who has been intimately associated with this district school work and who is at the present time aiding us in conducting a correspondence instruction:

“As you well know, a reading course for farmers on agricultural topics, after the plan of the Chautauqua course, has long been a cherished plan of mine, and when you asked me to go with Mr. Geo. T. Powell during the month of October, I gladly accepted, for it seemed to be a good opportunity to test the practicability of the idea. I still think it a good one, but the month's experience has shown me another plan more expedient for the time and giving more lasting and practical results. I do not suggest the abandonment of the plan for a reading course, but that it be held in abeyance as a sequel to a second plan, which is this: That the College of Agriculture of Cornell University prepare papers for teachers in our common schools qualifying them to develop the powers of observation of pupils on subjects pertaining to the field, forest and household. For instance, give each child a piece of bread and the teacher draw out everything appealing to the child's eye. The teacher could supplement many points the child failed to observe. Then begin an inquiry as to why such and such points come to be so,—begin



a study of the cause. The study into the cause of the porosity of the bread could be made to lead, step by step, to the whole chemistry of baking, and from that to starch and its frequency and great importance.

"I do not suggest that these exercises be made an added recitation, but a rest exercise of twenty minutes for once or twice each week. A clever teacher can give such subjects a wide range of adaptability from primary to nearly the highest grade. Themes can be made of some of the most familiar subjects involving chemistry, insect, plant life, and geology, arousing observation and a spirit of inquiry as to cause. It is not the superstructure that I think this plan would build, but the foundations for the superstructure, which is most important. Introduced into the schools, there would be a double benefit,—first upon the child, and then when he went home and talked about it with his parents they too would unconsciously become pupils. This last may seem merely incidental but I am sure that the aggregate results will be immense. It takes only five to eight years to raise a crop of boys and girls to the point where the majority of them are thinking of their qualification of getting their own living, and their preparation will be vastly enhanced, particularly for farm life, if they have developed an inquiring spirit to know the why of things.

"During the month of October I visited, either alone or with Mr. Powell, forty-two schools, representing an attendance of 4,687 pupils, located in the counties of Chautauqua, Erie, Niagara, Monroe, Livingston, Ontario, Steuben, Oswego, Jefferson and Oneida, and the schools have ranged from the brick temple of one thousand pupils to the little school-house of eleven. The children everywhere are alike,—all eager for instruction, and so are the teachers, except some with only one or two years' experience, who feel a lack of preparation and fear that they might not do the proper thing, but when assured that the plan of observation exercises was to reach the children only by fully equipping the teacher, all hesitation was banished. Not a single teacher has made an objection to the plan.

"In conclusion, I would suggest that your department prepare observation exercises in the spirit of the foregoing remarks. To schools employing the highest grade teachers, no solicitation will be necessary more than to present the literature. To the hamlet and district schools an exemplification of the work to the pupils will promote its adoption. I would advise pushing this last industriously during the present winter, depending for its future spread upon the popularity given by those schools visited this winter and by working through such centers as teachers' institutes in the next school year."

This correspondence-instruction is likewise experimental; that is, we are endeavoring at the present time to determine just how it can be carried on under our limitations and for New York state. We have no authority by law to establish a permanent or organic system of reading courses throughout our territory. We have kept the names of the participants in all of our September schools, and we have the names of the teachers and officers in the various rural and village schools which we have visited. In each of these public schools we have requested the teacher to have the pupils write their next compositions upon the subjects which were presented by our instructors, and to forward these compositions to us as samples of the kind and extent of interest which the children may be expected to take in this work. Both teachers and children have responded with surprising readiness, and the correspondence from this source which has already accumulated is large and is an indication that the work can be greatly extended with the most marked benefits. We have also taken the opportunity to write to the various correspondents who have been interested in our work, asking them certain specific questions upon certain bulletins which we have sent them and which have been used as texts in the schools, particularly upon Bulletins 119 and 120 (The Texture of the Soil, and The Moisture of the Soil). This correspondence has been the means of tying together the various agricultural interests of the Fourth Judicial Department and the College of Agriculture of Cornell University, and has resulted in a natural and organic union which, it seems to me, it would be violence to break.

All this work, as I have said, has been experimental,—an attempt to discover the best method of teaching the people in agriculture. We believe that the most efficient means of elevating the ideals and practice of the rural communities are as follows, in approximately the order of fundamental importance: (1) The establishment of nature-study or object-lesson study, combined with field-walks and incidental instruction in the principles of farm-practice in the rural schools; (2) the establishment of correspondence-instruction in connection with reading-courses,

binding together the University, the rural schools, and all rural literary or social societies; (3) itinerant or local experiment and investigation, made chiefly as object-lessons to farmers and not for the purpose, primarily, of discovering scientific facts; (4) the publication of reading bulletins which shall inspire a quickened appreciation of rural life, and which may be used as texts in rural societies and in the reading courses, and which shall prepare the way for the reading of the more extended literature in books; (5) the sending out of special agents as lecturers or teachers, or as investigators of special local difficulties, or as itinerant instructors in the normal schools and before the training classes of the teachers' institutes; (6) the itinerant agricultural school, somewhat after the plan of our horticultural schools, which shall be equipped with the very best teachers and which shall be given as rewards to the most intelligent and energetic communities.

All these agencies, to be most efficient, should be under the direction of a single bureau wholly removed from partisan political influence and intimately associated with investigational work in agriculture. Such a bureau should also have most intimate relations with the Department of Public Instruction, for not only must the public schools be reached, but teachers must be trained. The teachers in our public schools are now of a high grade, and they will quickly seize opportunities to prepare themselves to teach the elements of rural science. There should be facilities placed at the disposal of every normal school in the state, whereby it may receive courses of lectures upon rural subjects from teachers of recognized ability, and teaching-helps, in the way of expository leaflets, should be placed in the hands of every teacher who desires them. All this work of carrying the modern university extension impulse to the country, is too important and too fundamental to be confined to any one particular agricultural interest or to any one district of the state; and it is a work, too, which should be treated as a teaching extension and not as an experiment station extension.

In conclusion, I must say that the farmers, as a whole, are willing and anxious for education. They are difficult to reach

because they have not been well taught, not because they are unwilling to learn. It is astonishing, as one thinks of it, how scant and poor has been the teaching which has even a remote relation to the tilling of the soil; and many of our rural books seem not to have been born of any real sympathy with the farmer or any just appreciation of his environments. Just as soon as our educational methods are adapted to the farmer's needs, and are born of a love of farm life and are inspired with patriotism, will the rural districts begin to rise in irresistible power.

Respectfully submitted,

L. H. BAILEY,

In charge of the scientific and teaching work of the Nixon bill,  
Cornell University, December 1, 1896.

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BULLETIN 123—December, 1896.

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Cornell University—Agricultural Experiment Station,

ITHACA, N. Y.

ENTOMOLOGICAL DIVISION.

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# GREEN FRUIT WORMS.



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By M. V. SLINGERLAND.

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The regular bulletins of the Station are sent free to all who request them.

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## BULLETINS OF 1896.

106. Revised Opinions of the Japanese Plums.
107. Wireworms and the Bud Moth.
108. The Pear Psylla and the New York Plum Scale.
109. Geological History of the Chautanqua Grape Belt.
110. Extension Work in Horticulture.
111. Sweet Peas.
112. The 1895 Chrysanthemums.
113. Diseases of the Potato.
114. Spray Calendar.
115. The Pole Lima Beans.
116. Dwarf Apples.
117. Fruit Brevities.
118. Food Preservatives and Butter Increasesers.
119. The Texture of the Soil.
120. The Moisture of the Soil.
121. Suggestions for the Planting of Shrubby.
122. Second Report upon Extension Work in Horticulture.
123. Green Fruit Worms.

CORNELL UNIVERSITY, ITHACA, N. Y., *December 23, 1896.*

*Honorable Commissioner of Agriculture, Albany:*

Sir.—This bulletin contains a history of some insects which have recently caused considerable damage in our state. It is hoped that the description of the insects, with the methods of combating the same, will prove of value to our fruit growers. This paper is therefore submitted for publication under Chapter 437 of the Laws of 1896.

L. H. BAILEY.

## CONTENTS.

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- Introduction. Page 569.
- What Green Fruit Worms are. Page 570.
- Habits and Food of the Caterpillars and Moths. Page 570.
- Their History and Distribution. Page 571.
- Their Life-history. Page 572.
- The Different Species Discussed. Pages 573-580.
1. *Xylina antennata* Walk. Page 574.
  2. *Xylina laticinerea* Grt. Page 577.
  3. *Xylina grotei* Riley. Page 578.
- Natural Enemies. Page 580.
- How to Combat these Fruit-eating Caterpillars. Page 581.



## Green Fruit Worms.

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*Xylina antennata* Walk.

*Xylina laticinerea* Grt.

*Xylina grotei* Riley.

Order LEPIDOPTERA ; family NOCTUIDÆ.

In New York state, the year 1896 has been marked by the appearance in destructive numbers of several insects which have not been noticeably injurious here during the past decade or more. The army worm, which in July ravaged field crops in nearly every county in the state, is a familiar example; and the insects discussed in this bulletin also afford another illustration of this fact.

Most of our correspondence during May and June related to the cause of the large holes being eaten into the sides of young fruits, especially apples. The depredators proved to be large, light green caterpillars that have been popularly known as "green fruit worms." As these caterpillars had not seriously troubled New York fruit growers since 1877, they were a new insect pest to many. This year specimens were sent to the insectary from the following twelve counties: Niagara, Genesee, Orleans, Wayne, Oswego, Chautauqua, Ontario, Columbia, Clinton, Tompkins, Seneca and Saratoga. Judging from the reports accompanying the specimens, the caterpillars evidently did the most damage in the first five counties named. It was estimated that at least 25 per cent. of the apple crop was injured in many localities. Had there not been an unusually heavy crop of apples all over the state this year, the destruction of so large a percentage of the young fruit by these caterpillars would have been a much more serious matter. Fruit growers should acquaint themselves with these fruit-eating caterpillars so as to guard against their ravages in the future, when there may not be so many young fruits to spare as there were this year.

## WHAT THEY ARE.

These green fruit worms are large, light yellowish or apple-green caterpillars, with a narrow cream-colored stripe down the middle of the back, a wide cream-colored stripe along each side, and many similarly colored mottlings or spots which sometimes form quite distinct stripes along the body above the broad lateral stripes. When fully grown they range from an inch to an inch and a half in length. Some of them are shown at work in the illustration on the title page, and at *a*, plate 2; figures *f* and *g*, plate 1, *c* and *d*, plate 3, and *b*, plate 2 are from photographs of the worms taken twice natural size. Like many other caterpillars, these green fruit worms are the offspring or younger stage of insects known as moths or millers. These adult forms are represented natural size at *b*, plate 1, at *a*, plate 3 and at *f*, plate 2; and also twice natural size in the same plates.

## HABITS AND FOOD OF THE CATERPILLARS AND MOTHS.

For several years before the fruit-eating habit of these green fruit worms was discovered, they were known to feed upon the leaves of the apple and several forest trees; the leaves of poplar, hickory, wild cherry, box-elder, and the buds of roses are recorded among their food-plants. During the summer of 1870, however, the insects attracted unusual attention in Missouri and Illinois by being frequently found eating or boring into apples, peaches and the spongy oak-apple (a large apple-like swelling or gall often produced on oak-leaves by a minute gall-fly). This year, pears, peaches, plums, currants, and quinces were eaten in New York state, but the caterpillars confined themselves mostly to an apple diet. We have not observed the worms *boring* into the fruit. They simply begin eating on one side and often continue feeding until nearly half of the fruit is eaten, leaving a large cavity on that side (see illustration on title page, and figure *a*, plate 2). They work during May and the first half of June, and are not to be found on the trees again during the year. The insects go from fruit to fruit, one caterpillar thus ruining several fruits; an instance is recorded of one worm destroying six of the eight quinces on a tree. The caterpillars feed during the day, and

probably also at night. When young, they doubtless feed upon the foliage or buds, for, when the fruit is large enough for them to eat, the worms are found to be half grown or more. One of our correspondents writes: "We grafted some young Dutchess pear trees this spring, and have had to watch them continually to keep these worms from destroying the buds."

We have found some of the caterpillars apparently resting during the day on a silken web spun on one side of a partly rolled leaf; some of our correspondents have also observed this. We suspect that this is not a normal habit of the insects, for the only occasion we saw it resorted to in our cages was in the case of the caterpillar shown in figure *d*, plate 4; it was suffering from a serious internal trouble in the form of a parasitic grub which finally came out and fastened the worm to the leaf with its silken cocoon (see the figure).

Dr. Riley has recorded that the caterpillars can pinch with their little jaws quite sharply, so as to draw a little blood from a tender part. The worms are easily disturbed at their work of feeding on the fruits, for if the tree or limb be suddenly jarred, they at once drop to the ground, not spinning down by a silken thread as do the canker worms.

The parents of these green fruit worms—the moths—are night-flyers, remaining concealed on the bark of the trees or in other secluded places during the day. Most of them appear during September and October, and, hibernating in sheltered places, appear again in March, April and May; some evidently remain in the ground as pupæ over winter, the moths not appearing until spring. They are readily attracted to lights or sweetened baits at night, and are "often found in maple groves while sugaring is going on. Sometimes sap-pails are found in the morning with the surface of the liquid completely covered with the moths."

#### THEIR HISTORY AND DISTRIBUTION.

These green fruit worms first attracted serious attention by boring into apples and pears in 1870, in Missouri and Illinois; Dr. Riley also states that he had seen them for several years previously on the foliage of different trees. A newspaper slip, writ-

ten in 1872, states that the insects were very common and destructive in the South, where the worms made their appearance during April and May, in the latitude of Mobile and New Orleans. In 1877, the caterpillars appeared in large numbers in the orchards in the vicinity of Lockport, N. Y. Professor Comstock investigated this outbreak and found that much damage had been done in many apple and pear orchards. In the case of one young pear orchard, he counted the whole number of pears on several trees and found that 45 per cent. of them had been injured by the caterpillars. It was noted that this orchard was adjoining a forest from which the insects may have spread. It is a curious fact that although these green fruit worms were so numerous in 1877, they seem not to have attracted attention again anywhere in New York state until 1896, nineteen years later. In 1888, quite a number of apples were found apparently injured by these caterpillars in Maine.

The adult insects—the moths—are not uncommon in Canada and the northern and eastern portions of the United States; and the insects have been recorded as injurious in the South and as far west as Nevada. Collectors report the moths as common in, and we have this year received the caterpillars from, several widely separated localities in New York state. Thus, these fruit-eating caterpillars are very generally distributed throughout Canada and the United States.

#### THEIR LIFE HISTORY.

The green fruit worms do most of their damage to the young fruits in May, but some of them continue working until nearly the middle of June. During the first week in June most of the caterpillars get their full growth and then burrow into the soil beneath the trees to a depth of from an inch to three inches. Here they roll and twist their bodies about until a smooth earthen cell is formed. Most of them then spin about themselves a very thin silken cocoon; some spin no cocoon. Within the cocoon or the earthen cell, the caterpillar soon undergoes a wonderful transformation which results in what is known as the *pupa* of the insect. One of these dark brown, lifeless-looking pupæ is shown, natural size, at c, plate 2, and enlarged on the same

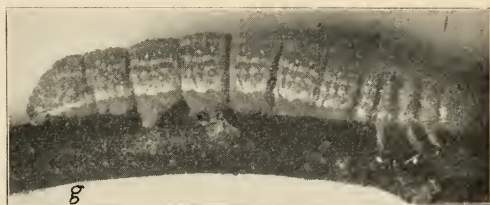


PLATE I.—*Xylina antennata* Walker. a. the moth at rest, natural size; b. the moth, natural size; c. the pupa, enlarged; d. caudal segment of the pupa, much enlarged; e. the caterpillar at work, natural size; f and g. the caterpillar, dorsal and lateral views, twice natural size; h. the moth, twice natural size.





PLATE II.—*Xylina lacticinerea* Grote. a, the caterpillar at work, natural size; b, the caterpillar, twice natural size; c, the pupa, natural size; d, the pupa, enlarged; e, caudal segment of pupa, much enlarged; f, the moth, natural size; g, the moth, twice natural size.





plate. Most of these insects spend about three months of their life in the ground during the summer in this pupal stage. Some evidently hibernate as pupæ, and thus pass nine months or more of their life in this stage. Usually about September 15th, the moths break their pupal shrouds and work their way to the surface of the soil. Most of them emerge in the fall before October 15th, and pass the winter as moths in sheltered nooks; some evidently do not emerge until spring. Warm spells in winter sometimes arouse a few of them from their hibernation.

During the first warm days of early spring, all the moths appear, and doubtless the mothers soon begin laying eggs. No observations have been made on the eggs or young caterpillars in the North, but in a newspaper article published in the South in 1872, it is stated that the eggs are deposited in the spring on the undersides of the leaves. They hatch in a few days, and the young worms begin at once to eat the foliage, or the fruit, or both.

There is thus but one brood of these green fruit worms in a year. They work mostly in May, pupate in the soil in June, live as pupæ during the summer and sometimes all winter, and most of the moths emerge in the fall and hibernate, laying their eggs in the spring.

#### THE DIFFERENT SPECIES DISCUSSED.

In all previous discussions of an economic nature regarding these green fruit worms, they have been considered as comprising but a single species of insect, namely, the ash-gray pinion (*Xylina antennata*). However, when the specimens of the caterpillars began to arrive at the insectary last spring, it was soon evident that there were at least two quite different kinds. We grew the supposed two species separately in our cages. When the moths appeared in September, they were sent to an expert, Professor J. B. Smith, for determination. He returned them labelled as *three* distinct species! We had thus bred two species of moths in the cage where we thought we had only one kind of green fruit worm. As the moths of all three species showed

remarkable resemblances to each other\* (compare figures *b* and *h*, plate 1, figures *a* and *b*, plate 3, and figures *f* and *g*, plate 2), we at once began a search for characters which might separate the insects in their caterpillar or pupal stages. It had been an easy matter from the first to separate the caterpillars into two distinct kinds, as represented in figures *e*, plate 1 and *a*, plate 2, or *g*, plate 1 and *b*, plate 2. It was also found that the pupæ developed from these two kinds of caterpillars were quite different; this difference is well shown in figures *d*, plate 1, and *e*, plate 2. Very fortunately, through the kindness of Mr. L. O. Howard, U. S. Entomologist, we were able to examine the single specimen preserved of the caterpillars which Dr. Riley had under observation when he wrote of the insect in 1870. This specimen (figured at *c* and *d*, plate 3, twice natural size) revealed some characters which we had overlooked, and enabled us to separate the caterpillars we had had in one cage into two species. We were also able to connect each species of caterpillar with the moth of the same species. In the discussion of the three species which follows, the differences mentioned above, and several others, are more fully brought out.

### 1. *Xylina antennata* Walk.

About three-fourths of all the green fruit worms sent to the insectary were of this species; from some localities, however, nearly as many of the next species discussed were received.

As early as 1858, a moth of this species (habitat unknown) found its way into the British Museum, and was there first described and named. When Dr. Riley discussed these green fruit worms in 1871, he also described the moths and named them *Xylina cinerca*. In 1879, specimens of *X. cinerca* were taken to England by Dr. Fernald and there compared with Walkers' *X. antennata*, and the identity of the insects thus established. In 1882, Dr. Riley stated (Papilio, II, 101), that his description of the moths of these insects included all three of the species to be discussed here; but he considered two of the forms as only varie-

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\* Professor Smith writes: "As I have them divided in my collection you can tell the difference between them; but if you undertake to locate it you will become lost in a short time."

ties, and not distinct species. Mr. A. G. Butler, of the British Museum, has recently also expressed his opinion (The Entomologist for 1891, p. 242), that all three forms were only variations of a single species, *X. antennata*. Our authorities on this group of moth, Professors Smith and Mr. Grote, however, have considered them as three distinct species; and our study of the earlier stages of the insects confirms this conclusion.

As all three species apparently occur in the same localities, and as the moths are so remarkably similar in size, color, and markings, it is not surprising that they should be classed as varieties of one species. We have never before seen three species of moths which showed such remarkable resemblance to each other, and yet were quite different in their caterpillar and pupal stages.

At *a* on plate 1 is shown a moth of *X. antennata*, natural size; the figure is reproduced from a photograph taken from life while the moth was at rest in the top of one of our cages. At *b*, plate 1, the moth is shown with wings expanded, natural size, and at *h* is shown same moth, twice natural size. These figures will show the size and markings of the moth, and also represent nearly its natural color. It usually differs from the moth of *X. laticinerea* in the ground color of its wings being of a more brownish cast; and from the moth of *X. grotei* in that its markings are not so bright and distinct. There may be slight antennal differences in the males of the three species, and there are certainly quite marked differences in the male genitalia of *X. antennata* and *X. grotei* as is shown, enlarged at *g* and *f*, plate 3.

The moth of *X. antennata* began to emerge in our cages September 13th, and all had appeared by October 6th; the specimens which Professor Comstock reared in 1877 emerged September 17th. In the following table the recorded captures of the moths, at lights or sweetened baits, are given:

PLACE.	Dates.
New York State .....	August 4, September 26, October 10, April 8, 20.
Clyde, N. Y. ....	September 10, and warm spells in winter up to April 15.
Schenectady, N. Y. ....	September 15, 30.
Newark, N. J. ....	September.
Orillia, Ont. ....	September 16, May.
St. Catharines, Ont. ....	September 16.
Newton, Mass. ....	September, October, March, April and May.
Evanston, Ill. ....	October.
Maywood, Ill. ....	August 18, 26.

The above table shows that the adults have appeared in some localities in August, but most of the records agree in giving September or October as the months when they are usually seen in the fall. The fact that the moths hibernate, as shown by Mr. Devereaux's captures during warm spells in winter at Clyde, N. Y., explains the records of captures in March, April and May. In some localities or seasons, perhaps all of the moths of this species do not emerge in the fall, but hibernate as pupæ. Our breeding experiments, however, indicate that all emerge in the fall, differing in this respect from *X. laticinerea* as will be shown later.

As was stated in the general discussion of the life-history of these green fruit worms, doubtless egg-laying takes place early in the spring, and the young caterpillars feed upon the buds and leaves until May, when the fruit is large enough for them to eat. The further life-history of this species follows closely the general account just mentioned.

The caterpillar of this species is figured, natural size, eating the apple, on the right in the frontispiece, and twice natural size, both lateral and dorsal views, at *f* and *g*, plate 1. It is of a light, apple-green color, sometimes yellowish, with the head of nearly the same color, and the venter darker. As the figures show, the hair-bearing spots are white and very distinct. A narrow mesal cream-colored stripe, slightly wider near the middle of the body, extends along the dorsum; there is a slightly narrower, but distinct subdorsal stripe of the same color that is somewhat broken toward the extremities; there is also a wide, stigmatal, cream-colored stripe, mostly below the spiracles, with its lower or ventral edge sharply defined, but with its upper or dorsal edge much indented with the body color and irregularly extending to a much broken, narrow, lateral stripe of cream-colored spots a little above the spiracles. Most of these characteristic markings are well shown in the figures at *f* and *g*, plate 1. The caterpillars spin a very thin cocoon of silk about themselves in their earthen cell before they change to pupæ.

The brown pupa, shown enlarged at *c*, plate I, resembles in size and general appearance that of *X. laticinerea* shown at *c* and *d*, plate 2. But a close examination of the caudal end of the pupæ of these two species reveals striking differences. These are well

shown in the enlarged figures of this portion of the pupæ at *d*, plate 1, and *e*, plate 2.

## 2. *Xylina laticinerea* Grt.

This green fruit worm was represented among the specimens received from each locality, and, in one or two instances, it seemed to be equally as numerous as the preceding species.

The moth of *X. laticinerea* was first described and named in 1874 from a Massachusetts specimen. The insect is illustrated on plate 2, figures *f* and *g* representing the moth, natural size and twice natural size, respectively. It seems to differ from the moth of *X. antennata* in the ground color of the wings being of a more decidedly ash-gray color and the markings are possibly a little more distinct; a comparison of the figures of the two species, shown on plates 1 and 2, will show that they are very similar. There may be antennal and genitalic differences in the males also; having bred no males of *laticinerea*, we cannot verify this.

Nothing has been recorded respecting the life-history or earlier stages of this species; the caterpillar described by Mr. Edwards (Papilio, III, 135) as belonging to this insect, was certainly another species, probably *X. grotei*, as we shall see later. Our observations show that the caterpillars appear in May with, and have the same habits as, those of *X. antennata*. Pupation takes place in earthen cells in the soil about the same time in June. But the caterpillars of *X. laticinerea* spin no trace of a cocoon. The insect remains in the pupa state until fall, when some of them give forth the moth, but in our cages most of the pupæ are now hibernating; one moth emerged September 26th. The following table, made up from the recorded captures of the moths this species, shows that they fly both in the fall and spring, many of them doubtless hibernating and others not emerging until spring.

PLACE.	Dates.
Schenectady, N. Y. ....	September 29, 30; October 4, 6, 10, 19, 21, 25.
Saranac Lake, N. Y. ....	April.
Orillia, Ont. ....	September 15.
St. Catharines, Ont. ....	October 8; May 2.
Newton, Mass. ....	September and October.
Evanston, Ill. ....	November and April.
Minnesota. ....	September 16; October 3; April 21, 22.

A comparison of the figures of the caterpillars of this species at *a* and *b*, plate 2, with those of the other two species represented on plates 1 and 3, will at once show that it is quite different from either of the others. It is of a light apple-green color, sometimes with a slight bluish cast; the head is sometimes a little lighter, and the venter is but slightly darker. The whole body is very finely mottled with minute cream-colored spots, and the hair-bearing spots are small and not very distinct. There is a narrow cream-colored mesal stripe on the dorsum, wider near the middle of the body; the narrow light lemon-yellow stigmatal stripe, widest toward the extremities, runs just *above* the spiracles, except in the case of the spiracle nearest each extremity, where it runs *below*; there is also a very narrow, much broken, sometimes quite indistinct, cream-colored stripe midway between the mesal and stigmatal stripes. On some specimens the yellow stigmatal stripe was bordered above with a blackish shade, as shown on the parasitized caterpillar at *a*, plate 4. A comparison of this description of the caterpillar with that of Mr. Edwards, referred to above, will show that they cannot apply to the same insect; for the lemon-yellow stripe is *narrow* and *above* the spiracles, and not *broad* and *below*, as in Mr. Edwards' description.

The pupa of this species is not formed within a cocoon, and also differs from that of *X. antennata* very strikingly in the structure of the caudal segment, as is well shown by a comparison of the enlarged figures of this part at *d*, plate 1, and *e*, plate 2. Otherwise the pupæ are quite similar, as the enlarged figures at *c*, plate 1, and *d*, plate 2, show.

Although the moths of *X. antennata* and *X. laticinerea* are distinguished from each other with considerable difficulty, the above descriptions and the accompanying figures show that the caterpillars and pupæ of the two species are quite distinct and can be easily separated. Thus both insects are distinct and valid species.

### 3. *Xylina grotei* Riley.

Only a small percentage of the green fruit worms sent us proved to be of this species.

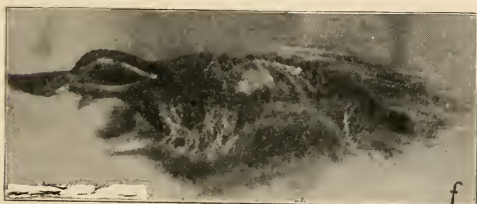
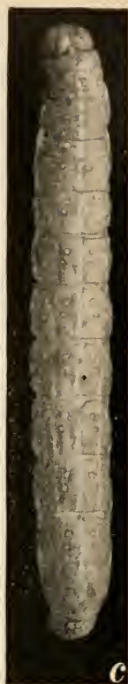


PLATE III.—*Xylina groeti* Riley. a, the moth, natural size; b, the moth, twice natural size; c and d, the caterpillar, dorsal and lateral views, twice natural size; e, the caterpillar at work, natural size; f, genitalia (right half,) of the male *Xylina groeti*, much enlarged; g, genitalia (right half,) of the male of *Xylina antennata*, much enlarged.





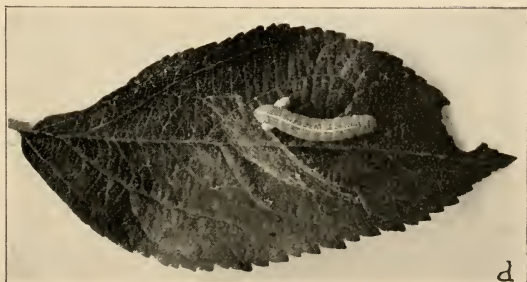


PLATE IV.—Some of the enemies of green fruit worms. a, caterpillar of *Xylina laticinerea* from which the parasitic grub of *Meteorus hyphantriae* has just emerged and is spinning its cocoon, natural size; b, two of the curious suspended cocoons of *Meteorus hyphantriae*, enlarged; c, the adult parasite (*Meteorus hyphantriae*), much enlarged; d, a caterpillar of *Xylina laticinerea* killed by the parasitic grub of *Mesochorus agilis* which has spun its cocoon beneath the caterpillar, fastening the latter to the leaf, natural size.



The moth was first described as *X. cinerosa* in 1879, from New York state specimens. In 1882, Dr. Riley pointed out that this name could not be used, as another insect belonging to the same genus had received the same name years before. He suggested the name *X. grotei* instead, but thought the insect was only a variety of *X. antennata*. Nothing has since been recorded about the species.

A comparison of the figures of the moth at *a* and *b*, plate 3, with the figures of the moths of the other two species on plates 1 and 2, will show how remarkably similar the insects are in the adult state. The moths of *X. grotei* have a much brighter appearance and their markings are more sharply defined than in either of the other two species. The ground color of their wings is much like that of *X. antennata*, but there is a decided difference in the male genitalia of these two species, as is shown in the enlarged figures at *f* and *g*, plate 3. Our specimens of the moths of *X. grotei* emerged from the 18th to the 26th of September. We have found no recorded captures of this species. Doubtless its life-history is very similar to that of *X. antennata*.

The caterpillars of *X. grotei* so closely resemble those of *X. antennata* that we did not notice their characteristic differences until the moths which appeared in one of our cages were determined as two distinct species; and until we had seen the only caterpillar preserved by Dr. Riley when he studied these green fruit worms in 1870. The caterpillar at the left in the frontispiece (the same one is shown at *e*, plate 3) is of this species; figures *c* and *d*, plate 3, are reproductions of photographs taken twice natural size, from Dr. Riley's preserved (blown) specimen. Compare these figures with those of the caterpillars of *X. antennata* at *e*, *f* and *g*, plate 1. The difference between the broad stigmatal stripes is readily seen; in *X. grotei*, both edges of the stripe are quite sharply defined, while in *X. antennata* the upper edge is much broken or indented with the body color. Another difference readily seen on the specimens, but not so evident in the figures, is that the subdorsal stripes in *X. grotei* are not so continuous as in *X. antennata*, but are made up of three or four irregular spots on each segment. Otherwise, as regards general color, size, etc.,

the caterpillars of these two species are practically alike. Dr. Riley's description of his green fruit worm agrees with his preserved specimen of *X. grotei*, and he states that the moth of this species (a variety, he then considered it) "heads his series." Mr. Edwards described a caterpillar of what he supposed was *X. latinerca*, but his description applies to the caterpillars of *X. grotei*, and not to those of either of the other two species under discussion.

The indications are that the caterpillars of *X. grotei* spin slight cocoons within which they change to pupæ, as in the case of *X. antennata*. But we cannot say whether there are any differences in the pupæ of these two species or not.

#### NATURAL ENEMIES.

Fortunately for the fruit grower, these green fruit worms have several deadly enemies. One correspondent reported that red-winged blackbirds had been seen either catching and eating the caterpillars or carrying them away to feed their young. Doubtless other birds which frequent orchards also include the worms in their menu.

The indications are, however, that the caterpillars suffered much more from the attacks of at least two minute foes among their own kind. From the material sent to the insectary, we bred two minute hymenopterous parasites. Apparently the most numerous and efficient one of these little enemies is shown much enlarged at *c*, plate 4; they are only about 1.5 of an inch in length. It was named *Meteorus hyphantriæ* by Dr. Riley in 1886. That year it did valiant work in checking the fall web-worms (*Hyphantria cunea*). Its method of working is to deftly insert an egg into the body of an unwary and defenceless caterpillar. A grub hatches from this egg and proceeds to live on the internal fats and juices of its host—the caterpillar. The host leads a lingering existence, and finally, a short time before death ensues, the parasitic grub bores its way out through the skin of its host and proceeds to spin the curious brown cocoon, shown natural size at *a*, and much enlarged at *b*, plate 4. Just how the grub manages to make these suspended cocoons is not known. Apparently it

first spins out the large suspending silken thread, and then, at the end of this, holding on in some manner (perhaps by its jaws), it proceeds to spin about itself a coarse, loose cradle of the same kind of silk. When secure inside this cradle it lets go its hold from the suspensory thread and spins its soft, dense, fine-threaded cocoon. These cocoons are attached to any part of the tree and the threads which suspends them vary in length from one-half an inch to four inches. From ten days to two weeks (in June) after the grub spins its cocoon the transformation through the pupal to the adult stage takes place. The little four-winged foe then emerges through a round hole made in the end of the cocoon, by deftly gnawing around the lower end and thus detaching a neatly fitting cap.

The other little enemy of these green fruit worms is about the same size as, and looks something like, the one just described. It also works inside the caterpillars in the same manner, gradually sapping out their life. But instead of undergoing its further transformations in a suspended cocoon, it bores its way out of the caterpillar, and crawling beneath its host, it proceeds to fasten the latter down to a leaf with its cocoon. This state of affairs is well shown at *d*, in plate 4. The two-thirds grown caterpillar is pinioned to the leaf by the cocoon of the grub which caused it to die a lingering death. This little parasitic foe is known to science at *Mesochorus agilis*.

Doubtless the efficient work of these little parasitic insects and the birds has been one of the main reasons why these green fruit worms have troubled New York fruit growers only at long intervals.

#### HOW TO COMBAT THESE FRUIT-EATING CATERPILLARS.

It is to be hoped that these caterpillars will not often visit our orchards in destructive numbers, for the past season's experience has shown that it is a difficult matter to check their ravages. It would seem at first thought that the pests might be readily killed with a Paris green spray. But several of our correspondents, who have a reputation for thoroughness in spraying and who successfully check fungi and other insects, reported that all of their

efforts in this line did not noticeably diminish the crop of these caterpillars. Some sprayed with the poison three or four times during the time the worms were at work. Mr. Albert Wood, Carlton, N. Y., collected 60 live worms and placed 20 on each of three large branches loaded with young apples; the branches were cut off and nailed up somewhere. One branch was sprayed with kerosene emulsion, one with arsenate of lead and the third with hellebore. Two days after the worms were all lively and well, and had kept on eating apples. The orchard from which these worms were taken had received three thorough applications of Bordeaux mixture and Paris green.

It is possible that one or two thorough applications of Paris green, made before the blossoms open, when the caterpillars are small and feeding on the buds and leaves, might kill many of them. However, the concensus of opinion among our correspondents seems to be that they cannot be effectually reached with a spray at any time. It is probably true that it is practically impossible to sufficiently coat the outside of a young apple with a poison spray, so that one of the caterpillars would get enough to kill it when it eats into the fruit. For this reason we concur in the belief that the worms cannot be effectually checked with a spray of any kind after the fruit gets large enough for them to feed upon it. But the young worms must feed upon the buds and leaves for a time before the fruit gets large enough, and it seems plausible that a Paris green spray, thoroughly applied at least once before the trees blossom, must result in the death of many of the worms. We would like to see this tried, but there is one difficulty which will always arise; that is, one can rarely, if ever, tell whether the insects are present in his orchard in destructive numbers until they begin to eat the fruit. It is always a good practice, however, to spray orchard fruits at least *once* (where bud moths or case-bearers are thick, *twice*) before the blossoms open with the combined Bordeaux and Paris green.

One correspondent writes that the caterpillars were the most numerous in a cultivated orchard. This does not agree with the observations of Professor Comstock made during the outbreak in 1877; he states that the fruit was injured most in those orchards

which were not cultivated. This fact led him to recommend that many of the insects could be destroyed by the cultivation of the orchards during July and August, while the worms are in the ground undergoing their transformations. We believe that thorough cultivation during the summer will tend to greatly lessen the crop of green fruit worms for the following year.

The fact, as reported by several correspondents, that the caterpillars will at once *drop* to the ground (not *spin* down as do canker worms) when the branch upon which they are at work is unnaturally jarred, affords a vulnerable point of attack against them. Why not jar them off into sheets and then kill them? We saw this successfully accomplished last spring in an orchard near Geneva, N. Y. "Curculio catchers" were in daily use to catch this most serious pest of stone-fruits, and hundreds of the green fruit worms were being caught at the same time, thus "killing two birds with one stone." On young trees this is the most efficient and practicable method of fighting these caterpillars we can suggest. Three or four good thorough jarrings ought to effectually check their ravages for the season. Of course, on old, large trees it would be a big undertaking to jar them, and when there was such a setting of fruit as we had last spring, it might not pay to do it. But with a small setting of fruit, it might mean the difference between a good crop and no crop at all, in which case it would certainly pay.

In brief then, our recommendations for fighting these fruit-eating caterpillars are to always spray the trees at least once with Paris green in the Bordeaux mixture before the blossoms open, to kill some of the worms while they are young. Later sprayings, after the fruit is large enough for them to eat, will avail but little. After the fruit sets, the only successful and practical way to fight them seems to be by jarring them off into sheets or "curculio catchers" and killing them. Follow this with thorough cultivation of the soil during the summer, and thus kill many of the insects while they are undergoing their transformations in the soil. They are difficult pests to fight, and it is to be hoped that at least another nineteen years may pass before our fruit growers receive a third visitation from destructive numbers of them.

MARK VERNON SLINGERLAND.





## APPENDIX II.

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Detailed Statement of receipts and expenditures of the Cornell University Agricultural Experiment Station, for the fiscal year ending June 30, 1896.

### RECEIPTS.

#### *From Horticultural Division.*

1895.		
July	12. Products sold.....	\$59 35
Nov.	1. Products sold.....	13 96
Dec.	2. Products sold.....	22 88
1896.		
Jan.	4. Products sold.....	6 32
	20. Products sold.....	26 33
Feb.	1. Products sold.....	28 25
	Hauling coal.....	18 04
March	3. Hauling coal.....	37 25
April	1. Hauling coal.....	32 41
	Hauling coal.....	5 72
		\$250 51
		\$250 51

#### *From Office.*

1896.		
Feb.	8. Eighty bulletins.....	\$4 00
	25. Forty bulletins.....	2 00
		\$6 00
		\$6 00

## EXPENDITURES.

*For Salaries.*

1895.

July	31.	I. P. Roberts, director, one month.....	\$125 00
		H. H. Wing, dairyman, one month.....	104 16
		G. C. Watson, assitant agriculturist, one month.....	100 00
		G. F. Atkinson, cryptogamic botanist, one month.....	91 66
		G. W. Cavanaugh, assistant chemist, one month.....	66 66
Aug.	31.	I. P. Roberts, director, one month.....	125 00
		H. H. Wing, dairyman, one month.....	104 66
		G. C. Watson, assistant agriculturist, one month.....	100 00
		G. F. Atkinson, cryptogamic botanist, one month.....	91 66
		G. W. Cavanaugh, assistant chemist, one month.....	66 66
		H. W. Smith, clerk, one month.....	62 50
Sept.	30.	I. P. Roberts, director, one month.....	125 00
		H. H. Wing, dairyman, one month.....	104 16
		G. C. Watson, assistant agriculturist, one month.....	100 00
		G. F. Atkinson, cryptogamic botanist, one month.....	91 66
		G. W. Cavanaugh, assistant chemist, one month.....	66 66
		H. W. Smith, clerk, one month.....	62 50
Oct.	31.	I. P. Roberts, director, one month.....	125 00
		H. H. Wing, dairyman, one month....	103 66
		L. H. Bailey, horticulturist, one month..	166 66
		G. F. Atkinson, cryptogamic botanist, one month.....	91 66
		G. W. Cavanaugh, assistant chemist, one month.....	66 66

1895.

Oct.	31.	M. V. Slingerland, assistant entomologist, one month.....	\$125 00
		H. W. Smith, clerk, one month.....	62 50
		S. H. T. Hayes, assistant agriculturist, twenty-seven days.....	67 50
Nov.	30.	I. P. Roberts, director, one month.....	125 00
		H. H. Wing, dairyman, one month.....	104 16
		L. H. Bailey, horticulturist, one month..	166 66
		G. F. Atkinson, cryptogamic botanist, one month.....	91 66
		G. W. Cavanaugh, assistant chemist, one month.....	66 66
		M. V. Slingerland, assistant entomologist, one month.....	125 00
		H. W. Smith, clerk, one month.....	62 50
		S. H. T. Hayes, assistant agriculturist, twenty-six days.....	65 00
Dec.	31.	I. P. Roberts, director, one month.....	125 00
		H. H. Wing, dairyman, one month.....	104 16
		L. H. Bailey, horticulturist, one month..	166 66
		G. F. Atkinson, cryptogamic botanist, one month.....	91 66
		G. W. Cavanaugh, assistant chemist, one month.....	66 66
		M. V. Slingerland, assistant entomologist, one month.....	125 00
		H. W. Smith, clerk, one month.....	62 50
		S. H. T. Hayes, assistant agriculturist, twenty-six days.....	65 00

1896.

Jan.	31.	I. P. Roberts, director, one month.....	125 00
		H. H. Wing, dairyman, one month.....	104 16
		L. H. Bailey, horticulturist, one month..	166 66
		G. F. Atkinson, cryptogamic botanist, one month.....	91 66
		G. W. Cavanaugh, assistant chemist, one month.....	66 66

1896.

Jan.	31.	M. V. Slingerland, assistant entomologist, one month.....	\$125 00
		H. W. Smith, clerk, one month.....	62 50
		L. A. Clinton, assistant agriculturist, one month.....	83 33
Feb.	29.	I. P. Roberts, director, one month.....	125 00
		H. H. Wing, dairyman, one month.....	104 16
		L. H. Bailey, horticulturist, one month..	166 66
		G. F. Atkinson, cryptogamic botanist, one month.....	91 66
		G. W. Cavanaugh, assistant chemist, one month.....	66 66
		M. V. Slingerland, assistant entomologist, one month.....	125 00
		H. W. Smith, clerk, one month.....	62 50
		L. A. Clinton, assistant agriculturist, one month.....	83 33
March	31.	I. P. Roberts, director, one month.....	125 00
		H. H. Wing, dairyman, one month.....	104 16
		L. H. Bailey, horticulturist, one month.	166 66
		G. F. Atkinson, cryptogamic botanist, one month.....	91 66
		G. W. Cavanaugh, assistant chemist, one month.....	66 66
		M. V. Slingerland, assistant entomologist, one month.....	125 00
		L. A. Clinton, assistant agriculturist, one month.....	83 33
April	30.	I. P. Roberts, director, one month.....	125 00
		H. H. Wing, dairyman, one month.....	104 16
		G. F. Atkinson, cryptogamic botanist, one month.....	91 66
		G. W. Cavanaugh, assistant chemist, one month.....	66 66
		L. A. Clinton, assistant agriculturist, one month.....	83 33
		E. A. Butler, clerk, one month.....	50 00

1896.

May	31.	I. P. Roberts, director, one month.....	\$125 00
		H. H. Wing, dairyman, one month.....	104 16
		G. F. Atkinson, cryptogamic botanist, one month.....	91 66
		G. W. Cavanaugh, assistant chemist, one month.....	62 50
		L. A. Clinton, assistant agriculturist, one month.....	83 33
		E. A. Butler, clerk, one month.....	50 00
June	30.	I. P. Roberts, director, one month.....	125 00
		H. H. Wing, dairyman, one month.....	104 24
		G. F. Atkinson, cryptogamic botanist, one month.....	91 74
		G. W. Cavanaugh, assistant chemist, one month.....	66 74
		L. A. Clinton, assistant agriculturist, one month.....	83 37
Total for salaries.....			\$7,934 98

*For Buildings.*

1895.

July	22.	Labor, painting insectary.....	\$9 75
	30.	Lumber and labor.....	6 62
	22.	Paint and sundry supplies.....	3 65
Aug.	14.	Labor, painting insectary.....	13 40
Feb.	14.	Fifty-two gallons oil.....	3 68
Oct.	2.	Plumbing.....	3 15
Total for building.....			\$40 25

*For Printing.*

1895.

June	22.	U. S. Express Co., expressage.....	\$0 25
July	16.	U. S. Express Co., expressage.....	25
	17.	U. S. Express Co., expressage.....	80
	16.	Franklin Engraving Co., electros.....	32 56

## 1895.

July	11. Franklin Engraving Co., express on photos . . . . .	\$0 25
	25. U. S. Express Co., expressage . . . . .	30
Aug.	13. L. V. R. R. Co., freight and cartage . . . . .	1 58
	27. U. S. Express Co., expressage . . . . .	25
	3. W. F. Humphrey, printing Bulletin No. 97 . . . . .	101 45
Sept.	7. U. S. Express Co., expressage . . . . .	30
	30. I. C. Chandler, drawings . . . . .	12 00
Oct.	21. U. S. Express Co., expressage . . . . .	25
	31. U. S. Express Co., expressage . . . . .	30
Nov.	8. U. S. Express Co., expressage . . . . .	25
	21. George Small, lumber and labor . . . . .	1 33
	29. Lovejoy Co., electros . . . . .	16
Dec.	9. Lovejoy Co., electros . . . . .	53
Nov.	23. Franklin Engraving Co., electros . . . . .	9 70
	30. Franklin Engraving Co., electros . . . . .	78
Dec.	7. U. S. Express Co., expressage . . . . .	15
	11. U. S. Express Co., expressage . . . . .	25
	23. U. S. Express Co., expressage . . . . .	80
	31. L. V. R. R. Co., freight and cartage . . . . .	1 84
	28. W. F. Humphrey, printing Bulletin No. 105 . . . . .	113 05

## 1896.

Jan.	1. National Express Co., expressage . . . . .	25
	2. U. S. Express Co., expressage . . . . .	75
	4. Lovejoy Co., electros . . . . .	1 09
	21. W. F. Humphrey, printing Bulletin No. 107 and No. 108 . . . . .	339 50
	9. L. V. R. R. Co., freight and cartage . . . . .	3 41
	30. E. G. Hance, cartage . . . . .	1 00
	31. National Express Co., expressage . . . . .	40
Feb.	1. National Express Co., expressage . . . . .	40
Jan.	29. Lovejoy Co., electros . . . . .	84
	30. U. S. Express Co., expressage . . . . .	65
Feb.	11. U. S. Express Co., expressage . . . . .	60
	24. New York Engraving Co., electros . . . . .	8 00

1896.

Feb.	29.	U. S. Express Co., expressage.....	\$0 25
March	10.	U. S. Express Co., expressage.....	40
	14.	U. S. Express Co., expressage.....	45
	13.	Lovejoy Co., electros.....	9 90
	20.	U. S. Express Co., expressage.....	35
	25.	E. G. Hance, cartage.....	25
April	6.	W. F. Humphrey, printing Bulletin No.	
		114. ....	60 25
	8.	D. L. & W. R. R. Co., freight and cartage,	8 38
	17.	U. S. Express Co., expressage.....	25
	30.	U. S. Express Co., expressage.....	90
May	5.	E. G. Hance, cartage.....	50
	22.	U. S. Express Co., expressage.....	1 05
Total for printing.....			<u>\$719 20</u>

*For Office Expenses.*

1895.

July	11.	National Express Co., expressage.....	\$0 80
	15.	Andrus & Church, stationery.....	2 00
	24.	Andrus & Church, stationery.....	5 25
	26.	T. S. Buck, rubber stamps.....	6 57
	31.	L. V. Maloney, labor.....	40 50
Aug.	2.	G. F. Atkinson, expenses to Denver.....	108 50
	24.	W. E. Barnes, labor.....	1 75
	26.	U. S. Express Co., expressage.....	45
	29.	W. O. Wyckoff, stationery.....	2 35
		Andrus & Church, stationery.....	10 15
	21.	Rural Pub. Co., subscription Rural New Yorker. ....	1 00
Sept.	2.	L. V. Maloney, labor.....	40 50
	3.	M. A. Adsitt, stationery.....	3 10
	28.	L. V. Maloney, labor.....	37 50
	30.	Andrus & Church, stationery.....	2 62
Oct.	5.	Ithaca Gas Co., gas.....	2 00
	15.	Andrus & Church, stationery.....	4 50
	12.	Andrus & Church, stationery.....	13 27

## 1895.

Oct.	18.	U. S. Post Office, stamps.....	\$10 00
	30.	U. S. Post Office, stamped envelopes....	10 90
	31.	L. V. Maloney, labor.....	40 50
	31.	Popular Science Monthly, subscription..	1 00
	25.	M. A. Adsitt, typewriter ribbons.....	2 10
Nov.	7.	Ithaca Gas Co., gas.....	1 20
	12.	Andrus & Church, stationery.....	1 35
	30.	L. V. Maloney, labor.....	39 00
	30.	M. A. Adsitt, typewriter supplies.....	3 25
	26.	U. S. Post Office, postage.....	5 00
	22.	Andrus & Church, stationery.....	2 00
	23.	Andrus & Church, pencils.....	45
Dec.	9.	U. S. Post Office, postage.....	5 00
	6.	Ithaca Gas Co., gas.....	40
	17.	M. A. Adsitt, 1 doz. carbon.....	50
	24.	U. S. Post Office, postal cards.....	1 00
	28.	U. S. Post Office, stamps.....	5 00
	31.	L. V. Maloney, labor.....	39 00
		A. T. Stout, labor.....	6 20

## 1896.

Jan.	3.	Andrus & Church, stationery.....	1 55
	4.	M. A. Adsitt, typewriter supplies.....	1 30
	9.	M. A. Adsitt, stationery.....	1 05
	7.	Ithaca Gas Co., gas.....	32
	14.	A. A. A. C. & E. S., fee.....	10 00
	17.	U. S. Post Office, stamps.....	7 00
	18.	Andrus & Church, stationery.....	1 25
	31.	L. V. Maloney, labor.....	40 50
Feb.	1.	A. T. Stout, labor.....	10 12
		Andrus & Church, stationery.....	2 50
Jan.	21.	M. A. Adsitt, carbon.....	25
Feb.	22.	U. S. Post Office, postage.....	5 00
	11.	Andrus & Church, stationery.....	3 15
	25.	Ithaca Stamp Co., rubber stamps.....	1 75
	29.	L. V. Maloney, labor.....	37 50



1896.

March	2.	M. A. Adsitt, stationery.....	\$1 75
	7.	Andrus & Church, stationery.....	5 20
	13.	M. A. Adsitt, stationery.....	3 35
	31.	E. A. Butler, labor.....	12 00
		L. V. Maloney, labor.....	39 00
April	2.	Balance on typewriter, M. A. Adsitt....	62 50
		Ithaca Gas Co., gas.....	64
	7.	Andrus & Church, stationery.....	5 00
	17.	M. A. Adsitt, stationery.....	4 40
	22.	L. V. R. R. Co., freight and cartage....	85
	24.	Tichenor & Son, repairs on typewriter desk.....	50
	28.	E. M. Hall, linoleum.....	45 00
		Library Bureau, book-case.....	17 50
	30.	L. V. Maloney, labor.....	39 00
		Andrus & Church, stationery.....	5 50
May	1.	W. R. Morey, cartage.....	25
	20.	Mary Miller, labor.....	75
	22.	I. P. Roberts, traveling expenses.....	20 73
		U. S. Express Co., expressage.....	35
		Andrus & Church, stationery.....	8 10
June	27.	U. S. Post Office, postage.....	8 95
May	26.	Ithaca Gas Co., gas.....	80
	30.	L. V. Maloney, labor.....	39 00
June	3.	E. M. Hall, door mat.....	65
		M. A. Adsitt, stationery.....	1 75
	9.	Andrus & Church, stationery.....	4 60
		M. A. Adsitt, stationery.....	1 05
	16.	U. S. Post Office, postage.....	5 00
May	22.	Bool Co., oil.....	1 50
June	22.	M. A. Adsitt, stationery.....	1 00
		M. A. Adsitt, stationery.....	1 60
	30.	Andrus & Church, stationery.....	5 43
		U. S. Post Office, postage.....	3 28
		L. V. Maloney, labor.....	39 00

1896.

June	27. James Seaman, labor.....	\$83 21
	30. M. A. Adsitt, carbon.....	50
	Total for office expenses.....	<u>\$1,059 51</u>

*For Agricultural Division.*

1895.

June	22. D., L. & W. R. R. Co., freight and cartage.....	\$1 48
July	20. J. C. Stowell & Son, wool sacks.....	2 40
	31. E. E. Lull, labor.....	27 26
Aug.	21. National Express Co., expressage.....	90
	15. L. V. R. R. Co., freight and cartage.....	1 11
	30. Theo. VanNatta, labor.....	28 46
Sept.	9. H. H. Wing, traveling expenses.....	9 70
	3. Aermotor Co., galvanized tanks.....	14 68
	9. Aermotor Co., galvanized iron.....	11 90
Aug.	31. C. S. Baker & Co., pamphlets.....	2 00
Sept.	23. H. H. Wing, traveling expenses.....	2 20
	28. R. D. Roberts, labor.....	15 83
	J. W. Gilmore, labor.....	7 30
	Treman, King & Co., glass.....	30
Oct.	7. D., L. & W. R. R. Co., freight and cartage.....	4 60
	31. John Stout, labor.....	31 92
	24. D., L. & W. R. R. Co., freight and cartage.....	1 00
Nov.	30. F. P. Hatch, labor.....	18 75
Dec.	20. Bush & Dean, cheese cloth.....	30

1896.

Jan.	18. D., L. & W. R. R. Co., freight and cartage.....	51
	23. Andrus & Church, stationery.....	4 13
	11. U. S. Post Office, postage.....	1 00
	17. Farmer's Fertilizer Co., fertilizers.....	2 50
	31. F. P. Hatch, labor.....	5 25
	18. E. G. Allen, periodicals.....	8 70

1896.

Feb.	26.	National Express Co., expressage.....	\$0 25
April	10.	U. S. Post Office, stamped envelopes....	10 80
	13.	U. S. Express Co., expressage.....	40
	14.	D. M. Thorburn & Co., seeds.....	1 94
	23.	Farmer's Fertilizer Co., fertilizers.....	7 23
	28.	National Express Co., expressage.....	2 05
May	2.	D., L. & W. R. R. Co., freight and cartage.....	3 11
		I. P. Roberts, traveling expenses.....	5 32
		D. Hill, trees.....	10 00
	7.	J. M. Johnson, labor.....	14 00
	11.	S. Raub, labor.....	3 90
	28.	National Express Co., expressage.....	45
		L. V. R. R. Co., freight and cartage.....	72
June	3.	F. Ellis, hay.....	12 93
	4.	J. J. Brown, mule.....	20 00
	11.	R. L. Speed, labor.....	14 00
	13.	E. A. Butler, tobacco plants.....	1 80
	22.	J. M. Johnson, labor.....	28 00
	26.	National Express Co., expressage.....	45
	23.	E. Hodge, labor.....	48
	29.	R. L. Speed, labor.....	18 40
		Farmer's Fertilizer Co., fertilizers.....	136 13
	30.	J. Shimada, labor.....	23 50
		A. T. Stout, labor.....	3 20
		C. B. Tailby, labor.....	2 03
		G. W. Tailby, labor.....	2 19
Total for Agricultural Division....			\$527 46

*For Horticultural Division.*

1895.

July	2.	American Gardening, subscriptions.....	\$2 35
June	29.	James Seaman, lumber.....	40 00
July	13.	Driscoll Bros. lime.....	2 05
	27.	Thos. Shea, labor.....	8 25
Aug.	1.	Ira Grover, labor.....	37 50

## 596 AGRICULTURAL EXPERIMENT STATION, ITHACA, N. Y.

1895.		
July	1. George Small, lumber.....	\$14 03
1896.		
Jan.	17. Bool Co., furniture.....	7 70
1895.		
Aug.	31. Ira Grover, labor.....	38 42
June	27. C. J. Rumsey & Co., hardware.....	78 78
Oct.	1. Ira Grover, labor.....	37 00
Sept.	27. U. S. Dept. Agr., index cards.....	2 00
Oct.	21. U. S. Express Co., expressage.....	65
	28. National Express Co., expressage.....	3 82
Nov.	1. Ira Grover, labor.....	37 00
Oct.	12. Andrus & Church, stationery.....	3 25
	5. Dennison Mfg. Co., tags.....	2 50
Aug.	19. G. E. Steibert, publications.....	21 75
Oct.	15. Andrus & Church, stationery.....	75
Aug.	17. J. J. McGowan, oats.....	10 18
Sept.	30. Bool Co., frames.....	90
Nov.	15. L. V. R. R. Co., freight and cartage.....	50
	2. Phoenix Nursery Co., trees.....	50
Oct.	8. Jamison & McKinney, plumbing.....	80
Nov.	30. Ira Grover, labor.....	37 00
	11. G. V. Nash, botanical specimens.....	7 50
Oct.	5. American Dry Plate Co., plates.....	9 78
Nov.	20. Selover & Atwood, plants.....	5 00
	23. Dennison Mfg. Co., glue.....	2 50
1896.		
Feb.	2. Andrus & Church, tags.....	75
1895.		
Dec.	20. F. E. Ellis, hay.....	11 54
Oct.	9. Driscoll Bros., lime.....	23 65
Sept.	28. Slocum & Taber, sundries.....	4 10
Nov.	3. Fall Creek Milling Co., feed.....	48 92
Dec.	14. U. S. Express Co., expressage.....	30
Sept.	29. Hook Bros., baskets and seeds.....	6 80
July	2. Geo. Rankin & Son, glassware.....	5 26
1896.		
Jan.	1. Ira Grover, labor.....	37 00

1896.

Jan.	9.	U. S. Express Co., expressage.....	\$0 60
	14.	Fall Creek Milling Co., sacks.....	96

1895.

Dec.	21.	John Reidy & Co., sundries.....	4 30
	19.	George Small, lumber and labor.....	1 75
	31.	E. & H. T. Anthony, printing frames...	1 40
	20.	C. J. Rumsey & Co., hardware.....	69 11
	21.	Pritchard & Son, wagon repairs.....	27 70

1896.

Feb.	1.	Ira Grover, labor.....	37 00
		A. Laurence, hay.....	15 58
Jan.	27.	U. S. Express Co., expressage.....	25
	18.	E. G. Allen, periodicals.....	9 85
	27.	E. D. Sturdevant, seeds.....	1 15
Feb.	29.	Ira Grover, labor.....	37 00
	28.	U. S. Express Co., expressage.....	30
	26.	Slocum & Taber, sundries.....	5 95
	29.	L. V. R. R. Co., freight and cartage.....	50
March	7.	U. S. Dept. Agr., index cards.....	2 00
Jan.	7.	Reynolds & Lang, steam fitting.....	108 24
July	26.	Rothschild Bros., netting.....	40
Feb.	25.	Burns Bros., horseshoeing.....	30 75
	15.	S. H. Bush, oats.....	42 98
March	25.	F. Ellis, hay.....	15 00
April	14.	Repairs.....	34 33
May	4.	Ira Grover, labor.....	37 00
June	29.	Barr Bros., hardware.....	70
	30.	Seaman, labor and lumber.....	356 37
		Driscoll Bros., lime and stone.....	25 25
		J. B. Lang, labor and fittings.....	98 95

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Total for horticultural division.... \$1,516 05

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*For Chemical Division.*

1895.

July	3.	Eimer & Amend, watch glasses and grinding.....	\$1 58
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1895.

Nov.	4.	J. K. Haywood, labor.....	\$26 10
July	26.	Treman, King & Co., pans.....	2 00
Oct.	11.	Bush & Dean, toweling.....	92
Nov.	30.	J. K. Haywood, labor.....	20 55

1896.

Jan.	3.	J. K. Haywood, labor.....	30 00
Feb.	8.	J. K. Haywood, labor.....	25 80
March	3.	J. K. Haywood, labor.....	13 80
April	1.	J. K. Haywood, labor.....	30 00
	14.	Repairs.....	20 63
May	2.	J. K. Haywood, labor.....	32 55
	5.	Eimer & Amend, retraction cartridges..	1 73
	11.	Rothschild Bros., linen.....	73
June	3.	J. K. Haywood, labor.....	33 10
	22.	Supplies.....	142 15
	23.	Eimer & Amend, chemical supplies.....	96 47

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Total for chemical division..... \$478 11

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*For Botanical Division.*

1895.

July	26.	White & Burdick, chemicals.....	\$3 20
June	7.	Reed & Montgomery, book binding.....	50
Aug.	19.	Bush & Dean, muslin.....	2 35
Sept.	2.	Campbell Bot. Supply Co., books.....	10 00
Nov.	1.	U. S. Express Co., expressage.....	55
Sept.	25.	Reed & Montgomery, book binding.....	80
Aug.	19.	G. E. Stechert, publications.....	1 00
July	17.	G. E. Stechert, publications.....	40
Nov.	8.	B. Stoneman, labor.....	2 00
Aug.	19.	G. E. Stechert, publications.....	14 31
Nov.	8.	M. A. Nichols, labor.....	1 00
		G. R. Chamberlain, drawings.....	1 50
Oct.	31.	Richards & Co., botanical supplies.....	24 50
	29.	Enz & Miller, stationery.....	3 15
	15.	Boal Co., lumber and labor.....	15 75
May	20.	Bausch & Lomb, chemical supplies.....	50 50

1895.

Aug.	21.	E. McGillivray, photo supplies.....	\$14 42
Oct.	5.	Botanical department, repairs.....	34 80
Nov.	16.	Treman, King & Co., hardware.....	8 40
Dec.	10.	Botanical department, repairs.....	23 90
Oct.	5.	Jamieson & McKinney, plumbing.....	41 36
	17.	Eimer & Amend, chemical supplies.....	46 66
Dec.	10.	Reed & Montgomery, book binding.....	1 00
Nov.	29.	G. E. Stechert, publications.....	3 08

1896.

Jan.	18.	E. G. Allen, publications.....	1 48
Feb.	28.	Cambridge Bot. Supply Co., books.....	5 00
June	20.	Bausch & Lomb, botanical supplies....	69 75
	23.	U. S. Express Co., expressage.....	65
	22.	G. E. Stechert, botanical supplies.....	126 72
	27.	Corning & Co., alcohol.....	21 88
		U. S. Post Office, postage.....	12 00
	30.	E. McGillivray, prints and photo sup- plies.....	56 91
		Bausch & Lomb, glass vials.....	4 50
		Rochester Optical Co., photo supplies...	87 60
		Bool Co., cabinet case.....	25 00
		Eimer & Amend, glass tubes and express.	7 15
		Richards & Co., chemical supplies.....	11 40

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Total for botanical division..... \$735 35

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*For Entomological Division.*

1895.

July	13.	U. S. Express Co., expressage.....	\$0 50
	31.	E. E. Lull, labor.....	1 20
	36.	E. McGillivray, photo supplies.....	4 14
	31.	Rural Pub. Co., copy of article.....	1 00
June	7.	C. J. Rumsey & Co., wheelbarrow.....	3 00
Aug.	24.	U. S. Express Co., expressage.....	1 30
	17.	Cramer Dry Plate Co., photo supplies..	4 13
Sept.	6.	E. McGillivray, photo supplies.....	10 15
	4.	M. V. Slingerland, labor.....	1 00

## 1895.

Sept.	21.	G. W. Herrick, labor.....	\$12 80
	30.	Peter Henderson, plants.....	4 36
	18.	Andrus & Church, stationery.....	1 40
Aug.	26.	Treman, King & Co., glass, etc.....	1 68
Oct.	18.	G. W. Herrick, labor.....	3 00
	17.	Treman, King & Co., hardware.....	3 25
	29.	E. McGillivray, photo supplies.....	2 41
Nov.	12.	Andrus & Church, stationery.....	21 05
Oct.	2.	Jamieson & McKinney, plumbing.....	1 96
Dec.	17.	U. S. Express Co., expressage.....	1 10
	2.	Treman, King & Co., hardware.....	1 10
	18.	Lawton & Co., supplies.....	3 77
	14.	G. Cramer, photo plates.....	7 10
	23.	G. W. Herrick, labor.....	6 10
	18.	E. McGillivray, camera and supplies...	65 11
	21.	Blongren Bros., cuts and express.....	2 73
	7.	A. B. Brooks, drugs.....	5 69

## 1896.

Jan.	27.	G. W. Herrick, labor.....	10 35
April	13.	C. J. Rumsey & Co., hardware.....	30
Jan.	29.	D. B. Stewart & Co., oil.....	5 13
Feb.	22.	G. W. Herrick, labor.....	11 40
March	6.	M. V. Slingerland, labor.....	1 00
	17.	G. W. Herrick, labor.....	12 00
	16.	M. V. Slingerland, labor.....	1 00
April	7.	G. W. Herrick, labor.....	8 15
	14.	Andrus & Church, stationery.....	80
		Platt Drug Co., drugs.....	35
	27.	Bausch & Lomb, supplies.....	4 50
May	4.	G. W. Herrick, labor.....	7 40
	5.	Treman, King & Co., hardware.....	3 10
		Bowker Fertilizer Co., fertilizers.....	2 88
	11.	Cramer & Co., photo supplies.....	6 62
	19.	G. W. Herrick, labor.....	7 90
June	9.	G. Cramer & Co., photo supplies.....	4 55
		W. Tetum & Co., aquariums.....	23 62
		Taylor & Preswick, book.....	1 44



1896.

June	9. Treman, King & Co., hardware.....	\$0 80
	Boal Co., furniture.....	23 05
	15. Eimer & Amend, camera and fixtures...	26 50
	16. G. Rankin & Son, glass jars.....	14 25
	19. G. W. Herrick, labor.....	10 10
	19. Library Bureau, furniture.....	15 00
	27. James Seaman, lumber and labor.....	92 05
	29. G. W. Herrick, labor.....	5 40
	30. E. Curtis, chemicals.....	12 45
		<hr/>
	Total for entomological division....	\$489 09
		<hr/> <hr/>

## SUMMARY.

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### The Agricultural Experiment Station of Cornell University in account with the United States Appropriation.

1896.

To receipts from treasurer of the United States as per appropriation for the year ending June 30, 1896, under act of Congress approved March 2, 1887. . . . .	\$13,500 00
<hr style="border-top: 3px double #000;"/>	
June 30. By salaries . . . . .	\$7,934 98
By buildings . . . . .	40 25
By printing . . . . .	719 20
By office expenses. . . . .	1,059 51
Equipment, labor and current ex- penses:	
Agriculture. . . . .	527 46
Horticulture. . . . .	1,516 05
Chemistry. . . . .	478 11
Botany. . . . .	735 35
Entomology. . . . .	489 09
	<hr style="border-top: 3px double #000;"/>
	\$13,500 00
<hr style="border-top: 3px double #000;"/>	
Receipts for produce sold:	
Balance from 1895-96. . . . .	\$593 78
Horticultural division . . . . .	250 51
Office. . . . .	6 00
	<hr style="border-top: 3px double #000;"/>
	\$850 29
<hr style="border-top: 3px double #000;"/>	
By balance to 1896-97. . . . .	\$850 29
	<hr style="border-top: 3px double #000;"/>

# GENERAL INDEX.

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	Page.
Act, making an appropriation to Cornell University Experiment Station, of 1887, establishing agricultural experiment stations.....	18 13
Adalia bifunctata, an enemy to the pear psylla.....	113
Allen, C. L., quoted.....	215
Agriculturist, report of, L. A. Clinton.....	29
Agriotes maneus Say, the wheat wire-worm.....	86
Apples, dwarf, bulletin 116.....	373
Appendix II, financial statement.....	585
Appropriations, objects of.....	7
federal and state.....	5
Asaphes decoratus Say.....	87
Atkinson, George F., report of botanist.....	23
Auditors certificate of, to treasurer's report.....	21
Austin, James, packing shed described.....	416
Babcock, E. F., mentioned.....	43
Bailey, L. H., work mentioned.....	310
bulletin, revised opinions of the Japanese plums.....	35
bulletin on chrysanthemums.....	255
bulletin 117, fruit brevities.....	405
bulletin on pole Lima beans.....	345
bulletin 110, extension work in horticulture.....	159
bulletin on the texture of the soil.....	465
bulletin 121, suggestions for the planting of shrubbery.....	503
bulletin 122, second report upon extension work in horticulture....	531
a brief of the evolution of plants.....	195
the philosophy and practice of pruning.....	196
the management of orchard lands.....	197
and A. P. Wyman, bulletin on sweet peas.....	207
Barry, Patrick, opinion on dwarf apples.....	376
Bartholomew, E. S., grape growing in Northern Chautauqua.....	200

	Page.
Barker, Michael, mentioned.....	163
Beans, pole Lima .....	115
Berchmans, P. J., mentioned.....	43, 44, 53
Berger, H. H., & Co., mentioned.....	45, 59, 61
Black, Gov. Frank S., letter of transmittal.....	2
Botanist, report of, George F. Atkinson.....	23
Bridgeman, Thomas, quoted.....	215
Bulletins, list of, issued 1888 to 1897.....	10
Burbank, Luther, mentioned.....	43, 45, 46, 47, 54, 56, 57, 62
Butter increasers, Bulletin 118, by Geo. W. Cavanaugh.....	457
Butter increaser, Chase's.....	463
Caldwell, G. C., chemistry of the soil and the grape.....	185
how can the farmer tell what fertilizer his soil needs.....	186
report of chemist.....	22
Canavalia ensiformis .....	362
Card, F. W., acknowledgment.....	425
Chase's butter increaser.....	463
Chautauqua grape belt, geological history of, bulletin 109, by R. S. Tarr, 123	
ancient beaches .....	144
bed rock .....	129
climatic conditions .....	155
contents of bulletin.....	125
gravel ridges.....	134
gravel ridges .....	145
hillside soils .....	132
influence of the gravel ridges.....	157
interpretation .....	149
introduction .....	127
irregularities of, level of, gravel ridges.....	148
lake clay soils.....	136
letter of transmittal, by L. H. Bailey.....	125
modern beaches .....	139
most favorable places for the location of vineyards.....	156
résumé of the geological history.....	150
shale gravel .....	138

	Page.
Chautauqua grape belt — ( <i>Continued</i> ).	
soils . . . . .	129
soils, relative value of. . . . .	138
topography . . . . .	128
variations in the gravel ridges. . . . .	147
Callerine, the ideal food preservative. . . . .	461
Cavanaugh, Geo. W., bulletin of food preservatives and butter increasers . . . . .	457
Chemist, report of, Prof. G. C. Caldwell. . . . .	22
Chrysanthemums, the 1895 bulletin 112, by L. H. Bailey, Wilhelm Miller and C. E. Hunn. . . . .	255
classification, reflections upon, by Mr. Miller. . . . .	261
color problems, Mr. Miller. . . . .	267
florets, description of, Mr. Miller. . . . .	265
fragrance, Mr. Miller. . . . .	272
letters of transmittal, by L. H. Bailey. . . . .	257
nomenclature, reflections upon, by Mr. Miller. . . . .	261
novelties, test of. . . . .	273
sundry remarks upon the subject. . . . .	259
varieties grown, named in alphabetical order. . . . .	275
varieties, Mr. Hunn's choice. . . . .	291
Bailey's choice of six. . . . .	292
variation, reflections upon, by Mr. Miller. . . . .	261
Clinton, L. A., bulletin on the moisture of the soil. . . . .	475
report of agriculturist. . . . .	29
Coates, Leonard, in California Fruit Grower, quoted. . . . .	54
Comstock, J. H., entomologist, report of. . . . .	26
Conditions of climate favoring the grape, from transactions of the Chautauqua horticultural society. . . . .	201
Conservation of moisture. . . . .	483
Craig, W. N., quoted. . . . .	221
Crimson clover in orchards. . . . .	451
Crissey, S. S., commercial grape culture Chautauqua county. . . . .	194
Cryptohypnus abbreviatus, Say. . . . .	90
Curtis, William (1788), quoted. . . . .	214
Dairy husbandry and animal industry, report of assistant professor of, H. H. Wing. . . . .	34
Daisies, the lesson of the. . . . .	477

	Page.
Dewberries, are they worth growing.....	435
summary of evidence.....	439
<i>Doryphora decemlineata</i> , Say .....	322
<i>Drasterias elegans</i> , Tabr .....	89
Duggar, B. M., appointed assistant cryptogamic botanist.....	23
Duhamel, quoted on Rennette apple.....	388
Durand, E. J., transferred to university.....	23
the nutrition of plants.....	188
Pollen: What it is and what it does.....	188
Dwarf apples, bulletin 116, by E. G. Lodeman.....	373
commercial value of dwarf apples.....	396
Daucin apple .....	387
dwarfing in general.....	377
dwarfing the apple.....	382
effect of checking the movement of sap.....	377
fruits grown as dwarfs.....	381
letter of transmittal, by L. H. Bailey.....	375
opinions of dwarf apples.....	376
paradise apple, the.....	383
propagation of dwarf apple stocks.....	389
pruning . . . . .	389
Rennette apple .....	388
summary of the evidence.....	404
varieties suitable for dwarfing.....	403
yield of standard orchards.....	399
<i>Eleganus longipes</i> .....	442
Entomologist, report of J. H. Comstock.....	26
Everbearing raspberry .....	421
<i>Epidapus scabies</i> , Hopkins.....	311
Extension work in horticulture, bulletin 110, by L. H. Bailey.....	159
brief of the evolution of plants, by L. H. Bailey.....	195
chemistry of the soil and the grape, by Prof. Caldwell.....	183
commercial grape culture in Chautauqua county, by S. S. Crissey and G. Schoenfeld.....	194
Conspectus of horticulture school held at Fredonia, N. Y., Decem- ber 26-29, 1894.....	170

Extension work in horticulture — ( <i>Continued</i> ).	Page.
Conspectus of horticultural school held at Youngstown, August 16 and 17, 1895.	173
at Jamestown, October 31, November 2, 1895.....	175
at Lockport, November 29-30, 1895.....	178
at Fredonia, December 30 and 31, 1895.....	180
flower growing for amateurs, by Ernest Walker.....	193
fungi and fungous diseases, by E. G. Lodeman.....	189
insects and insect enemies, by M. V. Slingerland.....	191
list of publications.....	204
management of orchard lands, by L. H. Bailey.....	197
nutrition of plants, by E. J. Durand.....	188
nutrition of plants, the, by Prof. Rowley.....	187
nursery, from the seed to the setting of the plantation, by N. C. Smith . . . . .	191
philosophy and practice of pruning, by L. H. Bailey.....	196
picking and packing grapes, by J. A. Tennant.....	194
Pollen: what it is and what it does.....	188
potato diseases, by E. G. Lodeman.....	190
publication . . . . .	203
plows and plowing, by Prof. Roberts.....	184
research or experiment.....	164
stock, silos and soiling for fruit-growers, by Prof. Roberts.....	184
synopses of subjects used in the horticultural schools.....	183
theory of tillage and productivity of land, by Prof. Roberts.....	183
teaching . . . . .	167
vegetable gardens under grass, by W. M. Munson.....	192
Extension work in horticulture, second report upon, bulletin 122, by L. H. Bailey . . . . .	531
announcement of school at Jamestown.....	538
bulletins recommended for study in horticultural schools.....	554
correspondence instruction . . . . .	562
extension teaching, experiments in.....	536
general scope of the work.....	533
horticultural schools, list of, held in September, 1896.....	537
How a squash plant gets out of the seed (a teacher's leaflet).....	556
programme of school at Clinton.....	540

Extension work in horticulture — ( <i>Continued</i> ).	Page.
report, by Mr. Powell.....	549
reading courses .....	552
suggestions for .....	553
school-house meetings, list of, held in October, 1896.....	543
teacher's leaflets, sample copy of.....	556
testimonials of teachers in regard to the work.....	551
the work classified.....	535
Food preservatives and butter increasers, bulletin 118, by Geo. W. Cavanaugh . . . . .	457
Callerine, the ideal food preservative.....	461
formalin or formic aldehyde.....	461
preservitas, a special cream preservative.....	460
Financial statement, appendix II.....	585
summary of .....	602
Formalin or formic aldehyde.....	461
its effects upon digestion.....	462
Fruit brevities, bulletin 117, by L. H. Bailey.....	405
apricots, winter killing of.....	450
dewberries, botanical types of.....	440
are they worth growing.....	435
crimson clover in orchards.....	451
dwarf cherries, effect of winter upon.....	451
everbearing raspberry .....	421
history of the Ohio raspberry.....	420
letter of transmittal.....	407
mistletoe disease of the blackberry.....	424
packing houses for fruit.....	409
peaches, and the treatment of injured fruit trees.....	448
plums, winter killing of.....	449
rainfall at Cornell.....	445
root-galls . . . . .	425
summary of evidence on dewberries.....	439
the winter injuries.....	444
Goumi, the .....	442
Grape belt, Chautauqua.....	123



	Page•
Grapes; developement of methods on large areas.....	198
Grape growing in Northern Chautauqua, by E. S. Bartholomew.....	200
Green fruit worms, bulletin 123, by M. V. Slingerland.....	565
contents of bulletin.....	568
habits and food of the caterpillars and moths.....	570
history and distribution.....	571
how to combat these fruit-eating caterpillars.....	581
introduction . . . . .	569
life history . . . . .	572
natural enemies . . . . .	580
species discussed . . . . .	573
1 <i>Xylina antennata</i> , Walk.....	574
2 <i>Xylina laticinerea</i> , Grit.....	577
3 <i>Xylina grotei</i> , Riley.....	577
what green fruit worms are.....	570
Heikes, W. F., mentioned.....	64
Higby, Geo. S., quoted.....	55
Help demanded by agriculturists.....	8
History of the Ohio raspberry.....	420
Horticultural extension work, bulletin 110.....	161
Horticulturist, report of, L. H. Bailey.....	31
Horticulture, extension work in a second report, by L. H. Bailey.....	531
Hopkins, A. D., paper referred to.....	331
Howard, L. O., quoted.....	120
Humus, a storehouse of nitrogen and moisture.....	491
Hunn, C. E., bulletin on chrysanthemums.....	255
choice varieties of chrysanthemums.....	291
Hutchens, W. T., mentioned.....	214
Japanese plums, bulletin 106, by L. H. Bailey.....	35
adapted to wide range.....	40
prefatory remarks, by L. H. Bailey.....	37
varieties, named in alphabetical order, described.....	41. 65
Jaques, George, opinion on dwarf apples.....	376
Kerr, J. W., mentioned.....	56

	Page.
Koch, quoted on Daucin apple.....	387
Lathyrus latifolius .....	217
tingilanus . .....	216
Lecanium juglandis? Bouche.....	118
Letter of transmittal, Gov. Frank S. Black.....	2
Pres. J. G. Schurman.....	5
Lodeman, E. G.....	163
fungi and fungous diseases.....	189
potato diseases .....	190
bulletin on diseases of the potato.....	293
Lord, H. B., auditors report.....	21
Lovett, Mr., mentioned.....	42, 43
Macrosporium solani, E and M.....	302
Magazine of horticulture quoted.....	422
Marvin, Hon. R. P., extract from, address by.....	202
Maskell, Mr., quoted in note.....	120
Matthews, T. Schuyler, quoted.....	220
McMahon (1806), quoted.....	214
McNair, Mr., experiments with potatoes.....	316
Melanotus communis, Gull.....	88
Miller, Philip (1754), quoted.....	214
quoted on Paradise apple.....	385
Wilhelm, bulletin on chrysanthemums.....	255
Mistletoe disease of the blackberry.....	424
Moisture, loss of, by trees.....	447
Moisture of the soil and its conservation, bulletin 120, by L. A. Clinton,	475
conservation or saving of moisture.....	483
cultivation and conservation of moisture.....	488
harrowing to save moisture.....	487
herbage mulches .....	400
how the soil holds its water.....	480
humus, a storehouse of nitrogen and moisture.....	491
lesson of the daisies.....	477
mineral substances as conservers of moisture.....	492
necessity of water for growing plants.....	481

Moisture of the soil and its conservation — ( <i>Continued</i> ).	Page.
plowing to save moisture.....	484
percolation, time of.....	485
roller, the, in its relation to soil moisture.....	489
selection and management of crops in relation to soil moisture....	493
soil moisture .....	479
suggestions for determining the amount of moisture in the soil....	494
summary of bulletin.....	496
under drainage as a conserver of moisture.....	491
wind breaks to save moisture.....	493
mulches, herbage .....	490
Munson, T. V., mentioned.....	45
W. M., vegetable gardens under glass.....	192
Nixon, S. F.....	161, 162
Normand, J. L., mentioned.....	44
Ospora scabies, Thax.....	310
Packing houses for fruit.....	409
Peaches, and the treatment of injured fruit trees.....	448
Pear psylla, the, and the New York plum scale, bulletin 108.....	103
appearance of .....	108
classification and name of.....	107
egg laying of the winter brood.....	109
egg laying and summer habits.....	110
habits of the adult.....	109
habits of the nymph.....	109
history and destructiveness of.....	105
honey-dew and excrement of.....	111
how it spreads.....	106
how it passes the winter.....	108
how to combat.....	114
indications of its presence.....	107
life history of.....	108
natural enemies of.....	111
number of broods of.....	110
success in destroying, Mr. Powell's.....	116

	Page
Plum scale, the New York.....	118
damage in 1894, extent of.....	118
damage in 1895, extent of.....	119
effect of the winter of 1894 on the scales.....	119
food plants of.....	121
history and distribution of.....	120
name of .....	120
natural enemies of.....	121
outlook of the future.....	120
results of spraying.....	122
Pettit, W. W., his packing house described.....	412
Phytophthora infestans, De Bary.....	297
Platt, N. S. mentioned.....	45
Planting of shrubbery, suggestions for the, bulletin 121, by L. H. Bailey, 499	
general suggestions .....	503
some specific examples.....	519
Plums, see Japanese plums.....	35
Pole Lima beans, bulletin 115, by L. H. Bailey .....	345
black or early black Limas.....	351
Chickasaw lima .....	362
growing Lima beans in New York.....	365
in California .....	368
Horticultural Lima.....	361
index of, bulletin 115.....	372
Sevas, the.....	350
synopsis of bulletin.....	347
types and varieties.....	349
varieties not tested.....	361
Willow-leaf Limas.....	351
Potato, disease of the, bulletin 113, by E. G. Lodeman.....	293
early blight, treatment of.....	312
early blight, leaf blight.....	302
flea-beetles .....	323
fungi, part I.....	297
insect diseases of the potato.....	322

Potato — ( <i>Continued</i> )	Page.
late blight or potato rot, treatment of.....	312
letter of transmittal, by L. H. Bailey.....	295
disease, historical notes on.....	296
rot, late blight, downy mildew.....	297
scab of potato.....	309, 318
spraying machinery .....	325
summary . . . . .	329
synopsis of bulletin.....	295
treatment of fungous diseases.....	312
Powell, G. T., report of experience destroying pear psylla.....	116
mentioned . . . . .	542
report by .....	549
Powell, Harold G.....	163
Preservitas, a special cream preservative.....	460
Prentiss, Prof. Albert N., illness and death of.....	23
Psylla pyricola .....	105
Psylla rubi and psylla tripunctata .....	425
Purdy, A. M., quoted on raspberry.....	421
Publications, extent of.....	9
Rainfall at Cornell, 1887-1895.....	445
Ramsay, F. M., quoted.....	53
Report of director, I. P. Roberts.....	7
Roberts, Daniel, mentioned.....	42
I. P., director, report of.....	7
I. P., theory of tillage.....	183
plows and plowing.....	184
stock, silos and soiling for fruit-growers.....	184
Rowlee, Professor, aid acknowledged.....	25
the nutrition of plants.....	187
Rohnert, Waldo, a seedsman's account of the varieties of the sweet pea .....	225
Root-galls .....	425
Rye in the vineyard, by G. Schoenfeld.....	203
Schoenfeld, G., commercial grape culture in Chautauqua county.....	194
why I sow rye in the vineyard.....	203
Schurman, Pres. J. G., letter of transmittal.....	5
Sciara, sp .....	311

	Page.
Shrubbery, see planting of.....	499
suggestions for the planting of, bulletin 121, by L. H. Bailey.....	503
Slingerland, M. V., report by.....	26
explanatory note by, in bulletin 107.....	71
bulletin by, on wire worms and bud moth (No. 107).....	69
bulletin by, on the pear psylla and New York plum scale (No. 108) .....	103
bulletin 123, on green fruit worms.....	565
quoted .....	425
insects and insect enemies.....	191
mentioned .....	163
Smith, N. C., the nursery.....	191
W. E., paper on root-galls, in California fruit-grower, reprinted...	430
Snow, Geo. C., his packing-house described.....	410
Soil, moisture of.....	475
texture of .....	465
Sorauer, "Handbuch der Pflanzenkrankheiten," quoted.....	427
Spencer, J. W., mentioned.....	542
report by .....	560
acknowledgment .....	127
Spray calendar (bulletin 114), by E. G. Lodeman.....	333
apple scab .....	335
bean, anthracnose of.....	336
beet, leaf spot.....	336
aphis of cabbage and cauliflower.....	336
carnation, anthracnose of.....	336
celery leaf blight and rust.....	337
cherry, black knot.....	337
chrysanthemum, leaf spot of.....	337
cranberry, fire worm, fruit worm of.....	337
currant, leaf blights of.....	337
egg plant, leaf spot of.....	337
gooseberry, mildew of.....	337
grape, anthracnose, black rot, downy mildew, powdery mildew, ripe rot, steely-bug .....	338
hollyhock rust .....	338

Spray calendar— (*Continued*).

Page.

leaf blight .....	340
nursery stock, fungous diseases.....	338
peach nectarine; apricot, brown rot of.....	338
pear, leaf blight or fruit spot, leaf blister, psylla, slug.....	339
plum, brown rot, leaf blight, black knot, curculio, plum scale, San Jose scale .....	339
potato, early blight, rot, scab, potato beetle.....	339
quince, leaf blight or fruit spot.....	340
raspberry, blackberry, dewberry, anthracnose, orange rust, saw-fly..	340
rose, black spot, mildew, aphid, leaf-hopper, red spider.....	340
tomato, leaf blight, rot.....	341
violet, blight, spot.....	341

## FORMULAS.

amoniacal copper carbonate.....	343
bordeaux mixture.....	341
copper sulphate solution.....	343
hellebore .....	343
iron sulphate and sulphuric solution.....	342
kerosene emulsion .....	343
london purple.....	341
paris green.....	341
potassium sulphate solution.....	342
tobacco water .....	343
Stark Bros., quoted.....	57, 62, 63, 64
Strong, W. C., opinion on dwarf apples.....	376
Sweet peas (bulletin 111), by L. H. Bailey and A. P. Wyman.....	207
Eckford, Henry, quoted.....	213
general sketch of.....	211
introduction, by L. H. Bailey.....	209
varieties .....	220
a seedsman's account, by Waldo Rohnert.....	225
grown at Cornell in 1895.....	231
list of, alphabetically arranged, with notes.....	233
where and how to grow sweet peas.....	218
Tarr, R. S., bulletin on geological history of the Chautauqua grape belt, No. 109.....	123

	Page.
Tennant, J. A., picking and packing grapes.....	194
M. D., acknowledgment.....	127
Texture of the soil (bulletin 119), by L. H. Bailey.....	465
Thaxter, Dr. R., paper referred to.....	310
Thomas, John J., opinion on dwarf apples.....	376
<i>Tmelocera ocellana</i> .....	92
Treman, R. H., auditor's report.....	21
Tracy, S. M., quoted on Chickasaw Lima beans.....	364
Tracy, W. W., mentioned.....	215
Treasurer, report of.....	20
<i>Trioza tripunctata</i> .....	425
Van Deman, H. E., quoted.....	54
Van Dusen, H. P., quotation on history of the Ohio raspberry.....	420
Van Lindley, J., quoted.....	54
Walker, Ernest, flower growing for amateurs.....	193
Warder, John A., opinion of dwarf apples.....	376
Watson, T. L., acknowledgment.....	127
Willard, S. D., mentioned.....	64
Williams, E. L., report of treasurer.....	20
Wing, H. H., report of, assistant professor of dairy husbandry and animal industry .....	34
Winter injuries to fruit trees.....	444
Wire worms and the bud moth (bulletin 107), by M. V. Slingerland....	69
bud moth, the, see table of contents.....	72
explanatory note .....	71
wire worms, see table of contents.....	72
Worms, green fruit.....	565
Wyman, A. P., and L. H. Bailey, bulletin on sweet peas.....	207
Wyman, Mr., a student's opinion of the sweet peas.....	228
<i>Xylinia antenata</i> , Walk.....	574
<i>laticinerea</i> , Grit.....	577
<i>grotei</i> , Riley.....	578
Yeomans, L. T., quoted on raspberry.....	421
Yeomans, T. G., & Sons, packing-house described.....	418



# INDEX OF CUTS.

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	Page.
Abundance plums .....	38
Abundance plum tree.....	42
A corner draped with honey suckle.....	529
A careless corner.....	528
<i>Adalia bipunctata</i> .....	113
A "fill" in a back yard.....	514
A front yard before planting.....	511
A good combination.....	513
<i>Agriotes mancus</i> , adult, enlarged.....	87
A little weedland alongside a rear walk.....	510
"Apple-blossom," a sweet pea.....	231
A native mass of shrubbery.....	505
An effective piece of planting.....	502
A newly-made landscape garden ready for the border planting.,.....	523
five years' growth upon the area shown above.....	524
A rustic corner.....	521
<i>Asaphes decoloratus</i> , larva of, enlarged.....	88
caudal segment of larva.....	88
adult, enlarged .....	88
A typical city lot.....	507
A water piece well planted.....	526
A water piece devoid of effective planting.....	526
Black Lima .....	351
"Blanche Ferry," a sweet pea.....	234
Bliss Lima bean.....	353
Bud moth, work of, in opening leaf buds.....	92
caterpillar of .....	94
pupa of .....	95
adult .....	95
nest and eggs of.....	96
egg of, showing developing caterpillar.....	98

	Page.
Bud moth — ( <i>Continued</i> ).	
leaf showing the work of the young caterpillar.....	98
twig showing position of the winter homes of the caterpillar.....	99
work of (frontispiece).....	69
Burbank plums (frontispiece to bulletin 106) .....	35
Burbank plum .....	46
Burbank tree .....	47
“Butterfly,” a sweet pea.....	236
Chabot plum .....	48
Chase plums .....	38
Challenger Lima bean.....	358
Chautauqua grape belt (frontispiece).....	123
Chickasaw Lima or Jack bean.....	362, 363
Chrysanthemums grown for special blooms.....	258
Chrysona oculata .....	112
Clay soil, showing its impermeable character.....	486
Click-beetle .....	74
Coarse, gravelly soil.....	489
Conserving moisture (frontispiece).....	475
Corn plant growing in cage infested by wire worms and click-beetles...	74
Corn plant showing contact with soil.....	482
Countess of Randor, a popular sweet pea.....	210
Crest of modern beach at Barcelona.....	140
Crimsonia, chrysanthemum.....	274
Cross sections of beach and bar.....	142
Cryptohypanus abbreviatus, details of the mouth parts of the larva.....	91
Development of the squash plant.....	557, 558
Double pea, the Splendor.....	222
Diagram of Figure 164.....	519
Diagram showing elevation of terraces.....	145
Drasterius, elegans, adult, larva and caudal segment of larva (Figs. 28, 29, 30)..	90
Dreer improved Lima bean.....	357
Dewberries on a wire screen.....	437
Dwarf Ben Davis apple tree.....	390
after pruning .....	392
Eckford, Henry, portrait of.....	213

	Page.
Forms of chrysanthemum florets.....	264
Front face of lower beach terrace, just west of Portland.....	147
Frontispiece (bulletin 117), strawberries.....	405
Frontispiece to bulletin 122.....	531
Georgeson plum .....	51
Georgeson tree .....	52
Good bean soil.....	468
Horticultural Lima bean.....	360
"Imperial Blue," a sweet pea.....	241
Iora (chrysanthemum).....	277
J. E. Lager, (chrysanthemum frontispiece).....	255
Kerria, canna and wind sunflower.....	527
Lady-bug beetles, spina larva skins of.....	121
Leaf of Mammoth kidney-shaped Lima bean.....	355
Leaf of New Extra Early Lima bean.....	354
Leaf of Willow-leaf Lima bean.....	352, 353
Lima beans, New Extra Early.....	348
Lucretia dewberry .....	438
Lucretia dewberries trained to stakes.....	435
"Madam Carnot".....	270
Mammoth Kidney-shaped Lima bean.....	357
Map of the region in the vicinity of the grape belt.....	130
Maps showing the average temperature and rainfall of the grape belt...	154
Maru plum .....	57
Melanotus cribulosus (Figs. 25, 26 and 27), wire worm of, caudal segment of larva and adult insect.....	89
"M. Georges Biron".....	268
Millipede .....	73
"Mistletoe" of blackberry.....	424
Modern beach at Barcelona, showing the crest in the background.....	138
Mrs. Henry Robinson, chrysanthemum.....	287
"Mrs. Gladstone," a sweet pea.....	246
Mr. Snow's packing table.....	413
Mrs. W. H. Rand, chrysanthemum.....	284
'Mum cutting, half size.....	260

	Page.
Neglected dwarf apple tree.....	394
Niagara escarpment, profile of.....	128
Niagara grape belt, location of.....	128
Northern Lights, chrysanthemum.....	280
Packing-houses of George C. Snow.....	410
Packing-house of W. W. Pettitt.....	412
Packing-room in Mr. Pettitt's house.....	414
James Austin .....	416
T. G. Yeomans & Son.....	418
Pear psylla (frontispiece).....	103
full-grown nymph of.....	108
adult insect .....	108
egg of .....	109
newly-hatched nymph of.....	109
Pebbles of the modern beach, at Barcelona.....	143
Perennial pea .....	217
Photograph showing the pebbly nature of old beach terrace, 'near Sheridan .....	144
Plum scale, infested branches.....	118
Potato sprayer, home-made.....	126
Potato tuber affected with dry rot.....	301
Power churn (frontispiece to bulletin 118).....	457
Red June plum.....	59
Red June plum tree.....	60
Root-galls upon apple trees.....	426
Root growth of the squash plant.....	559
Round the crest of a gravel ridge, just east of Fredonia.....	135
Samples of soil.....	471
Scab on potatoes.....	310
Section in the boulder clay on Mayville and Westfield road.....	132
Section of the grape belt.....	129
Section through a bar between Sheridan and Fredonia.....	143
Section through the upper beach at Westfield, showing stratification of pebbles and sand.....	137

	Page.
Section to show the relative position of the gravel ridges and the other classes of soils.....	134
Shavings, chrysanthemum .....	290
Showing the action of lime on clay and sandy soils.....	492
Soil, compacted by roller, tilled forest mulched.....	491
Spraying machine (Ward's rig).....	336
(rig for spraying bushes).....	338
(Yeoman's rig) .....	340
Spurs of Ben Davis dwarf apple.....	396
Squash plant a week old.....	556
Tangler Scarlet pea.....	216
The beginning of a back yard.....	516
The same back yard, four years later.....	518
The central open space and the moss flanked sides.....	522
The common or nursery type of planting.....	503
The same as 514, four years later.....	515
The same as 511, after planting.....	512
The pictorial type of planting.....	504
The soil sampler.....	494, 495
The soil mulch.....	480
The Goumi ( <i>Eleagnus longipes</i> ).....	443
Three typical sizes of sweet pea flowers.....	223
The sweet pea flower.....	221
The vine-covered cabin in which drawings for Cornell bulletins are made .....	520
The three guardsmen.....	509
Two types of sweet pea flower.....	224
Types of Lima beans.....	350
Union of Fallwater apple upon Paradise stock.....	380
Unproductive clay soil.....	468
Upper terrace southeast of Sheridan.....	136
"Venus," a sweet pea.....	252
Wave-cut cliff and beach of Lake Erie, north of Ripley.....	126
Well conceived but badly treated.....	508





3 5185 00258 5386

